SANDIA REPORT
SAND2019-12793
Printed October 2019

Sandia National Laboratories

Energy Storage Financing:
Advancing Contracting in Energy Storage

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ABSTRACT

The lack of standard financing contracts and supporting documents is inhibiting the growth of the energy storage industry. A number of firms are actively developing proprietary contract structures, resulting in a variety of unique attributes. This leaves the market disjointed for 3rd party financing groups looking to scale their lending. Lack of commonality and harmonization between developer and lenders raises project execution costs and causes delays in financing. Of special concern, projects based on emerging technologies are finding an increasing uphill climb for equal consideration by developers and lenders, leaving their potential commercialization in peril. This study will evaluate the development of standardized contracts to reduce the cost and contract approval time, learning from success in renewable energy project development. The goal of this study is to determine the key requirements for standard contracts in the emerging energy storage market, and suggest avenues for possible industry led development.

ACKNOWLEDGEMENTS

The author would like to acknowledge the support and guidance of Dr. Imre Gyuk, Director of the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability's Energy Storage Program, and Dr. Babu Chalamala and Dr. Ray Byrne of the Energy Storage Systems Program of Sandia National Laboratories.

The author would also like to thank all those who made these Advisory Committee Meetings possible:

January 18th, 2018

- Location New York, NY
- DOE Speaker Imre Gyuk, U.S. DOE Energy Storage Program
- Keynote Alicia Barton, President & CEO of the New York Energy Research & Development Authority (NYSERDA)
- Host Morrison & Foerster, LLP and Mustang Prairie Energy

April 20th, 2018

- Location Boston, MA
- Co-located: 2018 Energy Storage Association Conference & Expo
- Host Energy Storage Association

October 4th, 2018

- Location San Francisco, CA
- DOE Speaker Babu Chalamala, Sandia National Laboratories
- Keynote David Hochschild, Commissioner, California Energy Commission
- Keynote Scott Murtishaw, California Solar & Storage Association
- SNL Ray Byrne, Distinguished Member of the Technical Staff
- PNNL Patrick Balducci, Chief Economist
- Host Morrison & Foerster, LLP and Mustang Prairie Energy

January 23rd, 2019

- Location New York, NY
- DOE Speaker Ray Byrne, Sandia National Laboratories
- Keynote Alfred Griffin, New York Green Bank
- Host Kirkland & Ellis LLP and Mustang Prairie Energy

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Project finance works best when using a mature technology to sell products or services through long-term off-take agreements with credit-worthy counterparties. However, project financing in emerging commercial energy markets like energy storage combines the capital intensity of a relatively new technology while the governing market roles, codes, and regulations are still being developed. This situation leaves project developers facing skeptical lenders and customers wanting deeper clarity and better assurances for operating risk and liability management in the project development proposal in order to obtain better revenue certainty, and limited liability in the event of losses.

To overcome these challenges, the energy storage market needs better contracts and supporting documents for the project development effort. This will include off-take agreements to provide better revenue certainty, and more details supporting documents that cover the legal, engineering, and regulatory issues in order to reduce as much outstanding project risk for all involved. As it is, transaction costs remain high, slowing both stand alone and portfolio funded projects.

Into this emerging situation, energy storage project developers are faced with a dilemma: self-fund the project, which is faster, but the capital is more expensive and hard to come by, or find 3rd party, non-recourse debt which can be slower, but less expensive—but with only a few truly educated and experienced lending firms available. Since most developers do not have internal sources of revenue, the vast majority of developers must rely on this outside financing. Lacking a generally accepted set of off-take contracts and supporting documents, lenders are forced to work with a number of different project developers all with home-grown project development packages, which add complexity to the deal. This complexity slows the entire industry, and adds unnecessary risk to the process and reduces clarity for all.

Formalized contracts allow for a degree of revenue certainty and means of risk reduction to limit liability exposure. Depending on how the off-take contract is structured, it could rule out new and innovative operational strategies that would generate greater margins as new value streams arise. A more streamlined and lower risk process would save time and effort for developers to apply qualified new projects into a previously vetted performance guarantee framework, rather than drafting a new guarantee framework for every new project. Financing portfolios of storage projects gets easier as well if the systems fits a template for customer qualification, project structure and pricing.

Project financing is based on ensuring that the project in question will be able to generate sufficient revenues to cover the debt service, operating costs, and earn an acceptable return for the equity providers. The financing contact structure used will be the most financeable for a particular market; straightforward generation can operate with a simple offtake structure, while a complex operational profile will require a structure that can manage a more complex risk exposure for the facility. Since potential revenue from energy storage can both have location specificity, and temporal variability, the performance capability of the unit is critically important to ensure that the

project can obtain the needed contracted revenue, or the developer can provide sufficient insights to warrant banking on merchant revenue.

In support of the off-take agreement, a number of engineering, legal, and regulatory documents exist as part of an energy storage project development package. These contracts and regulatory/code requirements support the financeability of the project through limiting liability for the different parties involved through assigning responsibilities and obligations for the different aspects of the project to the party most able to manage the risk. Some of these risks are internal to the facility, including design, construction, and operations. Other project risks are external to the project, including market rules, regulatory, codes & standards, etc. The challenge for energy storage projects to date has been that many deployment opportunities have been, and are expected to remain unique, hindering the learning curve to make future projects easier to replicate. A more flexible and accountable project financing structure is needed to account for the safety and performance concerns in order to make the facility's financing cost effective.

The creation of standardized project development contracts is also critical to emerging energy storage technologies. Most lenders simply want to fund projects utilizing the technology with the lowest current operating risk profile. If one technology dominates deployment, many of the critical deciding metrics will use the leading technology's value as default as it makes developing contracts easier. Emerging energy storage technologies—many of which are being supported by U.S. Department of Energy funded research —are thus at a distinct disadvantage to more established storage technologies like lithium-ion in this regard due to their smaller commercialization experience. By providing a means to lower the risk profile of projects based on these emerging technologies, contractual language can be developed to account for these differences and ensure that there are well established and acceptable methods to incorporate any energy storage technology into a project at no greater cost or risk exposure.

Non-Lithium Technologies

Non-lithium technologies face a number of current challenges for wider commercialization. Even if the projected systems cost reductions and performance expectations are borne out, systems built around these other energy storage technologies still face a significant hurdle. Project developers are basing virtually all of their development planning around using lithium ion systems, and therefore, all of the default assumptions for their contracts are based on lithium ion specifications.

Lithium ion enjoys a number of advantages currently; it is commercially successful, and widely accepted by developers and system integrators. Leveraging the technological and cost improvements from the far larger vehicle market, lithium ion systems in the power grid market continue to gain a competitive advantage. As this technology has grown to represent the vast majority of stationary energy storage deployments, the capabilities of lithium ion technology are many times being used to define the applications for energy storage technologies.

Non-lithium ion energy storage technologies thus need objective and customer focused safety, technology, and commercial market standard contracts to create a level playing field for equal access to capital. In emerging markets like energy storage, it is common for a leading solution to create biases in standards as the market develops. As market groups look to define the performance

characteristics for emerging market roles, these are many times defined by what customers are already using. In this way, the capabilities and limitations of lithium ion systems set the guidelines for all energy storage technologies as to what market applications are possible for any energy storage technology.

Non-lithium technologies need performance metrics built around application profiles; in this way the relative value of their performance characteristics can be compared to independent metrics of what the application requires, not based against the capability of lithium-ion technology in any particular application. Then, contracts that only focus on the outcome, without any existing technology bias can be built off of these application-specific performance metrics. As technical and economic performance descriptions and requirements for different applications and usage profiles continue to evolve, from best practices to make models, and then onto full Standards, they will assist non-lithium technologies along three avenues: Technical risk, commercial risk, and market risk.

Best Practices

In the early stages of a commercial market, firms active in developing projects base their strategy on experience and expertise gained in related markets. That which can be translated directly from past experience is, while lessons learned in early deployments is used to fill in the gaps to address the new market's challenges. The know-how of managing the sale pipeline from customer capture to project deployment remains a closely guarded secret of these firms as project development costs remain stubbornly high, and know-how remains precious.

At this stage of the market, market growth remains hampered by the conflicting and confusing educational efforts. Regulators are in charge of developing market rules, but lack a knowledge of what application the technologies can competitively provide. Codes & Standards developers are tasked with writing about designing and using the technologies safely and effectively, but without market rules to designate how the products will be used, remaining hampered by not knowing necessary details of the market that have simply not emerged due to the early stage of market development.

At this point in the market's growth arc, sharing of project development best practices is critical to advance the industry overall. Typical diffusion of this valuable trade information typically occurs as staff leave one firms for another, and as developers build their knowledge base through experience. Since this can take many years, Government and industry leaders typically step in to help document what expertise is available, in order to support further growth in developing the necessary contract documentation. Typically, best practices cover 3 areas: common terminology (especially towards applications to support revenue certainty), interoperability among vendors, and methods to reduce slow adoption by customers.

The development of best practice resources will assist the energy storage industry on an ongoing basis as the industry grows. In the early days, best practices resources help spread basic, but critically needed knowledge. Even in an established commercial market, best practice resources to continue to support the market through maturity in disseminating changing product and market information that is beneficial to all. Because of the similarities in project development proposal

structure, the energy storage industry can leverage the experience of the solar, energy efficiency, wind, and electricity markets to provide a more open and useful suite of best practice resources. Through reviewing how these markets disseminated best practices for better a contract environment, the energy storage industry can accelerate the process for itself.

In order to improve the project development effort in the energy storage industry, a group of leaders in the energy storage community were brought together to form the Advancing Contracting in Energy Storage (ACES) Working Group. The objective of the ACES Working Group was twofold: help project developers craft higher quality project development packages more quickly and inexpensively; and help investors reduce their time reviewing proposals through their evaluation process. An Energy Storage Best Practice Guide was developed to document the expertise collected by the effort, with the final report being published by the Energy Storage Association to ensure wide distribution of the material.

Energy Storage

The energy storage industry needs a concerted and sustained effort towards providing best practice guidelines. First, the energy storage project development industry is still in its infancy—promoting better understanding of safety, reliability and performance, and business practice is imperative to broaden the number of well-educated groups participating in the market. Secondly, as we have seen in the solar, wind, and energy efficiency markets, even after the market matures, there is a need for continual effort towards updating an expanding best practice guides to both expand the resources promoting commonality and expedite the dissemination of the information to sustain market growth. Finally, best practice guidelines form the basis for the development of more detailed market models and industry Standards.

The Advancing Contracting in Energy Storage (ACES) Working Group was formed to document existing energy storage expertise and best practices in order to improve project development efforts across the energy storage industry. Through this combined effort, the ACES Working Group developed a library of educational resources to strengthen the fundamental understanding of energy storage project development for those developing and investing in energy storage projects.

This library takes the form of eight Best Practice Guides (BPGs) covering the key aspects of an energy storage project proposal. These Guides document the industry expertise of leading firms, covering the different project components in order to help reduce the internal cost of project development and financing for both project developers and investors.

The Best Practice Guides were structured in a standard content format so that, no matter what their background or familiarity with the subject, readers will be able to grasp important energy storage aspects more quickly, and have a library of useful resources for future reference.

Each Best Practice Guide was developed by committees of industry subject matter experts to document and organize available industry expertise on different project components. Committee Coordinators were responsible for ensuring the development of all chapters in their Best Practice Guide. Chapter Leads, were responsible for coordinating the necessary effort required to produce the chapter in question.

Model Contracts

As emerging industries mature, a handful of leading firms begin to drive market development, without any one single firm dominating in years previously, as is sometimes typical in nascent markets. Although the commercial market growth has begun to accelerate, these leading firms recognize that their internal costs remain higher than they'd like, and market growth continues to be impeded by a number of factors. These included multiple leading firms providing contracts that remain unique to preserve competitive advantage, customer confusion due to a lack of customer education on all of the different offerings, and the time needed by customers to maintain current knowledge.

At this point in an industry's growth cycle, industry trade groups or a consortium of leading firms typically join forces to craft industry wide market model contracts and supporting documents to improve the market in order to:

- **Accelerate market growth**—the leading firms typically agree to work together as they feel they're in a good position to capture most of the accelerating growth (and trailing firms are supportive of anything that could give them a change for more sales).

- **Increase competition**—most developers are not looking for greater competition for customers, but leading firms recognize they are better able to absorb cost reductions to improve their position, and they realize that the bulk of potential customers remain on the sidelines due to confusion.

- **Reduce risk**—as the market begins to expand considerably, efforts to reduce loss exposure becomes a critical requirement to lenders and insurance firms who are increasingly being tapped to fund the expansion of the industry and cover unexpected risks.

The development of additional and improved industry standard model revenue contracts and supporting risk management documents will benefit the growth of the energy storage market. Because of the similarities in project structure, energy storage can leverage the experience in solar, energy efficiency, wind, and electricity marketing to provide a more open and accepted suite of market model.

Energy Storage

No widely utilized industry standard model contracts for energy storage systems have been established as of the publication date of this report. However, the energy storage industry does not necessarily need the same centralized effort to develop useful industry model contracts as was the case in early renewable energy markets. Because of these previous examples, there are a multiple ways for the energy storage industry to obtain useful common project financing models and project documentation that will accelerate the growth of the energy storage market.

First, the energy storage market is more complex than the solar, wind, and energy efficiency markets. As it can act as operate akin to all three, the energy storage industry will require both

PPAs and energy savings performance contracts. Secondly, other markets may be primary to the function of the facility. For instance, in a solar/storage project, the financial contract is more defined as a solar production contract, rather than a storage service one. Therefore, the solar production will be core to the solar/storage contract to obtain revenue contracts in the market. Finally, because of these different financial structures exist, what is critically necessary for the development of project utilizing energy storage systems is to provide more structured supporting documentation to reduce the operating risk of the storage component through more standardized contracting environment. Key drivers for these include applications, performance metrics, common terms, and testing and verification.

Industry Standards

Formal industry standards are recognized specifications for product or practices that have been developed, approved, and published by a standards setting organization. Standards address the needs of market participants who adopt the standards to ensure that products or industry processes meet a minimum criteria for safety, quality, and performance. Depending on the need of the particular industry, they may establish specifications for a product or practice. In doing so, standards help to reduce prices, bring products to market more quickly, help increase the acceptance of new products by ensuring their interoperability, and generally reduce confusion through defining terms on how products and services are provided in an industry.

Authority's Having Jurisdiction (AHJs) are the groups that adopt the standard as they have the standing for enforcement to ensure compliance by industry participants. For example, in the 2014 National Electrical Code (NEC), the term Authority Having Jurisdiction (AHJ) is defined as "An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure." Adoption typically occurs at the national level, but amendments can be made to address specific needs of a local jurisdiction nor addressed at the national level.

At the global level, the International Electrotechnical Commission (IEC) develops and publishes standards for all electrical, electronic and related technologies. This effort is done with input and involvement from groups from across the globe. Standards in the United States is coordinated by the American National Standards Institute (ANSI), which accredits Standard Developing Organizations (SDOs)—the actual groups that develop and publish standards depending on the industry to address specific issues, technologies and design/construction solutions.

These (and other) SDOs develop and revise existing standards on a set schedule for publication, with each SDO organizing and managing the process according to its own guidelines. It is important to remember that the SDO organization administers the process for developing or updating a standard, but the documents themselves are developed by the market participants who are affected by the standard. For this reason, it is critical for industry participants to maintain involvement in the standards development effort for their industry—be they manufacturers, system integrators, EPCs, developers, etc.

Standards have played a critical role in the development of emerging energy industries. Looking at the solar, energy efficiency, and wind markets can provide examples for the energy storage

industry in how expanding standards can improve both the industry's market growth, and support the development of its contracting process. Products that adhere to formal standards do initially carry some additional costs due to the design and testing, but these same influences begin to drive costs down due to factors of scale when the market reaches commercial maturity. More importantly, adherence to standards by manufacturers, system integrators, and EPC firms during construction is one of the most important strategies in preventing unanticipated losses. Periodic inspections by AHJs during the construction can hold up the project until the issue is remedied—adding precious time and cost to the construction schedule. For this reason, Developers and lenders have a specific interested in ensuring adherence to all mandated codes and standards governing the construction and operation of the energy storage project.

The solar, energy efficiency, and wind markets can provide insights into codes and standards development for the energy storage industry through three frameworks: safety, performance, and business practice improvement. Each of these areas are a critical area for supporting and advancing the ability to develop project financing contracts, and the supporting materials that detail and define the financeability of the project. Through these frameworks, we not only see the content, but also the role different organizations play in developing the standards that help organize and structure the industry.

Energy Storage

The development of formal industry standards is crucial for the sustained growth of the energy storage industry. Formal safety, performance, and business practice standards underlie all mature energy markets.

Standards have a direct impact on the cost of an energy storage project through affecting the design, equipment selection and construction. Investors and developers have a vested interested in having the system integrator or EPC verify that appropriate codes and standards are followed throughout the process. Failing to ensure this can cause delay in operation, and possibly impacting the operational range of the facility.

Documenting compliance with the relevant codes and standards is a cost, but as was previously discussed, the investment is in maintaining momentum with the development and construction process; the cost of delays here can quickly overtake the compliance costs. The critical group for developers is to maintain the appropriate Authorities Having Jurisdiction (AHJ). These are typically the local organization or individual responsible for enforcing the requirement for a particular code or standard. How these groups enforce the requirements can vary, again emphasizing the need to ensure proper documentation for all required compliance. Therefore, a critical need is the incorporate them into the project from the beginning so you know when to obtain the needed review, approval and inspections as the AHJ deems appropriate.

The location of the energy storage system on the grid is where on the grid it is located. For systems in front of the meter, systems are subject to what the utility has adopted. For system located behind the meter, systems are subject to what local AHJs based on location, ownership, etc.

For all of these reasons, groups involved at all levels of the energy storage project development industry—including developers, OEMs, finance, etc.—need to be involved the development of new standards and/or the updating of existing standards and model codes to ensure those documents are current and accurate while being sensitive to their interests.

About the Energy Storage Financing Study Series:

The **Energy Storage Financing** study series is an outreach effort by the U.S. Department of Energy's Energy Storage Program to the financial community in order to accelerate energy storage technology investment and project development. The study series' goal is to promote wider access to low cost capital through reducing the economic, technical, and regulatory risk of investment in this emerging market. These studies are focused on a number of critical needs such as; removing barriers of entry and supporting a level playing field for emerging energy storage technologies, improving the information, tools, and insights needed, and highlighting where the energy storage industry can adopt lessons learned from related markets that had similar challenges in their early years of development.

The first study in the series, **Energy Storage Financing**: ***A Roadmap for Accelerating Market Growth*** [SAND2016-8109] laid the groundwork by evaluating the current market for financing energy storage projects, and provided a roadmap for possible actions the U.S. Department of Energy could pursue. Project financing is emerging as the linchpin for the future health, direction, and momentum of the energy storage industry. Market leaders have so far relied on self-funding or captive lending arrangements to fund projects. New lenders are proceeding hesitantly as they lack a full understanding of the technology, business, and credit risks involved in this rapidly changing market. The U.S. Department of Energy is poised to play a critical role in expanding access to capital by reducing the barriers to entry for new lenders, and providing trusted analytical benchmarks to better judge and price the risk in systematic ways.

The second study in the series, **Energy Storage Financing**: ***Performance Impacts on Project Financing*** [SAND2018-10110] evaluated the impact of performance on financing projects and the methods to de-risk project development. Understanding performance is the key to risk management in energy storage project financing. Technical performance underlies both capital and operating costs, directly impacting the system's economic performance. Since project development is an exercise in risk management, financing costs are the clearest view into how lenders' perceive a project's riskiness. Addressing this perception is the challenge facing the energy storage industry today. Growth in the early solar market was hindered until OEMs and project developers used verifiable performance to allay lenders' apprehension about the long-term viability of those projects. The energy storage industry is similarly laying the groundwork for sustained growth through better technical Standards and best practices. However, the storage industry remains far more complex than other markets, leading lenders to need better data, analytical tools, and performance metrics to invest not only to maximize returns, but also safely—through incorporating more precise performance metrics into the project's documents.

The third study in the series, **Energy Storage Financing**: ***Advancing Contracting in Energy Storage*** [SAND2019-12793] focuses on the development of standardized project development contracts language to reduce the time and cost for project development and financing approval.

The lack of standard financing contracts and supporting documents is inhibiting the growth of the energy storage industry. A number of firms are actively developing proprietary contract structures, resulting in a variety of unique attributes. This leaves the market disjointed for 3rd party financing groups looking to scale their lending. Lack of commonality and harmonization between developer and lenders raises project execution costs and causes delays in financing. Of special concern, projects based on emerging technologies are finding an increasing uphill climb for equal consideration by developers and lenders, leaving their potential commercialization in peril. This study will evaluate the development of standardized contracts to reduce the cost and contract approval time, learning from success in renewable energy project development. The goal of this study is to determine the key requirements for standard contracts in the emerging energy storage market, and suggest avenues for possible industry led development.

ACRONYMS AND DEFINITIONS

Abbreviation	Definition
AC	Alternating Current
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
ARPA-E	Advanced Research Projects Agency-Energy
ARRA	American Recovery and Reinvestment Act
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BESS	Battery Energy Storage System
BI	Business Interruption
BMS	Battery Management System
BOMA	Building Owners and Managers Association
BTM	Behind-the-Meter
CAFD	Cash Available For Distribution
CAISO	California Independent System Operator
CEC	California Energy Commission
CESA	Clean Energy States Alliance
COD	Commercial Operation Date
CPUC	California Public Utility Commission
CRL	Commercial Readiness Level
CSR	Codes, Standards, and Regulations
DARPA	Defense Advanced Research Project Agency
DC	Direct Current
DCSSA	Demand Charge Shared Savings Agreement
DER	Distributed Energy Resources
DERMS	Distribute Energy Resources Management System
DOD	Depth of Discharge
DOE	Department of Energy
DRESA	Demand Response Energy Storage Agreement
ECI	Electrical Construction Industry
EOL	End of Life
EPC	Engineering, Procurement, and Construction
EPRI	Electric Power Research Institute

Abbreviation	Definition
ERCOT	Electric Reliability Council of Texas
ESA	Energy Storage Association
ESCO	Energy Services Company
ESIC	Energy Storage Integration Council
ESPC	Energy Savings Performance Contract
ESS	Energy Storage Systems
FAT	Functional Acceptance Test
FERC	Federal Energy Regulatory Commission
FTM	Front of the Meter
GADS	Generator Availability Data System
HVAC	Heating, Ventilation, and Air Conditioning
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
INL	Idaho National Laboratory
IRP	Integrated Resource Plan
IRS	Internal Revenue Service
ISO	Independent System Operator
ISO	International Organization of Standardization
ISO-NE	Independent System Operator New England
ITC	Investment Tax Credit
kW	Kilowatt
kWh	Kilowatt hour
LBL	Lawrence Berkeley Laboratory
LCOE	Levelized Cost of Energy
LCOS	Levelized Cost of Storage
LD	Liquidated Damage
LFP	Lithium Iron Phosphate
LMO	Lithium Manganese Oxide
LMP	Locational Marginal Price
LOC	Letter of Credit
LPO	Loan Programs Office
LTO	Lithium Titanate
MACRS	Modified Accelerated Cost Recovery System
MBTF	Mean Time Between Failure
MESA	Modular Energy Storage Architecture

Abbreviation	Definition
MISO	Midcontinent Independent System Operator
MLP	Master Limited Partnership
MW	Megawatt
MWh	Megawatt hour
NAATBatt	National Alliance for Advanced Technology Batteries International
NCA	Nickel Cobalt Aluminum Oxide
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEIS	National Electrical Installation Standards
NEMA	Association of Electrical Equipment Manufacturers and Medical Imaging Manufacturers
NERC	North American Electric Reliability Corporation
NFPA	National Fire Protection Association
NMC	Lithium Nickel Manganese Cobalt Oxide
NRE	Non-Recurring Engineering
NRECA	National Rural Electric Cooperative Association
NREL	National Renewable Energy Laboratory
NTP	Notice to Proceed
NY-BEST	New York Battery and Energy Storage Technology Consortium
NYISO	New York Independent System Operator
NYSERDA	New York State Energy Research and Development Authority
O&M	Operation & Maintenance
OAT	Operational Acceptance Testing
OEM	Original Equipment Manufacturer
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PCS	Power Conversion System
PJM	PJM Interconnection, Inc.
PLR	Private Letter Ruling
PNNL	Pacific Northwest National Laboratory
PPA	Power Purchase Agreement
PRBA	Portable Rechargeable Battery Association
PTC	Production Tax Credit
PUC	Public Utilities Commission
PV	Photovoltaic

Abbreviation	Definition
R&D	Research & Development
RA	Resource Adequacy
REIT	Real Estate Investment Trust
RFP	Request for Proposal
ROI	Return on Investment
RPS	Renewable Portfolio Standards
RTE	Round Trip Efficiency
RTO	Regional Transmission Organization
SBIR	Small Business Innovation Research
SCADA	Supervisory Control and Data Acquisition
SDO	Standards Developing Organization
SGIP	Small Generator Incentive Program (CPUC)
SGIP	Small Generator Interconnection Procedures (FERC)
SNL	Sandia National Laboratories
SOC	State of Charge
SOR	Scope of Responsibility
SPE	Special Purpose Entity
SPP	Southwest Power Pool
T&D	Transmission and Distribution
TOU	Time-of-Use
TRL	Technology Readiness Level
UL	Underwriters Laboratories
UPS	Uninterruptable Power Supply
V2G	Vehicle-to-Grid

1. WHY CONTRACTS MATTER

Project finance works best when using a mature technology to sell products or services through long-term off-take agreements with credit-worthy counterparties. However, project financing in emerging commercial energy markets like energy storage combines the capital intensity of a relatively new technology while the governing market roles, codes, and regulations are still being developed. This situation leaves project developers facing skeptical lenders and customers wanting deeper clarity and better assurances for operating risk and liability management in the project development proposal in order to obtain better revenue certainty, and limited liability in the event of losses.

To overcome these challenges, the energy storage market needs better contracts and supporting documents for the project development effort. This will include off-take agreements to provide better revenue certainty, and more details supporting documents that cover the legal, engineering, and regulatory issues in order to reduce as much outstanding project risk for all involved. As it is, transaction costs remain high, slowing both stand alone and portfolio funded projects.

Into this emerging situation, energy storage project developers are faced with a dilemma: self-fund the project, which is faster, but the capital is more expensive and hard to come by, or find 3rd party, non-recourse debt which can be slower, but less expensive—but with only a few truly educated and experienced lending firms available. Since most developers do not have internal sources of revenue, the vast majority of developers must rely on this outside financing. Lacking a generally accepted set of off-take contracts and supporting documents, lenders are forced to work with a number of different project developers all with home-grown project development packages, which add complexity to the deal. This complexity slows the entire industry, and adds unnecessary risk to the process and reduces clarity for all.

Formalized contracts allow for a degree of revenue certainty and means of risk reduction to limit liability exposure. Depending on how the off-take contract is structured, it could rule out new and innovative operational strategies that would generate greater margins as new value streams arise. A more streamlined and lower risk process would save time and effort for developers to apply qualified new projects into a previously vetted performance guarantee framework, rather than drafting a new guarantee framework for every new project. Financing portfolios of storage projects gets easier as well if the systems fits a template for customer qualification, project structure and pricing.

Project financing is based on ensuring that the project in question will be able to generate sufficient revenues to cover the debt service, operating costs, and earn an acceptable return for the equity providers. The financing contact structure used will be the most financeable for a particular market; straightforward generation can operate with a simple offtake structure, while a complex operational profile will require a structure that can manage a more complex risk exposure for the facility. Since potential revenue from energy storage can both have location specificity, and temporal variability, the performance capability of the unit is critically important to ensure that the project can obtain the needed contracted revenue, or the developer can provide sufficient insights to warrant banking on merchant revenue.

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The creation of standardized project development contracts is also critical to emerging energy storage technologies. Most lenders simply want to fund projects utilizing the technology with the lowest current operating risk profile. If one technology dominates deployment, many of the critical deciding metrics will use the leading technology's value as default as it makes developing contracts easier. Emerging energy storage technologies—many of which are being supported by U.S. Department of Energy funded research —are thus at a distinct disadvantage to more established storage technologies like lithium-ion in this regard due to their smaller commercialization experience. By providing a means to lower the risk profile of projects based on these emerging technologies, contractual language can be developed to account for these differences and ensure that there are well established and acceptable methods to incorporate any energy storage technology into a project at no greater cost or risk exposure.

1.1. Revenue Certainty

Successful project financing is based on ensuring that the project in question will be able to generate sufficient revenues to cover the debt service, operating costs, and earn an acceptable return for the equity providers. The financing contract structure used will be the most financeable for a particular market; straightforward generation can operate with a simple offtake structure, while a complex operational profile will require a structure that can manage a more complex risk exposure for the facility.

For most energy storage installations several revenue streams are needed to provide the expected return on the project; this is commonly referred to as value stacking. Unfortunately, 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. 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 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). 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. 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 resiliency.

To ensure revenue certainty for energy storage projects, the energy storage industry has utilized and adapt existing financing structures that have proven successful in other markets: the Power Purchase Agreement (PPA) and the Energy Savings Performance Contract (ESPC). The challenge for the energy storage industry will be to identify the areas where the operational and performance characteristics of energy storage systems will operate differently, and determine an analytical framework to account for these to determine a risk adjusted return for these projects.

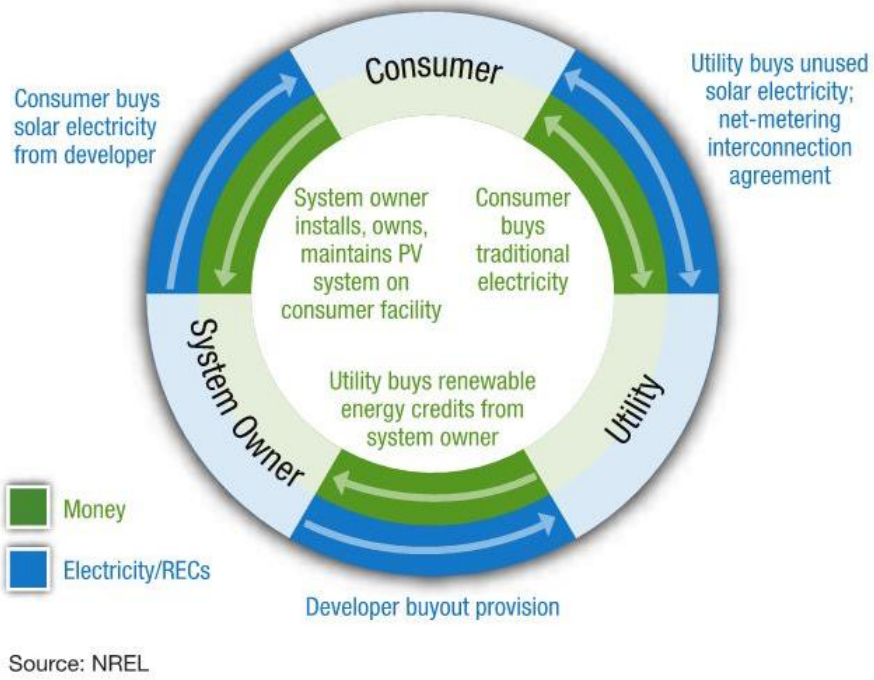
1.2.1. Power Purchase Agreement

A Power Purchase Agreement (PPA) is a contract between a generator of electricity (seller) and the recipient (buyer) of the electricity and/or grid services. The PPA is generally regarded as the central document in the development of independently financed electric power assets as it defines the term and requirements for the operation and off-take of the facility is used to obtain financing for the project.

The PPA structure is useful when the project revenue is uncertain as the PPA contract structure can allow for variability in the underlying contract details based upon an agreed upon performance criteria. Through its use, a typical PPA for a power generation facility can allow the generators a guaranteed revenue stream, while the purchaser receives stable delivery of electricity. The contract terms may last anywhere from 5 to 20 years, with an agreed upon price, including any annual escalation in the cost. Because of the defined time duration and costs, the rates are typically lower than the spot price of power. The PPA also defines how much energy will be delivered, including penalties for missing delivery. The contract will also typically require the seller to meet certain performance standards with specific performance guarantees including availability may be covered under another agreement.

Two types of PPAs are most common for energy storage projects so far, a tolling agreement, and a capacity service agreement. In the tolling agreement, the developer is responsible for project ownership and operation. The utility owns the electricity used to charge the energy storage system, and has the right to dispatch the charging or discharging of the system for its own benefit (energy, or grid services) within specified operating parameters. For operating the facility, the project developer 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 developer. The capacity service agreement is similar to the tolling agreement, but the developer is the owner of the electricity, and is responsible for all costs, including the charging cost. The utility pays a straight capacity payment for the ability to utilize the output of the system for energy and grid services. These capacity service agreements transfer more of the project risk to the developer, but also provide more of a possible upside—if the developer truly understands the performance of his system and other opportunities in the market if the utility capacity contract does not account for all of the system's capacity.



Source: National Renewable Energy Laboratory

Figure 1 – Contracts and Cash Flow in Power Purchase Agreements.

There are a number of key features that are important to include in the PPA according to the Overseas Private Investment Corporation (OPIC) report "Important factors of Bankable Power Purchase Agreements for Renewable Energy Power Projects"[1]. Some of these features are explicitly designed for international projects.

1. **Price / Revenue:** The revenue of the PPA is based on a fixed amount ($) per kWh generated. The estimation of the $/kWh is to cover the operating cost of the facility, the debt service, and provide an acceptable return on equity (ROE).
2. **Foreign Exchange:** The PPA should be denominated in the currency of the power producer's debt to avoid subjecting the power producer to currency risk.
3. **Offtaker Payment Support:** This represents a short-term liquidity instrument, facility and/ or a sovereign guaranty to support the offtake's payment obligations.

4. **Dispatch Risk:** Mitigating the risk of the generation facility if it will not be dispatched. Without being dispatched (and thus, paid), the generator would have trouble covering costs, such as debt service, fixed operating costs, and generating an acceptable return on equity (ROE). There are two typical means to alleviate the risk: (Take or Pay): The offtaker pays a fixed fee based a capacity charge (on available capacity) and amount paid based on the energy delivered. (Take and Pay) The offtaker must take, and pay a fixed fee for all energy delivered.
5. **Interconnection:** The PPA should indicate which party bears the responsibility of developing and maintaining the physical interconnection from the project to the nearest substation for the power grid.
6. **Change in Law / Tax:** The PPA should explicitly state which party takes the risk of a change in law / tax regime after the date of the agreement, and what party bears the potential exposure.
7. **Force Majeure:** The PPA should excuse the storage facility from performing its obligations if a force majeure event (an event beyond the reasonable control of the project owner/operator) prevents the stated performance required in the PPA.
8. **Dispute Resolution:** The PPA should provide for arbitration in a neutral location, under generally accepted rule of law.
9. **Termination:** The PPA should set out clearly how either party may terminate the PPA. For instance, if the PPA is terminated by the offtaker, the project may not have any access to the market for sale, and thus the termination should only be allowed for significant events.
10. **Assignment:** The PPA should allow for collateral assignment of the contract to the storage facility's lenders (with notice of default). Additional rights are generally set forth in a separate agreement between the lenders and the offtaker.

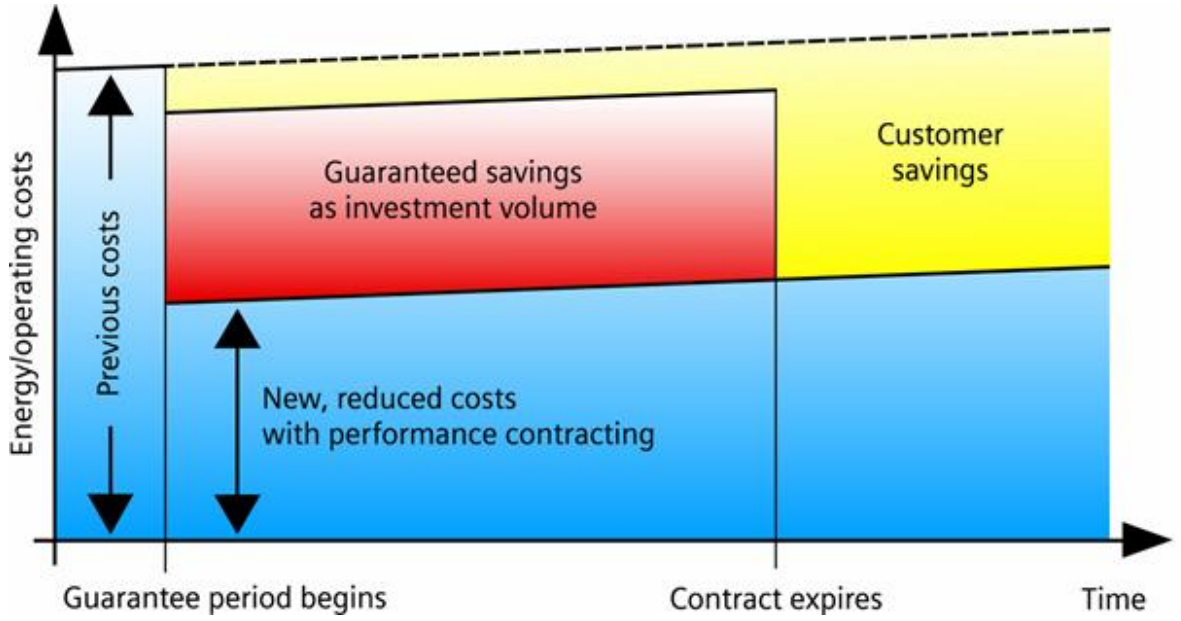
The typical process of crafting a PPA for a new industry is to adapt an existing PPA contract (as similar as possible) from a more mature market. For solar and wind, thermal power project PPAs were available and covered many of the same issues and much of the operating structure was similar. However, in energy storage we see a different starting point and a fundamentally different mode of operation, and so the development of more comprehensive energy storage PPAs is requiring some rethinking in approach. For instance, an energy storage PPA could be written so that the seller provides a guarantee on availability while the buyer actually controls the operation of the facility. Due to the limited discharge duration of a storage facility, the amount of output available is determined by the recent activity of the unit. Therefore, availability and control must be linked within the PPA in order to satisfy and protect both the owner and customer of the energy storage system.

1.2.2. Energy Savings Performance Contracts

An Energy Savings Performance Contract (ESPC) is the central financing contract for Behind-the-Meter (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 offering these types of contracts to customers usually arrange the financing from a 3rd party financing company, with the contract typically in the form of an operating lease. In this way, the ESPC is a contract defining a turnkey service for the scope of work desired by the client and which meets the investment criteria of the lender. The contract provides for guarantees that the savings produced by a project will be sufficient to finance the full cost of the project. The operation of the project is then monitored to verify the savings, but also provides data on availability to manage operational performance and preventive maintenance.

The ESPC is being adapted to the energy storage market for its ability to structure paying for equipment and to lower the customer's cost of electrical service. The ESPC framework has been widely used in the energy efficiency market to enable customers pay for energy efficiency upgrades to their facility by using a portion of the cost savings, thus eliminating the customer's to pay up-front for the desired project. An ESPC designed for the energy storage market could both ensure that energy storage project developers will be able to work with lenders on a level playing field, and ensure that commercial customers could benefit from the subsequent savings without the large outlays of capital.



Source: Building Owners and Managers Association

Figure 2 – Energy Savings Performance Contract.

ESPCs are well suited for the energy storage Behind-the-Meter commercial and industrial market. Commercial and industrial customers are increasingly exposed to higher and more volatile electricity rates, as utilities shift more of the service charge from a commodity (kWh) basis to a demand (kW) basis, through rising demand charges in their tariffs. Of course, while commercial and industrial customers are interested in lowering their energy service costs, they are reluctant to sign procurement agreements with private energy service firms that cannot guarantee savings. In the energy efficiency market, lighting and HVAC upgrades allow the energy service firm a means

by which they can lower the overall usage, but cannot selectively control the timing of the reduction—outside of all of the time. Here, an energy storage system enables the user to target reduction of load, without significantly affecting the operational profile of the facility. The benefit here is that the scale of the load reduction by using the energy storage device can easily be greater than that provided by the energy efficiency program, thus providing a greater reduction in the demand charges. By coupling the ESPC with the energy storage asset (and provide the necessary guarantee), together, the customer and the energy service provider can enter into an agreement whereby cost savings from demand charge reductions can be guaranteed. Including the capital cost of the battery equipment in the contract would allow the customer to enter into an operating lease agreement, which would provide guaranteed cost reductions, especially targeting the ever rising demand charges. Some service providers that provide such energy storage projects have called this "storage as a service".

Project developers and customers alike need a standardized, financeable contract to accelerate the market for bankable Behind-the-Meter energy storage projects. A number of developers active in the market are developing their own proprietary contracts to support their own commercial development. Two of the most widely used energy savings performance contracts between project developers and their customers in the energy storage market are the Demand Response Energy Storage Agreement (DRESA) and the Demand Charge Shared Savings Agreement (DCSSA). In the DRESA, a developer 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 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. The DCSSA contract follows 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.

Due to the rapidly maturing nature of the energy storage industry, there has been a wide range of service bill reduction promises and guarantees, with the trend being towards firmer guarantees of cost reduction as experience has taught the developers what the systems are capable of, and their ability to understand customer load profiles. As this area of the market continues to grow rapidly, other applications are being contemplated, such as providing cost reduction strategies for on-site electric vehicle chargers, which would otherwise exacerbate the peak load of the facility.

1.2. Project Development

There are a number of supporting documents as part of an energy storage project development package. These contracts and requirements support the financeability of the project through limiting liability for the different parties involved by assigning responsibilities and obligations for the different aspects of the project to the party most able to manage the risk. Some of these risks are internal to the facility include design, construction, operational project risks, while those external ones to the project could impact these aspects of the facility through impacting revenues and regulatory oversite.

1.2.1. Siting/Permitting

Any project development effort in the energy power industry requires a suitable site, long term control of that site, and allowance for intended uses over the life of the system. This process will vary for energy storage systems depending on its market role; is it a front of the meter, behind the meter, stand-alone, or hybrid deployment (and whether it is a greenfield or deployment to an existing site), etc.

Proper permitting is required to ensure the safety and compatibility of the permitted operation at the location with other existing activities or uses. Understanding what permitting requirements apply is essential. If the project developer does not dedicate sufficient resources to obtaining the needed permits correctly at the early stage of the development process, it can result in unplanned restrictions or blockage of anticipated operation, resulting in additional cost, time, and operational restrictions.

Safety and emergency response typical greatest concern for permitting agency. It is important for energy storage developers to understand that the same requirements and government-imposed restrictions and codes affect energy storage projects just as any other power project development effort. However, permitting and local codes designed for the energy storage industry will take more time and experience, so there will be somewhat of a learning curve by both sides to ensure that energy storage systems adhere to the all of the necessary oversight.

1.2.2. EPC / Construction

Most developers of large energy storage systems contract with an Engineering, Procurement and Construction firm in order to coordinate the construction and delivery of an energy storage facility. The EPC firm must be capable of providing highly specialized engineering, procurement, installation, construction and commissioning services through a number of subcontractors and suppliers who undertake specific aspects of the scope of work. These contracts are designed to clearly allocate the division of responsibilities between the developer of the energy storage projects and the firm responsible for the energy storage systems installation.

The EPC firm is the group responsible to the developer for knitting together all of the technical details of the equipment and the project onsite. Typically, EPCs are brought in for larger, Front of the Meter energy storage projects. As you move to smaller, less complex system, the integrator and electrical contractor is many times able to handle the construction on site. The EPC contract lays the foundation for profitable operation, and is a key component of attracting lenders by clearly allocating the primary areas of project risk. The EPC contract aims to both deliver the project according to the schedule while also limiting opportunities for the different parties to claim for other's responsibilities for the cost overruns.

Besides expertise and experience, increasingly EPC firm provide another key large project essential—a complete warranty wrap for the energy storage system. This warranty wrap will typically cover all equipment and operating performance of the complete system based on performance warranties which are built on the equipment warranties of the batteries, taking into account the energy capacity degradation. In order to provide this coverage, the EPC firm reviews

the warranties and operating experience of the different components in order to be comfortable in how each operates individually, and as part of a complete system. The willingness of a particular EPC firm to provide this coverage will be based on the familiarity and confidence of the EPC firm with the various components (battery modules, BMS, controls, PCS, HVAC etc.), and with its own engineered, designed and integrated energy storage system.

As it is quickly becoming apparent, the multifunctional operational capabilities of an energy storage system are a central area of concern—will all of the components of the energy storage system still be able to perform to their full stated operational range when coupled together? For many multi-component systems, the answer is no (sometimes only slightly, other times to a large degree). By working closely with the developer, the EPC can therefore be the single point of management for the technical challenges of deploying large, complex energy storage system. As the industry is rapidly expanding with multiple vendors of different components, the EPCs are facing potentially large performance risk acceptance in order to win the contracts. In response, it is natural for EPCs to then look for avenues to reduce these risks they are requested to cover, such as down-selecting vendors to a smaller pool so there is a deeper working relationship with OEMs of key components.

1.2.3. Operation & Maintenance Contracts

Operation and Maintenance (O&M) contracts are a critical component of a successful energy storage facility. In the solar market, O&M execution risks had ranked amongst the top concerns of equipment manufacturers, rating agencies, and investors in the early days of that industry. This concern is also found in the energy storage market; since O&M procedures will be more complex for energy storage than for solar projects, the importance of a comprehensive O&M contract covering all of the necessary issues to maintain proper operation of the facility is of even greater concern. With the recent number of fires at battery facilities, proper O&M procedures are seen as a good first step to find troublesome issues to reduce the potential for damage to the system.

O&M contracts for energy storage systems also play other key roles in ensuring compliance with project development requirements. Proper O&M procedures are key to obtaining the required performance results of course, but they are also integral to required project development requirements such as insurance, cyber-security, and first responder programs.

1.2.4. Warranty

Product warranty coverage provides project developers a means to ensure that the product meets specific manufacturing quality and performance capabilities. Warranties are important for two reasons. First, they provide assurance to developers to allow them to plan on what market applications the unit can reasonably support. Secondly, having the equipment's facilities remain under warranty during the duration of the facilities operating life is many times a requirement of lenders to ensure that the facilities remain in good working order so as to allow developers to repay the loan.

Warranty coverage typically focuses on two areas; manufacturing defect, and performance. Both types of warranty coverage are subject to usage in accordance with specified usage profiles:

temperature, cycling, energy throughput, and State of Charge (SOC) limits. The manufacturing warranty is typically limited to cover defects from manufacturing: this would provide relief to the owner for repair or replacement in case of defects in material or workmanship. The warranty covering manufacturing defect guarantees the battery system to be free from defects in material and workmanship and provides relief in the event only that there were defects in the manufacture of the product; if relief is provided, the vendor is required to repair or replace the defective components. Performance warranties are typically limited to specific performance metrics at the module level, such as cycle life, energy throughput over the lifespan of the system, etc. As these capabilities are critical to the system's operational, and thus financial success. Liquidated damage (LD) may be imposed to compensate for lost revenue in the event of failure in the warranty coverage.

1.2.5. Performance Guarantee

Performance guarantees are an agreement to ensure that energy storage systems meet the technical performance requirements found within off-take agreements. These performance guarantee agreements are required by customers (to fulfill off-take agreement requirements) and lenders (to maintain payment), and are common in renewable energy projects where performance is many times simply related to energy production over a set period of time.

These agreements require the developer (or a designated engineering firm) to be responsible for maintain the system's specified performance rating over the operating life of the facility (and usually aligned with the application needs, not the warranty). Depending on the need of the off-take agreement, they only need to be limited to a specific set of operational parameters. It should be noted that although they underlie the drivers of the financial contracts, they do not extend to the financial performance and success of the system.

As with the renewable energy markets as they matured, performance guarantees are becoming common for the energy storage projects in order to require specific technical performance parameters over the life of the system. However, energy storage projects operate differently and in a more complex manner than renewable energy ones. In renewable energy contracts, these agreements typically only concern energy production. Because of the more complex operating regime of energy storage system, their performance guarantees do not try and cover all possible usage profiles, but only those specific the application in the off-take agreement.

1.3. Market Roles

Energy storage systems are a versatile technology class that is proving itself in a variety of innovative uses across the electric power industry. However, to be deployed widely, they must be able to generate sufficient and reliable revenue streams in order for project developers to finance the project's deployment. The challenge for energy storage to date has been that many deployment opportunities have been, and are expected to remain, somewhat unique, hindering the ease of replicating deployments. Since the project opportunities are expected to remain bespoke, a more flexible and transparent financing structure is needed in order to account for differences. This included not just the financing document itself, but all of the supporting project development

documentation needed to account for the safety and performance concerns in order to make the facility's financing cost effective.

1.3.1. Front of the Meter

Revenue opportunities in the Front of the Meter (FTM) typically focus on obtaining a utility PPA contract to generate a guaranteed revenue stream for the facility. Technically, these facilities could be located anywhere, but developers have typically looked in formal wholesale markets (ISO/RTO regions) where the facility can engage in additional open market grid service sales to have merchant activity as well. The challenge for purely merchant revenue energy storage projects is that initially the only revenue stream lenders would recognize for lending purposes were fixed capacity payments. The only other option for project owners is to sell electricity or services into the wholesale market in a purely merchant role. With growing experience, some lenders are signaling that some revenue to support these facility's debt service can be derived from these merchant activities, as long as there are some fixed revenue contracts in the mix.

Besides a standalone energy storage facility a promising and hopefully significant opportunity for energy storage in the wholesale market is to be coupled with a renewable generating facility to construct a hybrid power facility. Typically, renewable projects are compensated based on total production (kWh) over a period of a month or year. Only when the output of the facility is either compensated for dispatchability, or penalized for lack of ramp control or other performance criteria over the output would the addition of an energy storage component be warranted. Since the renewable system will remain the bulk of the project assets, the financing for the hybrid project will be structured around that, with the impact of the energy storage component being limited to the risk exposure of the hybrid facility not fulfilling the expanded facilities.

1.3.2. Commercial

Behind the meter (BTM) commercial energy storage project development is typically geared toward providing peak demand capabilities, although grid services and on-site services are growing in importance. These BTM energy storage systems are typically offered by developers as a 10-year operating lease, keeping them off the balance sheet of the commercial customer. This lease ensures that the commercial customer has no direct capital or operating costs as the unit is owned and operated by the developer. Lenders and developers interviewed stressed the number of challenges still facing this market, including; software solutions to model complex building load profiles and site-specific tariff requirements, hardware solutions that integrate the building's load, possibly onsite generation units, and the existing building control software, and financing solutions to support standardized agreements that reduce the internal processing of bundled contracts with the lender providing the financing facility for the developer. In addition, multiple application stacking can produce operational interference for contractual performance requirements.

As project developers gain confidence and experience, combinations of the different programs described here can be supported cost effectively with only marginally additional capital equipment. Many of the existing energy storage providers have developed their own proprietary contractual

framework to enable market growth. However, by enabling energy storage systems to be easily incorporated into solar and energy efficiency programs through de-risking the performance unknowns will allow for a faster market adoption driven by these other, larger markets.

1.3.3. Residential

There are few individually monetizable value streams for residential energy storage systems, so the deployment strategy in this market segment has typically relied upon maximizing the energy shifting capability from solar for service cost reduction and back-up power, plus supporting additional value streams of utility distributed resource programs. The storage system here is not the primary driver for sales and financing, so structuring the contract is based on the solar asset; the requirements for the storage asset are based largely on what is stated in the warranty.

By expanding the scope of verifiable system performance, residential systems would be able to be incorporated more readily into additional utility grid service contracts (virtual power plants, etc.) to expand both the scale, and reliability of additional revenue streams. These business models leverage the capability of a fleet of such distributed resources to sell a combined capability to the utility or wholesale market. A key aspect of making these additional opportunities viable are commonality of technical performance metrics, and 3rd party validation so equipment vendors and utilities alike simply need to ensure that the equipment proposed for a potential utility programs meets an independent performance requirement shared among various utilities.

1.4. Non-Lithium Technologies

Non-lithium technologies face a number of current challenges for wider commercialization. Even if the projected systems cost reductions and performance expectations are borne out, systems built around these other energy storage technologies still face a significant hurdle. Project developers are basing virtually all of their development planning around using lithium ion systems, and therefore, all of the default assumptions for their contracts are based on lithium ion specifications.

Lithium ion enjoys a number of advantages currently; it is commercially successful, and widely accepted by developers and system integrators. Leveraging the technological and cost improvements from the far larger vehicle market, lithium ion systems in the power grid market continue to gain a competitive advantage. As this technology has grown to represent the vast majority of stationary energy storage deployments, the capabilities of lithium ion technology are many times being used to define the applications for energy storage technologies.

Non-lithium ion energy storage technologies thus need objective and customer focused safety, technology, and commercial market standard contracts to create a level playing field for equal access to capital. In emerging markets like energy storage, it is common for a leading solution to create biases in standards as the market develops. As market groups look to define the performance characteristics for emerging market roles, these are many times defined by what customers are already using. In this way, the capabilities and limitations of lithium ion systems set the guidelines

for all energy storage technologies as to what market applications are possible for any energy storage technology.

Non-lithium technologies need performance metrics built around application profiles; in this way the relative value of their performance characteristics can be compared to independent metrics of what the application requires, not based against the capability of lithium-ion technology in any particular application. Then, contracts that only focus on the outcome, without any existing technology bias can be built off of these application-specific performance metrics. As technical and economic performance descriptions and requirements for different applications and usage profiles continue to evolve, from best practices to make models, and then onto full Standards, they will assist non-lithium technologies along three avenues: Technical risk, commercial risk, and market risk.

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2. BEST PRACTICES

In the early stages of a commercial market, firms active in developing projects base their strategy on experience and expertise gained in related markets. That which can be translated directly from past experience is, while lessons learned in early deployments is used to fill in the gaps to address the new market's challenges. The know-how of managing the sale pipeline from customer capture to project deployment remains a closely guarded secret of these firms as project development costs remain stubbornly high, and know-how remains precious.

At this stage of the market, market growth remains hampered by the conflicting and confusing educational efforts. Regulators are in charge of developing market rules, but lack a knowledge of what application the technologies can competitively provide. Codes & Standards developers are tasked with writing about designing and using the technologies safely and effectively, but without market rules to designate how the products will be used, remaining hampered by not knowing necessary details of the market that have simply not emerged due to the early stage of market development.

At this point in the market's growth arc, sharing of project development best practices is critical to advance the industry overall. Typical diffusion of this valuable trade information typically occurs as staff leave one firms for another, and as developers build their knowledge base through experience. Since this can take many years, Government and industry leaders typically step in to help document what expertise is available, in order to support further growth in developing the necessary contract documentation. Typically, best practices cover 3 areas: common terminology (especially towards applications to support revenue certainty), interoperability among vendors, and methods to reduce slow adoption by customers.

The development of best practice resources will assist the energy storage industry on an ongoing basis as the industry grows. In the early days, best practices resources help spread basic, but critically needed knowledge. Even in an established commercial market, best practice resources to continue to support the market through maturity in disseminating changing product and market information that is beneficial to all. Because of the similarities in project development proposal structure, the energy storage industry can leverage the experience of the solar, energy efficiency, wind, and electricity markets to provide a more open and useful suite of best practice resources. Through reviewing how these markets disseminated best practices for better a contract environment, the energy storage industry can accelerate the process for itself.

In order to improve the project development effort in the energy storage industry, a group of leaders in the energy storage community were brought together to form the Advancing Contracting in Energy Storage (ACES) Working Group. The objective of the ACES Working Group was twofold: help project developers craft higher quality project development packages more quickly and inexpensively; and help investors reduce their time reviewing proposals through their evaluation process. An Energy Storage Best Practice Guide was developed to document the expertise collected by the effort, with the final report being published by the Energy Storage Association to ensure wide distribution of the material.

2.1. PV

The U.S. Government has supported the growth and development of the solar industry by providing a number of Best Practice guides to assist in better project development efforts from groups such as the EPA. For instance, the U.S. Government has provided more technical background detail and checklists to assisted customers issuing Request for Proposals (RFPs)[2] to obtain competitive bids on the project. These solar RFPs describe the solar opportunity requirements, the contract terms, and bidding process The RFP Issuance checklists that were developed helped to keep track of key components such as scope and deliverables, specific requirements, etc. Finally, RFP submission process were codified to streamline the coordination of key dates, scope of work, proposal requirements, evaluation criteria, etc. for respondents to manage. Additional support from the National Renewable Energy Laboratory (NREL) was designed for Universities issuing RPFs[3] while groups like the Solar Foundation provided support for local governments[4].

The U.S. Government support has been critical both in the early development of the solar leasing and solar PPA, and as the industry has matured. This has been critical to improve project transparency and accountability while accelerating solar deployment by reducing the time and cost of the contract development process. 3rd-party solar project financing typically follows one of two financing models: leases and PPAs. In the lease model, a customer signs a contract with a developer for the deployment and the use of a solar system over a set period of time. In the PPA model, the developer sells the power generated from a solar system to the customer at a fixed rate which supplement the customer's physical usage of utility purchased electricity service in order to reduce their service cost.

Besides the PPA contract, a number of critical reports and documents are necessary to craft bankable project development packages. Here too, the U.S. Department of Energy has supported the development of Best Practice Guides to improve the quality of those documents, and to keep them up to date, including Best Practices from the EPA for siting solar photovoltaics on municipal solid waste landfills[5] and PV system Installation[6], with NREL providing additional resources on Best Practices in photovoltaic system operations and maintenance. Sandia National Laboratories has also support Best Practice improvements for PV O&M agreements.

As the industry matures, so too does the requirements for better data management to support the need for interoperability among competing equipment providers to provide better products and services for customers. NREL has been in a leader in this area too, providing insights into improved data monitoring for PV solar plants while those in the industry provide insights into how to best use communication equipment for PV operation and maintenance contracts.

2.2. Energy Efficiency

Energy Savings Performance Contracts (ESPC) are well suited have been the basis for energy efficiency markets. The U.S. Government through the office of Energy Efficiency and Renewable Energy has supported the growth and development of the energy efficiency industry. This effort

to demystify the market is important especially for customers, who are of course interested in lowering their energy service costs, but are hesitant to sign procurement agreements with private energy service firms that cannot provide much detail on how the energy savings will impact their operations. The U.S. Government's support has been critical in the early development of the energy efficiency contract financing as highlighted by its inclusion in the EPA's National Action Plan for Energy Efficiency. State governments such as Maryland have also supported this effort to improve project transparency and accountability while accelerating energy efficiency deployment by reducing time and cost of the contract development process. Groups like the Connecticut Energy Fund supported Municipal governments to developed guides to highlight their particular needs.

Groups in the financial industry such as J.P. Morgan Chase have also provided support for improving Best Practices in the energy efficiency industry in order to develop additional project activity. Efforts to promote energy efficiency are also found globally, driven by groups such as the World Resource Institute as policy makers leverage industry knowledge to provide a path forward to deliver better buildings before cities "lock in" decades of inefficiency. Operational procedures are key towards producing energy savings while maintaining or enhancing other commercial building priorities such as indoor environmental quality and equipment reliability. The Climate Protection Division of the U.S. Environmental Protection Agency (EPA) funded research into energy efficiency O&M practices tht lead to efficient operation of commercial buildings typically fall within 4 areas:

- Management—incorporate O&M procedures into building management goals.
- Teamwork—work with other internal groups to incorporate processes into corporate goals.
- Resources—Sharing of information to expand education
- Energy-Efficient O&M—expanding the preventive maintenance program.

2.3. Wind

The wind industry has provided significant effort to develop and share best practice guides to develop and maintain the level of freely available information to support the growth of the industry, for example an effort driven by through trade groups such as the American Council on Renewable Energy to provide Renewable Energy PPA Guidebook for Corporate and Industrial Purchasers. The central effort continues on the development and issuance of the PPA. These efforts have spanned a variety of end-use customers, supported by state level efforts, and international ones by groups such as Renewable Energy Solutions for Africa.

Supporting the development of the wind industry has long been a priority for the U.S. Government labs like NREL both in the early days of the industry, and as currently to evaluate current practices and finance opportunities as the industry continues to grow as the needed contract financing structure evolves to address emerging challenges. In support of this governmental effort, the many law firms like Stoel Rives dedicate significant effort to help educate customers as to new and innovative ways to finance wind projects. In addition to those looking to develop projects, efforts like the Intelligent Energy Europe group have developed Good Practice Guides to help reconcile wind energy development with environmental and community interests.

In addition to the effort to secure project financing through the PPA, a number of critical reports and documents are necessary to craft bankable project development efforts. As wind farms continue to grow in size, the question of bankability moves from a question of the technology itself—a focus more on the earlier portion of the market—to a focus on the bankability of the wind farm[24], with complexity raising a number of risks, including system risk, energy deliverability, efficiency, reliability and maintenance, and safety. For each of these other markets, different project development issues are more critical than others for a particular market. Because of the sheer size of wind projects, property agreements for site control and use have significant importance for this market with groups such as the Farmer's Legal Action Group providing insights for its members.[25]

The U.S. federal government through its labs like Lawrence Berkeley Laboratories (LBL) has also driven the development of improving Wind project development and EPC efforts for the U.S. market[26], with other parts of the U.S. Department of Energy supporting and improving the knowledgebase in tribal communities for operation and maintenance programs for the wind industry.[27] Private industry has worked to highlight the use of software tools to help automate and manage operational needs to help reduce the cost and improve the insights for owners.[28] As evidences by the industry's need for clear and widely agreed-upon best Practices, industry trade groups, like the American Wind Energy Association in the wind industry, help develop and manage publication libraries of Best Practice guides to assist the industry maintain a high level widely agreed upon knowledge critical for good working of the industry.[29]

2.4. Energy Storage: The ACES Working Group

The energy storage industry needs a concerted and sustained effort towards providing best practice guidelines. First, the energy storage project development industry is still in its infancy—promoting better understanding of safety, reliability and performance, and business practice is imperative to broaden the number of well-educated groups participating in the market. Secondly, as we have seen in the solar, wind, and energy efficiency markets, even after the market matures, there is a need for continual effort towards updating an expanding best practice guides to both expand the resources promoting commonality and expedite the dissemination of the information to sustain market growth. Finally, best practice guidelines form the basis for the development of more detailed market models and industry Standards.

The Advancing Contracting in Energy Storage (ACES) Working Group was formed to document existing energy storage expertise and best practices in order to improve project development efforts across the energy storage industry. Through this combined effort, the ACES Working Group developed a library of educational resources to strengthen the fundamental understanding of energy storage project development for those developing and investing in energy storage projects.

This library takes the form of eight Best Practice Guides (BPGs) covering the key aspects of an energy storage project proposal. These Guides document the industry expertise of leading firms,

covering the different project components in order to help reduce the internal cost of project development and financing for both project developers and investors.

Table 1. ACES Working Group Best Practice Guides.

ACES Working Group Best Practice Guides	
BPG 01	Project Development
BPG 02	Engineering
BPG 03	Project Economics
BPG 04	Technical Performance
BPG 05	Construction
BPG 06	Operation
BPG 07	Risk Management
BPG 08	Codes & Standards

Source: ACES Working Group

The Best Practice Guides were structured in a standard content format so that, no matter what their background or familiarity with the subject, readers will be able to grasp important energy storage aspects more quickly, and have a library of useful resources for future reference.

Each Best Practice Guide was developed by committees of industry subject matter experts to document and organize available industry expertise on different project components. Committee Coordinators were responsible for ensuring the development of all chapters in their Best Practice Guide. Chapter Leads, were responsible for coordinating the necessary effort required to produce the chapter in question.

2.4.1. Objective

The objective of the ACES Working Group was twofold: help project developers craft higher quality project development packages more quickly and inexpensively, and help investors reduce their time reviewing proposals through their evaluation process. While project developers may be familiar with the many parts comprising a project package, they are, however, often unsure as to how energy storage systems will impact each part. For their part, investors interested in the returns predicted from energy storage are often hesitant to invest because legal, financial and regulatory guidelines have hitherto not been clearly explained. These Best Practice Guides are structured so that all readers, no matter their background or familiarity with the subject, can understand the issues and challenges that exist for energy storage, benefit from current industry insights, and know where to turn for additional resources.

The development of the Best Practice Guides was guided by asking a simple question:

What do you need to do your job better, faster, and cheaper?

2.4.2. Goals

- To reduce the internal cost of project development and financing for both project developers and investors
- Help project developers craft higher quality project development packages faster and cheaper
- Help investors reduce their time reviewing proposals through their evaluation process
- Document the industry expertise inherent in the different project development components
- Be structured so that all readers, can understand the issue, how energy storage impacts it, provide current insights, and how to find additional resources.

Covering different areas of a project development package, each Guide consists of three to seven components of the overall project development package. Each component appears as an individual chapter in the Guide.

2.4.3. Benefits

Multiple groups across the energy storage industry will benefit from these eight Best Practice Guides.

- Project developers will benefit through higher quality project documentation, interaction with more financial industry firms, and by having the ability to ensure that the resulting industry-accepted project documents will allow lenders to make decisions in a timelier manner. In addition, project developers will benefit from reducing their own internal costs and time to complete projects while increasing the success rate of those projects in process.
- Investors will receive higher quality proposals, thereby allowing them to make investment decisions more quickly, and with greater insight via better supporting documents.
- System integrators will benefit through an increase in the rate of successful project completions, and by ensuring that the industry grows to recognize the value of quality electrical design and fabrication to reduce the risk-adjusted cost of system integration.
- Engineering, Procurement, and Construction (EPC) firms will benefit from refining risk management strategies so they can be adequately compensated for taking on components of project risk.
- Insurance firms will benefit through a greater number of projects being completed, allowing for a clearer understanding and appreciation by developers of the need for better risk management in the project development process.
- Equipment manufacturers will benefit through an increased level of visibility into both the entire project development process and the players involved. As with system integrators, these providers of high-quality equipment will help ensure that the industry grows to recognize the value of quality manufacturing process—processes that help reduce the risk-adjusted cost of energy storage equipment components.

2.4.4. Groups involved in the ACES Working Group

Table 2. Groups involved in the ACES Working Group.

Groups Involved	
Sponsors	8
Legal Counsel	2
Advisory Board	16
Investor Review Board	10
Participating Firms	32
Total	68

Source: ACES Working Group

Table 3. Project Involvement in the ACES Working Group.

Project Involvement	
Time	9 Months
Conference Calls	27
Participants on Calls	250+

Source: ACES Working Group

2.4.4.1. Staff

A central staff provided coordination for the Working Group effort:

- Executive Director: Richard Baxter, Mustang Prairie Energy
- Assistant Director: Steve Austerer, Mustang Prairie Energy

2.4.4.2. Operating Committee

A group of experienced industry leaders provided leadership and program guidance to the ACES Working Group and spearhead further outreach to the wider energy storage industry.

- Ali Amirali, Starwood Energy Group
- Richard Baxter, Mustang Prairie Energy
- Jeff Bishop, Key Capture Energy
- Danny Kennedy, New Energy Nexus
- Troy Miller, GE Power

2.4.4.3. Legal Counsel

- Kirkland & Ellis LLP
- Morrison & Foerster LLP

2.4.4.4. Sponsors

- Clark ATC
- K&L Gates LLP
- Key Capture Energy
- Mustang Prairie Energy
- National Electrical Contractors Association (NECA)
- NEC Energy Solutions
- Powin Energy
- Sandia National Laboratories

2.4.4.5. Advisory Board

- American Council on Renewable Energy (ACORE)
- California Energy Storage Alliance (CESA)
- Clean Energy States Alliance (CESA)
- Coalition for Green Capital
- Electric Power Research Institute (EPRI)
- Energy Storage Association (ESA)
- NAATBatt International (NAATBatt)
- National Electrical Contractors Association (NECA)
- New Energy Nexus
- North American Energy Standards Board (NAESB)
- New York Battery and Energy Storage Technology Consortium (NY-BEST)
- Pacific Northwest National Laboratories (PNNL)
- Rocky Mountain Institute (RMI)
- Sandia National Laboratory (SNL)
- Solar Finance Council (SFC)
- Union of Concerned Scientists (UCS)

2.4.4.6. Investor Review Board

- Blackrock
- CIBC
- Hitachi Capital America
- New Energy Fund
- The New York Green Bank
- Nord/LB
- Quercus-Partners
- Siemens Financial Services
- Susi Partners Sustainable Investments
- Tortoise Advisors

2.4.4.7. Participating Firms

- Acelerex
- Anbaric Development Partners
- Black & Veatch
- Canadian Solar
- Cleantech Strategies
- CSA Group
- DNV-GL
- Energi Insurance Services
- Energy Storage Consulting
- Energy Tariff Experts
- Eversheds Sutherland US LLP
- FLEX
- GE Power
- Hartford Steam Boiler (Munich RE)
- Helix Power
- Highview Power
- Hotstart Inc.
- Hugh Wood Inc.
- Munich RE
- New Energy Risk
- Nexus Infrastructure Capital Management
- Norton Rose Fulbright US LLP
- Panasonic
- Power Edison
- Rhynland
- Schneider Electric
- Sound Grid Energy Partners
- Sparkplug Power
- Starwood Energy Group
- Strata Solar
- USI Insurance Services
- Willis Towers Watson

2.4.5. Committee Coordinators and Chapter Leads

- Committee Coordinators: Responsible for ensuring the development of all chapters in their Best Practice Guide
- Chapter Leads: Responsible for coordinating the necessary effort required to produce the Chapter in question

BPG 01: Project Development	**Bill Holmes, K&L Gates**
1. Overview	Bill Holmes, K&L Gates
2. Real Estate	Kyle Wamstad, Eversheds Southerland
3. Permitting	Kyle Wamstad, Eversheds Southerland
4. Regulatory	Robert Fleishman, Kirkland & Ellis
5. Incentives	Buck Endemann, K&L Gates
6. Off-Take Agreements	Bill Holmes, K&L Gates
7. Tax	Elizabeth Crouse, K&L Gates
BPG 02: Engineering	**Mark Manley, Black & Veatch**
1. Overview	Mark Manley, Black & Veatch
2. Independent Engineering Report	Mark Manley, Black & Veatch
3. Bankability Study	Mark Manley, Black & Veatch
4. Interconnection Study	Dan Sowder, Sound Grid Partners
5. Warranty	Davion Hill, DNVGL
BPG 03: Project Economics	**Russ Weed, Cleantech Strategies**
1. Overview	Russ Weed, Cleantech Strategies
2. Applications	Mike Jacobs, Union of Concerned Scientists
3. Rate Design	James Bride, Energy Tariff Experts
4. Project Proforma	Richard Baxter, Mustang Prairie Energy
5. Case Study	Ray Byrne, Sandia National Laboratories
BPG 04: Technical Performance	**Scott Daniels, Schneider Electric**
1. Overview	Scott Daniels, Schneider Electric
2. Data Interoperability	Dixon Wright, USI Insurance
3. Degradation / Augmentation	Richard Baxter, Mustang Prairie Energy
4. Performance Measurement	Scott Daniels, Schneider Electric
BPG 05: Construction	**Richard Baxter, Mustang Prairie Energy**
1. Overview	Richard Baxter, Mustang Prairie Energy
2. EPC Contract	Richard Baxter, Mustang Prairie Energy
3. Commissioning	Richard Baxter, Mustang Prairie Energy
4. Electrical Contractors	Richard Baxter, Mustang Prairie Energy
BPG 06: Operation	**Matt Koenig, DNVGL**
1. Overview	Matt Koenig, DNVGL
2. Operation & Maintenance	Joe Krawczel, Strata Solar & Matt Koenig, DNVGL
3. Performance/Availability Guarantee	Matt Koenig, DNVGL
4. End of Life	Richard Baxter, Mustang Prairie Energy
5. Thermal Management	James Hunt, Hotstart

BPG 07: Risk Management	**John Mooney, Hugh Wood**
1. Overview	John Mooney, Hugh Wood
2. Project Risk Insurance	David Tine, Hartford Steam Boiler
3. Exotic Insurance	John Mooney, Hugh Wood
4. Surety	Dixon Wright, USI Insurance
BPG 08: Codes & Standards	**Charlie Vartanian, PNNL**
1. Overview	Charlie Vartanian, PNNL
2. Safety	Dave Conover, PNNL
3. Reliability & Performance	Ryan Franks, CSA Group

2.4.6. Best Practice Guide Synopses

2.4.6.1. BPG 01: Project Development

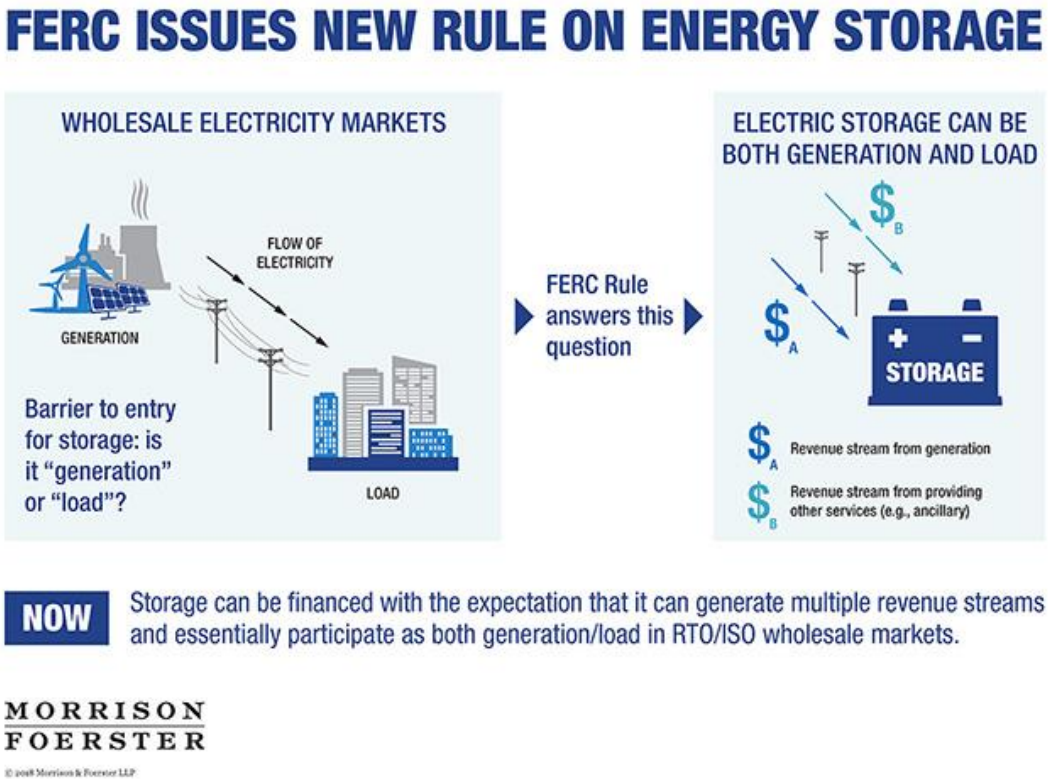
Project development documents help frame how an energy storage project is legally designed and how it interacts with external legal, regulatory, and financial frameworks. Since the energy storage industry has been maturing rapidly over the last few years, lessons learned in contract design and structure are extremely valuable. However, as in other energy project markets, commonality for project framework at all levels is highly valued as it assists project developers execute on their project pipelines with a higher success rate.

Table 4. BPG 01: Chapters – Project Development.

BPG 01 Chapters – Project Development	
1.	Overview
2.	Real Estate
3.	Permitting
4.	Regulatory
5.	Incentives
6.	Off-Take Agreements
7.	Tax

Source: ACES Working Group

Project development documents are designed to provide a legal structure for the project, identify revenue for the project for performance, and define what structural remedies (and their structure) are needed for non-performance. A well understood framework is necessary since it forms the basis for how creditors will be repaid; therefore, these documents need to highlight any conditions that directly affect the possibility of non-payment. They also help define the method of how projects can be structured (or not structured) such as the viability of retroactively fitting energy storage into existing renewable energy projects which might cause problems and open existing loan documents.



Source: Morrison & Foerster

Figure 3 – FERC Issues New Rule on Energy Storage.

A number of challenges remain with respect to developing a common framework for energy storage project development. For instance, if the project is not financially viable due to a regulatory change, how is this dealt with in the credit agreement? How do you define—and value—the experience of project developers? Finally, although the push for uniformity exists, project documents must take into account the variability of different jurisdictions and their impact on the project development process. For instance, local jurisdictions have an impact on real estate and permitting issues. Indeed, easements, building codes, and other safety restrictions are always site specific.

There remains the need for significant education by new project developers as to what is needed in order to successfully install and operate an energy storage system. Similarly, commonality between jurisdictions would allow easier translation of experience from one jurisdiction to another to take place more readily.

2.4.6.2. BPG 02: Engineering

Engineering analysis is the basis for any fundamental understanding of the capability and potential of the unit. The basis for the project's success hinges on its future cash flows; the return on and return of capital invested in the project. Understanding the viability and risk related to those cash

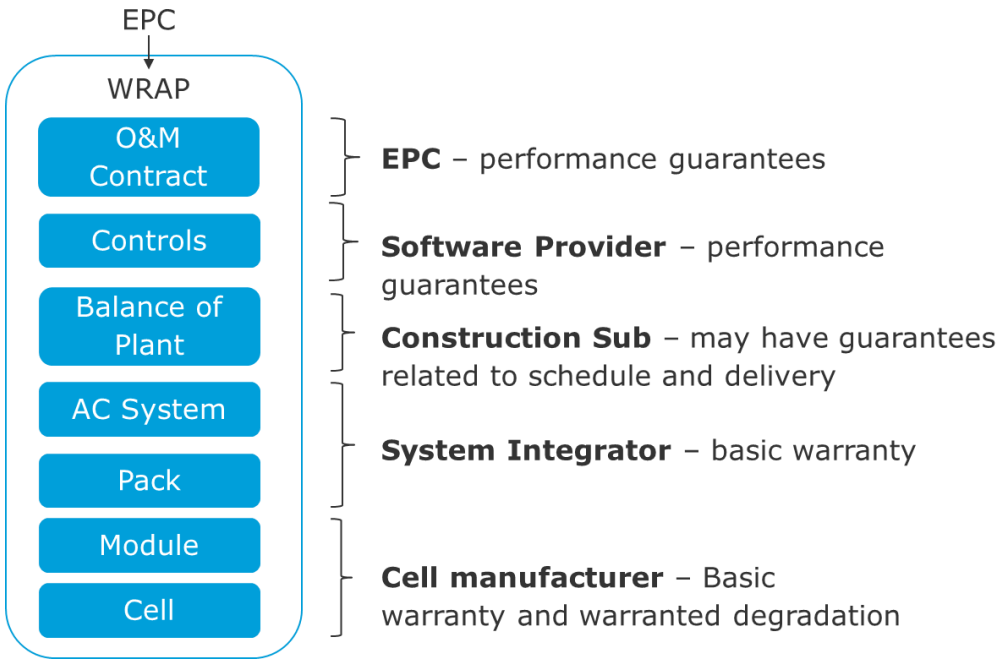
flows is, in large part, an exercise in understanding the technical aspects of the project. It must be designed in a well-planned manner, use proper equipment, and follow appropriate operating and maintenance (O&M) protocols in order to last its expected lifetime. Returns come from net income (revenue less expenses), so the project must be able to produce what is contractually expected and have O&M costs that align with budgets; both are subject to technical risks such as up-time, grid availability, equipment failures, resource constraints, fuel costs, and market prices.

Table 5. BPG 02: Chapters – Engineering.

Chapters: BPG 02 – Engineering	
1.	Overview
2.	Independent Engineering Report
3.	Bankability Study
4.	Interconnection Study
5.	Warranty

Source: ACES Working Group

The independent engineering report is important to investors in that it defines design and operating characteristics and costs, provides an opinion about degradation and the life of the project, and defines the risk for catastrophic failure. Battery degradation curves are critical, with often different groups on a project having different expectations. Finally, system interconnection is a critical point from a project development perspective.



Source: DNVGL

Figure 4 – Energy Storage EPC Components.

Continued refinement of the engineering analysis for energy storage systems will be fundamental to improving the ability to value use cases and applications under various real-world conditions. This understanding of the different degradation curves of the various technologies under assorted use cases is a key part in understanding the relative value of different energy storage technologies under different operating conditions. Energy storage is a more complex technological system than solar, so it will require more technological performance confidence.

A key next step will be the development of metrics for different performance characteristics so that they are easily understood and incorporated into contracts.

2.4.6.3. BPG 03: Project Economics

When a project developer intends to develop an energy storage project, it must be closely attuned to the requirements of the party providing project financing. These requirements can be financial (return on investment), policy-driven (procurements), technical (storage as best resource), and programmatic (storage as part of a solution set), and others.

Anticipating that increasing numbers of energy storage projects will be driven by ROI, it is important that the project developers, project financiers, solution providers, and other market participants clearly understand the different applications for storage, including the cost savings, revenue streams, and other benefits including resiliency. And for the benefit of the industry itself, energy storage also needs to build up case studies of such applications and projects employed in the market.

Table 6. BPG 03: Chapters – Project Economics.

Chapters: BPG 03 – Project Economics	
1.	Overview
2.	Applications
3.	Rate Design
4.	Project Proforma
5.	Case Study

Source: ACES Working Group

Many external inputs are important to project economics: demand charge, standby charge, capacity charge, etc. Different utility tariff structures make the project economic determination dependent upon utility / ISO location. A Proforma model is important in order to provide clarity into assumptions and expectations for developers and investors.

A number of challenges exist for improving the economic case for an energy storage project. For instance, determining the proper risk adjustment for the Proforma model relies on a clear understanding of technology performance and market rules. Investors continue to be more conservative about revenue streams than developers. Luckily, as the market expands, case studies will have added importance to showcase assumptions in action.

Some key next steps mentioned by participants in the ACES Working Group include having more standard definitions of market rules that would be tremendously beneficial to developers across jurisdictions. Also critical is having clarity that the regulatory environment will not change abruptly during the mid-life of project—and having protective adjustments in contracts if they do.

2.4.6.4. BPG 04: Technical Performance

The technical performance of the energy storage system is central to the ability of the developer to design and operate a successful system for the project. The various performance metrics are used in a number of ways, including driving the management of the operation of the system, deciding on any needed augmentation to fulfill service requirements, and serve as the basis for communicating performance and control of the system by the coordinating entity. Performance metrics also serve as the basis for other project contracts such as O&M contracts, and to determine if the system stays within warranty.

Table 7. BPG 04: Chapters – Technical Performance.

Chapters: BPG 04 – Technical Performance	
1.	Overview
2.	Data Interoperability
3.	Degradation / Augmentation
4.	Performance Measurement

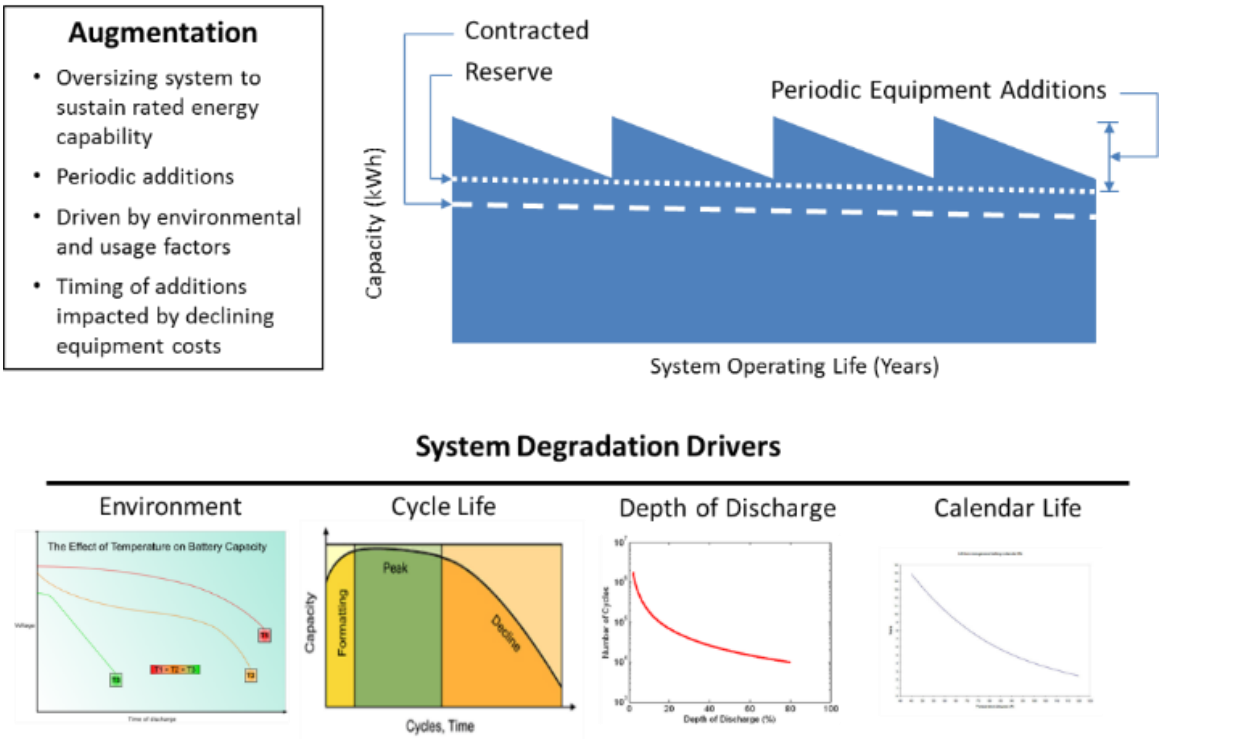
Source: ACES Working Group

In order for the system performance metrics to be representative of the project, performance needs to be understood and linked at the battery, module and system level. This detailed data analysis allows cell level warranty limits to be expressed at full system operation limits. In this way, the system level operational metrics can be designed to maintain these cell level warranty limits. This system level performance measurement can then be seamlessly shared through communications for system management and control.

At all levels of the industry, a number of challenges still exist for technical performance measurement regarding energy storage systems. Fundamentally, the questions is: What is the correct performance metric and how is it measured? The value of different performance metrics changes depending on what usage profile the energy storage system is attempting to follow. This is important to the various stakeholders because the value of different applications varies per market roles, along with the current operating condition of the energy storage system. This is also critical if stakeholders are trying to compare the performance of different energy storage technologies for the same use cases.

The industry needs to develop applications based on performance requirements that can be applicable to different energy storage technologies. This would allow for a more standard framework to provide commonality between application requirements for contract development.

As the market matures, best practices are leading to operation and maintenance contracts that are designed to be flexible yet provide a clear understanding of what is needed to keep equipment both within warranty and support contract requirements.



Source: Mustang Prairie Energy

Figure 5 – Augmentation and Battery Degradation.

2.4.6.5. BPG 05: Construction

The construction phase of a project is the critical period where all of the design and engineering elements are brought forth into a final system at the intended site. All aspects of this phase, including the Engineering, Procurement and Construction (EPC) contract, commissioning the system, and the choice in electrical contractors, are required to support the successful installation of a system at the customer's site.

Table 8. BPG 05: Chapters – Construction.

Chapters: BPG 05 – Construction	
1.	Overview
2.	EPC Contracts
3.	Commissioning
4.	Electrical Contractors

Source: ACES Working Group

EPC contracts govern the installation design and construction process for an energy storage facility. For this reason, the experience of the firm providing these services is critical. EPC contracts are designed to clearly state the requirements for the parties involved in the development of the energy storage projects. To that end, the contracts support successful execution of deployment, lay the foundation for profitable operation, and are a key component in attracting lenders by clearly stating and dealing with the primary areas of project risk.

Commissioning an energy storage system ensures that all components and the integrated system itself are installed, tested, and ready for operation according to the OEM's and system integrator's checklists. This process does not simply start when the construction is completed, but reaches back into the design phase where the commissioning team becomes familiar and comfortable with the equipment vendors' commissioning procedures. The team does this by reviewing the equipment specifications and applicable codes and standards that the system is required to meet, and then reviews or develops an integrated Sequence of Operations (SOO) for the commissioning process.

Using experienced electrical contractors can reduce construction time and outages during operation. As systems become larger and more complex, the expertise and experience of the electrical contractor is of critical importance for developers when choosing a firm.

Because of the central role of EPC firms to ensure risk management assurance for investors and lenders, the credit worthiness of the EPC firms remain is a concern. Many lenders have noted that it is imperative to get someone reliable to stand behind the integrated warranty coverage for the facility. For this reason, both a well-established, financed, and technically competent EPC partner is key to ensuring that lenders know where the limitations are in the contracts? Another concern by lenders in reviewing which EPC firm to use is the need to compare the experience of different EPC firms since all projects remain stubbornly unique.

Simply put, the industry needs to continue refining standard construction and commissioning procedures based on documented failures and successes

2.4.6.6. BPG 06: Operation

Understanding the operational capabilities and requirements of an energy storage system is central to maximizing the value of the system over its lifespan. Because of the integrated nature of the system in both design and integration, lessons learned from operational experience will prove invaluable towards improving the ability of these systems to support the usage profile over a system's planned lifespan.

Energy storage systems, like all capital equipment, face critical issues based on system operation parameters. Indeed, every element of the project's success relies on the ability of the unit to maintain its expected performance and availability. Therefore, it is imperative to have a well thought out allocation of responsibility among various parties in the O&M agreement. Other key factors, including operator experience, continue to gain in importance as to how the project delivers the promised cost savings. Overall, the O&M agreement highlights the integrated nature of the

O&M program for the project, which integrates safety, data collection and analytics, plant performance, training, and compliance in support of operational management and liability management for the project owners.

Table 9. BPG 06: Chapters – Operation.

Chapters: BPG 06 – Operation	
1.	Overview
2.	Operation & Maintenance
3.	Performance/Availability Guarantee
4.	End of Life
5.	Thermal Management

Source: ACES Working Group

Source: NAES Corporation

Figure 6 – O&M Best Practices.

A number of challenges exist in developing and maintaining the desired performance of the energy storage system during operation. One of the most important performance aspects is to establish clear scope of responsibilities for all parties as to what systems and subsystems they are responsible for operating, maintaining, and replacing if required. Another important item is to understand that, as the system ages, the initial specifications of the system will change, and it will be up to the operator to adjust the operational plan of the current system's capabilities in order to maintain the required output and performance.

A number of key operational procedures still require more definition and refinement. These are predicted to improve with time as the industry gains more and better experience. These improvements will help to improve standard O&M contracts so there will be less ambiguity concerning responsibility when critical issues arise—issues such as end of life considerations, and the impact on warranties by usage patterns and maintenance.

2.4.6.7. BPG 07: Risk Management

Risk management strategies incorporate understanding and managing the technical design and operational aspects of an energy storage system that can impact the exposure for loss by the different parties involved in the project. Insurance is a means for protecting against financial loss. For a complex and highly integrated issue such as energy storage project development, insurance is also a means to design risk management strategies that expand opportunities at a lower cost through leveraging the financial assets of the insurance firms.

This risk management and allocation focus is especially important for energy storage project development. Project developers and lenders both generally agree that energy storage projects are not fundamentally different than a typical power industry project finance transaction, especially with relation to risk allocation. The deal will not close until the known risks have been addressed and safeguards put in place for unknown risks. However, energy storage is somewhat different than other power projects. Therefore, the risk management strategy will need to take account of the unique energy storage project's technology, policy and regulatory mandates, and market issues.

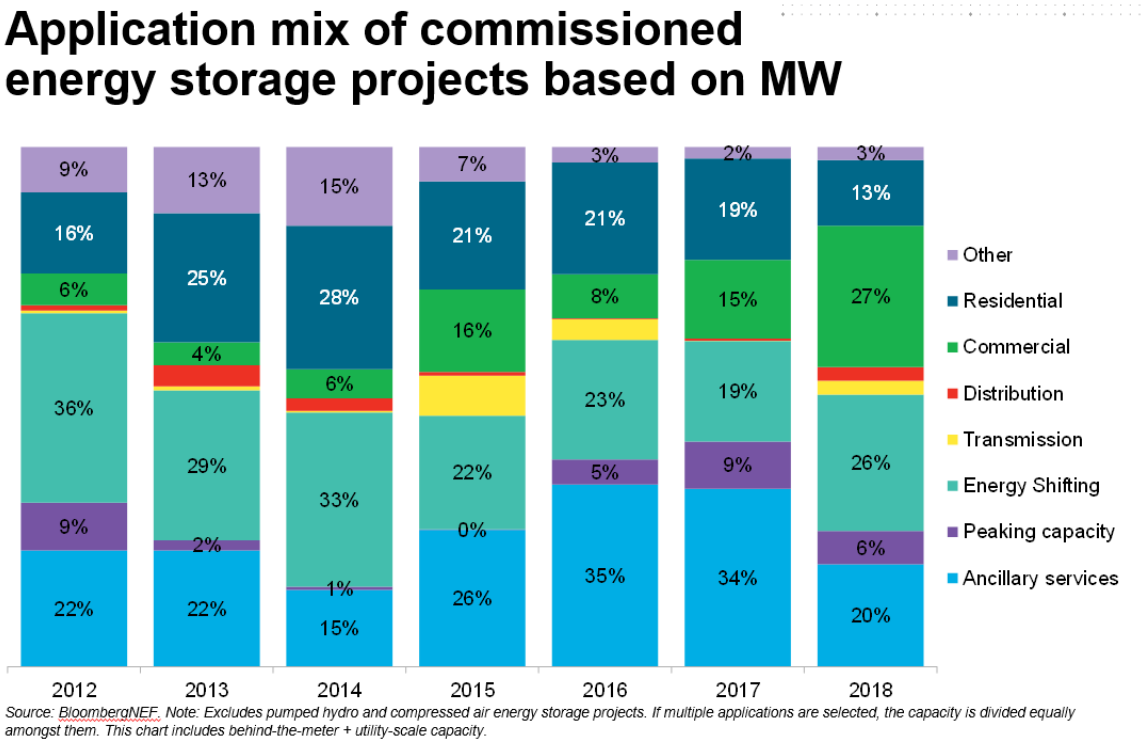
Table 10. BPG 07: Chapters – Risk Management.

Chapters: BPG 07 – Risk Management	
1.	Overview
2.	Project Risk Insurance
3.	Exotic Insurance
4.	Surety

Source: ACES Working Group

Insurance companies reduce their own risk exposure through a detailed understanding of a system's technology, operation, and interaction with the power market. Insurance policies are an important component of any energy storage project development, providing a cost-effective means to reduce the need to design and oversize the system. This is attractive to investors who also benefit from the insurance company's requirement for a formal design review and adherence to standards that ensures the project will be done on time, ahead of budget, and without surprises.

A number of key challenges exist for insurance providers to design products and strategies that bridge the gap between the understood capability of the system and the expectations of the unit during operation. For instance, how do you define and value the different possibilities of project interruption and failure? As the market matures, risk management firms need to ensure that those entities best suited to handle particular risks are adequately compensated.



Source: BloombergNEF

Figure 7 – Application Mix of Energy Storage Projects.

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 projects. Lacking sufficient data in emerging industries such as 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 with the ability to determine what the actual risk premium cost for a variety of project development choices is. As the industry gains more experience, re-insurers (insurance for insurance firms) will get involved, reducing further the cost for insurance coverage.

2.4.6.8. BPG 08: Codes and Standards

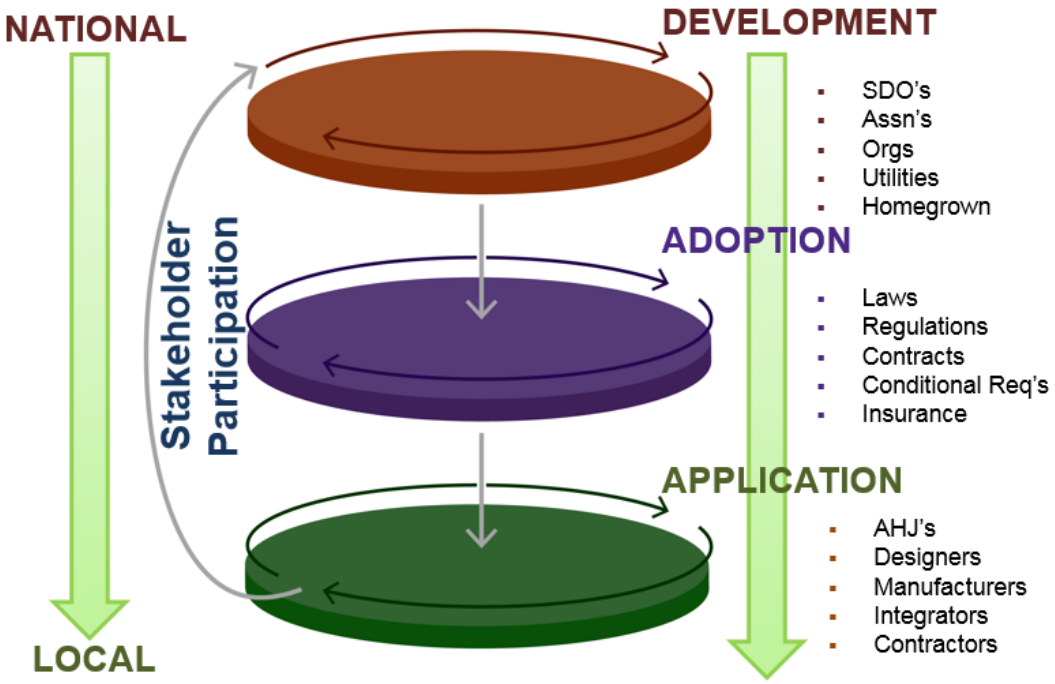
Codes and Standards are critical to the successful development of energy storage projects at all levels of the industry. First, these rules have a direct impact on the cost of the energy storage project through the requirements of specific equipment to be used, and the labor practices performed during construction. Secondly, these rules establish the procedures by which safety, performance and reliability are documented and verified. Failing to achieve signoff on these guidelines during construction can cause significant delays in the project achieving the required approvals needed for the facility to begin operation.

Table 11. BPG 08: Chapters – Codes and Standards.

Chapters: BPG 08 – Codes and Standards	
1.	Overview
2.	Safety
3.	Reliability and Performance

Source: ACES Working Group

Currently, there are two key areas of focus for Codes and Standards in the energy storage market: safety, and reliability and performance. Energy storage industry has well defined safety standards, but needs better reliability and performance standards. Many of the issues driving codes and standards in the energy storage market are cross-cutting issues that are relevant to many parts of the industry in general. First, they have significant impact on the timing of the approval process for the facility. Secondly, the more investors understand the existence and importance of codes and standards, the greater the likelihood they will invest in a project that adheres to requirements that ensure the project will not have any unforeseen delays—and therefore be ready on time for market operation.



Source: Pacific Northwest National Laboratory

Figure 8 – Formal Standards Development.

Of the two areas of focus, safety standards are more mature, with reliability and performance in a relatively earlier stage of development and adoption. There is a great need to advance this aspect

of the industry. Indeed, the DOE/EPRI 2013 Electricity Storage Handbook in Collaboration with NRECA (updated in 2015)[30] highlighted the fact that the lack of standards was one of the key challenges hindering adoption of energy storage technologies.

It is imperative for the industry to develop common reliability and performance standards to promote more reliable operation of energy storage systems. These actions will accomplish little, however, unless the Authorities Having Jurisdiction (AHJ) becomes a partner in documenting and adopting these standards for wider industry use.

3. MODEL CONTRACTS

As emerging industries mature, a handful of leading firms begin to drive market development, without any one single firm dominating in years previously, as is sometimes typical in nascent markets. Although the commercial market growth has begun to accelerate, these leading firms recognize that their internal costs remain higher than they'd like, and market growth continues to be impeded by a number of factors. These included multiple leading firms providing contracts that remain unique to preserve competitive advantage, customer confusion due to a lack of customer education on all of the different offerings, and the time needed by customers to maintain current knowledge.

At this point in an industry's growth cycle, industry trade groups or a consortium of leading firms typically join forces to craft industry wide market model contracts and supporting documents to improve the market in order to:

- **Accelerate market growth**—the leading firms typically agree to work together as they feel they're in a good position to capture most of the accelerating growth (and trailing firms are supportive of anything that could give them a change for more sales).

- **Increase competition**—most developers are not looking for greater competition for customers, but leading firms recognize they are better able to absorb cost reductions to improve their position, and they realize that the bulk of potential customers remain on the sidelines due to confusion.

- **Reduce risk**—as the market begins to expand considerably, efforts to reduce loss exposure becomes a critical requirement to lenders and insurance firms who are increasingly being tapped to fund the expansion of the industry and cover unexpected risks.

The development of additional and improved industry standard model revenue contracts and supporting risk management documents will benefit the growth of the energy storage market. Because of the similarities in project structure, energy storage can leverage the experience in solar, energy efficiency, wind, and electricity marketing to provide a more open and accepted suite of market model.

3.1. PV

Governments, organizations, and leading firms in the solar industry have joined forces to produce a succession of evolving and improving market models that have become widely accepted and used for solar project financing. One of the best examples, the Solar Access to Public Capital (SAPC)[31]. Working Group worked over a 3-year period between 2012 and 2015 to develop standard residential lease and commercial power purchase agreement (PPA) contracts available for use by solar developers, customers, and third-party finance providers. The SAPC was part of a National Renewable Energy Laboratory (NREL) multi-year project, funded by the U.S. Department of Energy's (DOE) Balance of System Program, which aimed to facilitate and hasten

the solar photovoltaic (PV) industry's access to public capital through securitized instruments and other investment vehicles. The project comprises three distinct efforts, each targeting a market barrier to solar securitization: SAPC working group, data collection, and analysis. The results of the effort are designed to improve consumer transparency, reduce transaction costs in the solar contracting process, and facilitate the pooling of associated cash flows so that they may be securitized and sold in the capital markets.

To continue to the development of valuable contracting tools, the SAPC Working Group reformed into the Solar Energy Finance Association (SEFA). The goal of the SEFA (which was first organized in late 2013) was to advance the availability of public capital and expand the financing options for the solar energy industry. SEFA relied on involvement of stakeholders in the solar industry, banking, government and the capital markets to promote their common interests and to improve financing conditions and availability of financing options for solar energy. The group's flagship initiative involves overseeing the standard lease and power purchase agreements developed by the Solar Access to Public Capital (SAPC) working group[32].

As the solar industry continued to expand, the need to harmonize efforts and provide higher quality and more capable model contracts to support further growth prompted the SEFA to merge with the Solar Energy Industries Association (SEIA)[33] on Jan 3, 2017. This is a clear example of the natural progression of market model development—an industry continues to evolve, a widely regarded trade group needs to step in to ensure broad agreement and support for continued contract development to maintain growth in the industry that will support all of the current and future market roles. SEIA maintains model leases and PPAs for the industry on its website.[34] These include:

Commercial Customers:

- Commercial PPA: PPA for Commercial Customers
- PACE Addendum: PACE Addendum
- Lease Agreements: Lease Agreement for Commercial Customers

Residential Customers:

- Residential PPA: PPA for Residential Customers (Aggregated)
- Residential PPA: PPA for Residential Customers (Disaggregated)
- Lease Agreements: Lease Agreement for Residential Customers (Aggregated)
- Lease Agreements: Lease Agreement for Residential Customers (Disaggregated)

State governments can also play a critical role improving the contractual environment. The California Energy Commission joined forces with the California Public Utility Commission to develop the Go Solar California! Campaign. The campaign's goal is to support California residents and businesses to install solar energy systems. The campaign provides California consumers a central location for information on solar programs, rebates, tax credits, and information on installing and interconnecting solar electric and solar thermal systems. The website provides data

on the various program rules, eligible equipment and standards, and how to locate an eligible, licensed solar contractor.

An important and unique aspect of the program is the California Energy Commission's Eligible Equipment Lists[35]. These lists cover PV modules, inverters, meters and related equipment. All of the equipment on the lists are required to undergo tests to verify minimum safety and performance standards. The power of this effort stems from the requirement that any solar energy system receiving ratepayer-based incentives must utilize equipment from these lists. In addition to requiring the use of equipment from these lists, the California Energy Commission establishes eligibility criteria, conditions for incentives, and rating standards for projects.

3.2. Energy Efficiency

The evolution of the flexible and robust contract framework in the energy efficiency market is another important example for the energy storage industry. Here, a consortium of the end-use customers spearheaded the effort to develop an industry wide and accepted market model for project financing after recognizing the benefit of greater usability and visibility of a move toward commonality of contract structure. As compared to the solar and wind industry, the energy efficiency market creates value for customers through cost saving of energy usage. This will have many parallels in the Behind the Meter commercial energy storage market.

In the early days of the energy efficiency industry, many developers crafted their own proprietary contracts to describe the terms and conditions of the efforts to save energy usage through energy efficiency retrofit projects on existing commercial and industrial buildings. Although this led to many innovative approaches, it also led to a number of different and somewhat unique contract language and structures—even though the end-product for the effort for the customer was the same. More importantly, and unfortunately, customers and lenders were left with a not insignificant self-educational requirement to understand the various offerings available to them from different service providers, typically limiting the number of counter-parties customers and lenders were able to work with, effectively limiting competition in the market. In particular, since the core of the savings contracts are effectively the same, groups developing their own products and tools intentionally maintaining the difference in their products to preserve their own market position.

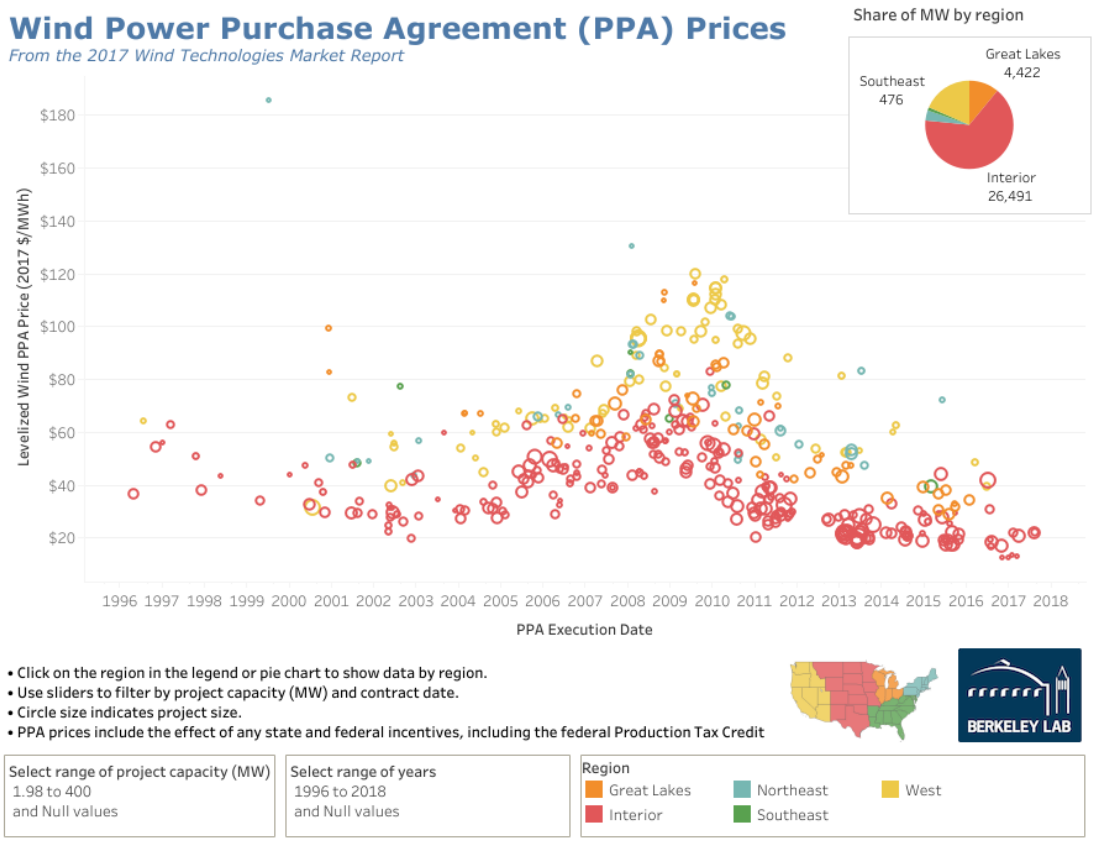
In order to reduce the barriers holding back market acceleration and a wider pool of participating firms, customers in the energy efficiency industry developed shared market contract models to advance project development efforts. In order to accelerate market growth and improve competition. Through the Building Owners and Managers Associations (BOMA), the energy efficiency industry developed a standard energy performance savings contract model to enable energy efficiency retrofit programs for commercial buildings. The *BOMA ENERGY PERFORMANCE CONTRACTING MODEL (BEPC)*[36] was designed to provide a straightforward path for building owners or managers to develop and execute investment-grade energy efficiency retrofit programs. By developing an industry-sponsored standard contracting model, building owners and energy service providers established a better starting point from which to tailor an energy performance contract for different customers, while retaining similarity of the core

operational structure. The BEPC model provides transparency on pricing and performance expectations and to give building owners a high degree of confidence that the project will meet the stated goals in a competitive manner.

3.3. Wind

The wind energy supported the development of early wind industry PPA contracts through adapting existing thermal plant PPA contract structures to their needs. Since the scale of the wind projects quickly rivaled that of other power industry generating projects, existing power project PPAs and supporting contract documentation and language was suitable, but required revision for non-dispatchable systems.

The American Wind Energy Association (AWEA) has continued to promote the advancement of PPA documentation through its publication series *Evolution of the Corporate Wind PPA: Market Insights*[37]. This report provides data and analysis on the structure and location of corporate wind PPAs over time. AWEA provides insights into PPA types, contract term lengths, settlement points, and parties involved. Another source of data on wind PPA prices is the U.S. Department of Energy. This type of data publication provide greater market visibility, helping potential off-takers more information of existing contract structure, details, and prices. This effort supported the general decline in PPA prices for wind over the last 20 years (except for a short period between 2007 and 2011 due to external forces).



Source: 2017 Wind Technology Market Report, Lawrence Berkeley Laboratory

Figure 9 – Wind Power PPA Prices

3.4. Energy Storage

No widely utilized industry standard model contracts for energy storage systems have been established as of the publication date of this report. However, the energy storage industry does not necessarily need the same centralized effort to develop useful industry model contracts as was the case in early renewable energy markets. Because of these previous examples, there are a multiple ways for the energy storage industry to obtain useful common project financing models and project documentation that will accelerate the growth of the energy storage market.

First, the energy storage market is more complex than the solar, wind, and energy efficiency markets. As it can act as operate akin to all three, the energy storage industry will require both PPAs and energy savings performance contracts. Secondly, other markets may be primary to the function of the facility. For instance, in a solar/storage project, the financial contract is more defined as a solar production contract, rather than a storage service one. Therefore, the solar production will be core to the solar/storage contract to obtain revenue contracts in the market.

Finally, because of these different financial structures exist, what is critically necessary for the development of project utilizing energy storage systems is to provide more structured supporting documentation to reduce the operating risk of the storage component through more standardized contracting environment. Key drivers for these include applications, performance metrics, common terms, and testing and verification.

3.4.1. Applications

Energy storage facilities are capable of a myriad of uses which range from behind the meter, to the wholesale market and the transmission and distribution system. The key for defining the applications is thus find a value for a customer in one of the market segments for the available usage profile. An in-depth overview of the different types of possible applications and their role in the markets can be found in the DOE/EPRI Electricity Storage Handbook in Collaboration with NRECA (2015)[38].

Table 12. Summary of Energy Storage Applications

Wholesale Applications	Retail Applications	Reliability Application
Reserves	Customer Demand Charge Reduction	Grid Resilience
Resource Adequacy	Time of Use (TOU) Charge Reduction	Voltage Support
Arbitrage: Renewable Energy Time Shift	Grid Resilience	T&D Upgrade Deferral
Transmission Congestion Reduction		Frequency Response
Frequency Regulation		Small Signal Stability

Source: ACES Working Group

Defining applications by the market segment provides categories more closely related to value and revenue potential from storage. The ability to recognize value from an application will differ by many attributes—time of day, cost of the system, value of services, who is the customer, etc. Because of the changing nature and capabilities of energy storage technologies, they will be able to address a variety of emerging new applications in the stationary electric power market. Therefore, there is no "final" list of applications as the needs and structure of the electric power market may provide additional opportunities for energy storage systems to operate successfully in the future.

3.4.2. Performance Metrics

An effective method to mitigate project operation risk to ensure easier project financing is to tie the compensation of the project to performance metrics. Some utilities have used this approach in their early projects to ensure these systems perform as agreed-to. System performance metrics are operating results based on technical performance measurements. By using these performance metrics, the performance of the energy storage system can be evaluated with the metrics used in contracts to ensure the system maintains its operational target.

- **Availability:** The degree to which an energy storage system is in an operable and dispatchable state.

- **Available Capacity:** The energy storage holding capability (kWh) of the energy storage system when fully charged.

- **Capacity Degradation:** The reduction is the energy storage holding capability (kWh) of the energy storage system over the life of the unit.

- **Duty-Cycle Round Trip Efficiency:** The useful energy output from an energy storage system divided by the energy input into the energy storage system over a charge/discharge profile that represents the demands associated with a specific application that is placed on an energy storage system, expressed as a percentage (%).

The U.S. Department of Energy has been supporting the energy storage industry to evaluate and define the performance of energy storage technologies in different applications through the development of tests and metrics for these technologies in different market applications. The report PNNL-22010 *Protocols for Uniformly Measuring and Expressing the Performance of Energy Storage Systems* (the "Protocols Report") and PNNL-233090 *Determination of Duty Cycle for Energy Storage Systems Integrated with Microgrids* were developed to define the technical characteristics of an operating energy storage system in design, factory acceptance testing, commissioning, and/or periodic testing over project service life. The reports defines a number of representative duty cycles for different applications based on real-world data. The Protocols report can also provide guidance on how to measure, derive, and define useful application metrics for energy storage systems.

The duty cycles are designed to model realistic usage patterns, and range from energy to power intensive, and include attributes of stacked use cases. Other Standards groups have endorsed this effort and show signs of adopting this methodology globally. As the industry continues to advance its understanding of the operation of these assets, this report will be updated (currently on revision 2), and provide the foundational basis for developing an initial standard for the uniform measurement and expression of energy storage system performance.

3.4.3. Common Terms

Developing common terminology for the energy storage industry is a critical part of standardizing contract development effort. The Electric Power Institute's Energy Storage Integration Council (EPRI-ESIC) is an industry forum where electric utilities guide a discussion with energy storage vendors, government organizations, and other stakeholders to develop safe, reliable, and cost-effective energy storage options.[39] The EPRI-ESIC is organized in three working groups. The group develops guidelines and definitions for evaluating energy storage system value and impacts on the power system. In addition, the EPRI-ESIC characterizes and standardizes technical parameters of energy storage system against utility requirements. The group works to improve industry standards by developing common metrics and establishing performance and test protocols.

The three EPRI-ESIC working groups are:

- Working Group 1: Grid Services and Analysis
- Working Group 2: Testing and Characterization
- Working Group 3: Grid Integration

The EPRI-ESIC has developed a series of publicly available reports, tools, and templates to support the deployment of energy storage projects. These include:

- A Guide to ESIC: The Energy Storage Integration Council
- ESIC Energy Storage Implementation Guide
- ESIC Energy Storage Request for Proposal Guide
- ESIC Energy Storage Technical Specification Template, v2.0
- ESIC Energy Storage Test Manual
- ESIC Energy Storage Modeling Bibliography
- Common Functions for Smart Inverters: 4th Edition
- ESIC Energy Storage Commissioning Guide
- ESIC Energy Storage Cost Template and Tool v2.0
- Energy Storage Safety: 2016
- StorageVET and supporting documentation

3.4.4. Testing & Verification

Third party equipment testing and performance verification is an important steps towards improving the environment for more standardized contracts to finance energy storage projects. Standardized 3rd party testing of equipment and performance will drive greater commonality between financing arrangements. Financial models and insurance coverage are based on future project performance. Currently, much of that forward performance is an assumption; as data on real projects under different conditions are able to be evaluated and cataloged, these assumptions can be verified and improved, resulting in lower cost due to a higher degree of accuracy of forecast. As the results of the testing and verification tighten the range of assumptions that various actors

make, this will also reduce the band of expectations from these systems towards and industry norm based on best practices.

Validation of these testing procedures will require significant input from the OEM and integrator community to ensure both validity, and common usage. As the market moves towards more standard market models for project contracts, this commonality will benefit the overall community, helping to provide a benefit to these firms for having 3rd party service providers be able to access proprietary areas of the system and controls.

3.5. Electricity Marketing

The Edison Electrical Institute (EEI) has worked to promote model contracts for the electric power industry that work to lower costs and improve the services offered to customers. It does this through a number of standing Committees and working Groups. For instance, the EEI Working Group and Contracting Drafting committee (CDC)[40] works to promote liquidity and reduce transaction costs in U.S. wholesale electricity and related markets. Its mission is to support:

1. **Standardized Contracts.** To develop and promote the use of standardized model contracts and product descriptions for physical energy transactions in U.S. wholesale markets;

2. **Standardized Optional Provisions.** To develop industry consensus positions and publish suggested contract provisions based on those positions for use, and

3. **Keep the Industry Informed**. To inform energy attorneys, credit risk managers, contract administrators, and other energy industry professionals of emerging issues and possible ways to solve those issues by using standardized contracts.

Another EEI group, the Contract Working Group (CWG) is a broad group of electricity market participants who provide input to the CDC. Through the CWG, the EEI worked with the National Energy Marketers Association (NEMA) and others to develop a model bilateral Master Contract[41] containing the essential terms governing forward purchases and sales of wholesale electricity. The Master Contract provides the following benefits:

- Streamlines establishing a trading relationship,
- Provides real-time credit provisions,
- Standardizes product definitions, and
- Focuses traders on the transaction's basic negotiable elements, e.g., price, quantity, location, and duration.

The EEI Master Contract has been used in a variety of market applications across the electric power industry to provide a core of well accepted terms as a basis for new and innovated business models that form basis of interoperability with other business processes in the electrical power market.

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4. INDUSTRY STANDARDS

Formal industry standards are recognized specifications for product or practice that have been developed, approved, and published by a standards setting organization. Standards address the needs of market participants who adopt the standards to ensure that products or industry practices meet a minimum criteria for safety, quality, and performance. Depending on the need of the particular industry, they may establish specifications for a product or practice. In doing so, standards help to reduce prices, bring products to market more quickly, help increase the acceptance of new products by ensuring their interoperability, and generally reduce confusion through defining terms on how products and services are provided in an industry.

Authority's Having Jurisdiction (AHJs) are the groups that adopt the standard as they have the standing for enforcement to ensure compliance by industry participants. For example, in the 2014 National Electrical Code (NEC), the term Authority Having Jurisdiction (AHJ) is defined as "An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure." Adoption typically occurs at the national level, but amendments can be made to address specific needs of a local jurisdiction nor addressed at the national level.

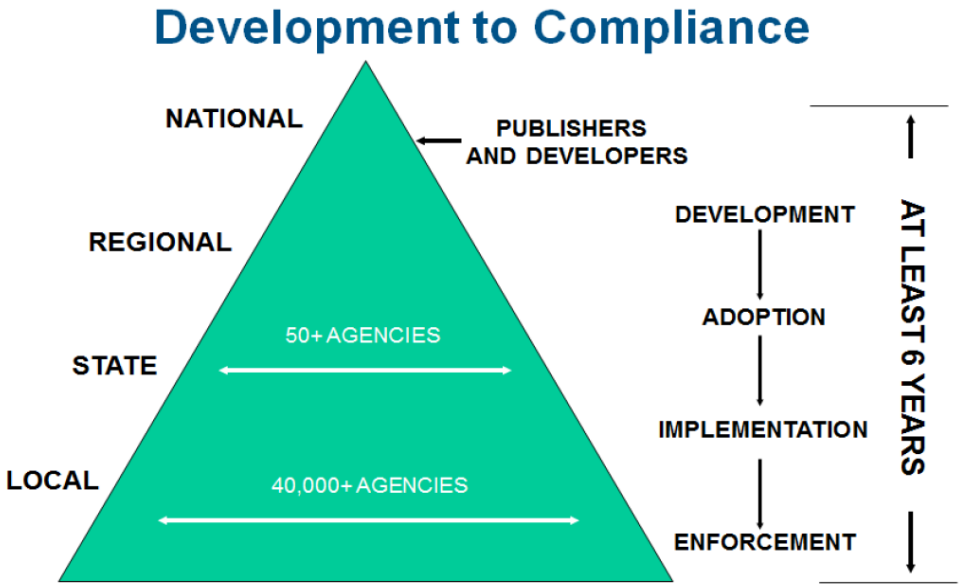
At the global level, the International Electrotechnical Commission (IEC) develops and publishes standards for all electrical, electronic and related technologies. This effort is done with input and involvement from groups from across the globe. Standards in the United States is coordinated by the American National Standards Institute (ANSI), which accredits Standard Developing Organizations (SDOs)—the actual groups that develop and publish standards depending on the industry to address specific issues, technologies and design/construction solutions.

Table 13. Key Standards Developing Organizations for Energy Storage

Key Standards Developing Organizations for Energy Storage	
ASTM	American Society for Testing and Materials
CSA	CSA Standards
IEEE	Institute of Electrical and Electronics Engineers
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
UL	Underwriters Laboratory

These (and other) SDOs develop and revise existing standards on a set schedule for publication, with each SDO organizing and managing the process according to its own guidelines. It is important to remember that the SDO organization administers the process for developing or updating a standard, but the documents themselves are developed by the market participants who are affected by the standard. For this reason, it is critical for industry participants to maintain involvement in the standards development effort for their industry—be they manufacturers, system integrators, EPCs, developers, etc.

Standards have played a critical role in the development of emerging energy industries. Looking at the solar, energy efficiency, and wind markets can provide examples for the energy storage industry in how expanding standards can improve both the industry's market growth, and support the development of its contracting process. Products that adhere to formal standards do initially carry some additional costs due to the design and testing, but these same influences begin to drive costs down due to factors of scale when the market reaches commercial maturity. More importantly, adherence to standards by manufacturers, system integrators, and EPC firms during construction is one of the most important strategies in preventing unanticipated losses. Periodic inspections by AHJs during the construction can hold up the project until the issue is remedied—adding precious time and cost to the construction schedule. For this reason, Developers and lenders have a specific interested in ensuring adherence to all mandated codes and standards governing the construction and operation of the energy storage project.



Source: PNNL

Figure 10 – Standards Development to Compliance

The solar, energy efficiency, and wind markets can provide insights into codes and standards development for the energy storage industry through three frameworks: safety, performance, and business practice improvement. Each of these areas are a critical area for supporting and advancing the ability to develop project financing contracts, and the supporting materials that detail and define the financeability of the project. Through these frameworks, we not only see the content, but also the role different organizations play in developing the standards that help organize and structure the industry.

4.1. Solar

Many groups within the solar industry have promoted to development of safety and performance standards in order to reduce the cost to end customer and open up greater opportunities for the industry. In particular, industry trade groups play a critical role. The Solar Energy Industries Association's (SEIA) Codes and Standards Working Group[42] monitors and participates in the development of product standards and building codes on behalf of the solar industry. The Codes & Standards Working Group works to support the development and refinement of product standards and conformity assessment procedures to ensure that products used in the industry meet a minimum threshold requirements for safety, performance, and reliability.

SEIA's critical role in the solar industry is to coordinate with Standards Developing Organizations (SDO) groups such as UL, ASHRAE, NIST, etc., code developers, first responders, etc. and advocate for the solar industry during the Standards making and review process.

Ongoing efforts will include supporting:

- **Building Codes:** Solar-friendly building and installation codes developed through the International Code Council (ICC) through its public consensus process, and then their adoption by local state regulatory bodies.

- **National Electrical Code**: The National Fire Protection Association (NFPA) also oversees a similar process for the National Electrical Code (NEC). The NEC is updated every 3 years, with 2020 being the next publication cycle.

- **International Solar Energy Provisions (ISEP)**. The ISEP is a reference book that assists building and inspection officials in the identification and application of solar-related provisions for use in inspecting solar installations.

4.2. Energy Efficiency

A number of groups have provides key support for the ongoing development of codes and standards in the energy efficiency market. The U.S. Department of Energy has been a critical driver for improving energy efficiency product standards in the United States.[43] Through the Energy Policy and Conservation Act of 1975 (EPCA), the U.S. Department of Energy was designated to implement and enforce efficiency standards for a range of residential and commercial equipment. The Department of Energy's Office of Enforcement verifies that products sold in the United States meet the energy and water conservation standards. Certification, compliance, and enforcement regulations for these products and equipment are published in the Code of Federal Regulations (CFR) at Title 10 part 429.

These Federal efficiency standards (where technically feasibility / cost effective) require product designers to reduce the amount of energy needed to operate the equipment Regular updates of the Standards ensure continuous improvement. The series of energy efficiency standards have

produced a number of benefits since their inception. The U.S. DOE's efficiency Standards cover more than 60 categories of products, and are estimated to reduce the nation's energy bill by $80 million in 2015.

Specific benefits of the introduction of energy efficiency Standards include:

- **Cost Savings**: The U.S. Department of Energy is required to establish appliance and equipment standards that are cost-effective for consumers. Manufacturers must guarantee that appliance and equipment price increases will be recovered through electricity savings within the product's lifetime.
- **Energy Savings:** Energy efficient appliances and equipment use technologies that are less energy intensive to reduce the amount of electricity used per product.
- **Energy Security:** Efficient appliances and equipment provide a cheaper, faster, and more reliable means of meeting increasing consumer demand without the need to develop or import more energy sources.
- **Emission Reductions:** Energy efficient appliances and equipment contribute to a reduction in greenhouse gas emissions, since declines in electricity consumption require less energy generation from fossil fuel-fired power plants.
- **Technology Innovations:** Appliance and equipment standards provide a means of ensuring that manufacturers move away from outdated technologies towards the most efficient, innovative, and competitive product designs.
- **Market Barriers:** Manufacturers benefit from national standards that provide market consistency and certainty across the United States, eliminating the need to comply with different state standards. Standards create economies of scale and simplify market entry for manufacturers, which reduces the retail cost of innovative technologies for consumers.
- **Job Creation**: Standards create research, manufacturing, and installation jobs. The American Council for an Energy-Efficient Economy (ACEEE) estimates that 340,000 jobs could be attributed to existing appliance standards in 2010.

Trade groups have also made meaningful support and contribution towards standards development where their expertise allows to provide the greatest contribution. The Institute of Electrical and Electronics Engineers (IEEE) has been a clearinghouse for performance related technical information on the effort to promote increase energy efficiency efforts in the U.S., and worldwide. This effort takes a number of avenues, including providing resource libraries[44], standardization frameworks on energy efficiency measuring and monitoring[45], and highlighting the advances in energy efficiency standards development in the area of energy efficiency and management[46].

Industry trade groups also play an important role in supporting building code development. BOMA International maintains an active presence and involvement contribution to building codes development. This effort is an important example as to why groups representing the industry participants should be involved in the codes and standards development. Through this effort, the national commercial real estate association can participate in the development of building codes which will have a direct impact on their business. BOMA International maintains an active

building codes advocacy program. BOMA International's building codes team working in conjunction with state and local BOMA Codes Committees to ensure that the interests of commercial real estate are represented from building codes development to implementation.

4.3. Wind

In the wind industry, we also find an industry trade group supporting a variety of safety and performance standards develop in support of the industry. Here, the American Wind Energy Association (AWEA) became an ANSI accredited standards development organization for consensus wind energy standards in the United States[47]. In this role, AWEA is the Secretariat, and administers the ANSI standards process through AWEA Standards Committees.

1. Wind Technical Standards Committee (WTSC)
2. Wind Workforce Standards Committee (WWSC)
3. Wind Environmental, Health, and Safety Standards Committee (WEHSSC)

These Standards Committees develop and maintain voluntary national consensus standards for the U.S. wind industry in accordance with the ANSI Essential Requirements procedures[48], and publishes the final product of the consensus process. Three different types of documents are developed by these Standards Committees.

1. **Standards**: documents with mandatory requirements
2. **Recommended Practices**: documents in which procedures and positions represent good practices
3. **Technical Reports**: documents in which alternative approaches to good practices are described and suggested but which make no clear-cut recommendations

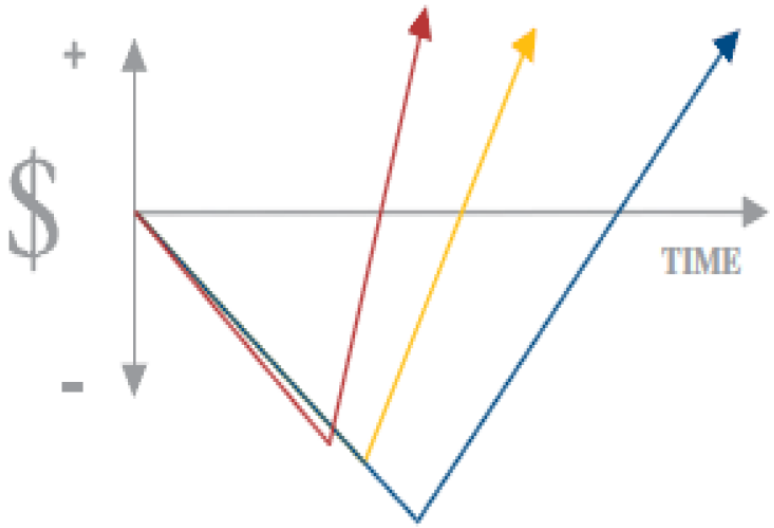
4.4. Energy Storage

The development of formal industry standards is crucial for the sustained growth of the energy storage industry. Formal safety, performance, and business practice standards underlie all mature energy markets.

Standards have a direct impact on the cost of an energy storage project through affecting the design, equipment selection and construction. Investors and developers have a vested interested in having the system integrator or EPC verify that appropriate codes and standards are followed throughout the process. Failing to ensure this can cause delay in operation, and possibly impacting the operational range of the facility.

Documenting compliance with the relevant codes and standards is a cost, but as was previously discussed, the investment is in maintaining momentum with the development and construction process; the cost of delays here can quickly overtake the compliance costs. The critical group for developers is to maintain the appropriate Authorities Having Jurisdiction (AHJ). These are

typically the local organization or individual responsible for enforcing the requirement for a particular code or standard. How these groups enforce the requirements can vary, again emphasizing the need to ensure proper documentation for all required compliance. Therefore, a critical need is the incorporate them into the project from the beginning so you know when to obtain the needed review, approval and inspections as the AHJ deems appropriate.



Source: PNNL

Figure 11 – Value of Standards Development

The location of the energy storage system on the grid is where on the grid it is located. For systems in front of the meter, systems are subject to what the utility has adopted. For system located behind the meter, systems are subject to what local AHJs based on location, ownership, etc.

For all of these reasons, groups involved at all levels of the energy storage project development industry—including developers, OEMs, finance, etc.—need to be involved the development of new standards and/or the updating of existing standards and model codes to ensure those documents are current and accurate while being sensitive to their interests.

4.4.1. Safety

The area of Safety enjoys the most mature area of standards development in the energy storage market. The U.S. Government has been a key driver for this effort, coordinating ongoing work by manufacturers and SDO groups. The Safety development effort continues to be development and coordinated through the Energy Storage (ES) Safety Collaborative.[49]

Through Sandia National Laboratories, the U.S. Government has published a number of safety related publications, with *Energy Storage System Guide for Compliance with Safety Codes and*

Standards[50] being the one of the most important collection. As the report states, "This Compliance Guide (CG) is intended to help address the acceptability of the design and construction of stationary ESSs, their component parts and the siting, installation, commissioning, operations, maintenance, and repair/renovation of ESS within the built environment." Because of the continuing change in the environment, a periodic update is provided, with the March 2019 publication of the Codes & Standards Update from the Energy Storage Safety Collaborative[51] being the most current as of the publication date of this report.

Safety standards are typically organized at different levels of the system. Ideally, all systems would be comprised of components that have all been tested and passed the applicable safety standards, with then the entire system being similarly tested. The installation of the equipment would then be done in accordance with relevant installation standards for energy storage systems (NECA 416, RECOMMENDED PRACTICE FOR INSTALLING ENERGY STORAGE SYSTEMS)[52], as well as any other relevant standard that would cover electrical equipment installation that encompass energy storage in their coverage. Safety standards are updated and published by the relevant SDO on a schedule that ranges from three to five years depending on the group, or sooner if warranted.

4.4.2. Reliability & Performance

There is currently only a limited amount of SDO published standards exclusively on reliability & performance of energy storage systems. Because the operation of energy storage systems typically interact with a number of existing power grid operations, much of the existing standards structure is based on standards governing closely related equipment or operational processes. As reliability and performance is critical to improving performance based contracting for energy storage systems, there is a significant amount of effort being focused on measuring and expressing energy storage system performance. The two parts of this area—reliability & Performance— are distinct, but have a number of operational similarities, hence for their combination into one group.

A number of governmental and industry trade groups have supported the development of standards in this area, including the EPRI-ESIC to develop technical references on application metrics. These and other efforts have provided fundamental support towards defining formal standards concerning reliability and performance of energy storage systems. Until formal performance standards are developed and adopted, the PNNL protocols report (and subsequent updates) will provide the best performance descriptions resource, and reliability will be addressed by a series of efforts by led by industry groups such as EPRI-ESIC, and the Energy Storage Association which has published a White Pater, *Updating Distribution Interconnection Procedures to Incorporate Energy Storage*[53] as a guide to policymakers looking to update distribution interconnection rules to better incorporate energy storage technology.

As mentioned earlier, to address current challenges, existing standards are being utilized until the proper formal standards can be updated. For distribution levels resources, IEEE 1547[54] (Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces) is the governing standard for all energy storage systems designated as a distributed energy resource. To address the incorporation of energy storage devices into the

existing standard, a Working Group has been convened to write the IEEE 1547.9 Guide for ESS interconnection. Until the updated IEE 1547 standard is published, the current practice is to use UL 1741 Certification as the means to assure compliance with IEEE 1547. UL 1741 is the *Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources*.[55] UL 1741 itself is currently being updated to add additional guidance for energy storage resources.

4.4.3. Business Practice

Model business practices promote a streamlined transactional process in a mature commercial market and are an important third area that will impact energy storage contract development. One of the key Standards Development Organization for developing business practices is the North American Energy Standards Board (NAESB). NAESB's standards and model business practices support both the wholesale market—by providing documentation for the Federal Energy Regulatory Commission (FERC) orders—and the retail market by providing documentation for the National Association of Regulatory Utility Commissioners (NARUC) among other groups.

Much of NAESBs business practice standards development are focused on streamlining transaction processes. This includes electronic data interchange in support of a variety of market transactions, including billing and payments and electronic retail billing transactions.

A prominent example of the NAESB's efforts on behalf of the electric power industry is the Green Button. Here, NAESB developed a standard communication protocol for the retail customer information. This standard has been adopted by over 50 utilities to allow customers secure access to their energy usage information. The standard supports the development of products and services by the utilities and 3rd party vendors to better understand and make better decisions with respect to their energy consumption.

Source: Green Button Alliance

Figure 12 – Green Button Alliance

NAESB's standards and business practices development extend into a variety of other parts of the electricity markets. NAESB measurement and verification standards have been essential to

facilitate both energy efficiency and demand response programs by establishing a common framework for transparency and accountability of the programs. In the wholesale market, NAESB efforts have been included into the Open Access Same-Time Information Systems (OASIS) to ensure provide new templates for designation of new resources to comply with FERC order 890. The group has also helped streamline the separation out of business practice standards and reliability standards for other services, such as transmission load relief (TLR) transactions. This allows for a more focused and targeted improvement effort in support of both areas to promote better transaction reliability, efficiency, and transparency.

NAESB's work on standards and business practices highlights the third area of industry standards development which will support the growth of energy storage industry, and the efforts underway to improve the environment for contract development for projects. This third area of standards development will be critical for ensuring stable energy storage project revenue because of the reliance by market rules on NAESB's business practice development efforts. The energy storage industry has been held back in developing many commercial market roles because of the inability for the governing bodies of these different markets to easily incorporate energy storage's flexibility into existing market rules. The development of business practices that address the ability of energy storage systems capability will support the integration of energy storage into existing market roles with more secure revenue streams available to them.

Business practice standards development will complement the ongoing safety and reliability standards development in the energy storage industry. The development of safety and performance standards is paving the way for a more a streamlined manufacturing, deployment, and operation of energy storage systems that adhere to recognized specifications to ensure the components and systems as a whole meet a minimum criteria for safety, quality, and performance. Business practice standards will compliment these other standards by focusing on streamlining business transaction processes. They will improve transparency, accountability, and efficiency and provide greater reliability, lower costs, and greater flexibility of the market transactions—ensuring a more stable revenue stream for the different applications. The link here will be to utilize the existing work defining market roles and performance metrics to provide the framework for how to define the business practice standards governing the operation of energy storage systems across the electric power industry.

The effort to incorporate energy storage into business practice standards development will progress along a number of avenues as groups like NAESB incorporate energy storage into all of the existing efforts. At the wholesale level and retail level, there are a number of existing business practice standards covering business transaction process. By reviewing and addressing the underlying requirements to participate in these business practices, energy storage projects will be more readily available as a resource for many more existing market roles. In addition, these groups can review and identify where standalone energy storage systems would be able to be active in the market, and if needed, develop new business practice standards that could be adopted at the wholesale and retail (state) levels to provide a streamlined business process to reduce the friction of these new market applications enter the power industry.

The U.S. Department of Energy has a central role to play fostering the development of better business practice standards in support of the energy storage industry. This effort would follow the

leadership role the U.S. DOE plays in supporting and promoting development in the safety and performance standards arena. The U.S. DOE has long played an important role in the NAESB business practice standard development process. By coupling the technical capabilities and expertise from the various laboratories active in the energy storage market (Sandia National Laboratories, Pacific Northwest National Laboratory, etc.) in support of the market rule making bodies (FERC, etc.) the U.S. DOE will foster an emerging crucial third standards arena that will ensure that energy storage project will have access to electricity markets through basic market accountability and billing mechanisms to compete as other resources. These capabilities will then benefit not just the transparency and accountability of the technical capabilities to reduce the performance risk in project development contract language, but also ensure that the billing mechanisms standard throughout the electricity market that support all other revenue generation processes can also be incorporated into the contract language for energy storage projects.

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APPENDIX A: U.S. DEPARTMENT OF ENERGY RESOURCES SUPPORTING ENERGY STORAGE FINANCING

U.S. Department of Energy

Database

- Global U.S. DOE Energy Storage Database: https://www.energystorageexchange.org/

Funding and Financing for Energy Projects

- Funding & Financing for Energy Projects: https://energy.gov/funding-financing-energy-projects

Areas of Support:

- Loan Programs Office: https://energy.gov/funding-financing-energy-projects
- State Energy Program: https://energy.gov/eere/wipo/state-energy-program
- Federal Financing Facilities Available for Energy Efficiency Upgrades and Clean Energy Deployment: Link to Report
- Federal Financing Programs for Clean Energy: https://energy.gov/sites/prod/files/2016/05/f32/Federal%20Financing%20Programs%20for%20Clean%20Energy.pdf

Sandia National Laboratory (SNL)

Energy Storage Program

- U.S. Department of Energy, Energy Storage Systems https://www.sandia.gov/ess-ssl/

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Energy Storage Valuation Modeling

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Key Reports

- DOE/EPRI Electricity Storage Handbook with NRECA: http://www.sandia.gov/ess/publications/SAND2015-1002.pdf
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- DOE OE Energy Storage Systems Safety Roadmap, http://www.sandia.gov/ess/publications/EnergyStorage_safetyroadmap_2017.pdf
- Energy Storage Procurement - Guidance Documents for Municipalities, http://www.sandia.gov/ess/publications/SAND2016-8544O.pdf
- Protocol for Uniformly Measuring and Expressing the Performance of Energy Storage Systems, http://www.sandia.gov/ess/publications/SAND2016-3078R.pdf
- Methodology to Determine the Technical Performance and Value Proposition for Grid-Scale Energy Storage Systems: A Study for the DOE Energy Storage Systems Program, http://www.sandia.gov/ess/publications/SAND2012-10639.pdf

Pacific Northwest National Laboratory (PNNL)

Energy Storage Program

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Energy Storage Valuation Modeling

- Energy Storage Optimization Tools https://availabletechnologies.pnnl.gov/technology.asp?id=413

Key Reports

- Energy Storage System Safety: Plan Review and Inspection Checklist, https://energymaterials.pnnl.gov/pdf/PNNL-SA-124486.pdf
- Measuring and Expressing the Performance of Energy Storage Systems (Presentation) https://energymaterials.pnnl.gov/pdf/PNNL-SA-118995.pdf
- Energy Storage System Guide for Compliance with Safety Codes and Standards; http://www.sandia.gov/ess/publications/SAND2016-5977R.pdf
- Protocol for Uniformly Measuring and Expressing the Performance of Energy Storage Systems, https://energymaterials.pnnl.gov/pdf/PNNL-22010Rev2.pdf
- Overview of Development and Deployment of Codes, Standards and Regulations Affecting Energy Storage System Safety in the United States; http://www.sandia.gov/ess/docs/safety/Codes_101_PNNL_23578.pdf
- Inventory of Safety-related Codes and Standards for Energy Storage Systems with some Experiences related to Approval and Acceptance; https://energymaterials.pnnl.gov/pdf/PNNL-23618.pdf

National Renewable Energy Laboratory (NREL)

Renewable Energy Finance

- Renewable Energy Project Finance, https://financere.nrel.gov/finance/

Energy Storage Valuation Modeling

- REopt: Renewable Energy Integration & Optimization, https://reopt.nrel.gov/tool

Key Reports

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- Identifying Potential Markets for Behind-the-Meter Battery Energy Storage: A Survey of U.S. Demand Charges, https://www.nrel.gov/docs/fy17osti/68963.pdf
- Battery Energy Storage Market: Commercial Scale, Lithium-ion Projects in the U.S., https://www.nrel.gov/docs/fy17osti/67235.pdf

Argonne National Laboratory (ANL)

Energy Storage Program

- https://www.anl.gov/pse/energy-storage

Joint Center for Energy Storage Research (JCESR)

Energy Storage Program

- http://www.jcesr.org/

Idaho National Laboratory (INL)

Energy Storage Program

- Clean Energy & Transportation, https://at.inl.gov/SitePages/Energy%20Storage.aspx

Energy Storage Publications

- https://avt.inl.gov/project-type/advanced-energy-storage-publications

Energy Storage Technology Advancement Partnership (ESTAP)

Energy Storage Technology Advancement Partnership (ESTAP)

- The Energy Storage Technology Advancement Partnership (ESTAP) is a federal-state funding and information sharing project, managed by the Clean Energy States Alliance (CESA), which aims to accelerate the deployment of electrical energy storage technologies in the U.S. https://www.cesa.org/projects/energy-storage-technology-advancement-partnership/

Key Reports

- Energy Storage Procurement Guidance Documents for Municipalities: http://www.cesa.org/assets/2016-Files/Energy-Storage-Procurement-Guidance-Document.pdf
- Commissioning Energy Storage: http://www.cesa.org/assets/Uploads/ESTAP-Webinar-Slides-5.20.14.pdf

APPENDIX B: LIST OF INTERVIEWEES

Interviews are drawn from the participants in the ACES Working Group conference calls.

	Company	First	Last	Title
1	ACORE	Tim	Olson	Policy and Reserch Manager
2	Black & Veatch	Mark	Manley	Manager, Consulting
3	Blackrock	Denny	Fuchs	Director
4	Blackrock	Rael	McNally	Director
5	California LMCC	Bernie	Kotlier	Executive Director of Sustainable Energy Solutions
6	CIBC	Andrew	Cleary	Executive Director
7	Clean Energy States Alliance	Todd	Olinsky-Paul	Project Director
8	Cleantech Strategies	Russ	Weed	Ptesident
9	Coalition for Green Capital	Alex	Kragie	Director
10	CSA Group	Ryan	Franks	Manager, Global Energy Storage
11	DNVGL	Davion	Hill	Global Energy Storage Segment Leader
12	Energi Insurance	Chris	Lohman	Vice President, Alternative Energy Solutions
13	Energy Storage Consulting	Matt	Koenig	President
14	Energy Tariff Experts	Jim	Bride	President
15	EPRI	Erin	Minear	Technical Leader
16	ESA	Tom	Simchak	Research & Program Director
17	Eversheds Southerland	Kyle	Wamstad	Associate Attorney
18	Eversheds-Southerland	Dorothy	Franzoni	Partner
19	Hartford Steam Boiler	David	Tine	Vice President
20	Highview Power	Richard	Riley	Business Development Manager
21	Hitachi Capital	Chris	Pagano	VP & General Manager
22	Hugh Wood	Jen	Aitchison	Senior Vice President
23	Hugh Wood	John	Mooney	Vice President
24	IFC	Peter	Mockel	Principal Energy Specialist
25	Investec	Ren	Plastina	Lead Originator - Emerging Energy Technologies
26	K&L Gates	Elizabeth	Crouse	Partner
27	K&L Gates	Buck	Endemann	Partner
28	K&L Gates	Dave	Hattery	Partner
29	K&L Gates	Bill	Holmes	Partner
30	Key Capture Energy	Jeff	Bishop	CEO
31	Kirkland & Ellis	Robert	Fleishman	Partner
32	Morrison & Foerster	Julie	Balas	Attorney
33	Morrison & Foerster	Elizabeth	Sluder	Partner
34	NEC Energy Solutions	Doug	Alderton	Director, Sales
35	NEC Energy Solutions	Deb	Collum	VP, General Counsel
36	NECA	Mir	Mustafa	Executive Director, Business Development
37	NECA-NEIS	Michael	Johnston	Executive Director, Standards & Safety
38	New Energy Risk	Tom	Dickson	CEO
39	Nexus Infrastructure Capital	Alan	Dash	Managing Director
40	North American Energy Standards Board	Jonathan	Booe	Executive Vice President
41	Norton Rose Fulbright	Deanne	Barrow	Associate
42	NYBEST	Bill	Acker	Executive Director
43	PNNL	David	Conover	Senior Staff Energy Engineer
44	PNNL	Charlie	Vartanian	Sr. Technical Advisor
45	Powin	Mitch	Boeh	Northeast Sales Manager
46	Quercus Partners	Asif	Rafique	Managing Director
47	Rhynland	Patrick	Verdonck	Managing Member
48	RMI	Jason	Prince	Senior Associate
49	Schneider Electric	Scott	Daniels	Technology & Innovation, Office of CTO
50	Siemens Financial Services	John	O'Brien	Director
51	Starwood Energy Group	Ali	Amirali	Senior Vice President
52	Strata Solar	Joe	Krawczel	Assistang General Counsel
53	Strata Solar	Josh	Rogol	VP of Energy Storage
54	Tortoise Infrastructure	Matt	Ordway	Partner
55	Tortoise Infrastructure	Jerry	Polacek	Managing Director
56	Union of Concerned Scientists	Mike	Jacobs	Technical & Strategic Consultant
57	USI Insurance	Dixon	Wright	Sr. Vice President
58	Willis Towers Watson	Danny	Seagraves	Vice President

APPENDIX C: DOE ENERGY STORAGE FINANCE ADVISORY COMMITTEE MEETING: 2018 U.S. DOE ENERGY STORAGE FINANCING SUMMIT (NYC)

Please mark your calendars for this U.S. Department of Energy sponsored summit, which is part three of a study on advancing standardized contract development in the energy storage market.

Focused on promoting the development of the market through reducing barriers to entry, reducing transaction costs, and promoting wider access to low cost capital, the study is targeted at evaluating the needs of expanded contract language and supporting materials to reduce risk as project development activity accelerates.

Speakers will include representatives from the U.S. DOE and industry experts who have experience with the challenges and opportunities of investing in energy storage projects.

This year's keynote speaker is Alfred Griffin, President of the NY Green Bank.

This complimentary event is by invitation-only. If you believe it would benefit a colleague with a similar focus, please respond to this invitation with that person's contact information and we will accommodate them as space allows.

Thursday, January 18, 2018
11:30AM – 6:00PM ET

Morrison & Foerster LLP New York
250 West 55th Street New York, NY 10019

Sandia National Laboratories

MORRISON FOERSTER

MUSTANG PRAIRIE

2018 U.S. DOE Energy Storage Financing Summit (NYC):
Advancing Energy Storage Contracting

11:30-12:00pm	**Registration / Lunch**
12:00-12:05pm	**Welcome** Jonathan Melmed, Partner, Morrison & Foerster, LLP
12:05-12:15pm	**Energy Storage Financing Study: Overview** Richard Baxter, President, Mustang Prairie Energy
12:15-12:45pm	**U.S. DOE Energy Storage Program** Babu Chalamala, Program Manager, Energy Storage Technologies and Systems, Sandia National Laboratories
12:45-1:15pm	**Keynote** Alicia Barton, President & CEO of New York State Energy Research and Development Authority (NYSERDA)
1:15-1:45pm	**Networking Break**
1:45-2:30pm	**Panel 1—Front of the Meter (FOM) Financing** Elizabeth Sluder, Partner, Morrison & Foerster, LLP [Moderator] John Roach, Assistant Vice President, Hartford Steam Boiler Barry Gold, Managing Director, Orix Infrastructure Jeff Bishop, Managing Partner, Key Capture Energy Asif Rafique, Managing Director, SUSI Partners
2:30-2:45pm	**Networking Break**
2:45-3:30pm	**Panel 2—Behind the Meter (BTM) Financing** Danny Kennedy, Managing Director of CalCEF & CalCharge [Moderator] Dan Dobbs, Vice President, Anbaric Development Partners Mark Nelson, Managing Director, Sentry Financial Steve Pullins, Vice President, Dynamic Energy Networks Michael Hastings, CEO, Half Moon Power
3:30-3:45pm	**Networking Break**
3:45-4:30pm	**Panel 3—Contract Experience, Execution, and Validation** Bob Fleishman, Sr. Of Counsel, Morrison & Foerster, LLP [Moderator] Ted Burhans, Director, Tucson Electric Power Company Matt Koenig, President, Energy Storage Consulting Michael Atkinson, Vice President—Business Development, Doosan Gridtech Tal Sholklapper, Founder & CEO, Voltaiq
4:30pm	**Closing** Richard Baxter, President, Mustang Prairie Energy
4:30-6:00pm	**Reception**

MORRISON
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Keynote Speakers

Babu Chalamala, Program Manager, Energy Storage Technologies and Systems, Sandia National Laboratories

Prior to joining Sandia in August 2015, he was a Corporate Fellow at SunEdison for five years, where he led R&D and product development in grid scale energy storage. He received his B.Tech degree in Electronics and Communications Engineering from Sri Venkateswara University and his PhD degree in Physics from the University of North Texas. He is a Fellow of the IEEE and Academy of Sciences St Louis, a Life Member of the Electrochemical Society, and a Member of the Materials Research Society.

Alicia Barton, President and CEO, New York State Energy Research and Development Authority (NYSERDA)

Alicia Barton is President and CEO of the New York State Energy Research and Development Authority. Ms. Barton has held public and private sector leadership roles advancing clean energy projects and companies for over a decade. Immediately prior to her appointment, Ms. Barton served as co-chair of the Energy and Cleantech Practice at Foley Hoag, LLP, a global law firm based in Boston. Prior to her work in the private sector, Barton served as chief executive officer of the Massachusetts Clean Energy Center (MassCEC),

Host

Jonathan Melmed, Partner, Morrison & Foerster, LLP

Jonathan Melmed is an M&A, Corporate partner based in New York. He is the Co-Chair of the firm's Global Private Equity & Buyouts practice and Co-Chair of the firm's Global Energy & Infrastructure practice. He is also the head of the firm's Canada practice. Mr. Melmed represents private equity funds, pension plans, sovereigns, family offices, hedge funds, corporate clients and investment banks on U.S. and International M&A, private equity and complex corporate transactions.

Summit Chairman

Richard Baxter, President, Mustang Prairie Energy

Richard Baxter is President of Mustang Prairie Energy where he bridges the financial and technical sides of the market. He is the author of the book "*Energy Storage: A Nontechnical Guide"* (Pennwell), and two reports on Energy Storage Financing for Sandia National Labs. He is the Chairman of the Board for NovoCarbon (TSX-V:GLK). He has been active in the energy storage industry for 18+ years, and served on the Board of Directors for the Energy Storage Association (ESA).

Panel 1: Front of the Meter Financing

Jeff Bishop, Managing Partner, Key Capture Energy

Jeff has a proven track record at the intersection of commercial and policy in all growth stages of renewable energy development. At Brookfield Renewable and EDP Renewables, Jeff oversaw market development that led to contracts for nearly a billion dollars of new wind projects. Jeff holds a Bachelor of Science in Electrical Engineering from Rice University and a Master of Business Administration from the University of Chicago Booth School of Business.

Barry Gold, Managing Director, Orix Infrastructure

Barry Gold is the Head of ORIX Infrastructure. Mr. Gold has over 30 years of experience in private equity, debt financing and advisory in power, energy, transport, water and other infrastructure sectors. Prior to joining ORIX, Mr. Gold was a Senior Advisor to a private equity infrastructure fund, co-founder and co-head of The Carlyle Group's infrastructure fund, co-head of Citigroup's structured and infrastructure finance group.

Asif Rafique, Managing Director, SUSI Partners

Asif is a Managing Director at SUSI Partners, a Swiss based asset manager leading their Energy Storage Infrastructure team. At SUSI, Asif is the portfolio manager for a dedicated energy storage fund responsible for creating and implementing its investment strategy, capital raising and asset management. Asif built and leads a six-man team focused on the sector and is an active member of SUSI's senior management team.

John Roach, Assistant Vice President, Hartford Steam Boiler

John Roach is an Assistant Vice President at Hartford Steam Boiler Inspection and Insurance Company (HSB). Prior to this he was a Principal Electrical Engineer at HSB with a concentration in power transformers and generators. John has a B.S. degree in Electrical Engineering from the University of New Haven and a Masters of Engineering degree in Electrical Power Engineering from Rensselaer Polytechnic Institute.

Moderator

Elizabeth Sluder, Partner, Morrison & Foerster, LLP

Elizabeth Sluder is a partner in the Los Angeles office of Morrison & Foerster. She focuses her practice on project finance, mergers and acquisitions, private equity, and general corporate advice. Ms. Sluder has substantial experience representing clients in renewable energy transactions, including construction and term debt financings, tax equity investments, and negotiating supply agreements, construction contracts and offtake arrangements.

Panel 2: Behind the Meter (BTM) Financing

Dan Dobbs, VP Microgrid Products & Finance, Anbaric Development Partners

Dan Dobbs is Vice President of Microgrid Products & Finance for Anbaric Development Partners. Dan started his energy sector career at SunEdison, where he progressed through finance, marketing and product management roles. Mr. Dobbs has an MBA from the Wharton School at the University of Pennsylvania. He holds Master's degrees in Mechanical Engineering and Technology & Policy and a Bachelor's degree in Mechanical Engineering from MIT.

Michael Hastings, CEO, Half Moon Power

CEO of Half Moon Ventures, an affiliate of Concord New Energy Group. Mike has been active in renewable energy since 2006. He previously led Half Moon Power, a utility scale developer of wind energy projects, and successfully sold the entire portfolio of nearly 800 MW in 2011. He is responsible for leading the development of renewable projects in strategic markets in the Americas.

Mark Nelson, Managing Director, Sentry Financial

Mark joined the Sentry team in 2011 and is currently focused on originating financing transactions in the energy efficiency, battery storage, telecom and healthcare sectors. Prior to joining Sentry, Mr. Nelson was Founding Partner of Cornerstone Capital Group, a private equity fund focused on investing in growth-stage technology companies and mid-market operating company buyouts. Mr. Nelson also served as Chief Financial Officer for one of Cornerstone's portfolio companies.

Steve Pullins, Vice President, Dynamic Energy Networks

Steven W. Pullins is Vice President, Dynamic Energy Networks.
Previously, he was Vice President, Microgrid Solutions at Hitachi's Social Innovation Business – Americas. Prior to that position, he was Co-Founder and Chief Strategy Officer for Green Energy Corp. (formerly President, Horizon Energy Group – merger with Green Energy Corp March 2013).

Moderator

Danny Kennedy, Managing Director of CalCEF & CalCharge

Danny Kennedy leads the California Clean Energy Fund, connecting entrepreneurs everywhere to capital to build an abundant clean energy economy that benefits all. He is also the President of CalCharge, a public private partnership with the National Labs and universities of California, unions and companies, working to advance energy storage.

Panel 3: Contract Experience, Execution, and Validation

Michael Atkinson, Vice President—Business Development, Doosan Gridtech

With an extended leadership career in the utility transmission & distribution industry culminating as the top executive leading the North American region for GE Grid Solutions and Alstom Grid, Michael has been an early evangelist in bringing technology solutions to bear on low-carbon electric distribution systems. He also headed up the Network Management Software Division of Alstom Grid where he sought out grid modernization projects that helped to advance the rising smart grid digital evolution.

Ted Burhans, Director, Tucson Electric Power Company

Mr. Ted Burhans is the Director of the Renewable Energy Resources department at UNS Energy, the parent company of both Tucson Electric Power and UniSource Electric, Inc. His primary responsibility is to oversee all aspects of renewable energy procurement and integration for residential, non-residential, and utility-scale projects. TEP has over 300 MW of utility-scale, over 230 MW of distributed generation renewable energy projects, and over 20 MW of energy storage

Matt Koenig, President, Energy Storage Consulting

Matt Koenig is one of the longest tenured and most successful sales and BD professionals in the lithium based energy storage marketplace.
Matt began his career in storage electrifying the propulsion systems of commercial vessels with Corvus Energy, and moved on to the leading stationary storage inverter maker and integrator of the time, Princeton Power Systems.

Tal Sholklapper, Founder & CEO, Voltaiq

Dr. Tal Sholklapper is CEO and Co-Founder of Voltiaq. Dr. Sholklapper has an extensive record of success as a cleantech engineer and entrepreneur. Prior to founding Voltaiq, he worked as the lead engineer on a DOE ARPA-E funded project at the CUNY Energy Institute, developing an ultra low-cost grid-scale battery. Before joining CUNY, Dr. Sholklapper co-founded Point Source Power, a low cost fuel-cell startup based on technology he developed while at Lawrence Berkeley National Laboratory and UC Berkeley.

Moderator

Bob Fleishman, Sr. Of Counsel, Morrison & Foerster, LLP [Moderator]

Robert Fleishman is senior of counsel in the firm's corporate department, resident in the Washington, D.C. office. Mr. Fleishman has a leading reputation defending energy and financial industry participants and individuals in energy markets against charges of market manipulation, particularly before the Federal Energy Regulatory Commission (FERC), the Commodity Futures Trading Commission (CFTC), and other regulatory bodies, and advising companies on the energy regulatory and compliance aspects of transactions and other energy market activities.

Attendee List

	Company	First	Last	JobTitle
1	Advanced Microgrid Systems (AMS)	Susan	Kennedy	CEO
2	C2 Energy Capital	Lee	Feliciano	Director - Business Development
3	California Clean Energy Fund	Danny	Kennedy	Managing Director
4	California Energy Commission	David	Hochschild	Commisioner
5	California Solar & Storage Association	Bernadette	Del Chiaro	Executive Director
6	Canadian Solar Inc.	Chester	Lyons	Director, Energy Storage & Related Markets
7	Capitas Energy	Steve	O'Rourke	Managing Director
8	Cobia Capital	Glen	Casanova	
9	Hugh Wood Canada	Jen	Aitchison	Senior Vice President, Sustainable Energy Insurance
10	Kirkland & Ellis LLP	Robert	Fleishman	Partner
11	LS Power	Cody	Hill	Director, Energy Storage
12	Mustang Prairie Energy	Steve	Austerer	Director, Business Development
13	Mustang Prairie Energy, LLC	Richard	Baxter	President
14	New Energy Risk	Thomas	Dickson	CEO
15	Pacific Northwest National Labratory (PNNL)	Patrick	Balducci	Chief Economist
16	Sandia National Laboratories	Ray	Byrne	Distinguished Member of the Technical Staff
17	Sandia National Laboratories	Babu	Chalamala	Manager
18	Starwood Energy Group Global, LLC	Ali	Amirali	Senior Vice President
19	Stem	Polly	Shaw	VP, Regulatory Affairs and Communications
20	Sunrun	Audrey	Lee	Vice President, Grid Services
21	Swinerton	Craig	Horne	
22	Tortoise	Jerry	Polacek	Managing Director & Group Lead, Clean Energy & Infrastructure
23	US DOE	Imre	Gyuk	Manager, U.S. DOE Energy Storage Program
24	Vision Ridge Partners	Sam	Cummings	Principal
25	Wells Fargo Securities LLC	Jon	Previtali	Vice President, Investment Portfolio
26	8minutenergy Renewables	Julia	Dobtsis	Vice President, Finance & Transactions
27	Able Grid Energy Solutions	Barnaby	Olson	Chief Executive Officer
28	AIMPERA Capital Partners	Paul	Ho	Partner
29	AIMPERA Capital Partners	Matthew	Kestenbaum	Investor
30	AIMPERA Management LLC	Aaron	Weinstein	Private Equity Associate
31	Amber Kinetics, Inc.	William	Golove	Vice President, Business Development
32	Anbaric Development Partners	Dan	Dobbs	Vice President, Microgrids
33	Bank of America Merril Lynch (BAML)	Kevin	Lang	Director of BAML, Renewable Energy Finance
34	BlackRock, Inc.	Martin	Torres	Managing Director
35	CIT Group, Inc.	Tyler	Hilliard	Associate
36	Cleanpath Ventures	Matt	Cheney	CEO
37	ClearSky Power and Technology Fund	James	Goldinger	Managing Director
38	Coronal Energy	Ed	Feo	Vice Chairman
39	Cumulus Energy Storage	Michael	Hurwitz	Chief Technology Officer
40	East Bay Community Energy	Todd	Edmister	Regulatory Affairs Director/Asst. General Counsel
41	Enovation Partners	Daniel	Gabaldon	Founding Partner
42	Enovation Partners	Simon	Greenberg	Manager
43	EPC Power	John	Bryan	VP of Commercial Applications
44	esVolta, LP	Randy	Mann	President
45	FlexEnergy	Pedro C.	Elizondo	Senior Manager, Business Development Manager
46	FlexGen	John	Prueher	CEP
47	Galehead Development	Matt	Marino	Chief Executive Officer
48	Generate Capital	Andrew	Hughes	Director
49	Generate Capital, Inc.	Edward	Bossange	Head of Capital Markets
50	Go Electric Inc.	Steven	Lichtin	Director of Business Development
51	Greenlots	Lin	Khoo	Senior Vice President, Strategy
52	Greenlots	Keerthi	Ravikkumar	Smart Grid Product Manager
53	Greenlots	Mark	Steffler	Chief Financial Officer
54	Greenlots	Mark	Steffler	CFO
55	Highview Power	Richard	Riley	Business Development Manager, North America
56	Hitachi Capital	Chris	Pagano	VP & General Manager, Structured Finance
57	iCON Infrastructure Canada Inc.	Jamie	Manson	Investments
58	IHI Energy Storage	Shane	Bediz	Business Development & Utility Sales
59	Investec USA Holdings Corp.	Ren	Plastina	Senior Originator
60	JinkoSolar	Nigel	Cockroft	General Manager

Attendee List (Cont.)

	Company	First	Last	JobTitle
61	K2 Energy Solutions	Jim	Hodge	Chief Technical Officer
62	Key Capture Energy	Jeff	Bishop	CEO
63	Key Capture Energy	Nicole	Wolf	Chief Commercial Officer
64	Landis & Gyr Utilities Services, Inc.	Vani	Dantum	Vice President - Partnerships & Planning
65	Lazard	Samuel	Scroggins	Power, Energy & Infrastructure M&A at Lazard
66	LG Chem	Kevin	Fok	Director, Operations
67	LG Chemical Ltd.	Peter	Gibson	VP Energy Storage
68	Microsoft Corporation	Brandon	Middaugh	Senior Program Manager
69	Morgan Stanley Infrastructure Partners	Brian	Kang	Vice President
70	Munich Reisurance America, Inc.	Jay	Goldin	Vice President, Green Tech Solutions
71	Navigant	Andrea	Romano	Managing Consultant
72	New Energy Risk	Jon	Cozens	Chief Commercial Officer
73	Ormat	Tal	Mund	Vice President
74	Panasonic Corporation	Janet	Lin	Director, New Business Development
75	Pattern Energy Group LP	Terrence	Cantorna	Manager, Business Development
76	Power 2 Storage LLC	Eric	Curry	President
77	Powin Energy Corpation	Geoffrey	Brown	President
78	Recurrent Energy	Adria	Schulman-Eyink	Senior Manager, Project Finance
79	Regenerate Power LLC	Reyad	Fezzani	Chairman & CEO
80	Romeo Power Technology	Ned	Horneffer	Director of Business Development
81	Roth Capital Partners, LLC	Craig	Irwin	Managing Director, Senior Analyst
82	Sandia National Laboratories	Ricky	Concepcion	Member of Technical Staff
83	SF Electrical Construction Industry	Alex	Lantsberg	Research & Advocacy Director
84	Sharp	Carl	Mansfield	AVP
85	Soltage LLC	Lori	Bilella	Vice President
86	Starboard Energy Advisors, LLC	David	Mintzer	President
87	STEM	Prakesh	Patel	VP Strategy and Capital Markets
88	SunRun Inc.	Sam	Chatterjee	Sr. Director, Project Finance
89	SunRun Inc.	Joseph	Eisenberg	Director - Project Finance
90	Ultra Capital	Kristian	Hanelt	Managing Director
91	Unemployed	John	Chmiola	N/A
92	UniEnergy Technologies, LLC	John	DeBoever	VP Global Sales
93	UniEnergy Technologies, LLC	Russell	Weed	VP BD & Marketing
94	UniEnergy Technologies, LLC	Gary	Yang	Chief Executive Officer
95	USI Insurance Services	Dixon	Wright	Senior Vice President
96	Wärtsilä Corporation	Risto	Paldanius	Business Development Director
97	Wells Fargo Cleantech Banking	Adam	Bergman	Senior Vice President
98	Willis Towers Watson	Danny	Seagraves	VP - Bankability Specialist
99	Zep Solar	Alex	Mayer	Principal Technologist, Solar City

Synopsis

On January 18th, 2018 Morrison & Foerster LLP and Mustang Prairie Energy in partnership with the U.S. Department of Energy presented a one-day Energy Storage Finance Advisory Committee Meeting at Morrison & Foerster's New York City office that had 99 attendees. Speakers included representatives from the U.S. Department of Energy, the New York State Energy Research and Development Authority (NYSERDA, and industry experts who have experience with the challenges and opportunities of investing in energy storage projects.

The Summit was the first Energy Storage Finance Advisory Committee Meeting for a U.S. Department of Energy sponsored study to identifying the opportunities for advancing energy storage contracting for energy storage projects. This study's goal is to understand the current challenges facing energy storage project financing, and gain insights into ways advancing the level of contract development in the energy storage industry could allow greater and more widespread commercial development in the industry. This series of studies are part of the U.S. Department of Energy's effort to promote market development through reducing barriers to entry, reducing transaction costs, and promoting wider access to low cost capital in order to promote development across the energy storage industry.

The summit began with an overview of the Study by Richard Baxter of Mustang Prairie Energy, followed by Babu Chalamala, Program Manager, Energy Storage Technologies and Systems, Sandia National Laboratories who gave an overview of federal support for energy storage technology development, and explained how that support is extending into the commercialization of these systems.

The Keynote address was given by Alicia Barton, President and CEO of the New York State Energy Research and Development Authority. Her presentation showcased the efforts of the State of New York's effort to promote the development of energy storage project development at all levels of the electrical power sector to promote customer choice, improved service, and a more resilient power grid.

The first panel of the day focused on Front of the Meter financing. The discussion focused on the current state of project financing for large scale energy storage projects currently, and how the market is changing, with expectations for where it will go in the next 2 years. The panelists shared their insights into the current competition driving down system costs and the stubbornly low expected profit margins on projects. As many project sizes continue to rise, competition for these marquee projects will continue to be fierce. Panelists believed there is a significant amount of unpriced market risk being born by many groups in the industry who are inexperienced and buying their way into the market. The panelists also discussed how capital costs are expected to continue to decline rapidly, helping these aggressive players continue to bid very aggressively. One key area of inexperience is in the operation of the units, and the underestimation of the complexity of operating an energy storage facility in a wholesale market setting. For instance, instead of it operating against one driving metric (wind speed for wind turbines, solar irradiance for solar PV), there are a whole host of interconnected issues that drive the operational strategy; it's more like a gas turbine with multiple market roles, which has implications for financing. The Panelists all

agreed what was needed now was for better contract standards that permitted better revenue surety while limiting the risk exposure of the operator, and investors (sponsors, and lenders).

The second panel of the day focused on Behind the Meter Financing. In this market, energy storage project development is more highly focused on retail sales, requiring many more projects to equate with the revenue of the Front of the Meter market. To enable this business case to be successful, all of the panelists believed that better and more developed contract language would help both speed up the development process, and reduce the risk of dealing with a larger number of smaller commercial customers. In particular, since the smaller customers would by and large not have formal credit rating, it was noted that a number of the existing behind the meter energy storage companies in California have developed a number of methods to create synthetic credit ratings from available financial information. The panel discussed a few of the more near term opportunities for growth, both in unit size, and potential for increased profitability; microgrids and solar/storage facilities. The microgrid opportunity presents an opportunity for an integrated storage as a service model, holding out the potential for a number of different revenue streams. Because of this, it was noted that the complexity of ensuring revenue certainty with the multiple value stacking roles would create a more complex contractual framework than a stand-alone storage solar/storage facility. However, even this opportunity, it was noted by the panelists, presented unique needs for better visibility into the liability exposure for adding storage to an existing solar project design, and especially to an existing solar facility with an existing PPA contract.

The final panel of the day focused on Contract Experience, Execution, and Validation. The panelists discussed the value of contracts, and the role of standardization of the contract language as a market matures. Based on experience in other markets, the panelists highlighted areas where they had expectation for development, specifically to ensure revenue certainty, and be more explicit as to liabilities in the event of loss on the project. All of the panelists agreed that who drives contract development and what they want is closely tied to the effort on seeing improved language develop in the market. For instance, many of the panelists noted that most contracts with utilities (customers) were focusing on availability and efficiency as key operational metrics, as the utilities were trying to limit their exposure to operational risk through only focusing on system level performance.

APPENDIX D: STAKEHOLDER MEETING: 2018 ENERGY STORAGE ASSOCIATION CONFERENCE & EXPO

ESA ENERGY STORAGE 28TH ANNUAL CONFERENCE & EXPO

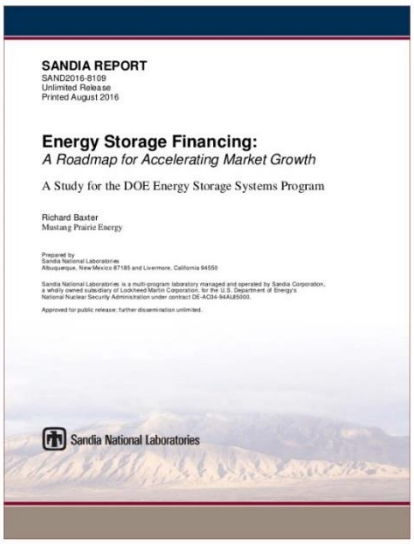
April 18-20, 2018
Boston, Massachusetts
Hynes Convention Center

Energy Storage Financing: *Advancing Contracting in Energy Storage*

Please come and share your insights into the challenges of securing financing for energy storage projects, and what steps would be helpful to move the industry forward.

This stakeholder meeting is part of a U.S. Department of Energy sponsored study evaluating ways to reduce the contract risks for energy storage project financing. We will have a panel of financial industry participants to provide insight into the current status and needs of the market. This study's goal is to understand the current challenges in the energy storage market, and gain insights from other markets as to what strategies were successful there. Discussion points will include: Criteria for debt financing, revenue certainty, technology acceptance, and system performance.

We look forward to your participation and input into the discussion.



Schedule

Friday, April 20th, 2018

12:30pm

Panelists

Moderator:	Richard Baxter, President, Mustang Prairie Energy
Speaker:	Bill Muston, R&D Manager, Oncor Electric Delivery
Speaker:	Troy Miller, VP Business Development, Power Edison
Speaker:	Dan Dobbs, VP Microgrid Products & Finance, Anbaric Development Partners
Speaker:	Mark Barnett, Partner, Foley Hoag
Speaker:	Jim Wrathall, Counsel, K&L Gates

Panelists

We have arranged for 5 senior financial industry leaders to take part in the stakeholder meeting to assist in the discussion.

Bill Muston, R&D Manager, Oncor Electric Delivery

Bill Muston is Manager of R&D at Oncor Electric Delivery Company LLC, a regulated electric utility in Texas. His role has included: R&D planning and management, path to commercial application, technical maturity and risks, and business and regulatory model considerations for emerging technologies in the utility industry. He is as a member of Oncor's corporate strategy & technology group. Bill graduated from The University of Texas at Austin with a B.S. in Electrical Engineering and an M.S. in Engineering. He is a Registered Professional Engineer in Texas, and Member of the IEEE Power & Energy Society.

Troy Miller, VP Business Development, Power Edison

Troy Miller is VP of Business Development with Power Edison, where he provides highly modular, utility grade, turn-key trailer mounted mobile ESSs. Previously he was Director of Grid Solutions at S&C Electric Company, where he had global responsibility for the Grid Solutions market segment that includes energy storage, var compensation, and microgrids. With more than 25 years in the Power Engineering industry, Troy has lengthy experience in the application and implementation of all aspects of power electronics and power quality.

Dan Dobbs, VP Microgrid Products & Finance, Anbaric Development Partners

Dan Dobbs is Vice President of Microgrid Products & Finance for Anbaric Development Partners. Dan started his energy sector career at SunEdison, where he progressed through finance, marketing and product management roles. He left to co-found Solar Grid Storage, where he served as CFO and developed the finance and operations models that created the first 3rd-party financed storage-as-a-service business. Dan returned to SunEdison in 2015 following its acquisition of Solar Grid Storage. Most recently, Dan was responsible for Product Management at Greensmith, a battery storage software company that is now part of Wärtsilä's Energy Solutions business. Mr. Dobbs has an MBA from the Wharton School at the University of Pennsylvania. He holds Master's degrees in Mechanical Engineering and Technology & Policy and a Bachelor's degree in Mechanical Engineering from MIT.

Mark Barnett, Partner, Foley Hoag

As co-chair of Foley Hoag's Energy & Cleantech Group, and head of the firm's Renewable Energy Project Finance and Development Practice, Mark Barnett has an extensive business law practice focused on the energy and clean sectors. Mark works closely with clients developing innovative technologies and business approaches to solving energy and sustainability challenges, advising emerging and high growth companies in all aspects of strategic development, financings and acquisitions, intellectual property and industry-specific regulatory and policy matters. He also leads the firm's renewable energy project finance practice with a particular focus on solar energy project development and finance, working with a broad range of developers, project sponsors and investors in this dynamic and growing sector.

James R. Wrathall, Counsel, K&L Gates

Jim Wrathall is counsel in the firm's Washington, D.C. office and focuses his practice on energy matters. He has particular experience in renewable and distributed energy development and financing transactions; mergers and acquisitions; regulatory and policy matters; litigation; and corporate compliance. Mr. Wrathall served from 2007 through 2011 as Majority Senior Counsel with the U.S. Senate Environment and Public Works Committee, responsible for climate and clean energy legislation and oversight. He previously was a partner in the D.C. office of a major international law firm for more than ten years.

Moderator

Richard Baxter, President, Mustang Prairie Energy

Richard Baxter is President of Mustang Prairie Energy where he bridges the financial and technical sides of the market. He is the author of the book "*Energy Storage: A Nontechnical Guide"* (Pennwell), and two reports on Energy Storage Financing for Sandia National Labs. He is the Chairman of the Board for NovoCarbon (TSX-V:GLK). He has been active in the energy storage industry for 18+ years, and served on the Board of Directors for the Energy Storage Association (ESA).

Attendees

	Company	First	Last
1	Hitachi Capital America Corp	David	Burr
2	Vistra Energy	Ralph	Adams
3	Startec Consulting Services	Roger	Lemus
4	Kansas City Power & Light	Ashwin	Shashindranath
5	Sempra Renewables	Timothy	Allen
6	Enmax	Raymond	McKay
7	Bracewell	Blake	Urban
8	STEM	Jeff	Olson
9	Con Ed	Adrienne	Lalle
10	TradeWind Energy	Stan	Shilling
11	Holland & Knight	Mark	Kaplin
12	Black & Veatch	Lou	Graving
13	SPower	Vennela	Yadhati
14	Hydro Quebec	Etienne	Fournier
15	GCL New Energy	Alex	Zhu
16	- NA -	Michael	Herbert

Synopsis

This Stakeholder Meeting at the was held at the 2018 Energy Storage Association Conference & Expo (Boston, MA on April 20th, 2018) as part of a U.S. Department of Energy sponsored study to evaluate ways to reduce the contract risks for energy storage project financing. Holding the meeting at the Energy Storage Association's conference allows members of the energy storage industry the ability to provide input into the current study: Energy Storage: Advancing Contracting in Energy Storage. A total of 96 people were present to listen to the industry thought leaders provide their insight, and discuss market developments with the audience.

This U.S. Department of Energy sponsored study is designed to identifying the opportunities for advancing contracting for energy storage projects. This study's goal is to understand the current challenges facing energy storage project financing, and gain insights into ways advancing the level of contract development in the energy storage industry could allow greater and more widespread commercial development in the industry. This Study is part of a series of studies supporting the U.S. Department of Energy's effort to promote market development through reducing barriers to entry, reducing transaction costs, and promoting wider access to low cost capital in order to promote development across the energy storage industry.

This Stakeholder Meeting consisted of a panel of financial industry participants that provide insight into the current status and needs of the market. This study's goal is to understand the current challenges surrounding the development of standardized contracts in the energy storage market, and gain insights from other markets as to what strategies were successful there. The discussion from the financial and legal discussion will include: current market developments, revenue certainty, supporting proposal documents, and means to reducing risk.

The first topic of discussion was current market developments in both front of the meter and behind the meter developments. The discussion updated the audience on the Panel's perception of the current state of project financing for energy storage projects currently, and how the market is changing, with expectations for where it will go in the next few years. The discussion highlighted the growing competition both helping the industry players through lower cost and better technology, and hindering them as more groups enter the market. The panel discussed the various groups driving activity, with special focus on the needs of utilities, and their role shaping the use of these technologies. The panel also discussed a few of the more near term opportunities for growth, both in unit size, and potential for increased profitability; microgrids and solar/storage facilities. The microgrid opportunity presents an opportunity for an integrated storage as a service model, holding out the potential for a number of different revenue streams.

The second topic discussed was the issue of revenue certainty. The key challenge for energy storage project developers continues to be finding sufficient revenue streams to cover debt service, operating costs, and provide an acceptable return for the developers and sponsors. In the front of the meter market, developers continue look for PPAs that will cover all three needs, but are increasingly looking to put together a basket of contracted revenue streams and merchant activity that will provide the needed revenue. Panelists noted that the complexity of ensuring revenue certainty with the multiple value stacking roles creates a more complex contractual framework that will vary depending on the location of the project—adding a geographical complexity to the effort.

The panelists did believe that experience was improving the situation, both in the development and spread of effective PPAs by utilities, and in the ability of developers to craft a multi-regional project pipeline.

The third topic discussed was the group of supporting project proposal documents and contracts. The panelists discussed the importance of the supporting materials in a project development package to highlight the areas of risk, and identify who bears the responsibility in the event of a loss. The panelists mentioned role of standardization of the contract language as an important development as the market matures. Based on experience in other markets, the panelists highlighted areas where they had expectation for development, specifically to ensure revenue certainty, and be more explicit as to liabilities in the event of loss on the project.

The final topic discussed was reducing risk. This covered a number of areas, including reduce the risk of dealing with a larger number of smaller commercial customers in behind the meter project development. The risks evaluated generally focused on issues previously mentioned such as revenue certainty and identifying who bears the responsibility in the event of a loss in the project. The incorporation of improved risk management strategies into project development efforts was highlighted as critical; in addition, it was evident that all participants approached the goal differently. Representatives from the insurance industry highlighted that in a properly working market, risk is allocated to the group that can handle it the best, and that is also best suited to pay for it. A suggestion was proffered that better performance metrics could help create better contracts to improve risk management. Other methods that were raise to de-risk the project development process included EPC wraps on the project equipment and construction, and insurance products that wrap warranty risks. One final discussion point was the need to incorporate customer experience into the development process, as customers lacking an education as to the capabilities of a system and their true needs, sometimes required changes to the physical system or contracts governing the operation of the unit later.

APPENDIX E: DOE ENERGY STORAGE FINANCE ADVISORY COMMITTEE MEETING: 2018 U.S. DOE ENERGY STORAGE FINANCING SUMMIT (SF)

Thursday,
October 4, 2018
11:00 a.m. – 7:00 p.m.

Morrison & Foerster LLP
425 Market Street, 33rd Floor
San Francisco, CA 94105

2018 U.S. Department of Energy (DOE) Energy Storage Financing Summit

You're invited to this event focused on advancing standardized contract development in the energy storage market. These studies are part of the U.S. DOE's effort to promote market development through reducing barriers to entry, reducing transaction costs, and promoting wider access to low cost capital.

Keynote speakers include Commissioner David Hochschild of the California Energy Commission and Bernadette Del Chiaro, Executive Director of the California Solar & Storage Association. Other speakers will include representatives from the U.S. DOE and industry experts who have experience with the challenges and opportunities of investing in energy storage projects. This summit is presented by the U.S. Department of Energy, Morrison & Foerster LLP, Mustang Prairie Energy, and Sandia National Laboratories.

This complimentary event is by invitation-only and you must be registered to attend. If you believe it would benefit a colleague with a similar focus, please respond to this invitation with that person's contact information and we will accommodate them as space allows.

2018 U.S. DOE Energy Storage Financing Summit (SF):

Advancing Energy Storage Contracting

11:00-12:00	**Registration**	Lunch
12:00-12:05	**Welcome**	Susan Mac Cormac, Morrison & Foerster, LLP
12:05-12:15	**Study Overview**	Richard Baxter, Mustang Prairie Energy
12:15-12:30	**U.S. DOE Energy Storage Program**	Babu Chalamala, Program Manager, Grid Energy Storage, Sandia National Laboratories
12:30-1:00	**Keynote**	David Hochschild, Commissioner, California Energy Commission
1:00-1:15	**Break**	Networking
1:15-1:45	**Keynote**	Scott Murtishaw, California Solar & Storage Association
1:45-2:00	**Sandia National Laboratories**	Ray Byrne, Distinguished Member of the Technical Staff
2:00-2:15	**Pacific Northwest National Laboratory**	Patrick Balducci, Chief Economist
2:15-2:45	**Break**	Networking
2:45-3:30	**Panel 1** **Front of the Meter Financing**	Robert Fleishman, Kirkland & Ellis, LLP [Moderator] Jen Aitchison, Hugh Wood Canada Ali Amirali, Starwood Energy Group Sam Cummings, Vision Ridge Partners Joe Heinzmann, GE Craig Horne, Swinerton Renewable Energy
3:30-4:00	**Break**	Networking
4:00-4:45	**Panel 2** **Behind the Meter Financing**	Danny Kennedy, CalCEF & CalCharge [Moderator] Jon Cozens, New Energy Risk Ren Plastina, Investec Jerry Polacek, Tortoise Polly Shaw, Stem Vishvesh Jharveri, Advanced Microgrid Systems
4:45-5:15	Break	Networking
5:15-6:00	**Panel 3** **Solar / Storage Financing**	Elizabeth Sluder, Morrison & Foerster, LLP [Moderator] Lee Feliciano, C2 Energy Capital Audrey Lee, SunRun Jon Previtali, Wells Fargo Adria Schulman-Eyink, Recurrent Energy
6:00	**Closing**	Richard Baxter, Mustang Prairie Energy
6:00-7:00	**Reception**	Networking

In Partnership With

Hosts

U.S. DOE Speakers

Babu Chalamala, Program Manager, Energy Storage Technologies and Systems, Sandia National Laboratories

Prior to joining Sandia in August 2015, he was a Corporate Fellow at SunEdison for five years, where he led R&D and product development in grid scale energy storage. He received his B.Tech degree in Electronics and Communications Engineering from Sri Venkateswara University and his PhD degree in Physics from the University of North Texas. He is a Fellow of the IEEE and Academy of Sciences St Louis, a Life Member of the Electrochemical Society, and a Member of the Materials Research Society.

Ray Byrne, Distinguished Member of the Technical Staff

Ray Byrne is manager of the Electric Power System Research department at Sandia National Laboratories, where he has been employed since 1989. He holds a Ph.D. in electrical engineering from the University of New Mexico, an M.S. in electrical engineering from the University of Colorado, Boulder, and a B.S. in electrical engineering from the University of Virginia. He also completed an M.S. in financial mathematics at the University of Chicago. Previously, he was a distinguished member of the technical staff at Sandia.

Patrick Balducci, Chief Economist

Patrick Balducci has 20 years of professional experience as an economist and project manager. He is a Chief Economist at the Pacific Northwest National Laboratory (PNNL) where he has been employed since 2001. He is currently leading the industrial acceptance areas of the PNNL Energy Storage Program. He has extensive experience in modeling the benefits of energy infrastructure and in leading research and development efforts supporting the U.S. Department of Energy (DOE) and the electric power industry.

Keynote Speakers

David Hochschild, Commissioner, California Energy Commission

Commissioner Hochschild's career has spanned public service, environmental advocacy and the private sector. He first got involved in the solar energy field in 2001 in San Francisco as a Special Assistant to Mayor Willie Brown where he launched a citywide $100 million initiative to put solar panels on public buildings. He went on to co-found the Vote Solar Initiative, a 60,000-member advocacy organization promoting solar policies at the local, state and federal level.

Scott Murtishaw, California Solar & Storage Association

Scott Murtishaw is a consultant to the California Solar & Storage Association where he works on issues related to rate design, legislation, storage incentives, and provision of grid services by distributed resources. Previously, he served as an energy advisor to President Peevey and President Picker at the CPUC, playing a key role in shaping the CPUC's rate design, distributed generation, net energy metering, and climate policies. Prior to joining the CPUC, Scott was a researcher at the Lawrence Berkeley National Laboratory where he authored reports on a wide range of energy efficiency and climate policy topics.

Host

Susan Mac Cormac, Morrison & Foerster, LLP

Susan Mac Cormac Taylor is a corporate partner at Morrison & Foerster where she serves as co-chair of the Energy and Clean Technology Group as well as the Social Enterprise and Impact Investing Group. Ms. Mac Cormac Taylor's work focuses on advising innovative, forward-thinking sustainable and renewable energy companies and investors on corporate structure, equity and debt financings, mergers, acquisitions, asset purchases and sales, reorganizations and joint ventures. She advises corporations on the intersection of fiduciary duties and environmental sustainability as well as disclosure around ESG. She has particular expertise on ensuring energy, sustainability and other investments have positive impact – through use of new corporate forms, hybrids, alternative debt and equity instruments and disclosure.

Conference Chairman

Richard Baxter, President, Mustang Prairie Energy

Richard Baxter is President of Mustang Prairie Energy where he bridges the financial and technical sides of the market. He is the author of the book "*Energy Storage: A Nontechnical Guide"* (Pennwell), and two reports on Energy Storage Financing for Sandia National Labs. He is the Chairman of the Board for NovoCarbon (TSX-V:GLK). He has been active in the energy storage industry for 18+ years, and served on the Board of Directors for the Energy Storage Association (ESA).

Panel 1: Front of the Meter Financing

Jen Aitchison, Hugh Wood Canada

Jen is Senior Vice President, Sustainable Energy Practice Leader at Hugh Wood Canada Inc. She's been acknowledged for fundamentally changing the insurance landscape for renewable energy and combining risk management with market-based solutions for win-win results. Jen is a founding member of Women in Renewable Energy (WiRE).

Ali Amirali, Starwood Energy Group

Ali Amirali is a Senior Vice President of Starwood Energy Group. In this role, Mr. Amirali is responsible for the expansion of Starwood Energy Group's StarTrans high-voltage transmission assets. He also supports the origination, development and acquisition activities associated with utility-scale power generation and storage projects.

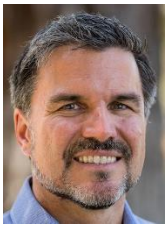
Sam Cummings, Vision Ridge Partners

Sam Cummings is a Principal at Vision Ridge Partners-a Colorado and New York based investment firm focused on Sustainable Real Assets. Sam joined Vision Ridge in early 2015 and focuses on electrified mobility, energy storage, and other opportunities. Previously, Sam served as a Sr. Associate within the Energy & Infrastructure Investment Banking Group at KGS-Alpha Capital Markets, L.P.

Joe Heinzmann, GE

Joe Heinzmann is the Senior Account Manager for GE Power's Energy Storage Business. In this role, Joe is responsible for developing cost effective technical solutions for GE's customers around the world that maximizes the economics and sustainability of our customer's energy Grid's. Joe holds a Mechanical Engineering Degree from the California Maritime Academy.

Craig Horne, Swinerton Renewable Energy



Jraig leads SRE's deployment of integrated storage solutions in the utility, commercial, and services markets. Dr. Horne has been working in the deployment and development of electrochemical energy systems and technologies for over 25 years with direct experience in flow, lead-acid and lithium ion batteries as well as fuel cells. Craig has served on ESA's Board since 2014.

Moderator

Robert Fleishman, Kirkland & Ellis, LLP

Robert Fleishman is a corporate partner in the Washington, D.C. office of Kirkland & Ellis LLP. Robert has a leading reputation defending energy and financial industry participants and individuals in energy markets against charges of market manipulation, particularly before the Federal Energy Regulatory Commission (FERC), the Commodity Futures Trading Commission (CFTC), and other regulatory bodies, and advising companies on the energy regulatory and compliance aspects of transactions and other energy market activities.

Panel 2: Behind the Meter Financing

Jon Cozens, New Energy Risk

Jon Cozens has been with New Energy Risk since 2014. He served as Managing Director until 2017, when he was elevated to Chief Commercial Officer and oversees execution of the company's business strategy. Jon holds a BS in Electrical Engineering from Lehigh University, and an M.Sc. in Finance from London Business School.

Ren Plastina, Investec

Ren joined Investec in 2017, and leads its origination activity in the Clean Energy sector for North America. Through his career, Ren has led over $10 billion of transactions across the energy sector for clients in the power, oil & gas, mining and public infrastructure sectors. Prior to Investec, Ren led the energy team at Varagon Capital Partners, where he built a portfolio of project finance and leveraged lending investments.

Jerry Polacek, Tortoise

Jerry Polacek is a co-founder of Tortoise's Clean Energy and Infrastructure business and serves as a Managing Director and Group Lead. Previously, Mr. Polacek was a co-founder of Energy & Infrastructure Capital LLC (EIC) and served as its CEO and Chief Investment Officer from 2014 to 2016. Prior to forming EIC, Mr. Polacek was a Managing Director at GE Capital.

Polly Shaw, Stem

Polly Shaw has served as Stem's Vice President of Regulatory Affairs and Communications since 2016. She has 25 years of clean energy and energy efficiency policy experience in the U.S. and China. Formerly Vice President of External Affairs at SunEdison. Polly holds a B.A. from Tufts University, a Certificate in Chinese Law from the University of London, and speaks English, French, Chinese, and basic Spanish.

Vishvesh Jharveri, Advanced Microgrid Systems

Vishvesh Jhaveri leads the Project Finance team at Advanced Microgrid Solutions (AMS) and over the past three years managed project finance transactions for energy storage and SolarStorage projects developed by AMS. Vishvesh lead the industry-leading project finance deal with Macquarie Capital to develop and operate a distributed portfolio of 50MW of behind-the-meter distributed energy storage projects in California.

Moderator

Danny Kennedy, Managing Director of CalCEF & CalCharge

Danny Kennedy leads the California Clean Energy Fund, connecting entrepreneurs everywhere to capital to build an abundant clean energy economy that benefits all. He is also the President of CalCharge, a public private partnership with the National Labs and universities of California, unions and companies, working to advance energy storage.

Panel 3: Solar/Storage Financing

Lee Feliciano, C2 Energy Capital

Lee is Head of Business Development for C2 Energy Capital. He started his solar career in 2004, and in 2007 founded SolEquity, the company responsible for developing the first commercial project in Arizona financed under a PPA. Lee also worked as a Senior Developer at Kyocera Solar International (NYSE:KYO)

Audrey Lee, SunRun

As Vice President of Energy Services, Audrey leads Sunrun's efforts to deploy and aggregate residential solar plus storage to create cleaner and less costly grid infrastructure while reducing customers' bills and providing back-up power in an outage. Before joining Sunrun, Audrey was Vice President of Analytics and Design at Advanced Microgrid Solutions, Inc. (AMS).

Jon Previtali, Wells Fargo

Jon Previtali leads technical due diligence for solar and wind projects at Wells Fargo, one of the largest financiers of renewable energy in the US. He also serves on the board of Wells Fargo's Innovation Incubator, a grant program for clean-tech starts-ups. Jon is an engineer with degrees from Stanford and the University of Colorado who has worked with Internet and renewable energy technologies for over twenty years with stints at SunEdison and Black & Veatch

Adria Schulman-Eyink, Recurrent Energy

Adria Schulman-Eyink is a Senior Manager at Recurrent Energy, which is the US solar project development arm of Canadian Solar. She is responsible for the origination and execution of utility-scale solar and storage project financings. Her scope includes equity sales, debt and tax equity financings.

Moderator

Elizabeth Sluder, Partner, Morrison & Foerster, LLP

Elizabeth Sluder is a partner in the Los Angeles office of Morrison & Foerster. She focuses her practice on project finance, mergers and acquisitions, private equity, and general corporate advice. Ms. Sluder has substantial experience representing clients in renewable energy transactions, including construction and term debt financings, tax equity investments, and negotiating supply agreements, construction contracts and offtake arrangements.

Attendee List

	Company	FirstName	LastName
1	8minutenergy Renewables	Julia	Dobtsis
2	Able Grid Energy Solutions	Barnaby	Olson
3	Advanced Microgrid Solutions	Vishvesh	Jhaveri
4	Advanced Microgrid Solutions	Hardh	Mehta
5	AIMPERA Capital Partners	Paul	Gurm
6	AIMPERA Capital Partners	Paul	Ho
7	AIMPERA Capital Partners	Matthew	Kestenbaum
8	AIMPERA Management	Aaron	Weinstein
9	Amber Kinetics	William	Golove
10	Bank of America Merril Lynch (BAML)	Kevin	Lang
11	BlackRock	Martin	Torres
12	C2 Energy Capital	Lee	Feliciano
13	California Clean Energy Fund	Danny	Kennedy
14	California Energy Commission	David	Hochschild
15	California Solar & Storage Association	Scott	Murtishaw
16	CIT Group	Tyler	Hilliard
17	Cleanpath Ventures	Matt	Cheney
18	ClearSky Power and Technology Fund	James	Goldinger
19	Cobia Capital	Glen	Casanova
20	Coronal Energy	Ed	Feo
21	Cumulus Energy Storage	Michael	Hurwitz
22	East Bay Community Energy	Todd	Edmister
23	Enovation Partners	Daniel	Gabaldon
24	Enovation Partners	Simon	Greenberg
25	EPC Power	John	Bryan
26	esVolta	Randy	Mann
27	FlexEnergy	Pedro C.	Elizondo
28	FlexGen	John	Prueher
29	Galehead Development	Matt	Marino
30	GE Power	Joseph	Heinzmann
31	Generate Capital	Edward	Bossange
32	Generate Capital	Andrew	Hughes
33	Go Electric	Steven	Lichtin
34	Greenlots	Lin	Khoo
35	Greenlots	Keerthi	Ravikkumar
36	Greenlots	Mark	Steffler
37	Highview Power	Richard	Riley
38	Hitachi Capital	Chris	Pagano
39	Hugh Wood Canada	Jen	Aitchison
40	iCON Infrastructure Canada	Jamie	Manson

Attendee List (Cont.)

	Company	FirstName	LastName
41	IHI Energy Storage	Shane	Bediz
42	Investec USA	Ren	Plastina
43	JinkoSolar	Nigel	Cockroft
44	K2 Energy Solutions	Jim	Hodge
45	Key Capture Energy	Jeff	Bishop
46	Key Capture Energy	Nicole	Wolf
47	Kirkland & Ellis LLP	Robert	Fleishman
48	Landis & Gyr Utilities Services	Vani	Dantum
49	Lazard	Samuel	Scroggins
50	LG Chemical	Kevin	Fok
51	LG Chemical	Peter	Gibson
52	LS Power	Cody	Hill
53	Microsoft Corporation	Brandon	Middaugh
54	Morgan Stanley Infrastructure Partners	Brian	Kang
55	Morgan Stanley Infrastructure Partners	Brian	Park
56	Morrison & Foerster LLP	Suz	Mac Cormac
57	Morrison & Foerster LLP	Elizabeth	Sluder
58	Munich Reisurance America	Jay	Goldin
59	Mustang Prairie Energy	Steve	Austerer
60	Mustang Prairie Energy	Richard	Baxter
61	NAATBatt International	Russell	Weed
62	Navigant	Andrea	Romano
63	New Energy Risk	Jon	Cozens
64	New Energy Risk	Thomas	Dickson
65	Ormat	Tal	Mund
66	Pacific Northwest National Labratory (PNNL)	Patrick	Balducci
67	Panasonic Corporation	Janet	Lin
68	Pattern Energy	Terrence	Cantorna
69	Power 2 Storage	Eric	Curry
70	Powin Energy Corpation	Geoffrey	Brown
71	Recurrent Energy	Adria	Schulman-Eyink
72	Regenerate Power	Reyad	Fezzani
73	Rocky Mountain Institute	Titiaan	Palazzi
74	Romeo Power	Lauren	Webb
75	Romeo Power Technology	Ned	Horneffer
76	Roth Capital Partners	Craig	Irwin
77	San Diego Gas & Electric Company	Robert	Lane
78	Sandia National Laboratories	Ray	Byrne
79	Sandia National Laboratories	Babu	Chalamala
80	Sandia National Laboratories	Ricky	Concepcion

Attendee List (Cont.)

	Company	FirstName	LastName
81	Sharp	Carl	Mansfield
82	SF Electrical Construction Industry	Alex	Lantsberg
83	Soltage	Lori	Bilella
84	Starboard Energy Advisors	David	Mintzer
85	Starwood Energy Group	Ali	Amirali
86	STEM	Prakesh	Patel
87	Stem	Polly	Shaw
88	Sunrun	Audrey	Lee
89	SunRun Inc.	Sam	Chatterjee
90	SunRun Inc.	Joseph	Eisenberg
91	Swinerton	Craig	Horne
92	Tortoise	Jerry	Polacek
93	U.S. Department of Energy	Douglas	Schultz
94	Ultra Capital	Kristian	Hanelt
95	UniEnergy Technologies	John	DeBoever
96	UniEnergy Technologies	Gary	Yang
97	USI Insurance Services	Dixon	Wright
98	Vision Ridge Partners	Sam	Cummings
99	Wärtsilä Corporation	Risto	Paldanius
100	Wells Fargo	Jon	Previtali
101	Wells Fargo Cleantech Banking	Adam	Bergman
102	Willis Towers Watson	Danny	Seagraves
103	Zep Solar	Alex	Mayer
104		John	Chmiola

Synopsis

On January 18th, 2018 Morrison & Foerster LLP and Mustang Prairie Energy in Partnership with the U.S. Department of Energy presented a one-day Energy Storage Finance Advisory Committee Meeting at Morrison & Foerster's New York City office that had 99 attendees. Speakers included representatives from the U.S. Department of Energy, the New York State Energy Research and Development Authority (NYSERDA, and industry experts who have experience with the challenges and opportunities of investing in energy storage projects.

The Summit was the second Energy Storage Finance Advisory Committee Meeting for a U.S. Department of Energy sponsored study to identifying the opportunities for advancing energy storage contracting for energy storage projects. This study's goal is to understand the current challenges facing energy storage project financing, and gain insights into ways advancing the level of contract development in the energy storage industry could allow greater and more widespread commercial development in the industry. This series of studies are part of the U.S. Department of Energy's effort to promote market development through reducing barriers to entry, reducing transaction costs, and promoting wider access to low cost capital in order to promote development across the energy storage industry.

The summit began with an overview of the Study by Richard Baxter of Mustang Prairie Energy, followed by Babu Chalamala, Program Manager, Energy Storage Technologies and Systems, Sandia National Laboratories who gave an overview of federal support for energy storage technology development, and explained how that support is extending into the commercialization of these systems.

The first Keynote address was given by David Hochschild, Commissioner of the California Energy Commission. His presentation showcased the efforts of the State of California's effort to promote the development of energy storage project development at all levels of the electrical power sector to promote customer choice, improved service, and a more resilient power grid. The second Keynote address was given by Scott Murtishaw from the California Solar & Storage Association. His presentation showcased the efforts of the CSSA's efforts to broaden the State of California's energy storage industry, and helping customers use energy storage system to improve their generation and use of electricity.

The first panel of the day focused on Front of the Meter Financing. The discussion focused on the current state of project financing for large scale energy storage projects currently, and how the market is changing, with expectations for where it will go in the next few years. The panelists highlighted their expectations for continued competition driving down system costs. It was noted that although this part of the market contained the largest systems, the Residential sector contained much of the market activity, and was expected to continue. It was noted that in other markets, Tax equity investors played a significant role, but many of these groups had significant limits for unproven technology such as energy storage—which also hindered hybrid projects. Modeling of energy storage projects was highlighted as critical to understanding the value stacking of the project, and core to the understanding of the interconnection of equipment needs in support of multiple application needs.

The second panel of the day focused on Behind the Meter Financing. In this market, energy storage project development is more highly focused on retail sales. Unfortunately, every project remains unique—bespoke in the term of the day. The panel mentioned standardization of project development process—both in the PPA, but also in the supporting documents to ensure revenue certainty. Value stacking has been seen as the most viable path to bankability, but the revenue streams developed are based on energy cost savings, increasing the complexity and variability of the possible revenue. It is expected that as experience is gained, the inherent risk of the projects will decline. In support of the system being able to provide the capabilities for the needed applications—and maybe more—it was highlighted that there needs to be a significantly greater knowledge of hybrid use cases, and marginal impacts from use on the overall life and capability of the unit.

The final panel of the day focused on Solar/Storage Financing. Many challenges were highlighted in this fast growing area of the market. Revenue certainty concerns are more muted in this application as the energy storage system acts to support the revenue generation of the solar PPA, and thus the concerns on the energy storage system revolve more around possible areas of risk. The panel declined to recite the areas of discussion in the previous panels, and focused on gaps needed for the development of the storage industry if you were going to mirror the expansion of the solar market. This included a deeper integration of storage into IRP language, accelerated lifetime testing to give hard data behind insurance, and more advanced risk management (insurance) tools to both protect existing revenue streams while opening up the possibility of leveraging the existing asset for new revenue streams at a acceptable risk adjusted level.

APPENDIX F: DOE ENERGY STORAGE FINANCE ADVISORY COMMITTEE MEETING: 2019 U.S. DOE ENERGY STORAGE FINANCING SUMMIT (NYC)

2019 U.S. DOE ENERGY STORAGE FINANCING SUMMIT

New York, NY | January 23, 2019

Presented by:

KIRKLAND & ELLIS

MUSTANG PRAIRIE

In partnership with:

Sandia National Laboratories

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

2019 U.S. DOE Energy Storage Financing Summit (NYC):

Advancing Energy Storage Contracting

January 23rd, 2019

8:00-9:00am	**Registration / Breakfast**
9:00-9:05am	**Welcome** Rohit Chaudhry, Partner, Kirkland & Ellis LLP
9:05-9:10am	**Energy Storage Financing Study: Overview** Richard Baxter, President, Mustang Prairie Energy
9:10-11:10am	**DOE Energy Storage Valuation Workshop** Jason Doling, New York State Energy Research & Development Authority Ray Byrne, Sandia National Laboratories [Moderator] Patrick Balcucci, Pacific Northwest National Laboratory Tu Nguyen, Sandia National Laboratories David Copp, Sandia National Laboratories Felipe Wilches-Bernal, Sandia National Laboratories Ricky Concepcion, Sandia National Laboratories
11:10am	**Closing** Richard Baxter, President, Mustang Prairie Energy
11:10am-12:00pm	**Registration / Lunch**

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2019 U.S. DOE Energy Storage Financing Summit (NYC):

Advancing Energy Storage Contracting

January 23rd, 2019

12:00-12:05pm	**Welcome** Rohit Chaudhry, Partner, Kirkland & Ellis LLP
12:05-12:15pm	**Energy Storage Financing Study: Overview** Richard Baxter, President, Mustang Prairie Energy
12:15-12:45pm	**U.S. DOE Energy Storage Program** Ray Byrne, Sandia National Laboratories
12:45-1:15pm	**Keynote** Alfred Griffin, President, NY Green Bank
1:15-1:45pm	**Networking Break**
1:45-2:30pm	**Panel 1—Front of the Meter Projects Financing** Bob Fleishman, Corporate Partner, Kirkland & Ellis, LLP [Moderator] Ali Amirali, Starwood Energy Group Alan Dash, Nexus Infrastructure Capital Management John O'Brien, Siemens Financial Services Mirko Molinari, GE Power Jason Moore, NY Green Bank
2:30-3:00pm	**Networking Break**
3:00-3:45pm	**Panel 2—Distributed & Hybrid System Project Financing** Elizabeth Sluder, Partner, Morrison & Foerster, LLP [Moderator] Jeff Bishop, Key Capture Energy Terry Cantorna, Pattern Energy Ken McCauley, 127 Energy Ren Plastina, Investec
3:45-4:15pm	**Networking Break**
4:15-5:00pm	**Panel 3—Best Practices in Energy Storage Contracting: What Works?** Ali Zaidi, Corporate Of Counsel, Kirkland & Ellis LLP [Moderator] Doug Alderton, NEC Energy Solutions Nate Gabig, KPMG Danny Seagraves, Willis Towers Watson Dixon Wright, USI Insurance
5:00pm	**Closing** Richard Baxter, President, Mustang Prairie Energy
5:00-6:00pm	**Reception**

In Partnership With | **Hosts**

DOE Speaker

Ray Byrne, Distinguished Member of the Technical Staff

Ray Byrne is manager of the Electric Power System Research department at Sandia National Laboratories, where he has been employed since 1989. He holds a Ph.D. in electrical engineering from the University of New Mexico, an M.S. in electrical engineering from the University of Colorado, Boulder, and a B.S. in electrical engineering from the University of Virginia. He also completed an M.S. in financial mathematics at the University of Chicago. Previously, he was a distinguished member of the technical staff at Sandia.

Keynote Speakers

Alfred Griffin, President, NY Green Bank

Alfred Griffin is an industry leader in developing innovative solutions in support of the financing of renewable energy generation and energy efficiency projects, and brings 25 years of experience in banking and finance to NY Green Bank. As President, Mr. Griffin oversees partnerships with private sector capital providers and other clean energy market participants to address barriers that limit private investment into attractive renewable energy and energy efficiency projects.

Host

Rohit Chaudhry, Partner, Kirkland & Ellis LLP

Rohit Chaudhry is a debt finance partner in the Washington, D.C., office of Kirkland & Ellis LLP. Rohit's practice focuses on energy and project finance transactions, sales and acquisitions, as well as project restructurings across the energy spectrum, including independent power, oil & gas, midstream and LNG sectors. Rohit represents lenders, private equity funds, developers, institutional investors, and multilateral and bilateral agencies on domestic and international transactions.

Conference Chairman

Richard Baxter, President, Mustang Prairie Energy

Richard Baxter is President of Mustang Prairie Energy where he bridges the financial and technical sides of the market. He is the author of the book "*Energy Storage: A Nontechnical Guide"* (Pennwell), and two reports on Energy Storage Financing for Sandia National Labs. He is the Chairman of the Board for NovoCarbon (TSX-V:GLK). He has been active in the energy storage industry for 18+ years, and served on the Board of Directors for the Energy Storage Association (ESA).

DOE Energy Storage Valuation Workshop

Jason Doling, New York State Energy Research & Development Authority

Jason Doling is Program Manager for Energy Storage at the New York State Energy Research and Development Authority (NYSERDA), a public benefit corporation that advances innovative energy solutions to improve New York State's economy and environment. At NYSERDA, he and the team are working to reduce market impediments to energy storage deployment on the electric grid in New York State.

Patrick Balducci, Chief Economist

Patrick Balducci has 20 years of professional experience as an economist and project manager. He is a Chief Economist at the Pacific Northwest National Laboratory (PNNL) where he has been employed since 2001. He is currently leading the industrial acceptance areas of the PNNL Energy Storage Program. He has extensive experience in modeling the benefits of energy infrastructure and in leading research and development efforts supporting the U.S. Department of Energy (DOE) and the electric power industry.

Tu Nguyen, Sandia National Laboratories

Tu A. Nguyen is a Senior Member of the Technical Staff at Sandia National Laboratories. He received his B.S degree in Power Systems from Hanoi University of Science and Technology, Vietnam in 2007. He worked as a Power Transformer Test Engineer in ABB High Voltage Test Department in Vietnam from 2008 to 2009. He received his Ph.D. degree from Missouri University of Science and Technology in December 2014.

David Copp, Sandia National Laboratories

David Copp is a Senior Member of the Technical Staff at Sandia National Laboratories, where he is working on grid integration, analysis, optimization, and control of energy storage. He received his M.S. and Ph.D. degrees in mechanical engineering from the University of California, Santa Barbara in 2014 and 2016, respectively, where he was a member of the Center for Control, Dynamical-Systems, and Computation. He received his B.S. degree in mechanical engineering from the University of Arizona in Tucson, Arizona, in 2011.

Felipe Wilches-Bernal, Sandia National Laboratories

Felipe Wilches-Bernal received the M.S. degree in control systems and signal processing from Université Paris-Sud XI, Orsay, France and the Ph.D. degree in electrical engineering from Rensselaer Polytechnic Institute, Troy, NY, USA. He joined the Electric Power Systems Research Department at Sandia National Laboratories in 2015 where he currently works as a Senior Member of Technical Staff.

Ricky Concepcion, Sandia National Laboratories

Ricky Concepcion joined the Electric Power Systems Research group at Sandia National Laboratories as a member of technical staff in 2014. He has conducted research in the areas of electric transmission systems and energy storage system valuation. He is the lead developer of QuESt, Sandia's open source software tool for energy storage valuation and related applications.

Moderator

Ray Byrne, Distinguished Member of the Technical Staff

Ray Byrne is manager of the Electric Power System Research department at Sandia National Laboratories, where he has been employed since 1989. He holds a Ph.D. in electrical engineering from the University of New Mexico, an M.S. in electrical engineering from the University of Colorado, Boulder, and a B.S. in electrical engineering from the University of Virginia. He also completed an M.S. in financial mathematics at the University of Chicago. Previously, he was a distinguished member of the technical staff at Sandia.

Panel 1—Front of the Meter Projects Financing

Ali Amirali, Starwood Energy Group

Ali Amirali is a Senior Vice President of Starwood Energy Group. In this role, Mr. Amirali is responsible for the expansion of Starwood Energy Group's StarTrans high-voltage transmission assets, as well as for new business/project opportunities in the transmission and distribution arena in North America. He also supports the origination, development and acquisition activities associated with utility-scale power generation and storage projects.

Alan Dash, Nexus Infrastructure Capital Management

Alan Dash is a Managing Director at NEXUS Infrastructure Capital Management, a partnership focused on infrastructure in transition. Prior to his current role, he was responsible for leading the transformation of Vionx Energy, a vanadium redox flow battery company, from a late stage development to commercial company.

John Obrien, Siemens Financial Services

John O'Brien is a Director within Siemens Financial Services' Energy Finance team. John joined the team right after its inception in 2008 and is responsible for originating and structuring renewable (wind, solar, and storage) and traditional thermal (CCGT and CT) power transactions. Since 2008 SFS EF has lent in excess of $10 billion to power projects and currently has a portfolio of over $5.5 billion split roughly between renewable and thermal transactions.

Troy Miller, GE Power

Troy Miller is the North American Sales Leader for Energy Storage at GE Power. He has over 25 years of experience in the Power Engineering industry. Mr. Miller has lengthy experience in the application and implementation of all aspects of energy storage, renewable energy, and microgrids. Mr. Miller is the Vice Chair of the Board of Directors at the Energy Storage Association (ESA).

Jason Moore, NY Green Bank

Jason Moore is a Director at NY Green Bank on the Investment & Portfolio Management team, where he works to accelerate the deployment of clean energy assets in New York by structuring and executing transactions for clients and business partners.

Moderator

Robert Fleishman, Kirkland & Ellis, LLP

Robert Fleishman is a corporate partner in the Washington, D.C. office of Kirkland & Ellis LLP. Robert has a leading reputation defending energy and financial industry participants and individuals in energy markets against charges of market manipulation, particularly before the Federal Energy Regulatory Commission (FERC), the Commodity Futures Trading Commission (CFTC), and other regulatory bodies, and advising companies on the energy regulatory and compliance aspects of transactions and other energy market activities.

Panel 2—Distributed & Hybrid System Project Financing

Jeff Bishop, Key Capture Energy

Jeff Bishop has a proven track record at the intersection of commercial and policy in all growth stages of renewable energy development companies. At Brookfield Renewable and EDP Renewables, Jeff oversaw market development that led to contracts for nearly a billion dollars of new wind projects. Jeff was responsible for the financial models at Horizon Wind Energy (when owned by Goldman Sachs) for over $2 billion of operating wind farms today, and worked on the sale and IPO of the company to EDP Renewables.

Terry Cantorna, Pattern Energy

Terrence Cantorna is a Business Development Manager focused on incorporating energy storage into Pattern Development's renewable energy portfolio. With a global footprint spanning the United States, Canada, Mexico and Japan, Pattern Development's team has brought more than 5,500 MW to market. Its publicly-traded affiliate, Pattern Energy, owns and operates renewable energy assets through its Houston-based Operations Control Center.

Ken McCauley, 127 Energy

Prior to co-founding 127 Energy early in 2016 to develop and finance renewable energy and energy storage projects, Ken was President & CEO of Princeton Power Systems, Inc. (PPS). At Princeton Power Systems, he worked on islandable grid-tied and off-grid micro-grid systems globally including U.S. Department of Defense sites, National Park Service locations, Africa, and private island systems.

Ren Plastina, Investec

Ren joined Investec in 2017, and leads its origination activity in the Clean Energy sector for North America. Through his career, Ren has led over $10 billion of transactions across the energy sector for clients in the power, oil & gas, mining and public infrastructure sectors. Prior to Investec, Ren led the energy team at Varagon Capital Partners, where he built a portfolio of project finance and leveraged lending investments.

Moderator

Elizabeth Sluder, Partner, Morrison & Foerster, LLP

Elizabeth Sluder is a partner in the Los Angeles office of Morrison & Foerster. She focuses her practice on project finance, mergers and acquisitions, private equity, and general corporate advice. Ms. Sluder has substantial experience representing clients in renewable energy transactions, including construction and term debt financings, tax equity investments, and negotiating supply agreements, construction contracts and offtake arrangements.

Panel 3—Best Practices in Energy Storage Contracting: What Works?

Doug Alderton, NEC Energy Solutions

Doug Alderton was brought in as the Eastern North America Region Director of Sales at NEC Energy Solutions, a Westborough Massachusetts based energy storage company, in February of 2016. Prior to joining NEC, Doug worked at Vionx Energy Corporation, a Woburn Massachusetts based vanadium redox flow battery company, as the Director of Marketing & Sales where he managed all client relationships and marketing activities related to launching a United Technology Corporation licensed energy storage technology into the grid marketplace.

Nate Gabig, KPMG

Managing Director in KPMG's Financial Advisory & Risk Consulting practice with a particular focus on solar securitization and esoteric ABS (auto, aircraft, fleet, student loans, credit card, cell tower & whole-business securitization). Leading "live" transactions alongside our investment banking and issuing clients: Goldman Sachs, Credit Suisse, JP Morgan, Deutsche Bank, RBS, Citi, Guggenheim & Morgan Stanley

Danny Seagraves, Willis Towers Watson

Danny Seagraves is recognized globally as a leading expert in the creation and implementation of sophisticated risk finance and risk management solutions whose primary purpose is to allow his clients' to achieve superior bankability for their cutting-edge investments. The solutions created by his team are typically characterized by having a "return on investment" element as they stabilize an investment's non-bankable long-term revenue stream through the use of S&P A or better rated risk finance products.

Dixon Wright, USI Insurance

John K. Dixon Wright started his surety career in 1981 and is Senior Vice President at USI Insurance Services San Francisco Bay Area Office following the Wells Fargo Insurance Services acquisition in 2017. Prior to joining Wells Fargo in 2009 Dixon owned a surety only agency along with a technology company active in developing internet based applications for surety.

Moderator

Ali Zaidi, Corporate Of Counsel, Kirkland & Ellis LLP

Ali Zaidi is a corporate Of Counsel in the Washington, D.C., office of Kirkland & Ellis LLP. Ali focuses his practice on identifying, mitigating, and managing climate and environmental risks, primarily as they arise in the context of corporate transactions, governance, and crisis response. He also counsels clients on complex regulatory matters related to energy, water, and mobility technologies, including on standards governing artificial intelligence and autonomous systems like drones and driverless vehicles.

Attendee List

	Company Name	First Name	Last Name	Job Title
1	127 Energy, LLC	Ken	McCauley	Partner & Co-Founder
2	Able Grid Energy Solutions	David	Cieminis	Chief Commercial Officer
3	Acelerex	Dr. Randell	Johnson	CEO
4	AECOM	Alpesh	Dharia	AVP Project Development
5	Anbaric Development Partners	Dan	Dobbs	VP of Microgrid Products & Finance
6	APEX Clean Energy	Steve	Varvrik	
7	Bank America Merril Lynch (BAML)	Claudia Correa	Welch	
8	Bank of America Merryl Lynch	Kevin	Lang	Director
9	Black & Veatch Corp.	Mark	Manley	Manager, Consulting
10	BQ Energy	James	Falsetti	Director
11	BQ Energy	Alicia	Scott	Project Manager
12	Canadian Solar	Amir	Akhtar	Director, Project Finance and M&A
13	Canadian Solar Inc.	Chet	Lyons	Director Energy Storage & Related Markets, Energy Group
14	Centrica Business Solutions	Stephen	Buryk	Strategy Manager
15	Centrica Business Solutions	Divyesh	Lad	Director, Contractor Management
16	Centrica Business Solutions	Dan	Svejnar	VP Commercial
17	Centrica Business Solutions	Kristel	Watson	Principal, Commercial Risk & Underwriting
18	CIT Bank, N.A.	Neerav	Jashnani	
19	CIT Group Inc.	Marc	Theisinger	Managing Director
20	Clarke Investments	Scott	Cockerham	
21	Cleantech Strategies	Russ	Weed	
22	CMI Energy	Xavier	Dhubert	Manager Americas (ENERGY)
23	ConnectGen, LLC	Caton	Fenz	Chief Development Officer
24	CSA Group LLC	Ryan	Franks	Manager, Energy Storage Group
25	Energy Capital Partners	Enrique	Garcia	Associate
26	Energy Storage Consulting	Matt	Koenig	President
27	Energy Tariff Experts, LLC	James	Bride	President
28	EPRI	Ben	Kaun	Program Manager, Energy Storage and Distributed Generation Program
29	E-Storage	Francisco	Leiva	
30	E-Storage	Cristobal	Muñoz	
31	E-Storage	Gabriel	Olguin	
32	Eversource Energy	Steven	Casey	Manager, Strategic Planning
33	Flex	Pedro	Elizondo	Senior Manager / Business Development
34	Fractal Energy Storage Consultants	Daniel	Crotzer	Principal Consultant, Energy Storage and Renewable Energy
35	Galehead Development	Michael	McNeley	Project Development Manager
36	GE Capital	Rahul	Mittal	Senior Vice President
37	GE Capital	Oscar	Villalonga	Managing Director
38	GE Energy Storage	Mirko	Molinari	Chief Commercial Officer
39	GE Financial Services	Ed	Chao	Vice President, Power & Development
40	Gee Strategies Group, LLC	Robert	Gee	President
41	Geronimo Energy	Nick	Tsai	Financial Analyst
42	Glidepath Power Solutions	Chris	Vickery	VP, Business Development
43	Goldman, Sachs & Co.	Harry	Singh	Vice President
44	Hartford Steam Bioler (Munich RE)	John	Roach	Assistant Vice President
45	Hartford Steam Bioler (Munich RE)	David	Tine	Product Development Manager - Energy
46	Helix Power	Frank	Diluna	Advisor
47	Helix Power	Laura	Sapien-Grabski	Communication & Government Affairs
48	Helix Power Corporation	Matt	Lazarewicz	President
49	Highview Power	Richard	Riley	Business Development Manager
50	Highview Power	Carl	Sheldon	

Attendee List (Cont.)

	Company Name	First Name	Last Name	Job Title
51	Hitachi Capital America Corp	David	Burr	
52	Hitachi Capital America Corp	Chris	Pagano	Vice President and General Manager of Structured Finance
53	Hugh Wood	John	Mooney	Vice President
54	Hugh Wood Canada Ltd.	Jen	Aitchison	Senior Vice-President, Sustainable Energy Practice
55	International Finance Corp (IFC)	Peter	Mockel	Senior Industry Specialist
56	International Market Analysis	James	Grant	Program Manager
57	Investec USA Holdings Corp.	Ren	Plastina	Member of the Investec Group
58	Japan Electric Power information Center	Hiroyuki	Yomori	General Manager of Washington Office
59	Key Capture Energy	Jeff	Bishop	Co-Founder and Chief Executive Officer
60	Key Equipment Finance	Kenneth	Evans	Vice President
61	KeyBank	Schuyler	Tilly	
62	Kipp's Bay Consulting, Ltd	Kipp	Miller	President
63	Kirkland & Ellis LLP	Rohit	Chaudhry	Partner
64	Kirkland & Ellis LLP	Robert	Fleishman	Partner
65	Kirkland & Ellis LLP	Brett	Nuttall	Associate
66	Kirkland & Ellis LLP	Amanda	Rahav	Associate
67	Kirkland & Ellis LLP	Ashton	Starr	Business Development Coordinator
68	Kirkland & Ellis LLP	Ali	Zaidi	Of Counsel
69	KPMG	Nate	Gabig	Managing Director - Securitization & Risk Consulting
70	kWh Analytics	Richard	Matsui	Chief Executive Officer
71	Longroad Energy Partners	Thomas	Siegel	VP Transmission
72	Malta Inc	Elvir	Mujanovic	VP Finance
73	Massachusetts Convention Center Authority	Deirdre	Manning	Energy & Sustainability Manager
74	Miller Brothers	Gerard	deLisser	VP Development
75	Morrison & Foester	Elizabeth	Sluder	Partner
76	Mustang Prairie	Richard	Baxter	President
77	Mustang Prairie Energy	Steve	Austerer	Director of Business Development
78	NEC Energy Solutions	Doug	Alderton	Director, Sales
79	NEC Financial Services	Herschel	Salan	President
80	NEC Financial Services, LLC	Samuel	Enad	Senior Credit Analyst
81	NEC Financial Services, LLC	Katsuhiro	Tarumi	
82	New Energy Fund II, LP	Mark Townsend	Cox	Partner and Chief Investment Officer
83	New Energy Fund LP	Olushola	Ashiru	Partner and PM
84	New Energy Risk	Tom	Dickson	CEO
85	New York Green Bank	Rodrigo	Parra-Ferro	Associate
86	New York Power Authority	Gabriel	Cowles	Program Manager, Build Smart NY
87	Nexamp	Greg	Reichardt	Capital Markets Analyst
88	Nexamp	Rob	Ritchie	Business Development Manager - Energy Storage
89	Nexus Infrastructure Captial	Alan	Dash	
90	Nexus Infrastructure Captial	Barry	Gold	
91	NovoCarbon	Paul	Ferguson	President
92	NRStor C&I	Moe	Hajabed	President
93	NY Green Bank	Alfred	Griffin	President
94	NY Green Bank	Jason	More	Director
95	NYC Fire Department	Paul	Rogers	Lieutenant
96	NYSERDA	Jason	Doling	Program Manager, Energy Storage
97	NYSERDA	Scott	Larsen	Project Manager
98	NYSERDA	Mark	Sperry	Innovation Advisor
99	Pacific Northwest National Laboratory	Patrick	Balducci	Chief Economist
100	Pacific Northwest National Laboratory	Charlie	Vartanian	Sr. Technical Advisor

Attendee List (Cont.)

	Company Name	First Name	Last Name	Job Title
101	Panasonic Corporation	Janet	Lin	Director, New Business Development
102	Pattern Energy Group Inc.	Terrence	Cantorna	Business Development Manager, Energy Storage
103	Pickwick Capital Partners LLC	Kevin	Blackman	Managing Directors
104	Power Business Chile	Valeria	Munoz	Consultant
105	Power Business Chile Ltd	Gabriel	Olguin	Principal Consultant
106	Power Edison	Yazan	Harasis	
107	Power Edison	Shihab	Kuran	Chief Executive Officer
108	Power Strategies LLC	J. Norman	Allen	President
109	PowinEnergy	Mitch	Boeh	Northeast Sales Manager
110	Rabobank	Hemani	Jadhav	Executive Director, Project Finance, Renewable Energy
111	Rhynland	Patrick	Verdonck	
112	Rocky Mountain Institute	Jeff	Waller	Principal
113	Sandia National Laboratories	Ray	Byrne	
114	Sandia National Laboratories	Babu	Chalamala	
115	Sandia National Laboratories	Ricky	Concepcion	Research & Development Engineer
116	Sandia National Laboratories	David	Copp	Senior Member of Technical Staff at Sandia National Laboratories
117	Sandia National Laboratories	Tu	Nguyen	Senior Member of Technical Staff at Sandia National Laboratories
118	Sandia National Laboratories	Felipe	Wilches-Bernal	Senior Member of Technical Staff at Sandia National Laboratories
119	Sandia National Labs	Howard	Passell	Ecologist
120	Schneider Electric SA	Scott	Daniels	Technology & Innovation, Office of the CTO
121	Siemens Financial Services	John	O'Brien	Director
122	Sound Grid Partners, LLC	Dan	Sowder	Principal
123	Sparkplug Power	Sean	Becker	President
124	Starwood Energy Group Global LLC	Ali	Amirali	Senior Vice President
125	Strata Solar	Joshua	Rogol	Vice President, Energy Storage
126	SUSI Partners	Gustavo	Coito	
127	ThermSolutions	James	Hunt	Sales Engineer, Clean Energy Market
128	Tortise Infrastructure Partners	Jerry	Polacek	Managing Director and Group Lead - Clean Energy and Infrastructure
129	True Green Capital Management LLC	Chris	Kirkman	Managing Director and Head of Project Finance
130	USI Insurance	Dixon	Wright	Senior Vice President
131	Vision Ridge Partners	Jules	Kortenhorst	Associate
132	Willis Towers Watson	Danny	Seagraves	VP
133	World Bank	Chandrasekar	Govindarajalu	Team Leader, Energy Climate Finance
134		Shane	Smith	MD Project Finance and GenCo Strategy

Synopsis

On January 23rd, 2018 Morrison & Foerster LLP and Mustang Prairie Energy in Partnership with the U.S. Department of Energy presented a one-day Energy Storage Finance Advisory Committee Meeting at Morrison & Foerster's New York City office that had 99 attendees. Speakers included representatives from the U.S. Department of Energy, the New York State Energy Research and Development Authority (NYSERDA, and industry experts who have experience with the challenges and opportunities of investing in energy storage projects.

The Summit was the third Storage Finance Advisory Committee Meeting for a U.S. Department of Energy sponsored study to identifying the opportunities for advancing energy storage contracting for energy storage projects. This study's goal is to understand the current challenges facing energy storage project financing, and gain insights into ways advancing the level of contract development in the energy storage industry could allow greater and more widespread commercial development in the industry. This series of studies are part of the U.S. Department of Energy's effort to promote market development through reducing barriers to entry, reducing transaction costs, and promoting wider access to low cost capital in order to promote development across the energy storage industry.

The summit began with an overview of the Study by Richard Baxter of Mustang Prairie Energy, followed by Babu Chalamala, Program Manager, Energy Storage Technologies and Systems, Sandia National Laboratories who gave an overview of federal support for energy storage technology development, and explained how that support is extending into the commercialization of these systems.

The Keynote address was given by Alicia Barton, President and CEO of the New York State Energy Research and Development Authority. Her presentation showcased the efforts of the State of New York's effort to promote the development of energy storage project development at all levels of the electrical power sector to promote customer choice, improved service, and a more resilient power grid.

The first panel of the day focused on Front of the Meter Projects Financing. The discussion focused on the current state of project financing for energy storage projects currently, and how the market is changing, with expectations for where it will go in the next few years. Developers are aggressive in bidding on projects, resulting in shrinking margins rapidly which is forcing people to be creative to drive down project costs. It was noted that five years ago energy storage was perceived as a "novelty test projects." Now it's competing in some places as a successful substitute for Peaker's in areas where they can provide services when traditional services can't. A key questions for developers was how to obtain more financing in the emerging market. There are many groups looking to participate in the wholesale storage market, the introduction of debt into project finance is happening rapidly. Insurance products were seen as a key method to remove technical uncertainties, including key issues such as degradation control. Unfortunately, it was noted that there are currently no insurance products in the marketplace to make debt financing comfortable.

The second panel of the day focused on distributed & hybrid system project financing. It was noted that there are many new different sources of potential revenue emerging, and that battery prices are anticipated to drop between 30% - 50% over a 10 year period. These trends re expected to improve the change for profitability of the projects. With many believing in at least some of these trends, the environment for financing is expected to improve, with one developer stating that a near term project could be developed off-balance sheet soon. The goal would be a 20-year tenor for the debt, but right now lenders are not looking that far ahead storage. It was mentioned that lender's key concerns continue to be who the counterparty is, and what is the real revenue model. It was discussed that developers need to clearly structure the merchant risk they have in their projects so lenders can see where the market floors and ceilings are in merchant projects. Lastly, warranties were mentioned as either coming straight from the OEM, or passing through an EPC or Integrator. The goal for many developers would be a 20-year guarantee on a battery component, but the possibly variable usage profile continues to scare many groups away from offering such a package—for now.

The final panel of the day focused on Best Practices in Energy Storage Contracting, and what works. Many wished for more standardize contracts and/or uniformity to support revenue certainty and liability responsibility on loss. This uniformity stretched from term, language, and to contract structure. This effort will be essential as a number of groups are looking to buy up portfolios of projects, and need to understand the contract risks, in addition to the more obvious technology and market risk.

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