The Impact of New Energy Production Technologies on Equipment Finance

Opportunities and Challenges Shaping the Future of the Finance Industry

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Table of Contents

Section 1
EXECUTIVE SUMMARY

1.1 The Energy Cloud Transformation

Disruption in the energy system is shifting the emphasis from centralized fossil power generation to renewable energy, with increasing emphasis on distributed energy resources (DER). In the US, 31 states and territories now have renewable energy targets, with California and Hawaii setting the bar with 100% renewable energy mandates. As states achieve these targets, utilities will seek to mitigate intermittency with a combination of natural gas and strategically located energy storage, among a growing number of supply and demand side strategies. The full value of onsite DER is unlocked when managed with software and tied to "as a service" business models. Corporate off-takers are increasingly procuring large amounts of renewable energy via multiple channels. Residential customers are being targeted by a growing number of onsite generation and energy management solutions (utility-owned, third-party owned), both financed and non-financed. The US market transformation is well underway and accelerating.

The trifecta of technology cost reductions, business model development, and finance innovations has disrupted the traditional utility business model and opened new opportunities for energy service companies to respond to customer demand for energy solutions that are clean, distributed, intelligent, and mobile. The energy system transformation includes the digital transformation of the electric grid, which, taken together, Navigant Research defines as the Energy Cloud.

1.2 Utility-Scale Solar Surges Despite Tax Rule Change and Import Tariffs

The US utility-scale solar energy industry has developed over the last ten years driven by regulatory support at state and federal levels. Costs for utility-scale solar have fallen by more than 80% in the last decade and now is the cheapest source of electricity in regions with strong solar irradiance such as in California, Arizona, and Nevada. In many cases, such as in Texas, solar is increasingly competitive in states with low natural gas prices. Some of the most important trends affecting the utility-scaled solar PV market include:

- **Lower corporate tax effect on tax equity:** The lower corporate tax rate has two main effects. First, a lower corporate tax rate makes depreciation less valuable. Each dollar of depreciation is now worth $0.21 per dollar of capital cost rather than $0.35 to a tax equity investor. Before 2017, except for the corporate tax rate and sometimes how depreciation is calculated, the investor took tax-change risk about the deal structure but otherwise tracked its yield based on actual tax results.

- **BEAT Tax provisions:** The Base Erosion Anti-Abuse Tax (BEAT) which applies a 10% minimum tax for taxable income adjusted for base erosion payments. The tax only affects non-US businesses where US gross receipts are in excess of $500 million (aggregated on a global group basis). This could limit the capital available for solar developments as several investors are non-US-based.

- **Yieldco buyouts:** In 2018, three of the main Yieldcos were acquired by infrastructure investment funds. 8point3 Energy Partners was bought by Capital Dynamics, NRG Energy share of NRG Yield was sold to Global Infrastructure Partners and Brookfield Invested TerraForm Power made an offer to buy out Spanish Yieldco Saeta Yield.

- **Community Solar:** Community solar, where the off-take is dispersed and are relatively small-scale, require new structures to finance the projects as tax equity is not always an option.

1.3 Wind Lowest Cost Resource in Large Portion of US

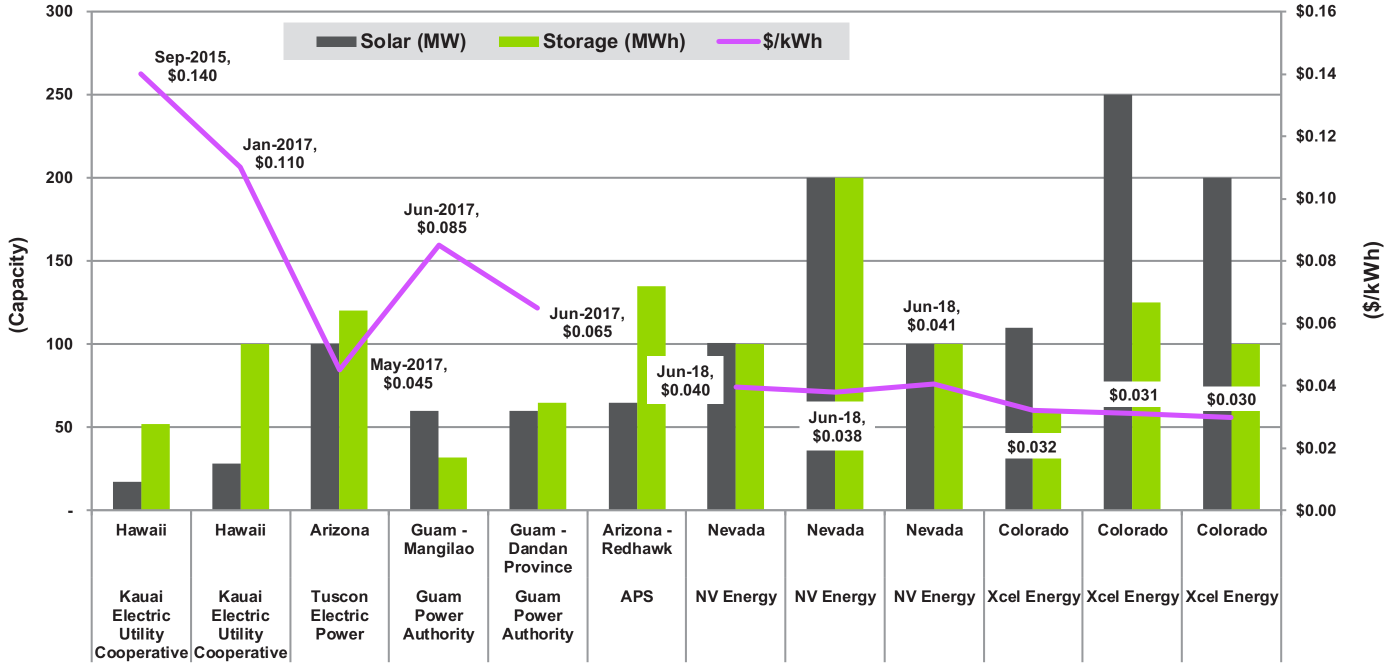
During the last decade, the wind power industry has become a dominant, mature, and cost-effective central power generation source. Cost for utility-scale wind power plants have fallen by more than 66% in the last seven years and now is the cheapest source of electricity in windy areas of the US including the vast central corridor spanning South from Texas up through most of the Midwest. The price of wind as benchmarked by long-term Power Purchase Agreements (PPAs) has been reduced from an average of over $90/MWh in the early 2000s to well under $25/MWh in recent years. Some of the most important trends affecting the utility-scale wind market include:

- **PPAs:** Due to the must-run nature of wind energy, long-term off-take agreements, known as PPAs are the cornerstone of wind power plant financing. Usually, wind project off-takers accept and pay for all electrical output produced by the plant on a take-or-pay basis. In this arrangement, off-takers must pay for electricity regardless of if they take the electricity or not.
- **Corporates:** Traditionally, utilities have taken the role of off-takers for wind power, but increasingly, large commercial and industrial (C&I) corporates are acting as off-takers.
- **Project Structures:** There are two main financial structures for funding a wind project: single owner, and partnership flip.
    - **Single owner** is the simpler of the two transactions and is used when the sponsor of the project can fund the project with its own capital (or source sufficient debt) and can also efficiently monetize the federal tax credits. An example would be a large US-based developer that also operates other utility businesses and therefore is subject to a large tax burden at the corporate level.
    - **Partnership flip** is the more common project structure. It is more common because many developers do not have the tax burden to efficiently monetize all federal tax credits. In this case, a project sponsor brings in a tax equity investor, usually a large financial institution, who will own the majority of the wind project during the majority of the 10-year Production Tax Credit (PTC) phase. More details on the partnership flip structure are provided in the Case Study /Project Highlights section below and in the Appendix to the report.

1.4 Energy Storage Addresses Renewables Intermittency, Offers Grid Flexibility

Pricing for utility solar plus energy storage PPAs has fallen dramatically in the past three years. This decrease has triggered a wave of new projects being announced in the US. Chart 1-1. tracks pricing for large-scale utility PPAs for solar plus energy storage projects from September 2015 to June 2018. While this does not show all utility solar plus storage PPAs, these projects are noteworthy for breaking records in terms of either price or project size.

Chart 1-1. Utility Solar plus Energy Storage Project PPA Prices: 2015-2018



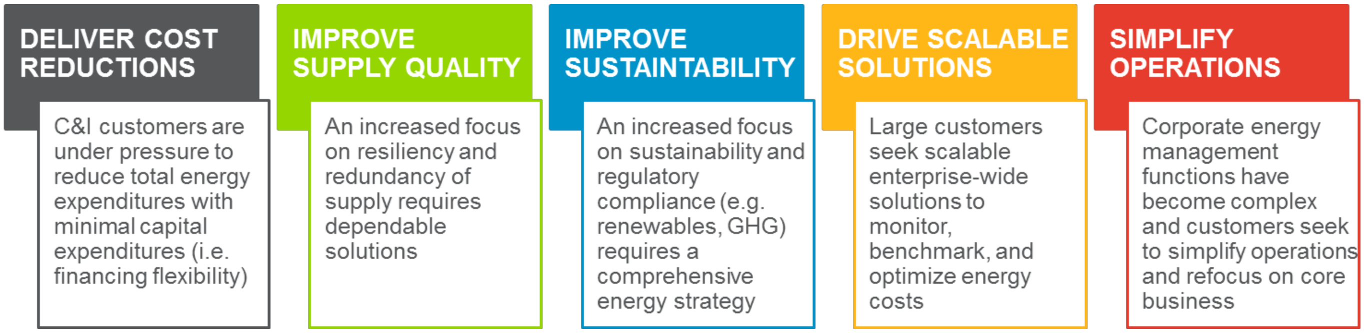
(Source: Navigant Research)

With a utility solar plus energy storage PPAs, the solar plus storage vendor provides access to a comprehensive software platform that integrates solar PV production with the battery energy storage solutions (BESS) and the local power market dispatch requirements.

1.5 DER Unlock "As a Service" Business Models

Taking advantage of the significant hardware reductions, C&I customers are now seeking cost-effective, customized, and comprehensive energy solutions that reduce energy use and spend without CAPEX or effects to their day-to-day operations. Onsite solar PV, energy, storage, EV charging, and other DER technologies are rapidly being adopted as costs continue to drop and utilities, independent power producers seek transform their traditional business models. These needs are driving the emergence of Energy as a Service (EaaS) solutions that leverage DER to meet evolving customer demands.

Figure 1-1. Customer Energy Demands



(Source: Navigant Consulting, Inc.)

1.6 Intelligent Buildings Leverage IoT, DER for Optimizing Building Operations

The intelligent buildings market defines digital transformation of commercial facilities. A combination of hardware, software, and services is driving a paradigm shift across the buildings industry. While the market has been growing since the emergence of building energy management systems in the early to mid-2000s, market adoption is expanding today as technology industry trends become mainstream across the economy.

The Internet of Things (IoT) has become a household term, and the commercial building industry is facing new pressure to adopt technology to improve occupant experience. The result is a new and universal upward pressure on building owners to invest in new technologies, regardless of the business operating within. Facility upgrades and new equipment investments can be necessary for existing buildings as customers begin their intelligent buildings journey; and, therefore, financing options are important to support market development:

- Performance contracts remain central to energy efficiency upgrades for public sector customers
- Software as a service is becoming the norm for the foundational software analytics to support building optimization
- Some solutions providers are exploring new “as a service” or managed services business models to engage private sector customers in more comprehensive upgrades with no upfront cost

1.7 Conclusion

As federal and state incentives ramp down in the next five years, and corporate renewable energy procurement increases, costs will continue to drop, opening further opportunities for a growing number of software-enabled demand side “as a service” solutions to be deeply integrated into intelligent buildings. This transformation represents a significant opportunity for investors, financiers, equipment vendors, and solutions providers to develop new ways to meet changing customer needs.

Section 2
THE ENERGY TRANSITION

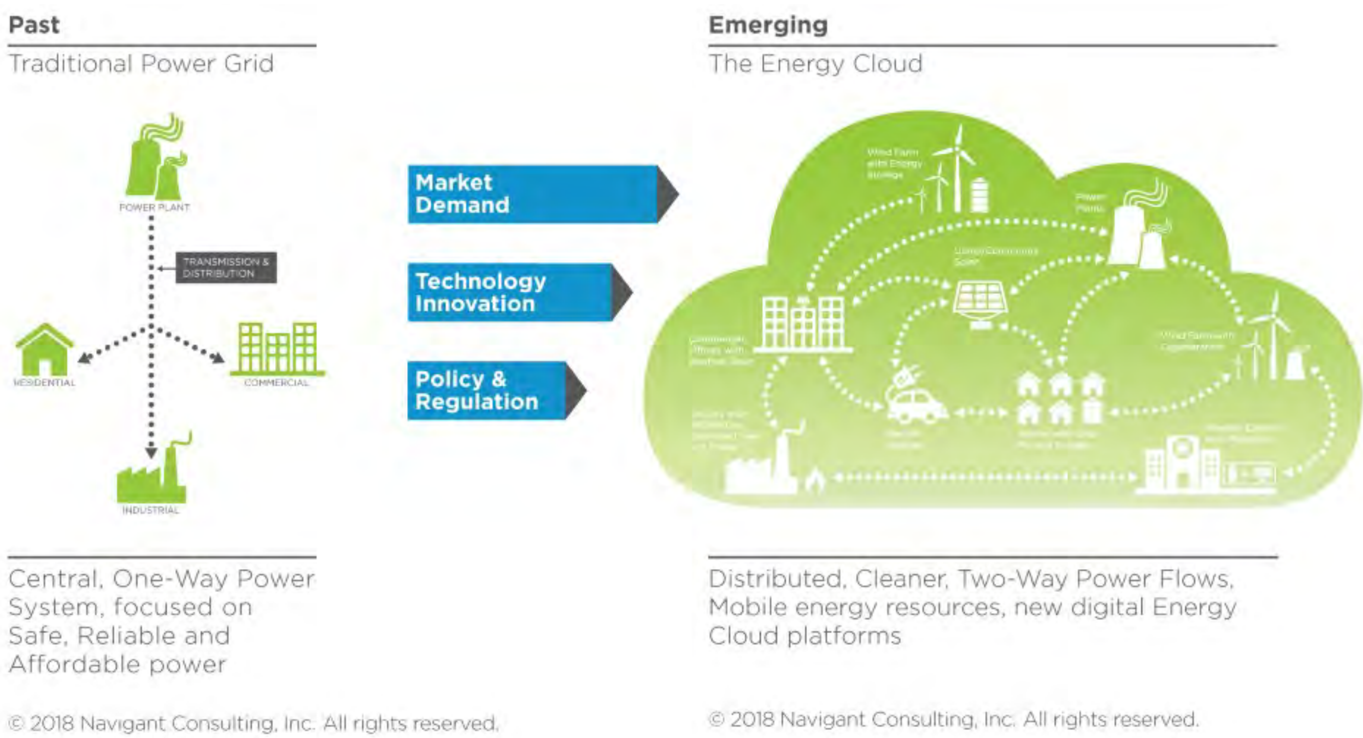
2.1 The Energy Cloud Transformation

The US energy sector is experiencing a rapid transformation, consistent with global trends. During the next 5-15 years, Navigant expects massive disruption across the entire energy value chain that will affect a broad set of stakeholders. This transformation is primarily being fueled by multilateral efforts focused on decarbonizing the global economy to address climate change and a shift toward an increasingly clean, intelligent, mobile, and distributed energy ecosystem.

Linear value chains supporting one-way power flow from centralized generation to end customers will give way to a more sustainable, highly digitized, and dynamic energy system. Moving toward a multidirectional network of networks and away from a linear hub-and-spoke model, this system will support two-way energy flows in which customer choice (optionality), clean energy, innovation, and agility command a premium.

The energy system transformation includes the digital transformation of the electric grid, which, taken together, Navigant Research defines as the Energy Cloud. This new paradigm is resulting in dramatic disruptions for industry incumbents and opportunities for customers, technology providers, and financiers.

Figure 2-1. The Energy Cloud



(Source: Navigant Consulting, Inc.)

2.1.1 Utility Scale Renewables Reach Maturity

Project finance for utility-scale renewable energy is a mature market, characterized by large solar PV projects that are typically 1 MW to 50 MW, and up to several hundred megawatts for wind projects. During the past ten years, the US has become one of the most attractive markets for renewable energy investment. Renewable portfolio standards (RPS) that currently exist in 31 states and territories, including Hawaii and California's notable 100% renewable energy goals, have been one of the primary regulatory drivers. Federal incentives including the Production Tax Credit (PTC) for wind and the Investment Tax Credit (ITC) for solar provided stability for projects to be considered bankable by leading financiers, with low risk given the typical 20-year PPAs utilized by utilities to procure renewable energy capacity.

Utility-scale renewables market growth has been catalyzed by significant hardware cost reductions, increased efficiency, and complex hedging structures that allow merchant projects to be built. Large corporate renewable energy purchases are also a growing trend that has contributed to industry growth. The result is that solar and wind to compete with natural gas for new sources of power in many regions of the US. Energy storage is just beginning its rise in the US, and globally, integrated into renewables and natural gas plants alike today and increasingly in the future. These cost reductions, and shifting demand for onsite energy solutions, in the commercial, industrial, and residential sectors have resulted in considerable finance and lease innovation in the sector known as distributed energy resources (DER).

2.1.2 Customer-Sited DER Solutions on the Rise

Project finance fundamentals in the customer-sited DER arena have evolved much differently than in the utility-scale wholesale power sector. The primary challenge that traditional energy project financiers will have when considering the pursuit of new innovative DER financing solutions is the management of new DER project risks that can influence cash flows. The fundamentals of energy-related project finance regarding cash flows are always based on the degree of risk associated with each step of the project delivery value chain. These fundamentals are now being applied to new DER project delivery value chains that are being developed.

Figure 2-2. highlights the fundamentals of these DER project delivery value chain.

Figure 2-2. DER Project Delivery Value Chain

(Source: Navigant Research)

Each step in the value chain is critical to the successful implementation of the project, and each step presents its own unique set of challenges and financial risks that DER financiers must assess and manage. The categories of risks across the DER project delivery value chain step are typically categorized as highlighted in Table 2-1.

Table 2-1. Overview of DER Project Finance Risks

Risk Category	Risk Issue	DER Example
Regulatory	Regulatory requirements	Uncertain power market rules or tariff charges
	Rebates or incentives	Access to state or local incentive payments or tax benefits
Technology	Performance	Solar panels, battery power, energy capacity, and cycle life
	Warranty	Solar panels, battery SoC limits, life cycle, and duration limits
Operational	Software system optimization	Operational algorithms, weather variations
	Routine O&M	Solar PV panel cleaning. Solar PV/battery inverter warranty
Owner/Host	Credit	Ability of project owner or host to repay financing

(Source: Navigant Research)

The primary form of financing to date for customer-sited solutions has been the evolution of energy savings performance contracting (ESPC). For non-ESPC customer-sited DER financing, the solar PPA, where a C&I customer hosts a solar PV generating asset onsite at its building and pays a third-party a per kilowatt-hour rate for output from the solar PV system, was a successful early entrant into the DER financing arena. Traditional energy project finance investors have begun examining additional DER financing instruments in conjunction with DER solutions providers and commercial and industrial (C&I) energy users to create new financing asset classes, discussed in Section 4.

2.2 Emergence of EaaS

The rise of new innovative DER financing asset classes is enabling building owners and facility managers to pursue with new service business models that can meet their sustainability, energy cost savings, and risk tolerance needs. The advent of these new energy as a service (EaaS) solutions, discussed in Section 4.1.1. of this report are defined by Navigant Research as follows:

> *The management of a customer's energy portfolio needs—such as portfolio strategy, program management, energy supply, energy use, and asset management—by applying new products, services, technology solutions, and both project and enterprisewide financing instruments that avoid customer capital expenditures while reducing energy use, spend, and risk.*

Financing innovation sits at the heart of this shift as a key EaaS enabling factor for the delivery of these new utility customer choice options driven by their needs described below.

2.3 Customer Energy Needs

Within the emerging Energy Cloud dynamics, several important customer trends have emerged across C&I segments:

- **Deliver cost reductions:** C&I customers are under pressure to manage energy spend fluctuations and to guarantee the reduction of total energy use and expenditures with minimal capital expenditures (i.e., financing flexibility).
- **Improve supply quality:** C&I customers are placing increased focus on resilience and redundancy of supply by deploying DER on their premises to self-generate to make their energy spend more predictable. Further, due to the emergence of new renewable energy procurement business models, customers now have new choices for procuring green, low-cost energy from offsite projects that many utilities do not.
- **Improve sustainability:** For the last several years, customers have increasingly moved to set targets for greenhouse gas (GHG) reduction, energy efficiency, and renewable energy to reduce their energy spend and green their portfolio. This requires a comprehensive energy strategy. Notably, 48% of the 2016 Fortune 500 have a GHG target, renewable energy target, an energy efficiency target, or some combination.[1]
- **Drive scalable technology solutions:** Large customers seek scalable enterprisewide solutions to monitor, benchmark, and optimize energy costs. New and disruptive technology market entrants are giving customers new energy usage insights and options related to their business. Previously, energy was viewed as an unavoidable operating cost, which was difficult to effectively manage its use or financial impact. New energy use technologies are changing this dynamic.
- **Simplify operations:** Energy portfolio managers face complex challenges and customers seek strategy portfolio guidance to help simplify operations and refocus on core business.

C&I customers are now seeking cost-effective, customized, and comprehensive energy solutions that can meet their needs and reduce energy use and spend without capital expenditures or effects to their day-to-day operations. These needs are driving the emergence of EaaS applications.

2.4 Looking Ahead

This report analyzes the opportunities, challenges, and examples of lease and finance structures in the energy sector in the US, with a particular focus on areas of disruption. Navigant forecasts growth across the board—utility-scale renewables and energy storage, DER, with intelligent buildings offering new opportunities for financed solutions in particular, as incumbent industries and finance models are disrupted. This disruption has already resulted in far-reaching impacts for equipment vendors, financiers, utilities, and other service providers operating in this new paradigm.

To complete this report, Navigant leveraged its existing market research data, combined with interviews with key industry stakeholders, with feedback from the Equipment Leasing & Finance Foundation.

Section 3
UTILITY-SCALE SOLAR PV

3.1 Utility-Scale Solar PV

Utility-scale solar PV is a segment of the overall solar industry. Utility-scale solar projects are those that are connected to the distribution or transmission grid without any load present at the site. Utility-scale projects sell all the electricity generated to a third-party, usually a utility, but more recently this includes large electricity consumers.

3.1.1 Introduction

The US utility-scale solar energy industry has developed over the last ten years driven by regulatory support at state and federal levels. Costs for utility-scale solar have fallen by more than 80% in the last decade and now is the cheapest source of electricity in regions with strong solar irradiance such as in California, Arizona, and Nevada. In many cases, such as in Texas, solar is increasingly competitive in states with low natural gas prices.

Despite these advances, the solar industry still has room to improve before it reaches full maturity. Cost is expected to fall by between 4%-8% per year for the next decade. In addition, adding supporting technologies, such as onsite energy storage systems, could help optimize earnings by reducing curtailment and achieve higher prices in wholesale markets.

Most utility-scale solar installations are financing using variations of project finance structures. The project sponsor typically provides 5%-30% of the project costs and tax equity providers and syndicated lenders the remaining capital. These projects rely on bankable off-takers to be financed.

The most important factor affecting financing structures is the ITC given to solar projects. The reduction of the ITC in the next three years will likely impact the structures chosen by developers.

3.1.2 Finance and Lease Structures

- **PPA:** Due to the must-run nature of solar energy, long-term off-take agreements, known as PPAs are the cornerstone of utility-scale solar financing. Usually, solar project off-takers accept and pay for all electrical output produced by the plant on a take-or-pay basis. In this arrangement, off-takers must pay for electricity regardless of if they take the electricity or not.

  Traditionally, utilities have taken the role of off-takers for utility-scale solar, but increasingly, corporates are acting as off-takers.

  There are three main tax equity structures for transferring tax benefits, with two significant variations. The three are partnership flips (two variations), sale-leasebacks, and inverted leases.

3.1.3 Industry Trends and Drivers

- **Technology:** Cost reductions in modules and inverters continue as the industry continues to scale. The pipeline of potential solar technology upgrades remains strong, helping the industry to increase module’s power output and with it, lower installation costs.

- **Policy/Regulatory:** After a 2017 full of uncertainty, the industry now faces a more stable regulatory environment. A new import tariff was imposed on solar modules, which could increase utility-scale solar installation cost by up to 10%, but most of this increase will be offset by cheaper module prices.

  In 2018, the solar ITC was extended through IRS commence construction language, providing longer-term certainty to the industry.

  Additionally, 37 states now have renewable portfolio standards or voluntary renewable energy targets, with utility-scale solar likely to be one of the primary sources of new renewable energy generation (in addition to wind). Numerous states have targets above 50%, with several proposing legislation to reach 100%. States without RPS mandates are located in the Southeast United States, but this does not necessarily negate the opportunity. Georgia and Florida, for example, are two of the top ten states for cumulative solar installed capacity due to strong solar resources.

- **Market (business models):** While most of the growth is expected to come from traditional utility-sourced PPA auctions. Large corporate PPAs and event merchant solar projects are becoming a reality.

3.1.4 Finance and Lease Trends and Drivers

- **Lower corporate tax effect on tax equity:** The lower corporate tax rate has two main effects. First, a lower corporate tax rate makes depreciation less valuable. Each dollar of depreciation is now worth $0.21 per dollar of capital cost rather than $0.35 to a tax equity investor. Before 2017, except for the corporate tax rate and sometimes how depreciation is calculated, the investor took tax-change risk about the deal structure but otherwise tracked its yield based on actual tax results.

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- **Yieldco buyouts:** In 2018, three of the main Yieldcos were acquired by infrastructure investment funds. 8point3 Energy Partners was bought by Capital Dynamics, NRG Energy share of NRG Yield was sold to Global Infrastructure Partners and Brookfield Invested TerraForm Power made an offer to buy out Spanish Yieldco Saeta Yield.

- **Community Solar:** Community solar, where the off-take is dispersed and are relatively small-scale, require new structures to finance the projects as tax equity is not always an option.

3.2 Case Study/Project Highlights: Clean Energy Collective Structuring of Community Solar Projects

It is taking the financial community a long time to come up the learning curve for community solar, but there have been advances as lenders start to get comfortable with the risks around the off-take arrangements.

With their first projects, Clean Energy Collective (CEC) needed take-or-pay PPAs with electric cooperatives that supplied the electricity, in turn, to the community. CEC managed to get financing based on these PPAs.

As cooperatives gained confidence, they began helping CEC find the subscribers, still utilizing a take-or-pay PPA, but with the cooperative as a backstop. This model represents roughly half of CEC's current business.

More recently, lenders are starting to see community solar as a combination of residential, C&I, and utility solar. It has multiple customers and, therefore, risk diversification like the rooftop sector, with the advantage of a simplified process for customer defaults—simply switching the service to another customer on a waiting list. Operations and maintenance (O&M) are also simplified as solar is concentrated at one site—similar to traditional utility-scale projects. This portfolio approach, leveraging onsite installations also offers cooperatives and utilities the ability to locate solar arrays where they will maximize output, and integrate into their near- and long-term planning.

The challenge with community solar is scale. Most tax equity investors are scale investors. Therefore the reduced size of community solar projects—mostly below 50 MW and often below 10 MW, reduce the pool of tax equity investors.

CEC has managed to underwrite their smaller projects by reaching to local or regional banks to borrow. For tax equity, CEC has worked with high-net-worth individuals, but there is a limit to it. Finally, CEC is starting to aggregate projects so that when submitted by utilities and approved by regulators, they are better able to consolidate under a single financing facility. CEC then runs all subsequent deals in that state through that financing facility.

3.3 Top Three Opportunities from Lender Perspective

- After a drop in 2017 and a stalling in 2018, the utility-scale solar industry is expected to grow again at least until 2022. Between 2018 and 2027, the industry is expected to add 123.6 GW of new utility-scale solar capacity, which will need around $86 billion of investment.
- The split between developers and their Yieldco's might increase the number of projects that are available to lenders, that otherwise would have been funded by the Yieldco.
- Community solar is an emerging asset category that could become attractive to lenders as the industry matures. Community solar semi-distributed features make it less attractive to large-scale non-financial investors.

3.4 Top Opportunities from Lessor Provider Perspective

Leasing does not play a significant role in utility-scale solar financing.

3.5 Top Risks from Lender Perspective

- The main risk for lenders is the competition from non-financial entities for utility-scale projects. Large corporates—usually utilities like EDF Energy, Enel, or Avangrid. These corporates usually finance projects with their balance sheet, leaving lenders aside.
- Despite increasing interest rates in the US, competition for utility-scale projects is fierce. More lenders are seeking US deals, especially Asian banks that want to diversify their portfolios. Some based in South Korea and Japan are finding better margins in US solar than in investments at home. Therefore, lenders are accepting smaller margins to win deals from solar developers. In 2018, loans

of seven years or longer can be obtained for 137.5 basis points over Libor, down from as much as 200 basis points in 2017.[2] The situation is similar for short-term construction loans, which have fallen from 100 basis points over Libor, to 80 basis points.

- Increasing interest rates are a concern specifically for developers; a significant number are buying interest rate hedges to cover the period between signing the PPAs and starting construction. There are various ways to hedge. Straight interest rate hedges are sometimes backstopped by a balance sheet. In other cases, they are suing deal-contingent hedges where banks take risk on a non-recourse basis that projects will come to fruition. Banks are requiring at least a minimum of 75% of the interest payments to be hedged through the maturity of the loan.
- For a project where their off-take agreement does not cover the whole tenor of the debt or the total generated capacity, Merchant risk management becomes an important issue as the project gets exposed to natural gas and electricity price risks that need to be hedged.
- Supplier risk is also something that must be understood. Panel suppliers sell products under the same product line that can vary significantly unit per unit due to the manufacturing plants level of automation, and constant cost-cutting exercises due to the intense competition they face, including product sub-contracting to small producers with lower quality control.
- Another supply risk is supplier bankruptcy. In the industry history, this has been a contest and include high profile bankruptcies like SunEdison and Suntech, which were considered leaders at their time.
- On the technical side, getting transmission rights is a significant concern.

3.6 Top Three Risks from Lessor Perspective

Leasing does not play a significant role in utility-scale solar financing.

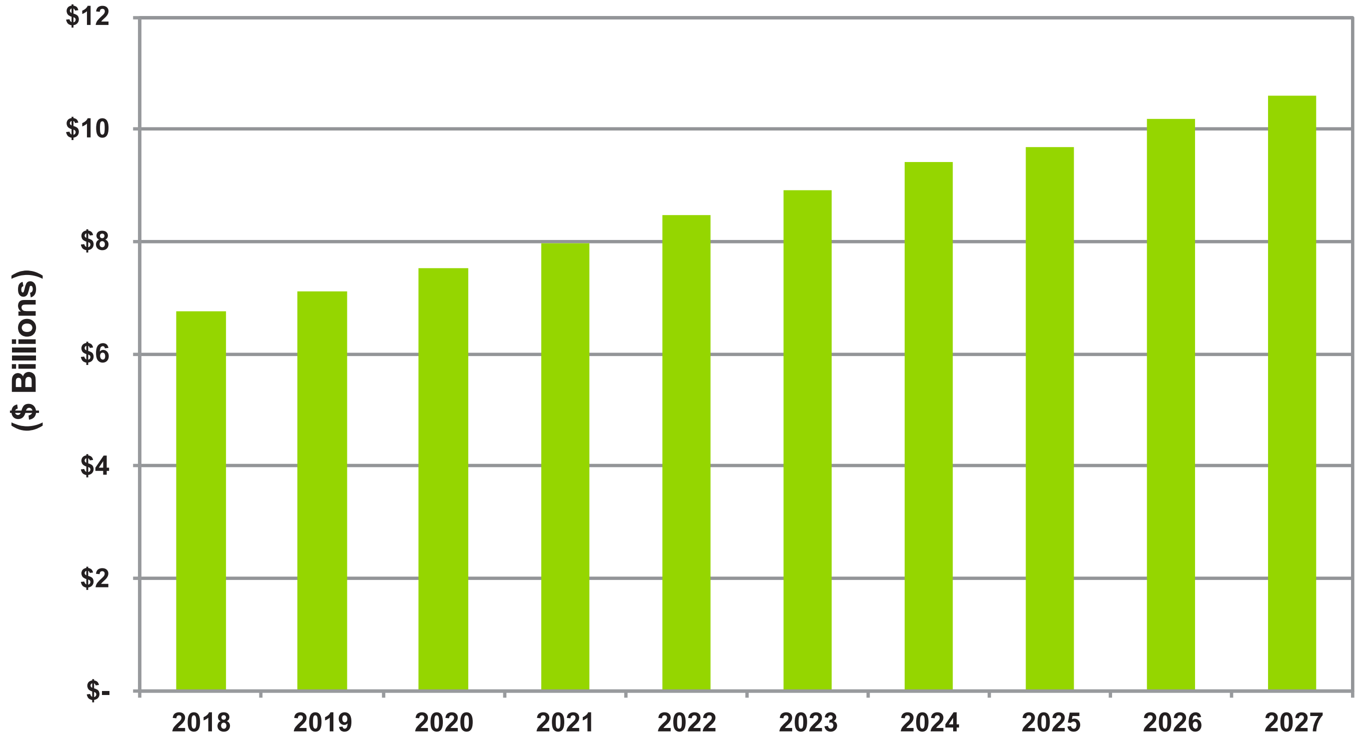
3.7 Market Size

The total US solar market from a finance perspective is best measured in CAPEX since these are equipment and construction intensive projects that require significant upfront project finance.

The total project cost estimated in megawatt capacity is approximately $0.95 million/MW in the US for projects in 2018. This includes development cost, equipment, construction, substations, and all other balance of plant costs. CAPEX has been falling fast as economies of scale and technology improvements are implemented. The technology pipeline in the solar sector is strong. Therefore further reductions going forward are expected. The projection for solar CAPEX cost will decrease over a 10-year period to 2027 at a projected $0.55 million per installed megawatt.

Applying Navigant Research's forecasts for installed capacity, this represents a market worth approximately $6.7 billion in 2018 when an estimated 7.1 GW will be installed, growing to 19.5 GW in 2027, worth approximately $10.6 billion.

Chart 3-1. Solar Market by CAPEX, US: 2018-2027



(Source: Navigant Research)

3.8 Conclusion

The financing of utility-scale solar has reached a plateau, in which project risks under the current regulatory environment are well-understood, and a consensus on best practice has been reached. In the medium term—when the ITC expires, the industry will need to evolve its financing structures as, currently, they are designed to capture as much value from tax equity as possible.

Another trend that will become more prevalent in the future is the exposure of projects to different types of off-take risks, moving away from full-tenure utility PPAs to a mix of utility, commercial and residential off-takers and some exposure to wholesale prices.

Anticipated increases in interest rates and lower federal and state incentives will be compensated by technology and process improvements that will reduce the CAPEX needed to finance projects, allowing the industry to grow over the next decade.

Section 4
UTILITY-SCALE WIND

4.1 Introduction

The commercial-scale wind energy industry has developed globally over the last three decades driven by regulatory support in many countries. In recent years, subsidy reforms have been sweeping across all global markets in reaction to more efficient turbines and more cost-effective wind plants that require less or zero subsidy support. Utilities are increasingly soliciting least-cost competitive bids, and wind plant developers are delivering aggressively competitive power prices thanks to advances in modern wind turbine technology.

During the last decade, the wind power industry has become a dominant, mature, and cost-effective central power generation source. Cost for utility-scale wind power plants have fallen by more than 66% in the last seven years and now is the cheapest source of electricity in windy areas of the US including the vast central corridor spanning South from Texas up through most of the Midwest. The price of wind as benchmarked by long-term PPAs has been reduced from an average of over $90/MWh in the early 2000s to well under $25/MWh in recent years.

4.1.1 Finance and Lease Structures

- **PPA:** Due to the must-run nature of wind energy, long-term off-take agreements known as PPAs are the cornerstone of wind power plant financing. Usually, wind project off-takers accept and pay for all electrical output produced by the plant on a take-or-pay basis. In this arrangement, off-takers must pay for electricity regardless of if they take the electricity or not.
- Traditionally, utilities have taken the role of off-takers for wind power, but increasingly, large C&I corporates are acting as off-takers.

Project Structures: There are two main financial structures for funding a wind project: single owner, and partnership flip.

Single owner is the simpler of the two transactions and is used when the sponsor of the project can fund the project with its own capital (or source sufficient debt) and can also efficiently monetize the federal tax credits. An example would be a large US-based developer that also operates other utility businesses and therefore is subject to a large tax burden at the corporate level.

Partnership flip is the more common project structure. It is more common because many developers do not have the tax burden to efficiently monetize all federal tax credits. In this case, a project sponsor brings in a tax equity investor, usually a large financial institution, who will own the majority of the wind project during the majority of the 10-year PTC phase. More details on the partnership flip structure are provided in the Case Study/Project Highlights section below and in the Appendix to the report.

4.2 Industry Trends and Drivers

- **Technology:** Wind turbines and wind plants as a whole are expected to continue to see efficiency and cost improvements, and the existing wind fleet in the US will gradually be upgraded and replaced as newer machines replace older turbines. In addition, adding supporting technologies like onsite energy storage systems could help optimize earnings by reducing curtailment and achieve higher prices in wholesale markets.
    - Competitive, cost-effective, and mature wind plants are typically multiple turbine configurations with hub heights of at least 80 meters and rotor diameters at least 100 meters and rated nameplate power of 2 MW or more.
    - A continuing technology trend already firmly underway is that small- and medium-sized wind turbines that would be typically installed at a residential home or small business are increasingly being phased out as lower cost solar PV systems overtake that market segment.
- **Policy/Regulatory:** The most important factor affecting financing structures for wind is the wind energy PTC, which provides $0.024/kWh ($24/MWh) of energy produced over a 10-year period. As noted above, the PTC policy is in the middle of a long-term phase-out. Wind plants that began construction by the end of 2016 receive 100% PTC value. Projects that started construction in 2017 will receive 80% of the PTC value, and the percentage will continue to decline through 2020 (2018: 60%; 2019: 40%; 2020: 0%). Revised guidance provided by the US IRS in 2016 changed the construction window from 2 to 4 years. Therefore, projects on the tail-end of the PTC window in 2019 could still be finishing construction through 2023. However, in practice, most wind developers seeking the maximum financial return on their wind projects aim to qualify their projects as having started in 2016 or 2017, which underpins the likely peak of annual commissioning in year 2020.
- **Market:** While most of the growth is expected to come from traditional utility-sourced PPA solicitations and agreements, large corporate PPAs between wind projects and C&I off-takers (buyers of power) will continue to see significant growth.

4.2.1 Finance and Lease Trends and Drivers

- **PTC-driven Tax Equity in Partnership Flip Project Transactions:** Since the wind energy market in the US is currently sustained largely through tax credits (the PTC), the majority of wind projects are majority owned by tax equity investors, usually large financial institutions that have the significant tax burdens needed to take advantage of tax credits. Most wind plant developers and owner/operators do not have enough tax liability to fully utilize the PTC, so a tax equity partnership is created. PTC represents approximately 30% of present value CAPEX over 10-year duration according to a 2017 report from the National Renewables Energy Laboratory on wind energy finance in the US.[3] Arrangements vary but in general, most usually begin on the project's Commercial Operation Date with tax equity investors owning 99% of a wind project and the project developer retaining 1%. These are often combinations of debt finance for project construction and project equity. Once the 10-years of the PTC duration finishes, the tax equity investor flips its ownership majority to the original wind plant developer/owner/operator who then operates the project.

- **MACRS:** Additional tax monetization benefits are primarily accelerated depreciation via Modified Accelerated Cost-Recovery System (MACRS) The MACRS establishes a set of class lives for various types of property, ranging from three to 50 years, over which the property may be depreciated. A number of renewable energy technologies are classified as five-year property. MACRS over five years can represent around 27% of CAPEX (NREL Wind Finance, 2017). In addition to the five-year MACRS schedule, qualifying renewable energy projects have the option to depreciate 50% of an investment operation under a so-called bonus depreciation scheme. The 2017 Tax Reform Bill modifies bonus depreciation under Code Section 168(k) to allow 100% expensing for property placed in service after September 27, 2017 and before January 1, 2023 and then phases out bonus depreciation with 20% reductions each year.
- **Balance Sheet Financing for Most US Wind Plants:** The large and mature wind plant market in the US has been increasingly dominated by large corporate developers and wind plant owners who can self-finance wind projects on balance sheet without needing outside debt financing. They do, however, in many cases still bring in an outside tax equity investor who is better positioned to monetize the PTC tax credits. This increasing balance sheet financing is reducing the number of wind project investment opportunities for an increasingly large pool of interested outside investors. This is leading to lenders accepting very low margin returns on wind plant investment.
- **Lower corporate tax effect on tax equity:** The lower corporate tax rate has two main effects. First, a lower corporate tax rate makes depreciation less valuable. Each dollar of depreciation is now worth $0.21 per dollar of capital cost rather than $0.35 to a tax equity investor. Before 2017, except for the corporate tax rate and sometimes how depreciation is calculated, the investor took tax-change risk about the deal structure but otherwise tracked its yield based on actual tax results. The lower tax rate will reduce the present value of depreciation tax benefits but will also reduce the after-tax costs of income allocations to each partner and this will likely accelerate the flip date for many operational wind projects.

4.3 Case Study/Project Highlights: Partnership Flip with Tax Equity Investor

The majority of wind power plants built in the US are structured as a partnership flip. The high-level explanation of this structure is that it allows a tax equity investor to own around 99% of a wind project during the 10-year PTC period (plus other tax benefits such as accelerated depreciation). The developer retains a minority equity stake, usually around 1%, operates the project, conducts O&M, and receives remuneration at various stages in the project life cycle. The reason for this structure is that most developers—even the large ones—do not have the annual tax liabilities to fully monetize all the tax credits. Many large financial institutions such as banks, private equity, insurance companies, and others do have large tax burdens and actively seek out tax mitigation strategies. Wind plants are a low-risk option to reduce tax burden. Therefore, the wind market has evolved with this partnership flip as a symbiotic financial arrangement between wind plant developers, wind plant owners, and the tax equity community. This report provides more details of the structures and stages of a partnership flip and visual diagram in the Appendix.

Figure 4-1. depicts a hypothetical partnership flip structure for a $100 million wind project:

Figure 4-1. Hypothetical Partnership Flip Structure for a $100 Million Wind Project

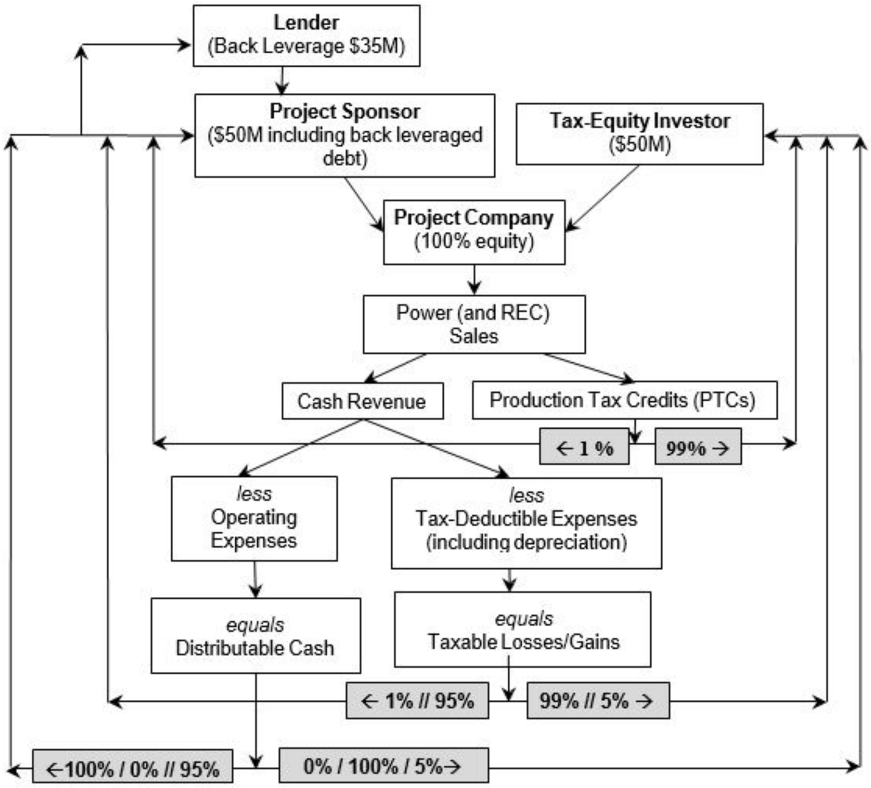


Figure 4. Hypothetical partnership flip structure for a $100 million wind project

/= first flip point in transaction where distributions ratios are initially altered

//= second flip point in transaction where distribution ratios are again altered

(Source: Wind Energy Finance in the United States, Current Practice and Opportunities, Paul Schwabe, Davide Feldman, Jason Fields and Edward Settle, National Renewable Energy Laboratory)

4.4 Top Three Opportunities from Lender Perspective

- Tax liability reductions via monetizing PTC.
- Tax liability reductions via accelerated depreciation MACRS and bonus depreciation.
- Modest long-term returns for debt and equity financing from a mature, well-understood and socially acceptable industry, usually with an equally long-term and well-understood PPA as the project's financial foundation.
- Financing partial turbine supply agreements provide developers with safe-harbor under IRS regulations to qualify for PTC and other tax benefits for multiple wind projects in the development pipeline, thereby guaranteeing tax equity investors will have many project participation options for years to come, and the associated tax credits. The last of the PTC enabled wind plants have until 2023 to come online (almost most will go online around year 2020).

4.5 Top Three Opportunities from Developer and Owner/Operator Perspective

- Financing access necessary for CAPEX-intensive projects. Wind plants are not cost-effective in smaller sizes. Project sizes in the US often exceed $100 million and most small- and medium-sized developers cannot self-finance such expenditures.
- Financing partial turbine supply agreements provide developers with safe-harbor under IRS regulations to qualify for PTC and other tax benefits for multiple wind projects in the development pipeline, thereby guaranteeing ongoing business for years to come. The last of the PTC enabled wind plants have until 2023 to come online (almost most will go online around year 2020).
- Sale Lease-back model could be a good option in unique circumstances where there is a high CAPEX component to a wind plant. In this case, a developer may prefer not to incur the cost or debt associated with a large component or an item they do not have expertise with. For example, purchasing land, a complex grid-tie substation, or large transmission line, or an underwater transmission line. This asset can be built, sold to a well-healed expert in said component area who leases the asset use back to the developer.

4.6 Risk Factors

The commercial-scale wind energy industry has over decades grown from an alternative energy to a mature and mainstream energy industry. Much of the risk involved in wind project finance has been managed out of the full project value chain through experience, evolving best practices and technology innovation. Wind project developers (project sponsors) and tax equity investors tied together through a partnership flip arrangement of project ownership represent the majority of wind project finance in the US. Therefore, the two entities are equally concerned with most of the risks associated with a wind project so the risks to lender and lessee are similar. The exception is that the lessor perspective (project sponsor) takes on the development risk alone before equity investors and back-leverage debt lenders join the project.

- **Pre-construction energy estimate risk:** As a wind project is developed, a wind energy resource measurement campaign is conducted to estimate likely future energy production at the site. This campaign usually lasts at least 2-years, and often longer. Expectations are critical to successful project development, project finance, and profitable operation for the duration of the project lifespan. Decades of refinements in measurement campaigns have greatly improved site power production estimates. However, inaccurate pre-construction energy estimates can result in financial targets being missed and reduced project profitability.
- **Market, regulatory, or selling price risk:** Most wind plants in the US operate on long-term fixed PPAs with bankable power off-takers so selling price risk is greatly reduced. However, some projects operate on a merchant basis (no fixed contract) and sell into a wholesale power market with fluctuating prices. That introduces revenue risk, although most merchant projects employ protective financial hedges with third parties to mitigate that risk. Regulatory risk is minor in the US, but an example would be Congress retroactively changing the PTC or other tax policy assumptions, and this could negatively impact the stakeholders behind wind projects in range of development or operational stages.

- **Project equipment performance and reliability risk:** The performance of a wind plant and its associated revenue and finance structure can be negatively affected by many factors. This can include performance degradation of the wind turbines, curtailment of the power output to the grid due to transmission congestion, component failures, such as gearboxes and blades, and other O&M cost overruns. Warranties from turbine OEMs project a wind plant in the early warranty stages (between 1-4 years). However, project performance risk increases once out of the warranty stage.
- **Development risk:** Wind project developers typically take on the development of multiple projects concurrently because not all attempted projects reach fruition due to a variety of commonplace challenges. This includes difficulty accessing site control for a wind project, lack of economically viable transmission access, sub-par or uncertain wind resources (after measurement campaign).
- **Project equipment performance and reliability risk:** The performance of a wind plant and its associated revenue and finance structure can be negatively affected by many factors. This can include performance degradation of the wind turbines, curtailment of the power output to the grid due to transmission congestion, component failures, such as gearboxes and blades, and other O&M cost overruns. Warranties from turbine OEMs project a wind plant in the early warranty stages (between 1-4 years); however, project performance risk increases once out of the warranty stage.

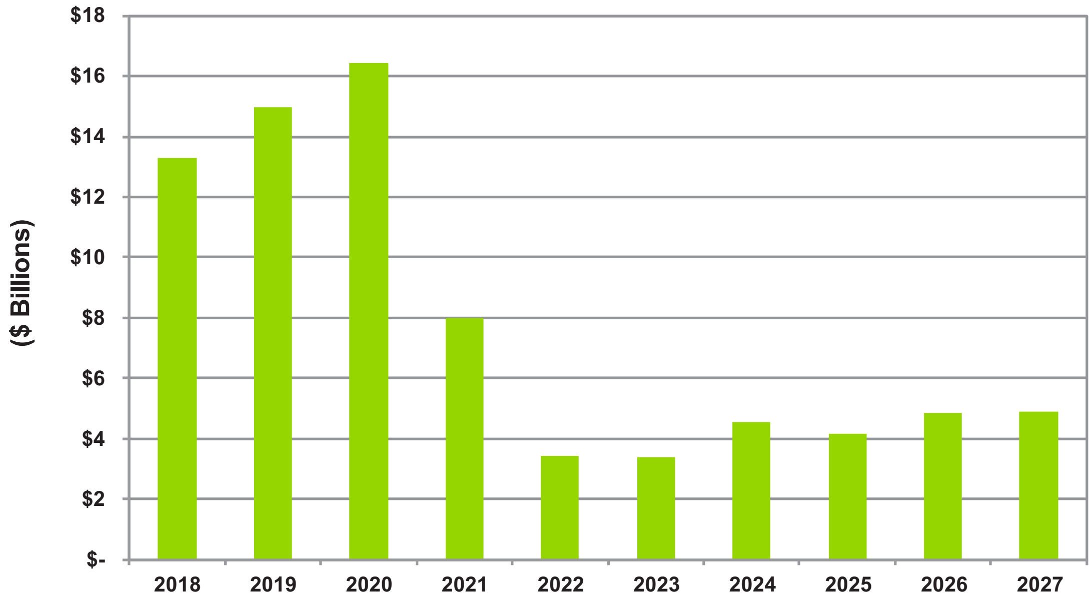
4.7 Market Size

The total US wind market from a finance perspective is best measured in CAPEX since these are equipment and construction intensive projects that require significant upfront project finance. OPEX costs are also significant but are much smaller than CAPEX and are addressed within a wind plant project financial structure.

The total project cost estimated in MW capacity is approximately $1.64 million per MW in the US for onshore projects in 2018. This includes development cost, wind turbines, foundations, construction, substations and all other balance of plant costs. CAPEX has been gradually decreasing as wind turbines become more efficient, and the wind industry in general advances cost savings strategies. In general, the wind market has managed CAPEX costs to nearly as low as possible and further reductions going forward will be minor even as turbines and wind plant operation continue to implement new advancements. The projection for wind CAPEX cost will decrease slightly over a 10-year period to 2027 at a projected $1.53 million per installed MW.

Applying Navigant Research’s forecasts for installed capacity, this represents a market worth approximately $13.28 billion in 2018 when an estimated 8 GW will be installed (a gigawatt is 1,000 MW). The wind market is in the middle stages of a major increase in wind project development and construction due to the enactment of a long-term tax credit phaseout (details explained in earlier Policy/Regulatory section). Wind plant construction will peak in year 2020 with approximately 10.1 GW expected to be installed—and this may be exceeded. The value at this peak of the market will top $16.43 billion at which point installations and associated market value will begin to decline sharply and settle to an average of 2.71 GW from years 2022 through 2027. During those six years of a plateaued market, the value will be approximately $4.21 billion annually.

Chart 4-1. Wind Market by CAPEX, US Market: 2018-2027



(Source: Navigant Research)

4.8 Conclusion

- During the last decade, the wind power industry has become a dominant, mature and cost-effective central power generation source. Cost for utility-scale wind power plants have fallen by more than 66% in the last seven years and now is the cheapest source of electricity in windy areas of the US including the vast central corridor spanning South from Texas up through most of the Midwest.
- Much of the risk involved in wind project finance has been managed out of the full project value chain through experience, evolving best practices and technology innovation.
- Since the wind energy market in the US is currently sustained largely through tax credits (the PTC), the majority of wind projects are majority owned by tax equity investors, usually large financial institutions that have the significant tax burdens needed to take advantage of tax credits. Most wind plant developers and owner/operators do not have enough tax liability to fully utilize the PTC, so a tax equity partnership is created, usually through a partnership flip (described in more detail in Section 2.12 and the Appendix).
- While most of the growth is expected to come from traditional utility-sourced PPA solicitations and agreements, large corporate PPAs between wind projects and C&I off-takers (buyers of power) will continue to see significant growth.

Section 5
UTILITY-SCALE ENERGY STORAGE

5.1 Utility-Scale Energy Storage Definition

The grid-tied stationary battery energy storage sector includes two primary segments. One segment includes utility-scale battery energy storage systems (BESSs) located on the transmission and distribution (T&D) system that provide grid and ancillary services (known as front-of-the-meter, or FTM, installations). The second segment includes BESSs located behind the customer's utility meter (behind-the-meter, or BTM, installations) at residential or C&I properties. Financing ESSs in the C&I BTM sector is discussed in Section 4.

Individual BESSs are now being built and financed in both BTM and FTM segments. Given that the battery energy storage project delivery chains are just now starting to mature, many participants are playing multiple roles. Some systems integrators are starting to develop their own projects, while other systems integrators now provide balance sheet-backed turnkey engineering, procurement, and construction services with performance guarantees that deliver fully operational BESS projects.

BESSs provide a multitude of specific services for the grid. Overall, however, the use of ESSs is driven by the need either to improve the efficiency of the grid and optimize existing assets or to effectively integrate new renewable energy generation. With traditional grid planning frameworks, the need to provide sufficient grid capacity to serve an ever-increasing peak demand has resulted in a significantly overbuilt and inefficient system in many areas, as assets may not be fully utilized for 20 years or longer. Maintaining and upgrading T&D networks represents one of the most significant expenses for electric utilities, and traditionally there were few alternatives to costly investments in expanded capacity. The new generation of less expensive and more intelligent DER and energy storage technologies located on both the T&D grid and customers' properties has opened the door to a compelling array of new options for how to best utilize existing infrastructure.

While energy storage can provide significant value on the grid regardless of the introduction of renewables, the technology's most substantial value lies in facilitating the integration of these new resources and moving away from a reliance on fossil fuels. Aside from the US, most countries leading the development of renewables and energy storage continue to be those without domestic fossil fuel resources that are embracing the energy transition as a key economic growth and diversification tool.

The growth of energy storage is expected to continue following the increasing development of renewable generation. Many countries have recently seen significant growth in renewable generation, but energy storage has yet to take hold. This is expected to change in the coming years as ESS prices continue to decline and project developers gain experience efficiently building, integrating, and monetizing ESSs alongside renewable plants.

5.2 Introduction to Utility-Scale Energy Storage Financing

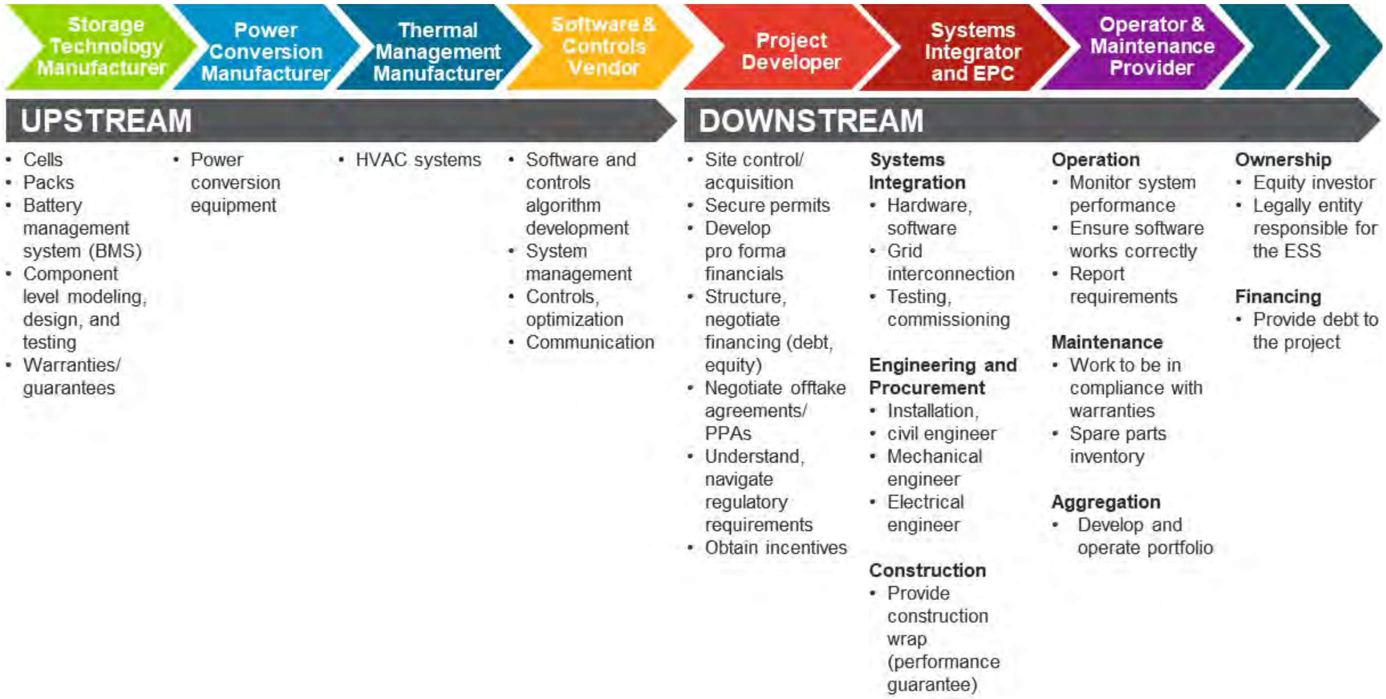
The evolution of project finance in the energy sector has been instrumental in the development and construction of coal, combined cycle natural gas, and renewable energy generation assets. And the advent of solar PPAs has driven technology adoption in the renewable energy sector.

BESS projects are now delivering unique grid benefits and load management value in ways that can be better defined financially. As a result, more predictable project revenue flows are creating new energy storage financing asset classes that will speed the adoption of stationary energy storage technology.

Given this evolution, energy sector project finance investors are now moving into the grid-tied, utility-scale stationary battery energy storage sector. As such, the unique risks associated with the operation BESSs on the T&D system along with the potential revenue and operating costs are being quantified for the first time.

Figure 5-1. highlights the entities and tasks involved in BESS projects across the value chain that are tasked with managing these risks to ensure viable projects are commissioned. For energy project finance investors considering battery energy storage, the risks, revenue, and costs associated FTM project delivery value chains will be unique.

Figure 5-1. BESS Project Delivery Value Chain



(Source: Navigant Research)

The general types of project finance risks associated with outlined in Table 5-1. underpin the detailed analyses undertaken by investors in each energy storage financing asset class.

Table 5-1. Overview of Utility-Scale Energy Storage Project Finance Risks

Risk Category	Risk Issue	Energy Storage Example
Regulatory	Regulatory requirements	Uncertain power market rules or tariff charges
	Rebates or incentives	Access to ITC for storage sited with renewables
Technology	BESS performance	Power, energy capacity, C-rate, cycle life
	Warranty	Based on state of charge, life cycle, duration restrictions
Operational	System optimization	Software charge/discharge algorithms
	Routine equipment operations and maintenance	Battery, inverter, HVAC warranty requirements
Owner/Host	Credit	Ability of project owner or host to repay financing

(Source: Navigant Research)

5.3 Finance and Lease Structures

Energy storage financing instruments consists of FTM projects that are operated by local utilities (in regulated electricity markets) or in accordance with regional transmission organization (RTO)/ independent system operator (ISO) power market rules (in deregulated electricity markets). The three current types of FTM utility-scale projects financing instruments are shown below.

It is important to note that some utility-scale solar PV and wind asset operators are now considering when and where to add energy storage to existing installations to mitigate curtailment and congestion charges under the current PPAs terms to and potentially take advantage of day-ahead or hour-ahead capacity markets. It remains to be seen whether these energy storage add-on installations will be deployed under financing scenarios.

- **Utility Energy Storage Services Agreement (UESSA):** An UESSA, where a local utility in a regulated market contracts for energy storage services at agreed, predictable compensation rates.
- **Utility Solar PV plus Energy Storage PPA:** The second type of utility-scale energy storage financing instrument is a utility solar + energy storage capacity PPA, where the utility makes payment on a per-kilowatt-hour basis for firmed and smoothed, dispatchable solar power provided to the grid.
- **Merchant Energy Storage Services Agreement (MESSA):** A MESSA is a financing instrument where an independent power producer with energy storage capabilities provides energy storage services in accordance with wholesale power market pricing and scheduling rules to an RTO/ISO.

Each of these financing instruments is discussed in greater detail below. Table 5-2. summarizes the key drivers and hurdles by financing asset class.

Table 5-2. Summary of Energy Storage Financing Drivers and Hurdles

Financing Agreement Type	Key Drivers	Key Hurdles
UESSA	Recognition of energy storage value by local utility	Cost, unclear power market rules, and poorly valued benefits of storage
Utility solar plus energy storage PPA	Software platform, high solar intensity, and high peak day time or evening wholesale prices	Cost, lack of capacity market rules for solar plus storage integration, and impact of smoothing, firming on battery life
MESSA	Well-defined energy storage valuation by RTO/ISO or local utility	Cost and investor appetite for merchant (non-contractual) revenue

(Source: Navigant Research)

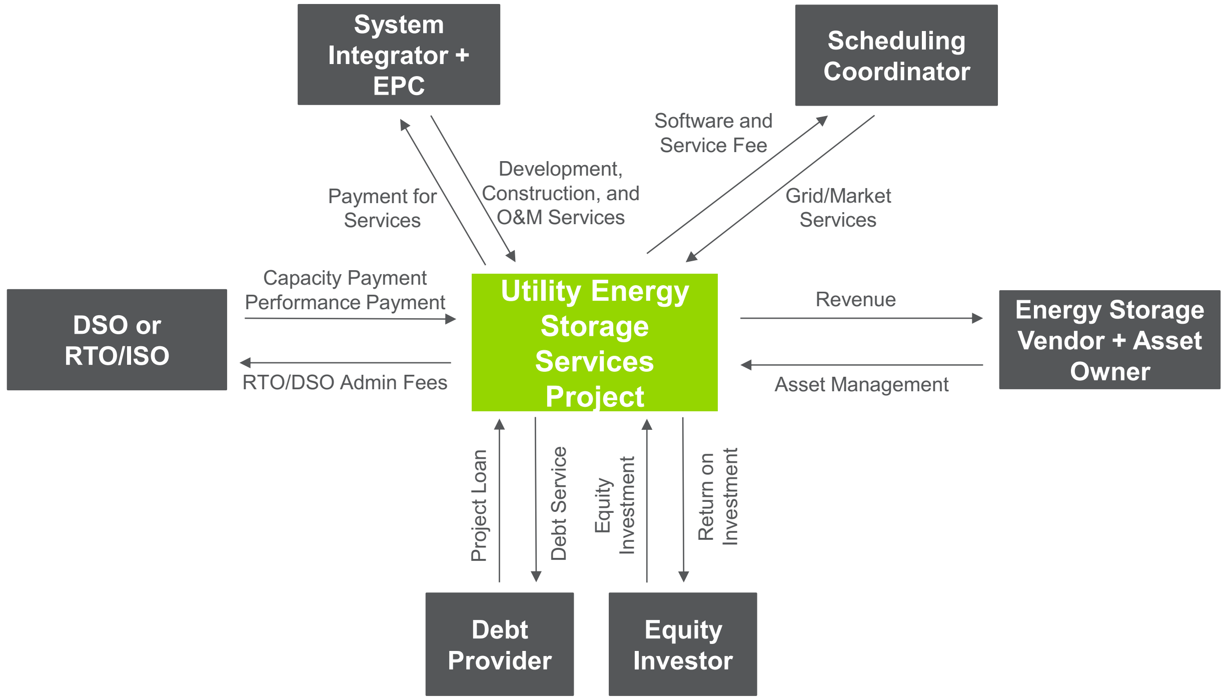
5.3.1 UESSA

A UESSA is executed in a regulated market where the local utility contracts with a third-party vendor to provide energy storage services. A BESS under a UESSA is compensated for meeting grid requirements for capacity availability should the utility anticipate the need for energy storage services and the actual energy storage services provided. These BESSs have capacity injection rights and charge and discharge from and to the grid while injecting power similar to a power purchase tolling agreement for conventional power. The third-party vendor will design, integrate, develop, permit, install, interconnect, finance, own, and maintain the BESS on behalf of the local utility. The local utility may or may not serve as the project's scheduling coordinator.

Key project performance requirements for UESSA financing include:

- A reliable battery pack and battery management system backed by a creditworthy battery supplier that can back the battery performance guarantee/warranty.
- Software that can evaluate utility use case scenarios and their impact to long-term battery condition to determine project financial performance.
- Software that can allow for system visibility and control by the local utility.
- Software system that can track real-time local utility capacity and performance signals and pricing.
- Ability to meet contractual capacity and performance charges based on system availability capacity and BESS round-trip efficiency targets.
- Predictability of capacity and performance payments from the local utility.

Figure 5-2. UESSA Project Costs and Revenue



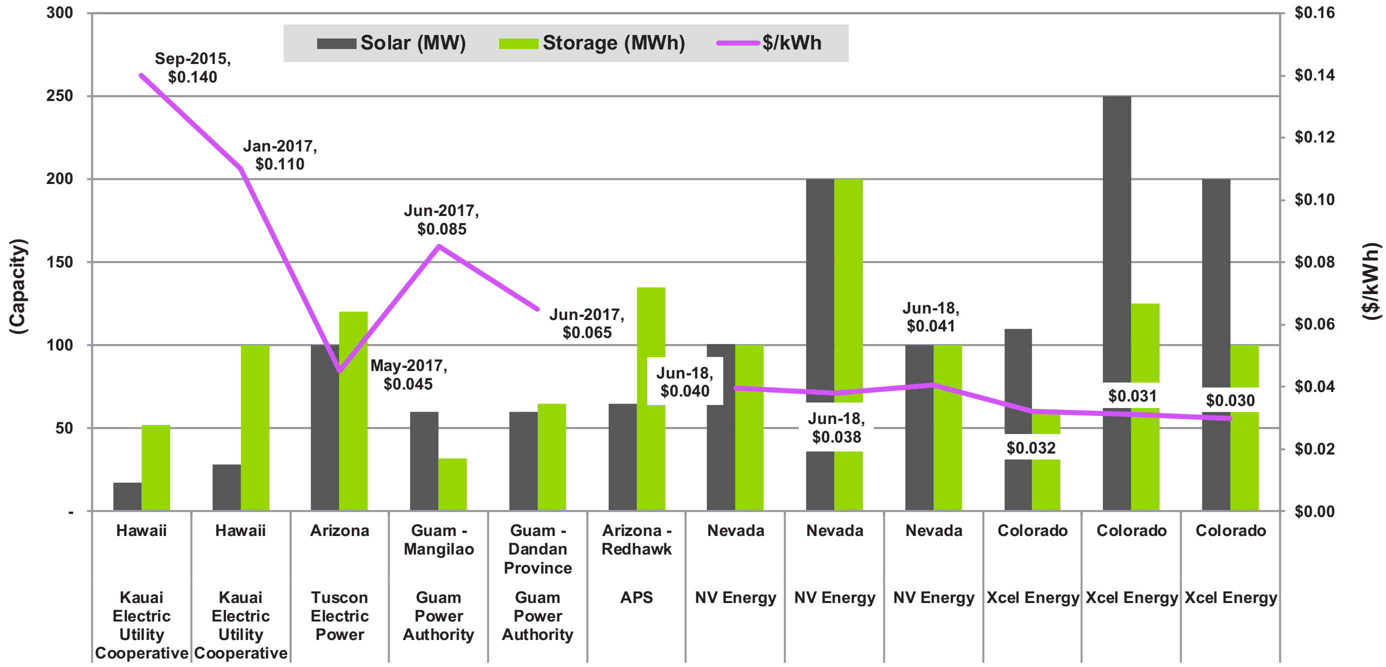
(Source: Navigant Research)

5.3.2 Utility Solar plus Energy Storage PPA

A utility solar plus energy storage capacity PPA mimics the contractual approach employed by solar PV developers to finance solar. In this case, however, the instrument is generally deployed in vertically regulated power markets where the utility makes a payment on a per-kilowatt-hour basis for firmed and smoothed dispatchable solar power provided to the grid by the project either during daytime or evening peak use periods. The utility typically engages with a third-party solar storage + storage vendor to design, integrate, install, finance, own, and operate the integrated solar PV and BESS system, which is interconnected on the local transmission and/or distribution grid. The business case for utility solar plus energy storage PPAs focuses on grid systems with strong solar intensity and high wholesale electricity prices during daytime or evening peak periods.

Pricing for utility solar plus energy storage PPAs have fallen dramatically in the past three years. This decrease has triggered a wave of new projects being announced in the US. Chart 5-1. tracks pricing for large-scale utility PPAs for solar plus energy storage projects from September 2015 to June 2018. While this does not show all utility solar plus storage PPAs, these projects are noteworthy for breaking records in terms of either price or project size.

Chart 5-1. Utility Solar plus Energy Storage Project PPA Prices: 2015-2018



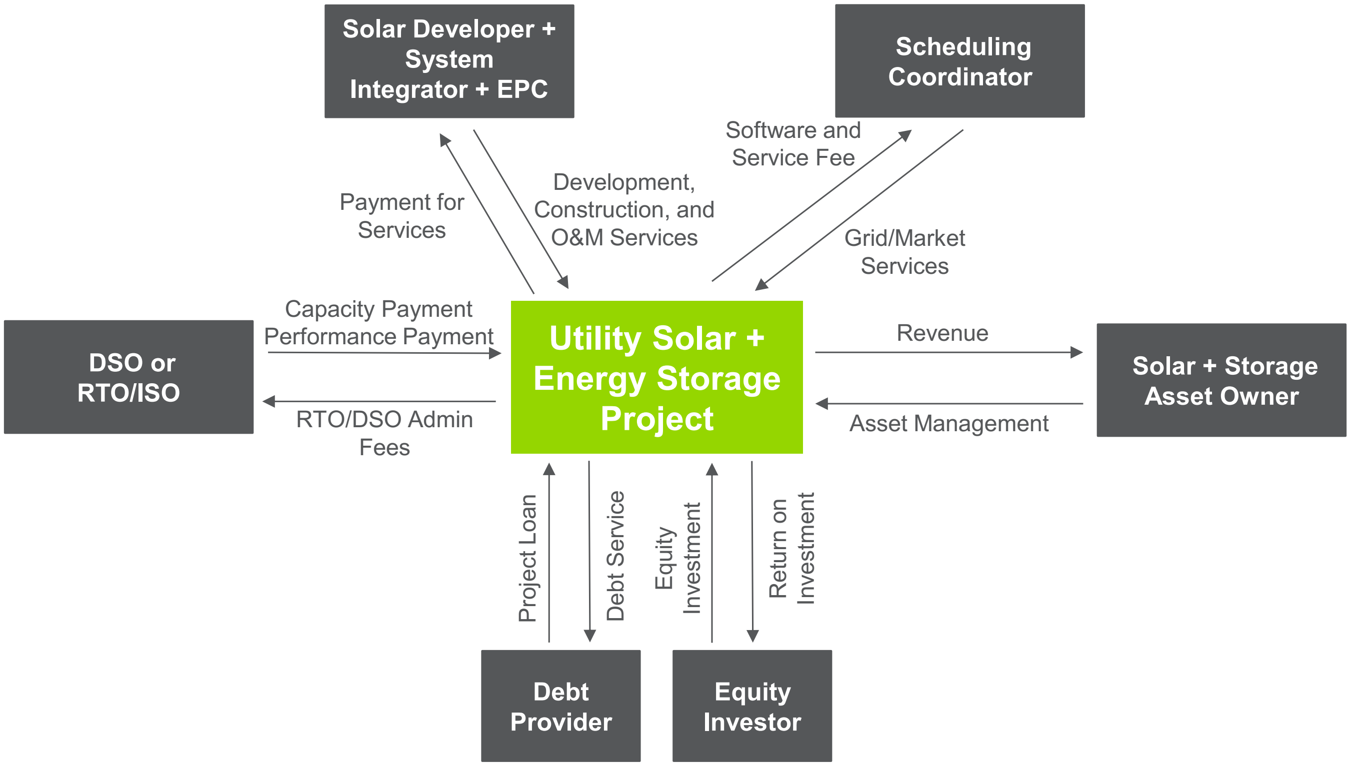
(Source: Navigant Research)

With a utility solar plus energy storage PPAs, the solar plus storage vendor provides access to a comprehensive software platform that integrates solar PV production with the BESS and the local power market dispatch requirements.

Key project performance requirements for utility solar plus energy storage PPA financing include:

- A reliable battery pack and battery management system supported by a creditworthy battery supplier that can back the battery performance guarantee/warranty.
- For projects in the US, the ability for the solar plus energy storage installation to take advantage of the 30% ITC under Section 48 of the IRS tax code.
- Software that can evaluate utility use cases and their impact on long-term battery condition to determine project financial performance.
- Software that can integrate solar PV production with the BESS and PPA requirements to ensure the project is optimized financially.

Figure 5-3. Utility Solar plus Energy Storage PPA Project Costs and Revenue



(Source: Navigant Research)

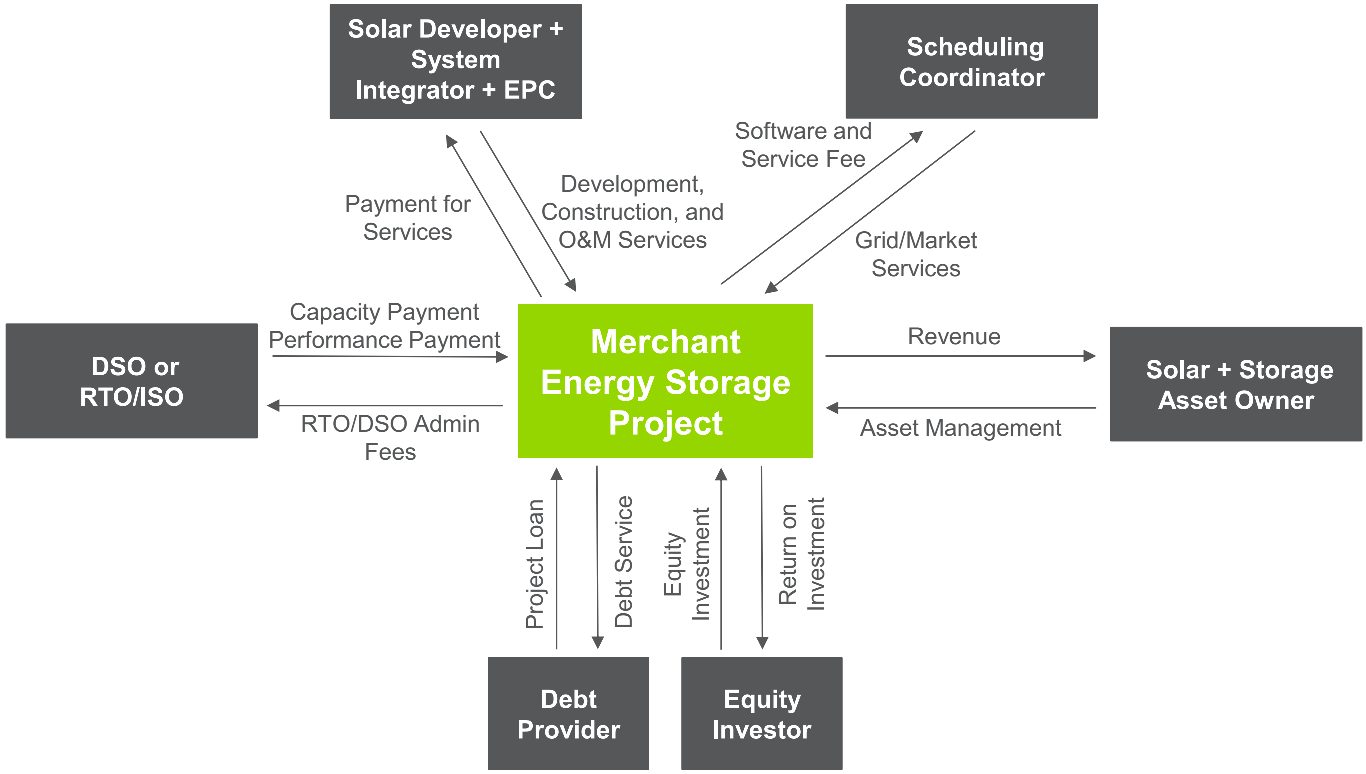
5.3.3 MESSAs

Driving MESSAs are RTO/ISO programs that created energy storage power market rules in wholesale markets to allow independent power producers with energy storage capabilities to design, integrate, install, finance, own, and operate the BESS on the local transmission and/or distribution grid. The business case for MESSAs has focused primarily on fast frequency response ancillary services projects in wholesale power markets like PJM in the US, where the power market price for slower responding energy storage assets or generation balancing services can create favorable energy storage compensation pricing. Like other merchant power projects, revenue for these projects is less predictable and subject to changes in power market prices, local power market rules, or dispatch requirements.

Key project performance risks for merchant energy storage financing include:

- A reliable battery pack and battery management system backed by a creditworthy battery supplier that can back the battery performance guarantee/warranty.
- Software that integrates predicted battery use case scenarios with mid- to long-term power market pricing forecasts for energy storage services to optimize projects financially.
- Software that can track and anticipate mid- to long-term battery life cycle limitations and warranty implications based on current and future use case scenarios.
- Access to a balance sheet-backed energy trading entity that can mitigate the merchant revenue risk inherent in these types of energy storage projects.

Figure 5-4. MESSA Project Costs and Revenue



(Source: Navigant Research)

5.3.4 Industry Trends and Drivers

The utility-scale energy storage industry is developing at different rates and with different characteristics in regions around the world. Several countries have emerged as clear leaders, with many others seeing significant growth in storage market activity but on a smaller scale. However, in most of the world, the industry remains nascent with only a handful of pilot or R&D projects in each country. Evolutions in government policies, electricity market regulations, and energy storage business models are expected to drive exponential growth in project development over the coming years. The following sections detail the key trends in terms of technology, policy and regulations, and market developments/business models.

- **Technology:** Lithium-ion (Li-ion) batteries have emerged as the favorite technology for new projects around the world. While Li-ion batteries have advantages over other technologies in terms of performance, energy density, and cost, the main reason for their success is the reputation and financial strength of battery manufacturers. Many other ESS technologies are provided by smaller startup companies, yet Li-ion batteries are produced by some of the world's largest multinational electronics manufacturers. These companies have the financial resources to both lower prices and provide reliable long-term warranties. Additional drivers of the dominance on Li-ion batteries in this market include performance characteristics and price.

- **Performance and energy density:** Li-ion batteries are among the best storage technologies in terms of round-trip efficiency. The technology is also the most energy dense, resulting in a smaller physical footprint for large-scale systems. This characteristic is an important consideration for projects in urban areas and on islands where real estate and land is at a premium.

- **Price:** Prices for large-format Li-ion batteries have decreased dramatically in the past several years. Navigant Research estimates that installed system prices for Li-ion bulk storage systems decreased 48% from 2014 to 2017. Falling costs are driven by the rapid expansion of Li-ion manufacturing capacity to serve both the stationary and EV markets with similar products.

- **Project Delivery:** The recent growth in new ESS project activity has also resulted in a major reduction in the time required to build projects. Only two years ago, many new ESS projects took well over one year to commission once announced. The past 12 months have seen new, large-scale projects sign contracts and be fully commissioned in under three months. This development has brought to fruition the key advantages ESSs have over many conventional grid assets: the ability to be built quickly and with the flexibility to closely match the needs of the grid.

- **Federal Policies:** Actions are also being taken to support energy storage at the federal level in the US, albeit at a slower pace. The most notable development is the Federal Energy Regulatory Commission's (FERC's) Order 841 issued in early 2018, which seeks to, "remove barriers to the participation of electric storage resources and DER aggregations in the capacity, energy, and ancillary service markets." The FERC has wide-ranging jurisdiction over the ISOs that supply electricity to most customers in the US. Current regulations in many of these markets often do not consider the unique technical attributes of energy storage and, in some cases, forbid the technology from providing certain services. ISO's in the US are currently establishing their market reforms to comply with Order 841. Initial reforms are expected to be announced at the end of 2018 and fully implemented by the end of 2019.

- **State Policies:** Most impactful actions have been taken at the state level to encourage energy storage development. Specifically, mandates and deployment targets directing local utilities to deploy energy storage have spurred market growth in leading states.

  - **California:** The first and most impactful mandate came in California in 2013 with the passage of the Assembly Bill 2514 law that required the state's large investor-owned utilities to deploy a total of 1,325 MW of energy storage by 2020. The California Public Utilities Commission then issued an order in 2017 requiring utilities to procure an additional 500 MW of behind-the-meter for distribution grid-connected energy storage. These mandates have played a critical role in California being establishing as one of the leading energy storage markets worldwide.

Following in California's footsteps, similar but smaller mandates and procurement targets have been passed in other states around the country.

- In 2017, **Massachusetts** announced a modest target of 200 MWh of installed storage capacity by 2020.

- Later in 2017, **New York** surpassed Massachusetts with a much more ambitious target of 1,500 MW of storage capacity by 2025 as part of the state's "comprehensive agenda to combat climate change." The exact structure and effect of these two targets are yet to be seen, with initial deployments of projects expected in 2018 or 2019.

- The state of **Oregon** also instituted a small energy storage procurement mandate for its utilities in 2015, requiring just 5 MWh of capacity to be installed by 2020. However, in 2017, one of the state's largest utilities, Portland General Electric, announced a plan to deploy 39 MW of energy storage over the coming years. Not only does this amount of storage exceed the utility's requirement, it represents the maximum capacity allowed through the 2015 law.

- **Integrated Resource Planning:** US states have also acted to accelerate the energy storage industry by requiring utilities to evaluate storage alongside other infrastructure investments they must make. In states around the country, including New Mexico, Colorado, Washington, Arizona, and Oregon, utilities are now required to compare the costs and benefits of storage against their traditional investments in power lines, substations, and new generation capacity. In Arizona, two of the state's largest utilities have now announced plans to deploy storage in their integrated resource planning documents.

5.4 Case Study/Project Highlights

Utility solar plus storage PPAs have become a driving force in the energy storage market in the US over the past three years. As shown in Figure 3, PPA rates have fallen nearly 78% from \$0.14/kWh for a project in 2015 to \$0.03/kWh for a project announced in 2018. The state of Hawaii has been a leader in the development of combined solar plus storage projects and in particular the island of Kauai through its locally owned utility, the Kauai Island Utility Cooperative (KIUC). KIUC has contracted and/or built three large-scale solar plus storage projects that serve as peaking generation resources and displace the use of imported fossil fuels.

KIUC's first solar plus storage PPA project was awarded in September 2015 to Tesla and SolarCity, which collaborated on the development of a 13 MW solar plant integrated with a 52 MWh battery ESS. The PPA price for this project was listed at \$0.14/kWh, a record for the USA when announced. This project was fully developed and went online in mid-2018. In January 2017 KIUC announced its next project. With developer AES Distributed Energy, KIUC contracted to purchase power from a 28 MW solar plant combined with 100 MWh of battery ESS capacity. This project offered the utility a PPA price of \$0.11/kWh. A third project was announced in June 2018, also developed by AES Distributed Energy with 19.3 MW solar and 70 MWh battery ESS. While the exact PPA price has not been disclosed for this final project, it is likely in the \$0.10/kWh range of the two previous projects the utility awarded.

Contracting through PPAs for these projects allows KIUC to avoid large upfront capital expenditures and greatly limits the technology risk it assumes. As energy storage is still a relatively new asset on the grid, few utilities have in-depth knowledge of its technical operating parameters and maintenance requirements. PPA structures allow the utility to leave both O&M to two of the leading storage vendors in the industry. The developers for all three projects, Tesla and AES Distributed Energy, will be the long-term owners and operators of the projects. KIUC will purchase energy provided by these plants and will have some level of control over the dispatch to ensure that the use of solar energy is maximized to offset costly fossil fuel generation during peak demand periods. The Tesla project comes with a 20-year PPA; the two AES distributed projects have 25-year PPA terms, all including O&M services.

5.5 Top Three Opportunities from Lender Perspective

The need to integrate intermittent renewables coupled with the need to optimize the T&D system with low-cost, flexible assets such as energy storage will combine to create the demand for new financed utility-scale energy storage solutions. The following top opportunities from the lender perspective are discussed below:

- Traditional energy sector project finance investors' move beyond traditional fossil fuel-based coal and natural gas central generation and large-scale renewable energy project finance investment instruments into new DER solutions will create new investment opportunities to take advantage of energy storage's unique flexible capabilities.
- Traditional energy sector project finance investors moving into energy storage will see growth in investment opportunities in UESSAs, solar plus energy storage PPAs, and MESSAs.
- Traditional energy sector project finance investors moving into energy storage should also closely track the emergence of new FERC rules for energy storage market participation to identify new storage investment opportunities. This path forward will include the ability of FERC power market rules to allow for energy storage to take advantage of its unique flexibility by providing multiple revenue-generating applications.

5.6 Top Three Opportunities from Lessor Provider Perspective

As highlighted herein, the need for low-cost, flexible assets such as energy storage will create the demand for new financed utility-scale energy storage solutions. The following top opportunities from the lessor (C&I energy user) perspective are discussed below:

- IPPs looking to add financed energy storage options can leverage investor interest in energy storage to meet their asset performance and cost savings needs. These types of integrated storage finance solutions are now being considered for the first time.
- Independent power producers are now facing an opportunity to move beyond deploying intermittent renewable energy assets by deploying these renewable assets with energy storage that can enable stronger project performance. The path forward to stronger project performance will include the ability of FERC power market rules to allow for energy storage to take advantage of its unique flexibility by providing multiple revenue-generating applications.
- C&I energy users and DER solutions providers are also now facing an opportunity to capitalize on the emergence of new software capabilities across integrated financed energy efficiency and DER asset class to improve the ability of these integrated solutions to reduce energy savings with improved monitoring and verification.

5.7 Top Three Risks from Lender Perspective

The demand for new financed utility-scale energy storage solutions will create new opportunities for project finance investors. Many of these investors are looking at these risks associated with utility-scale energy storage for the first time. The following top risks from the lender perspective are discussed below:

- To grow the utility-scale energy storage market, investors will need to focus on understanding energy power market participation rules for energy storage. The development and nature of these factors will vary across each North American RTO/ISO.
- As the growth of utility-scale energy storage market continues, investors will need to develop standardized contracts for to manage risks better and reduce transaction costs.
- Utility-scale energy storage financing asset classes are in the early stages of development. As these new financing asset classes mature, lenders will need to ensure that end independent power producers and grid operators are comfortable with the ability of software platforms to deliver predictable project revenues to ensure these financing asset classes can scale.

5.8 Top Risks from Lessor Perspective

The demand for new financed utility-scale energy storage solutions will create new opportunities for energy storage system lessors. The following top risks from the lessor perspective are discussed below:

- Despite the growth to date and move toward more modular designs, the deployment of integrated utility-scale renewable energy and energy storage is still in the early stages. The ability of Internet of Things (IoT) technology, metering, sub-metering, and hardware and software technology solutions to deliver anticipated project revenues considering evolving FERC power market rules should be closely tracked.
- Creating utility-scale energy storage solutions that can take advantage of the unique flexible capabilities is complex. For example, integrating intermittent renewable energy assets with energy storage across power market participation rules while maximizing the life cycle potential of the battery storage technology adds to this complexity.

5.9 Market Size

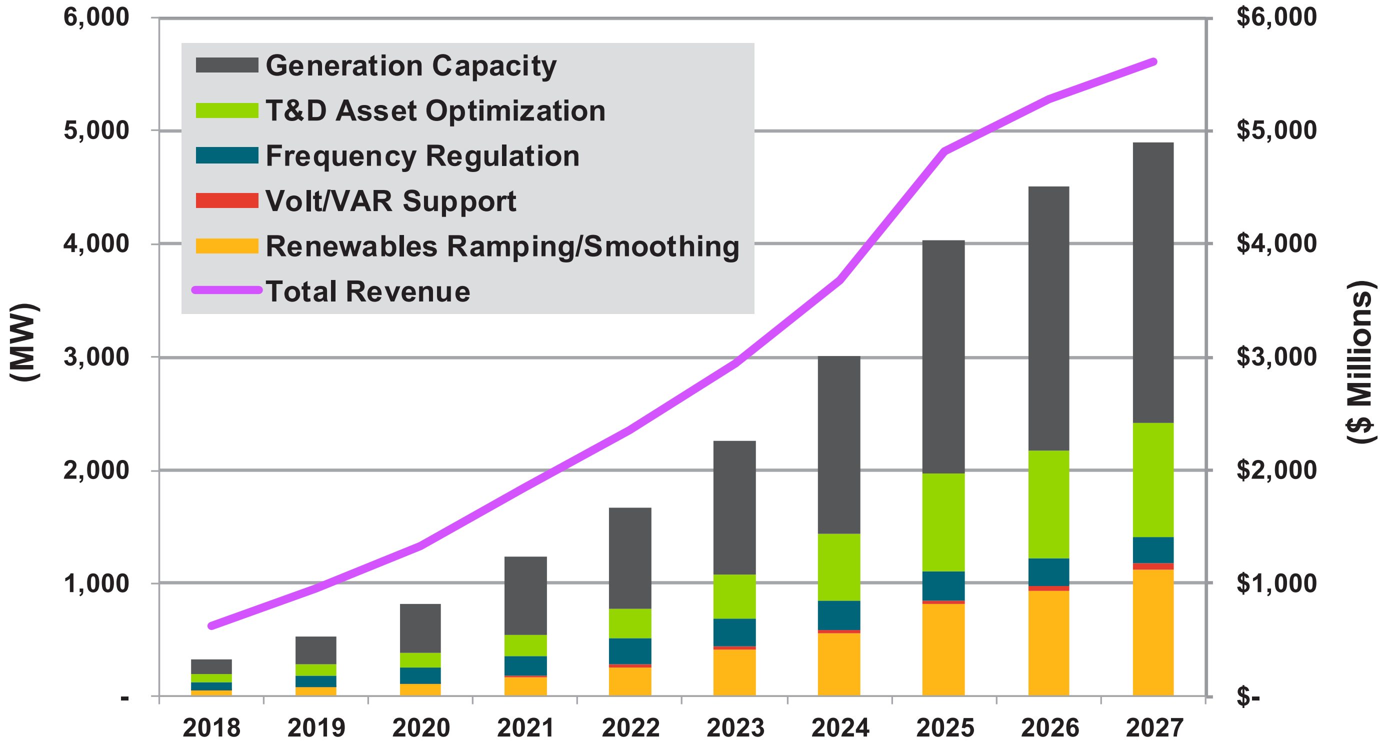
While there are a variety of individual services that utility-scale energy storage provides on the power grid, Navigant Research has established five key application segments based on required performance characteristics. These application segments are detailed below:

- **Generation Capacity:** This application includes services typically provided by conventional thermal generators such as spinning reserves, non-spinning reserves, and load following. The application segment also includes the shifting of renewable energy from when it is produced to times of high demand.
- **T&D Asset Optimization:** The T&D asset optimization application ensures that electricity lines, substations, and other equipment have enough resources to handle peak demand.
- **Frequency Regulation:** Balances the fluctuations between electricity generation and electrical load, manages the variability in the grid's frequency and maintains the frequency of the current on transmission lines within safe ranges by pulsing large bursts of power on and off the grid.

- **Volt/VAR Support:** This application manages reactive power to maintain the power system's voltage at acceptable ranges given the operating conditions it is likely to face. One of the shortest duration applications included in this report, Volt/VAR support often requires much less than 5 minutes of discharge duration.
- **Renewables Ramping/Smoothing:** The renewables ramping/smoothing application includes services directly tied to managing the output of variable renewable generation. The variable output from both wind and solar plants provides challenges to grid operators, as changing conditions can lead to dramatic swings in the amount of energy and voltage being fed onto the grid.

Chart 5-2 outlines the projected annual deployments of utility-scale energy storage for each of these five major application segments.

Chart 5-2. Annual Installed Utility-Scale Energy Storage Power Capacity and Project Deployment Revenue by Application, US: 2018-2027



(Source: Navigant Research)

Over the coming 10-year period the US is expected to be one of the largest individual country markets for new utility-scale energy storage capacity. Overall new capacity additions in the country are expected to grow from 321.6 MW in 2018 to 4,987.6 MW in 2027, representing a compound annual growth rate of 35.3% and a cumulative market of 23,269.1 MW. Within the country, the generation capacity application is expected to account for the most growth. This application includes both electricity reserves currently provided by conventional generation plants, and the shifting of renewable generation through PPA's. The next most widely utilized applications are expected to be T&D asset optimization, and renewables ramping and smoothing.

5.10 Conclusion

- Utility-scale energy storage is emerging as a project finance opportunity to allow for the grid integration of intermittent renewable energy technologies and to take advantage of evolving FERC power market rules that can utilize energy storages' unique flexible capabilities.
- Traditional energy sector project finance investors will increasingly look beyond traditional fossil fuel-based coal and natural gas central generation and large-scale renewable energy project finance investment instruments into new energy storage solutions to take advantage of energy storages' unique flexible capabilities.
- Utility-scale energy storage software platforms can now demonstrate improved integrated analytics, operational control, and optimization capabilities for utility-scale energy storage deployments. This evolution will help reduce financial risks for investors and asset owners.
- To address the financial risks associated with utility-scale energy storage, independent power producers, energy project investors, energy storage systems integrators, and policymakers need to work together to develop power market participation rules. This cooperation will be particularly important to allow for energy storage to take advantage of its unique flexibility by providing multiple revenue-generating applications.

Section 6
INTELLIGENT BUILDINGS

6.1 Intelligent Buildings Definition

Today, the proposition for investing in intelligent building technologies for energy management is only part of the conversation. Customers are looking for solutions that translate a complete data profile of their facilities, systems, and operations into business metrics. The result is an evolving technology landscape. Building energy management systems (BEMSs) that were once the foundation of the market are being rebranded. Building management systems that once delivered the technical details of automation and controls are being integrated with greater analytics capabilities and remote accessibility. Meanwhile, the rapid evolution of technology under the umbrella of IoT is introducing lower cost alternatives to help engage new customers and deepen the capabilities of existing intelligent building systems.

6.2 Introduction

The intelligent buildings market has reached an inflection point as IoT creates a pathway to cost-effective data creation, collection, and communication to increasingly powerful analytics and service offerings. Today, building owners and operators must navigate the IT/OT convergence for optimizing facility operations to reduce costs, but also realize the value in their buildings as business assets. Intelligent building technologies deliver energy and operational cost savings, enhance occupant satisfaction through comfort, convenience, and productivity, and support corporate sustainability and climate goals.

For many years, intelligent building technologies were only showcased in the largest, most complex facilities and campuses, but today and into the future the solutions are moving to mass market adoption. The fully integrated intelligent building utilizes comprehensive systems for automation and control with analytics to gather cohesive business insights.

Overall intelligent building solutions revenue is expected to grow from approximately $15.1 billion in 2018 to $67.5 billion in 2027 at a compound annual growth rate (CAGR) of 18.1%. This forecast reflects revenue associated with the following components:

- Hardware revenue reflects investment in communication devices, controllers, sensors, valves and actuators, and edge devices.
- Software revenue is associated with reporting applications, energy management software, and analytics on equipment optimization.
- Services revenue is generated by engagements for remote monitoring and diagnostics, mechanical systems management and integration, integrated energy, and operational improvement.

6.3 Finance and Lease Structures

Facility upgrades and new equipment investments can be necessary for existing buildings as customers begin their intelligent buildings journey; therefore, financing options are important to support market development:

- Performance contracts remain central to energy efficiency upgrades for public sector customers.
- Software as a service (SaaS) is becoming the norm for the foundational software analytics to support building optimization.
- Some solutions providers are exploring new "as a service" or managed services business models to engage private sector customers in more comprehensive upgrades with no upfront cost.

6.4 Industry Trends and Drivers

- **Technology:** The intelligent buildings market has been evolving for more than twenty years. The information technology infrastructure and supporting software analytics are mature yet continuing to evolve in line with IoT. The legacy building equipment and controls systems used for decades in large buildings are becoming more integrated with information technology to support system optimization beyond scheduling and energy management.
- **Policy/Regulatory:** The intelligent buildings market first gained traction through the energy efficiency use case. Few enabling technologies are mandated yet in some markets such as California controls are becoming required to meet code. Policy can have an indirect influence on the market through incentives for intelligent building technologies that deliver energy savings or support benchmarking and reporting as examples.
- **Market:** IP-addressable, remotely accessible building systems are the backbone of facility optimization in the intelligent building construct. IT/OT convergence is a challenge for many customers because of the legacy siloes between operational staff managing building systems such as HVAC and lighting, and information technology staff managing corporate networks. The result is a challenge for human capital and change management. As a result, there is a growing market for managed services, and integrated software analytics-advisory service models supporting customers as they invest in and integrate intelligent building solutions.

6.5 Finance and Lease Trends and Drivers

- **Intelligent Buildings Supports Investment in Lease Spaces:** Commercial building lease structures have long created a split incentive for energy upgrades that complicated the value proposition for intelligent building solutions that deliver specific tenant benefits. Today, however, facility owners recognize the brand and customer acquisition/retention benefits of intelligent building solutions, supporting investment in leased spaces.
- **Opportunity for "as a service" Solutions:** Major equipment retrofits (e.g., HVAC and lighting) remain CAPEX for the most part. The "as a service" model is being introduced particularly around lighting as a service.

- **Public Sector Benefits:** Public sector customers are challenged to manage deferred maintenance and equipment upgrades with limited budgets, which has supported and continues to support the energy service company (ESCO) performance contract financing approach. ESCOs are incorporating intelligent building solutions alongside traditional energy efficiency measures.

6.6 Case Study/Project Highlights

Sparkfund, a DC-based startup, has a monthly subscription model to help building owners deploy cutting-edge energy technologies for less money and less hassle. Sparkfund owns the equipment and customers make a single monthly operating expense payment that includes a no-risk guarantee and all maintenance. Sparkfund deploys its solutions through major energy providers, including Shell. Aloft and Element Hotels in Miami have a five-year Sparkfund Technology Subscription for LED lighting and smart thermostats, which is estimated to generate more than $90,000 in cost savings.

6.7 Top Three Opportunities from Lender Perspective

There are new opportunities for financing customer projects as the building technologies market evolves. Technology and service providers can engage customers in deeper engagements that deliver recurring revenue streams by bundling equipment retrofits, automation, and controls, alongside data analytics and advisory services. The opportunity for comprehensive project development borrows from the framework of the energy savings performance contract business model that the ESCOs have utilized to drive the public sector energy efficiency market but refined to appeal to the business dynamics in the private sector. Three main opportunities from the lender perspective include:

- **New partnerships for top-line growth:** Lenders can work with specialty technology and service providers to expand market penetration of next-generation building technologies. As these vendors position their bundled offerings, they can provide a new channel to business for financial institutions.

- **Capitalize on customer demand for intelligent building technologies:** Many customers struggle to balance budget demands for CAPEX building projects but retain strong creditworthiness. As a result, there is a significant gap in investment for energy efficiency upgrades, which lenders can help bridge with project financing.

- **Develop targeted customer acquisition programs:** Lenders can introduce offerings designed to showcase the sustainability benefits of intelligent building technologies. Customers seek intelligent building technologies to address a wide range of business challenges from operational efficiency to occupant satisfaction, but there are associated energy and sustainability benefits that can help achieve corporate targets, city, state, and national policy objectives. Financiers can align their own corporate initiatives with targeted financing programs to help drive these energy and sustainability benefits.

6.8 Top Three Opportunities from Lessor Provider Perspective

Innovative approaches to financing can help accelerate the adoption of intelligent building technologies and the energy efficient equipment retrofits that also support improvements in operations and comfort. Three specific opportunities for customers leveraging new financing models include:

- **Overcome capital budget constraints, timelines, and opportunity costs:** The intelligent buildings market continues to mature, but within customer organizations, a lack of understanding of the investment benefits remains. A battle for funding can be the result of this customer uncertainty. Therefore, lenders and financial partners that can eliminate the upfront capital burden can help champions move their intelligent buildings projects along faster and overcome pushback from competing corporate initiatives.
- **Utilize third-party expertise:** The convergence of IT and OT systems is the foundation of the intelligent building solution, and the pathway to deliver data-driven insights and facility improvements. However, the customer process for evaluating investment options can be complicated because the decision may require technical knowledge outside the core budget holder's domain. New partnerships between financiers and vendors can help customers overcome this barrier by offloading the specification and even management of the solutions.
- **Leverage creditworthiness today:** Even for those customers without capital budgets, there are significant opportunities to replace inefficient systems and integration automation, controls, and analytics to increase the value of buildings. Lenders can support market adoption with minimal risk by focusing on creditworthy customers such as those operating facilities for the public sector, institutional organizations, and higher education.

6.9 Top Three Risks from Lender Perspective

The building technologies market is relatively low risk from a lender's perspective beyond the standard concerns of customer creditworthiness. That said, here are three considerations lenders consider when exploring partnership opportunities with technology vendors to offer non-traditional financing such as a performance contract with a new or smaller scale ESCO or an as a service contract for a new technology project:

- Staying power of emerging technology providers can be a consideration for lenders when these vendors aim to install projects with more than 3-year payback periods.
- Viability of technology with longer finance terms in a market with relatively rapid evolution.
- The culpability of cybersecurity breaches is a new concern as smart building solutions emerge as key components of major technology upgrades.

6.10 Top Three Risks from Lessor Perspective

Customers are facing new options for financing intelligent building investments as vendors introduce as a service models and other options to reduce the CAPEX burden. The benefits of no-upfront cost retrofits are appealing, but there remain a few risks that are limiting mainstream market adoption such as:

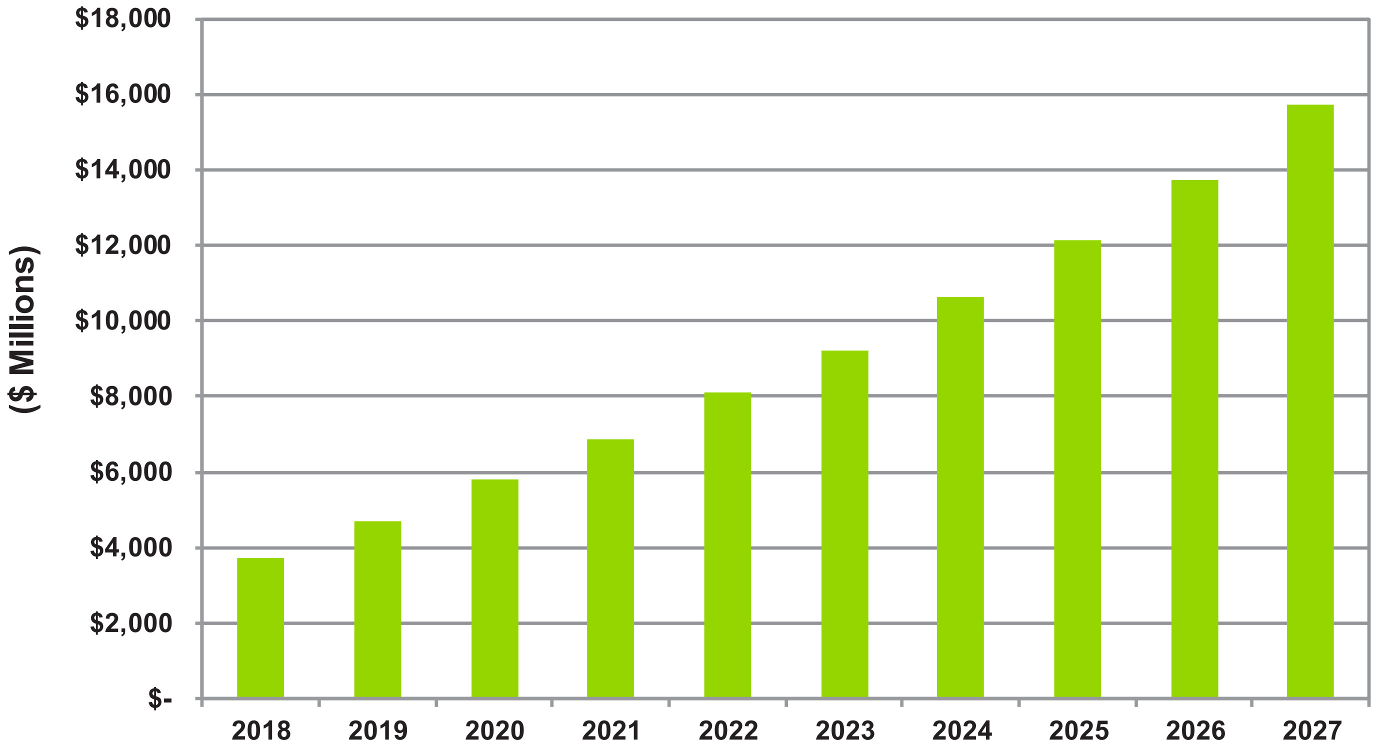
- **Estimating staying power** of vendors new to the building technologies market can be challenging. Innovation in data analytics and IoT is burgeoning with a vibrant startup community, but customers may struggle to determine the longevity of potential partners, which is an important question as they grapple with entering into multiyear contracts.
- **Lender thresholds for payback** based on creditworthiness assessment may limit financing for cap of 5-7 years, which can constrain menu of possible measures customers can deploy such as higher cost retrofits for core building systems such as HVAC and lighting.
- **Human capital limitations can threaten decision-making capabilities** as intelligent building solutions reflect a convergence in IT and OT systems. Traditional decision makers for facilities management struggle to navigate the information technology merits of solutions, traditional IT decision makers struggle to determine the value of different facilities management capabilities, and executives struggle to balance the financial return requirements and domain expertise of other traditional decision makers.

6.11 Market Size

Navigant Research presents an optimistic outlook on the intelligent buildings market over the forecast period of 2018-2027 as building owners, and managers respond to increasing demand for technology-enabled facility improvement.

Overall intelligent building solutions revenue in the US is expected to grow from approximately $3.7 billion in 2018 to $15.7 billion in 2027 at a CAGR of 17.4%, as shown in Chart 6-1.

Chart 6-1. Intelligent Buildings Market Forecast, US: 2018-2027



(Source: Navigant Research)

The forecast projects overall growth in hardware revenue as intelligent building technologies further penetrate the market. The growth in investment in edge devices is more significant than the growth in other hardware segments. This new hardware segment reflects the introduction of multipurpose devices with embedded communications, controls, and analytics capabilities.

Software trails in terms of total share of global intelligent buildings revenue due to the lower cost pricing models (including SaaS) that lead the market. Navigant Research estimates global revenue associated with three main applications to characterize a shift in the market toward the adoption of more sophisticated analytics. While offerings today may include all three types of applications, the forecast is intended to showcase how, over the forecast period, more sophisticated analytics—optimization applications—will gain market share as the leading use case.

Advisory services are key to growth of the intelligent buildings market. The human capital constraints underscore the need for domain-expert partners that can guide customers through the transition into intelligent buildings management. Navigant Research characterizes the service offerings to illustrate the momentum toward more advanced services as the hardware and software segments are presented. Over time, Navigant Research expects enterprise customers to rely more heavily on intelligent building partners for deeper advisory relationships, as illustrated by the shift in market share toward integrated energy and operational improvement over time.

6.12 Conclusion

The intelligent buildings market defines the digital transformation of commercial facilities. A combination of hardware, software, and services is driving a paradigm shift across the buildings industry. While the market has been growing since the emergence of BEMSs in the early to mid-2000s, market adoption is expanding today as technology industry trends become mainstream across the economy.

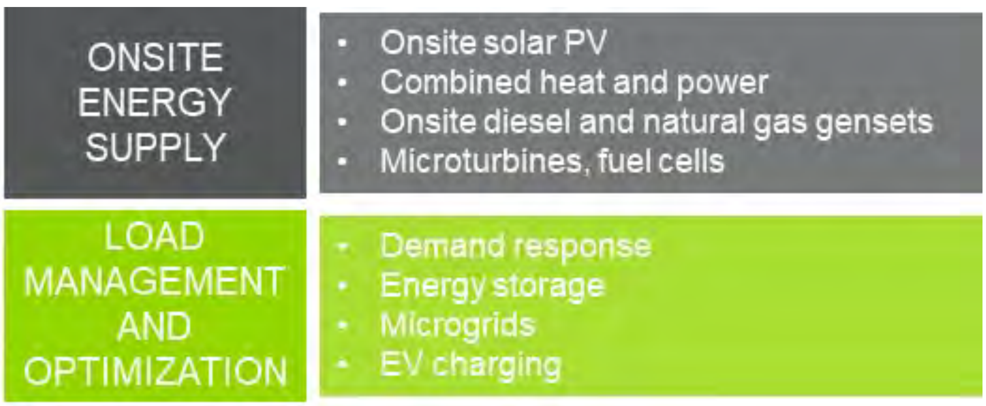
IoT has become a household term, and the commercial building industry is facing new pressure to adopt technology to improve occupant experience. The result is a new and universal upward pressure on building owners to invest in new technologies, regardless of the business operating within. As a result, there is healthy competition in the intelligent buildings market as incumbent players aim to deepen relationships with the largest building owners, startups aim to disrupt these industry giants' modes of operations, and service providers look to infuse technology into their engagements. In addition, new entrants from adjacent markets—notably cloud computing and professional services—are ramping up their presence.

Section 7
DISTRIBUTED ENERGY RESOURCES

7.1 Distributed Energy Resource Industry Definition

DER is defined as onsite supply and load management and optimization technologies shown in Figure 7-1. that are installed behind the utility meter on the C&I energy users' property. DER includes onsite distributed generation technologies such as solar PV, combined heat and power (CHP), microturbines, fuel cells, and natural gas and diesel-fired gensets, and load management and optimization technologies such as battery energy storage, microgrids, demand response (DR), and EV charging infrastructure.

Figure 7-1. DER Technologies



(Source: Navigant Research)

7.1.1 Introduction to DER Financing

The global electric power industry is facing a fundamental shift from centralized generation toward a mix of DER and smart grid solutions known as the Energy Cloud now poised to disrupt traditional utility models for C&I customers. C&I energy users will increasingly seek cost-effective, customized, and comprehensive energy solutions that can guarantee energy use reduction and savings without CAPEX or impact to their day-to-day operations.

Figure 7-2. C&I Customer Expectations

(Source: Navigant Research)

Specifically, C&I energy users will increasingly seek proven, investment-grade DER technology partners and balance sheet-backed project delivery vendors that can guarantee energy and cost savings through innovative DER financing offerings, which has been less common. Navigant Research anticipates the continued growth of DER project finance asset classes will be required that goes beyond standalone energy efficiency to support the need for deployment of customer-sited DER at C&I facilities without CAPEX.

While the Energy Cloud transformation and customer needs are combining to create the demand for new financed DER solutions, traditional energy project financiers are also facing new challenges. Combining both new demand for electrification and demand reduction associated with the growth of DER, Navigant Research anticipates that up to a 50% reduction in centralized generation demand by 2030 is possible. This trend is driving energy project finance investors to look beyond traditional fossil fuel-based coal and natural gas central generation and large-scale renewable energy project finance investment instruments into new DER solutions. However, the deployment of financed DER solutions will be undertaken across increasingly complex use case scenarios at standalone C&I facilities. This is new territory for most energy project financiers, and many are examining the risks associated with these types of investment for the first time.

Beyond the emergence of new DER solutions at standalone C&I facilities, the Energy Cloud transformation will also drive the emergence of new DER hardware/software platforms. These will allow customer-sited DER and other advanced applications such as virtual power plant (VPP) software technology to aggregate the benefits of customer-sited DER to optimize the local grid. This shift encourages distribution system operators to interact with DER solutions providers and C&I energy users through new channels:

- **Optimization of customer DER:** Distribution system operators will increasingly be asked to accommodate C&I customer demand for optimizing the use of their installed DER technology. Regulated utilities that do not provide customer solutions in-house or partner with outside vendors will be vulnerable to competition from third-party DER solutions providers.

- **Accessing ancillary services and capacity markets:** C&I energy users and DER solutions providers will increasingly look to distribution system operators and regulators for revenue opportunities for customer-sited DER beyond traditional utility DR programs in new ancillary services or capacity markets. Here too, third-party DER solutions providers can offer services to C&I energy users that regulated utilities may not have historically offered, such as aggregated bidding into flexible ancillary services and capacity markets.

- **Source wholesale power:** Some large C&I energy users in the US are moving away from their utility as a supplier altogether, with some deploying onsite supply, while in other cases paying exit fees and sourcing wholesale power from a utility-scale, offsite renewable energy project to reduce energy costs and procure more renewable energy.

7.1.2 Finance and Lease Structures

Building off the early successful efforts with ESCO performance contracting for energy efficiency and by DER solutions providers with solar PPAs, several classes DER transaction financing instruments have emerged. Table 7-1. summarizes the most common types of DER financing asset classes and financing examples available today.

Table 7-1. Overview of DER Project Finance Asset Classes

Financing Asset Class	DER Financing Solution Example
Equipment Leases/Loans	• Solar Equipment Lease or Loan • Distributed Generation Lease or Loan • Energy Storage System Lease • EV Charging Equipment Lease
Power Purchase Agreement (PPA)	• Solar PV PPA • Solar plus Energy Storage PPA • Microgrid PPA • Distributed Generation PPA • CHP PPA
Efficiency Savings Agreement	• Energy Storage Demand Charge Reduction Agreement
Shared Savings Agreement	• Energy Storage Demand Charge Savings Agreement • DR Capacity Market Agreement • DR Energy Storage Services Agreement • Property-assessed Clean Energy Bond Agreements

(Source: Navigant Research)

These four DER financing asset classes—equipment leases and loans, PPAs, efficiency savings agreements, and shared savings agreements—have been developed by DER project developers and financiers relative to the potential risks associated with the project risks and potential cash flows of the project deployments. These risks can be categorized as high, moderate, and low, as discussed below:

- **High risk:** High risk DER project finance instruments require a significant effort across manual project analytics and monitoring and verification (M&V), which created uncertainty for customer energy savings and cash flows. As integrated DER are deployed, these instruments will require increasingly complex pre-project analytics, operational control, optimization, and automated M&V to manage the investment's performance.

For high risk DER financing instruments, the ability of DER to be installed, operated, and optimized in tandem with each other as well as building load changes, tariff details, and weather variations to deliver energy savings will become critical and will be best addressed by an integrated DER-enabled intelligent building software platform to ensure customer savings.

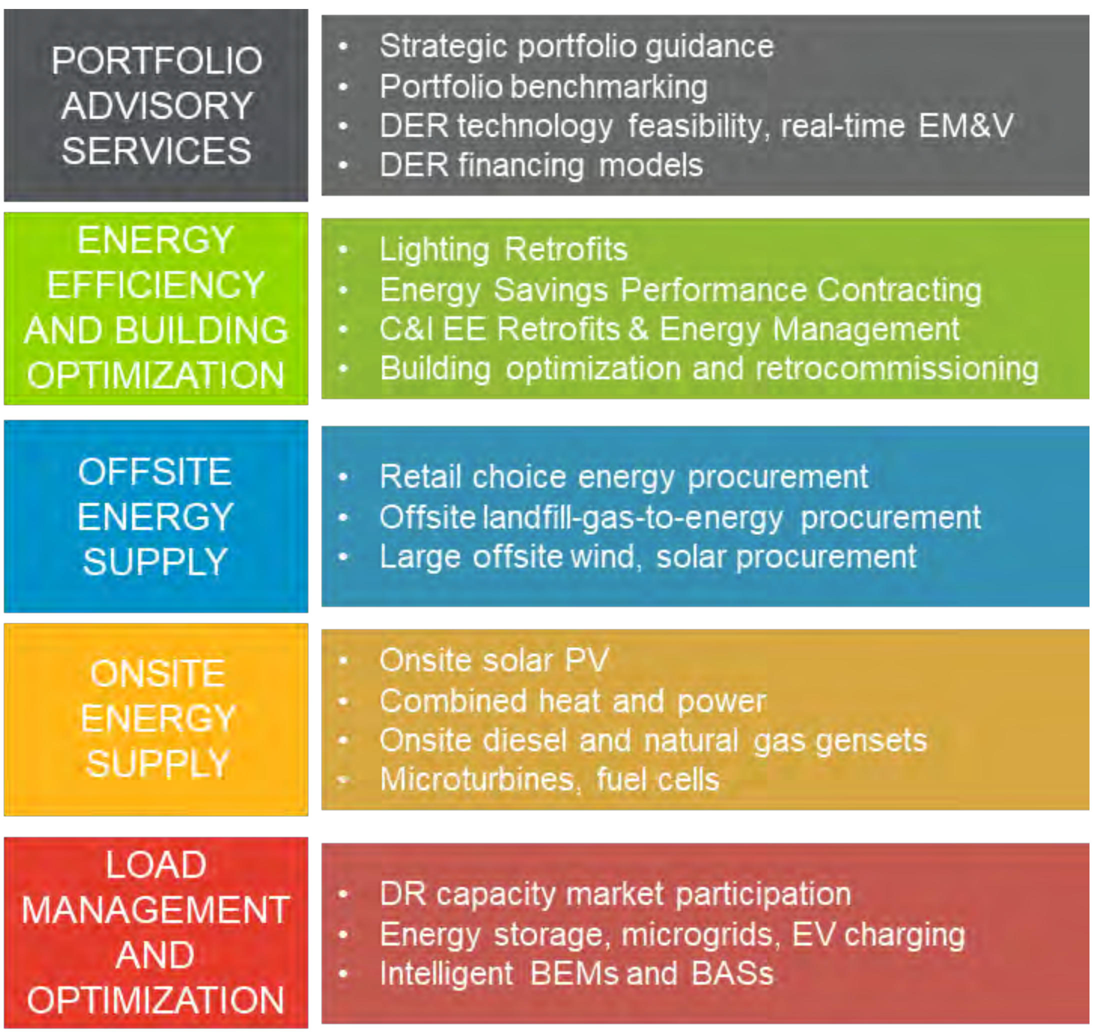
- **Moderate risk:** Moderate risk DER project finance instruments use proven pre-project analytics software and M&V to manage the investment. For moderate risk DER financing instruments, a single DER type is installed, such as solar PV under a PPA. But in this scenario, the ability of the solar PV power delivered to the facility and operated and optimized in tandem with other DER to deliver energy savings is typically managed outside the PPA performance.

In this scenario, the DER financier's risk management needs are addressed by a creditworthy payment for each kilowatt-hour of solar PV produced, and the customer's payback hurdle challenge is overcome. But the customer's need to have solar PV work with other DER, building load changes and tariff details to demonstrate energy savings will be challenged without support from an integrated DER-enabled intelligent building software platform to operate and optimize deployed DER.

- **Low risk:** With a low risk DER project finance instrument, customer credit is the primary risk. A low risk instrument does not require complex pre-project analytics or ongoing M&V to manage the investment. Rather, the DER equipment or technology is deployed by a vendor and payment is made on a routine periodic basis over the length of the contract. In this scenario, the DER project financier's risk management needs are met when the customer makes the payment, and the customer's payback hurdle challenge is overcome. As with a moderate risk investment, the need to have DER optimize building load changes and tariff details to demonstrate energy savings can at times be addressed without support from an integrated, DER-enabled intelligent building software platform to operate and optimize deployed DER.

Third-party solutions providers will increasingly need to deliver a full set of integrated financed DER solutions across larger portfolios of sites that include onsite energy supply and load management solutions, with the integration of energy efficiency, offsite energy supply, and intelligent buildings management capabilities as key enabling factors. The broader set of integrated solutions that vendors and DER financiers now need to consider as part of managed energy services offerings to customers is highlighted below:

Figure 7-3. New Integrated Energy Efficiency, Intelligent Buildings-based DER Solutions



(Source: Navigant Research)

Given this evolution, there will be increasingly complex interactions between building load and tariff-specific energy, demand, and time-of-use (TOU) charges and the operation of onsite energy supply, energy efficiency, and load management technology. This interaction will require increasingly sophisticated pre-project analytics, operational control, and optimization capabilities across intelligent building-enabled DER software platforms to support the growth of DER financing at standalone C&I facilities.

Beyond the emergence of new DER solutions at standalone C&I facilities, the Energy Cloud transformation will also drive the emergence of hardware/software platforms. These platforms will allow customer-sited DER and other advanced applications such as VPP software technology to aggregate the benefits of customer-sited DER to optimize the local grid. This shift will lead distribution system operators to interact with DER solutions providers and C&I energy users through new business models.

7.1.3 Industry Trends and Drivers

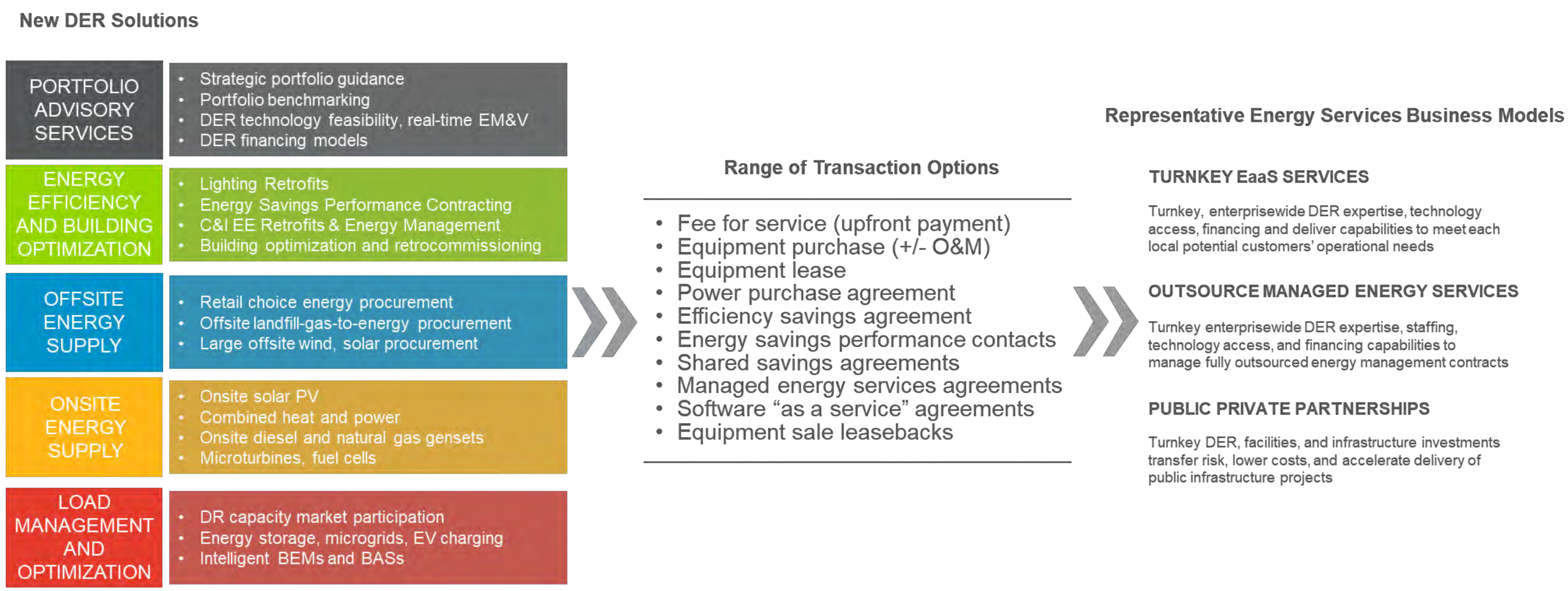
- **Technology:** Proven DER technology such as solar PV, fossil fuel-based distributed generation like diesel and nags gensets, CHP, microturbines, and fuel cells, energy storage, and microgrids continue to become more cost-effective. As many C&I energy user have already focused on energy efficiency, these customers are increasingly interested in portfolio-wide opportunities for broader energy and cost reduction opportunities, which requires a more sophisticated DER deployment approach that transcends standalone energy efficiency solutions.
- **Policy/Regulatory:** The rise in customer-sited DER is giving large C&I energy users new options for operational efficiency, resilient energy supply, and energy cost management. Some C&I energy users are even moving away from their utility as a wholesale electricity supplier altogether by paying exit fees and sourcing wholesale power from an offsite, utility-scale, offsite renewable energy project to reduce energy costs and procure more renewable energy.
- **Market:** The rise of customer-sited DER and new DER-focused transaction-based financing asset classes will give rise to new business models that will create new options for managed energy services, as shown in Figure 7-4.

7.1.4 Finance and Lease Structures

- **CAPEX to OPEX:** C&I energy users seek balance sheet-backed vendors that can guarantee energy and cost savings through innovative DER financing offerings. This need shifts the challenge to DER deployment away from CAPEX—generally less favorable from an accounting perspective—toward service contracts categorized as OPEX, which is more favorable accounting-wise.
- **Shift to DER:** Traditional energy sector project finance investors will increasingly look into new DER solutions to address the anticipated reduction in centralized generation demand driven by the Energy Cloud transformation. These new DER investors are now looking more closely at new DER financing classes and the risks and cash flow predictability of DER projects.
- **Software Unlocks Full DER Value:** More integrated, DER management systems and software platforms are demonstrating improved integrated analytics, operational control, and optimization capabilities for customer-sited DER. This type of software platform will be increasingly important to address DER finance risks and customer needs for integrated DER deployments when shared savings, or multiple financing instruments are deployed, with or without energy efficiency.

The Impact of New Energy Production Technologies

Figure 7-4. Integrated DER Financing Options Supporting Managed Service Business Models



(Source: Navigant Research)

- **Property Assessed Clean Energy (PACE) Bond Financing:** PACE financing is a popular and effective financing method for integrated energy efficiency upgrades and DER installations. In the first half of 2017, PACENation has documented PACE commercial financing totaling $400 million across 1,030 projects. PACE financing is based on repayment terms that are assessed to a property's normal tax bill. It is similar in financial structure to the way other public benefits, such as local sewer systems, have been financed for many decades.

  PACE programs have been used for commercial, nonprofit, and residential properties, and are implemented in two steps: by the establishment of a state PACE Bond law, and then the implementation of enabling legislation tax assessment level in municipalities, townships, or counties.

  The PACE model has faced considerable obstacles in the recent past, including the high-profile opposition of the residential lending giants Freddie Mac and Fannie Mae. The mortgage industry's main opposition to the PACE model is the first lien clause for the repayment of the energy project if the property falls into default. Lenders perceive the clause as a significant financial risk.

  The attractiveness of PACE financing hinges on these common characteristics:

  - PACE financing can cover 100% of a project's hard and soft costs.
  - PACE financings can be secured for long-term periods up to 20 years.
  - PACE can be combined with utility, local, and federal incentive programs.
  - Energy efficiency upgrades and DER solutions are permanently affixed to a property.
  - The PACE assessment is filed with the local municipality as a lien on the property.

7.2 Case Study/Project Highlights: Advanced Microgrids Solution

AMS was founded in 2013 and specializes in distributed energy resource fleet optimization and design, as well as wholesale energy market trading optimization for new and existing assets. Most recently AMS pioneered a software platform that allows others to design, optimize and transact energy assets in wholesale markets globally. This deep neural network optimization and trading platform is specifically designed to enable the real-time, optimized transaction of complex energy assets, including batteries, solar, wind, pumped hydro and distributed energy resources. Specifically, this platform provides access to a web-based market portal that provides:

- Real-time, price-elastic bid generation for complex energy assets.
- Stochastic co-optimization using probabilistic price forecasting for energy and financial products across asset classes and within portfolios.
- Location-specific nodal price forecast at sub-second frequency capturing real-time market dynamics and volatility.

When it comes to DER fleet optimization and design AMS has focused on developing large-scale, behind-the-meter energy storage projects in California and a handful of other states with 90 MW / 360 MWh under utility contract. AMS' initial turnkey energy storage solutions for C&I customers include access to its advanced software platform, a partnership with Macquarie to provide capital for the joint development, construction & financing of a $200 million fleet of storage projects, and a demand charge savings guarantee to host facilities.

The company first came to market when it won four DR energy storage agreements totaling 50 MW / 200 MWh with Southern California Edison (SCE) in 2014 in an all resource competitive solicitation for resources to fill in supply gaps due to the retirement of the San Onofre nuclear power plant. It was later awarded an additional 40 MW / 160 MWh across five 15-year PPAs. To date, AMS has interconnected a total of 20.5 MW/ 95 MWh of the SCE commitment as part of a Virtual Power Plant that provides 4-hour resource adequacy capacity to SCE under 10-year capacity contracts. In the past year alone AMS assets have been dispatched into the CAISO over 350 hours.

AMS' distributed energy resource platform combines advanced analytics with continuous optimization to deliver maximum financial performance from distributed energy resource portfolios across technologies from both retail and wholesale revenue streams. The platform provides:

- Revenue forecasting and portfolio design for maximum financial performance across distributed energy resource technologies - battery storage, solar PV, load control.
- Simultaneous co-optimization of customer savings and wholesale market revenues.
- Portfolio aggregation and dispatch with 24/7 performance monitoring including tariff schedules, market rules, event forecasting.

AMS operates by selling software as a service and by jointly owning the systems it installs with its financing partner at a customer's facility, with an agreement to provide a set level of demand charge savings for its customers in exchange for a recurring energy management fee.

Its clients include Southern California Edison, Walmart, Irvine Company, Morgan Stanley Real Estate Investment Trust, Kaiser Permanente, the California State University system, Irvine Ranch Water District and the Inland Empire Utilities Agency.

7.3 Top Three Opportunities from Lender Perspective

The Energy Cloud transformation toward DER and evolving customer needs will combine to create the demand for new financed DER solutions. The following top opportunities from the lender perspective are discussed below:

- Traditional energy sector project finance investors' move beyond traditional fossil fuel-based coal and natural gas central generation and large-scale renewable energy project finance investment instruments into new DER solutions will create new investment opportunities for a broad set of customer-sited financed DER solutions.
- Both traditional energy sector project finance investors moving into DER and current investors that are supporting financed customer-sited energy solutions will see growth in investment opportunities DER equipment lease, loan, and PPA asset class opportunities.
- Both traditional energy sector project finance investors moving into DER and current investors that are supporting financed customer-sited energy solutions should also closely track the emergence of newly integrated energy efficiency and DER asset class enabled by improved intelligent buildings technology and power market revenue opportunities.

7.4 Top Three Opportunities from Lessor Provider Perspective

The Energy Cloud transformation toward DER and evolving customer needs will combine to create the demand for new financed DER solutions. The following top opportunities from the lessor (C&I energy user) perspective are discussed below:

- C&I energy users and DER solutions providers are now being presented new opportunities to leverage DER technology and investor interest in new DER financing asset classes to meet needs for energy savings and sustainability without CAPEX expenditures. These types of integrated, financed DER solutions are now being commercialized for the first time.
- C&I energy users and DER solutions providers are also now facing an opportunity to move beyond just standalone energy efficiency projects that required short-term return-on-investment paybacks using CAPEX to be able to obtain deeper savings across integrated financed DER solutions.
- C&I energy users and DER solutions providers are also now facing an opportunity to capitalize on the emergence of new software capabilities across integrated financed energy efficiency and DER asset class to improve the ability of these integrated solutions to reduce energy savings with improved M&V.

7.5 Top Three Risks from Lender Perspective

As highlighted herein, the Energy Cloud transformation toward DER and evolving customer needs will combine to create the demand for new financed DER solutions. But many investors are looking at these risks for the first time. The following top risks from the lender perspective are discussed below:

- Many of the early successful DER financing instruments, such as solar PPAs, focused on string, creditworthy C&I energy users. To continue to grow these integrated DER asset classes, lenders will need to focus on underwriting approaches for the second wave of new customer targets that may not present the same credits risk as earlier movers and adopters of DER financings.
- As the growth of these new DER financing asset classes has emerged, standardized contracts for leases, loans, and even PPAs are in the early stages. Lenders will need to focus on standardization of DER contract terms over time to better manage risks and reduce transaction costs.
- Several of the DER financing asset classes are in the early stages of development. Lenders to date that have moved into these investments have minimized risks to the investment partners while leaving many of the performance risks with the vendors or customers. As the growth of these new DER financing asset classes begins to mature, lenders will need to ensure that end customers are comfortable with the ability of vendors and software platforms to deliver savings to ensure these DER financing asset classes can scale.

7.6 Top Three Risks from Lessor Perspective

The Energy Cloud transformation toward DER and evolving customer needs will combine to create the demand for new financed DER solutions. But many C&I energy users are looking at the risks of deploying these integrated solutions for the first time. The following top risks from the lessor (C&I energy user) perspective are discussed below:

- **Interoperability Challenges:** Deployment of new integrated DER like solar PV plus energy storage coupled with DR and other DER is still in the early stages. It will take time to develop effective IoT, metering, sub-metering, and hardware and software technology solutions that can interact with building loads, DER, and DER-enabled software platforms to ensure customer energy savings.
- **Complexity:** Creating solutions that can address the full variety of DER types and deployment scenarios is complex. For example, integrating energy efficiency upgrades into a multi-DER deployment scenario with onsite supply, energy storage to ensure energy savings are difficult to address across a single platform, and local grid power market participation adds to this complexity.
- **Financing Limitations:** While many C&I energy users are increasingly willing to consider DER financing solutions, many are hesitant to sign long-term agreements necessary to make financing instruments financially viable. And even if C&I energy users overcome these barriers, they often express concerns that the cost of capital for DER solutions financing is higher than their own internal cost of capital. This paradox can further hinder deployments.

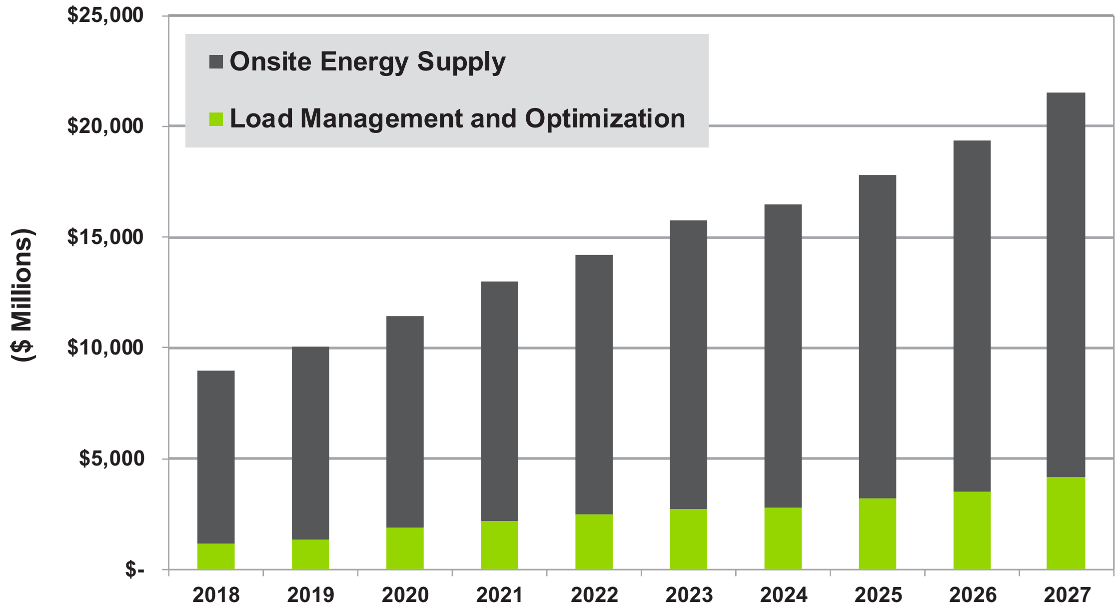
7.7 Market Size

The following market sizing describes the core financed DER solutions that C&I EaaS providers are bringing to the market to meet customer needs, excluding energy efficiency and intelligent buildings solutions discussed in Section 3. As highlighted herein, the financed delivery of these DER solutions to overcome simple payback hurdles that large C&I customers face. The core financed DER solutions applications discussed in this forecast include:

- **Onsite Energy Supply:** A comprehensive suite of activities and technology to deploy generating assets at customer's facilities to improve resilience and decrease costs, including:
  - o Distributed solar PV
  - o CHP
  - o Diesel and natural gas generator sets (reciprocating gensets)
  - o Microturbines: Smaller (sub-MW) turbine generators that convert high-speed rotation into electrical energy
  - o Fuel cells: Electrochemical devices that extract electrical energy from fuels without the use of combustion
- **Load Management and Optimization:** End-to-end energy management solutions that integrate software-based load management and predictive analysis technology to optimize supply and demand at a single site as well as an enterprise-wide level, including:
  - o DR services
  - o Distributed Energy Storage
  - o Microgrid Controls
  - o EV Charging Equipment

Chart 7-1. shows the North American revenue forecast for these DER solutions, which represented a combined annual market of $8.9 billion in 2018 and is forecast to reach $21.5 billion in 2027, representing an 10.2% CAGR. The largest EaaS solution category in 2018 was the onsite supply segment, with $7.7 billion in annual revenue, which is forecast to grow to $17.3 billion by 2027 (9.3% CAGR).

Chart 7-1. Annual Financed DER Revenue by Application, North America: 2018-2027



(Source: Navigant Research)

7.8 Conclusion

- C&I energy users seek balance sheet-backed vendors that can guarantee energy and cost savings through innovative DER financing offerings. This need shifts the challenge to DER deployment away from CAPEX—less favorable from an accounting perspective—and toward service contracts categorized as OPEX, which are more favorable.
- The need for DER solutions providers to deploy these financed solutions across increasingly complex use case scenarios at standalone C&I facilities and to optimize the local grid will increase.
- Traditional energy sector project finance investors will increasingly look beyond traditional fossil fuel-based coal and natural gas central generation and large-scale renewable energy project finance investment instruments into new DER solutions to address the anticipated reduction in centralized generation demand driven by the Energy Cloud transformation. These new DER investors are looking more closely at the risks and cash flow predictability of DER projects.
- It is possible to address DER project finance risks for individual finance instrument classes like PPAs, leases, or loans when they are deployed as part of an individual DER solution. These same individual finance instruments can help overcome customer payback risks for C&I customers looking to reduce energy spend and costs when they are deployed as part of an individual DER solution.
- To address DER finance risks and customer needs for integrated DER deployment for a high-risk investment such as a shared savings agreement or multiple low or moderate risk DER financing instruments with or without energy efficiency, a more integrated, DER-enabled intelligent buildings-based software platform will be increasingly important.

Section 8
CONCLUSION

8.1 Summary of Key Findings

Disruption in the energy system is shifting the emphasis from centralized fossil power generation to renewable energy, with increasing emphasis on DER. As states achieve their renewable energy targets, utilities will seek to smooth intermittency with a combination of natural gas and renewables increasingly with energy storage integrated. As federal and state incentives ramp down in the next five years, and corporate renewable energy procurement increases, costs will continue to drop, opening further opportunities for a growing number of software-enabled demand side "as a service" solutions to be deeply integrated into intelligent buildings. Increased corporate involvement in procuring clean energy while also aligning strategic business and sustainability goals will continue to accelerate in the near-term. This transformation, already well underway in the US, represents a significant opportunity for investors, financiers, equipment vendors, and solutions providers. The following conclusions are summarized by industry.

8.2 Utility-Scale Solar PV

- The financing of utility-scale solar has reached a plateau, in which project risks under the current regulatory environment are well-understood, and a consensus on best practice has been reached. In the medium term, when the ITC expires, the industry will need to evolve its financing structures as they currently are designed to capture as much value from tax equity as possible.
- Another trend that will become more prevalent in the future is the exposure of projects to different types of off-take risks, moving away from full-tenure utility PPAs to a mix of utility, commercial and residential off-takers and some exposure to wholesale prices.
- Anticipated increases in interest rates and lower federal and state incentives will be mitigated by technology and process improvements that will reduce the CAPEX needed to finance projects, allowing the industry to grow over the next decade.

8.3 Utility-Scale Wind

- During the last decade, the wind power industry has become a dominant, mature, and cost-effective central power generation source. Cost for utility-scale wind power plants has fallen by more than 66% in the last seven years making wind the cheapest source of electricity in windy areas of the US including the vast central corridor spanning south from Texas up through most of the Midwest.
- Much of the risk involved in wind project finance has been managed out of the full project value chain through experience, evolving best practices and technology innovation.
- Since the wind energy market in the US is currently sustained largely through tax credits (the PTC), the majority of wind projects are majority owned by tax equity investors, usually large financial

institutions that have the significant tax burdens needed to take advantage of tax credits. Most wind plant developers and owner/operators do not have enough tax liability to fully utilize the PTC, so a tax equity partnership is created, usually through a partnership flip (described in more detail in Section 2.12 and the Appendix).

- While most of the growth is expected to come from traditional utility-sourced PPA solicitations and agreements, large corporate PPAs between wind projects and C&I off-takers (energy purchasers) will continue to see significant growth.

8.4 Energy Storage

- Utility-scale energy storage is emerging as a project finance opportunity to allow for the grid integration of intermittent renewable energy technologies and to take advantage of evolving FERC power market rules that can use energy storages' flexible capabilities.

- Traditional energy sector project finance investors will increasingly look beyond traditional fossil fuel-based coal and natural gas central generation and large-scale renewable energy project finance investment instruments into new energy storage solutions to take advantage of energy storages' unique flexible capabilities.

- Utility-scale energy storage software platforms can now demonstrate improved integrated analytics, operational control, and optimization capabilities for utility-scale energy storage deployments. This evolution will help reduce financial risks for investors and asset owners.

- To address the financial risks associated with utility-scale energy storage, independent power producers, energy project investors, energy storage systems integrators, and policymakers need to work together to develop power market participation rules. This cooperation will be particularly important to allow for energy storage to take advantage of its unique flexibility by providing multiple revenue-generating applications.

8.5 Intelligent Buildings

- The intelligent buildings market defines the digital transformation of commercial facilities. A combination of hardware, software, and services is driving a paradigm shift across the buildings industry. While the market has been growing since the emergence of BEMSs in the early to mid-2000s, market adoption is expanding today as technology industry trends become mainstream across the economy.

- IoT has become a household term, and the commercial building industry is facing new pressure to adopt technology to improve occupant experience. The result is a new and universal upward pressure on building owners to invest in new technologies, regardless of the business operating within. As a result, there is healthy competition in the intelligent buildings market as incumbent players aim to deepen relationships with the largest building owners, startups aim to disrupt these industry giants' modes of operations, and service providers look to infuse technology into their engagements. In addition, new entrants from adjacent markets—notably cloud computing and professional services—are ramping up their presence.

8.6 DER

- C&I energy users seek balance sheet-backed vendors that can guarantee energy and cost savings through innovative DER financing offerings. This need shifts the challenge to DER deployment away from CAPEX—less favorable from an accounting perspective—and toward service contracts categorized as OPEX, which are more favorable.

- DER solutions providers are being asked to deploy these financed solutions across increasingly complex use case scenarios at standalone C&I facilities and to optimize the local grid will increase.

- Traditional energy sector project finance investors will increasingly look beyond traditional fossil fuel-based coal and natural gas central generation and large-scale renewable energy project finance investment instruments into new DER solutions to address the anticipated reduction in centralized generation demand driven by the Energy Cloud transformation. These new DER investors are looking more closely at the risks and cash flow predictability of DER projects.

- It is possible to address DER project finance risks for individual finance instrument classes like PPAs, leases, or loans when they are deployed as part of an individual DER solution. These same individual finance instruments can help overcome customer payback risks for C&I customers looking to reduce energy spend and costs when they are deployed as part of an individual DER solution.

Section 9

APPENDIX

9.1 Utility Solar

9.1.1 Yieldcos

The idea behind Yieldcos is not new. It involves the creation of a company with the purpose to buy and retain operational infrastructure projects and pass the majority of cash flows from those assets to investors in the form of dividends. Structurally, Yieldcos are similar to Real Estate Investment Trusts. They are also almost ideal for renewable energy projects, such as solar and wind projects.

A crucial aspect of Yieldcos is that they are not exposed to development or construction risk—this is borne either by the parent company or a third-party developer. They simply acquire infrastructure projects that are or have recently become operational. They fund the acquisitions by issuing shares (normally debt is only used at the project level), which they can do at a lower cost of capital (the return on the investment that shareholders want to invest in the company) than their parent companies or developers because they are shielded from development and construction risks.

Another key aspect of Yieldcos is that their assets must be using a business model of producing fairly predictable cash flows which can be paid to shareholders as dividends. That is why renewable energy projects, such as wind farms, are perfectly suited for them. Wind farms and solar power projects are not significantly exposed to changes in the market. On their upstream, they depend on a free resource—wind and light—while on the downstream they are protected by regulations (feed-in tariffs, long-term PPAs, RPS, and so on).

For developers, Yieldcos offer a quick way to sell maturing assets and reuse their money into early-stage developments that can give them better returns on their investment. From an investor point of view, Yieldcos offer an investment option with little risk left—which is a testament to how far the investor's understanding of wind and solar technologies has come.

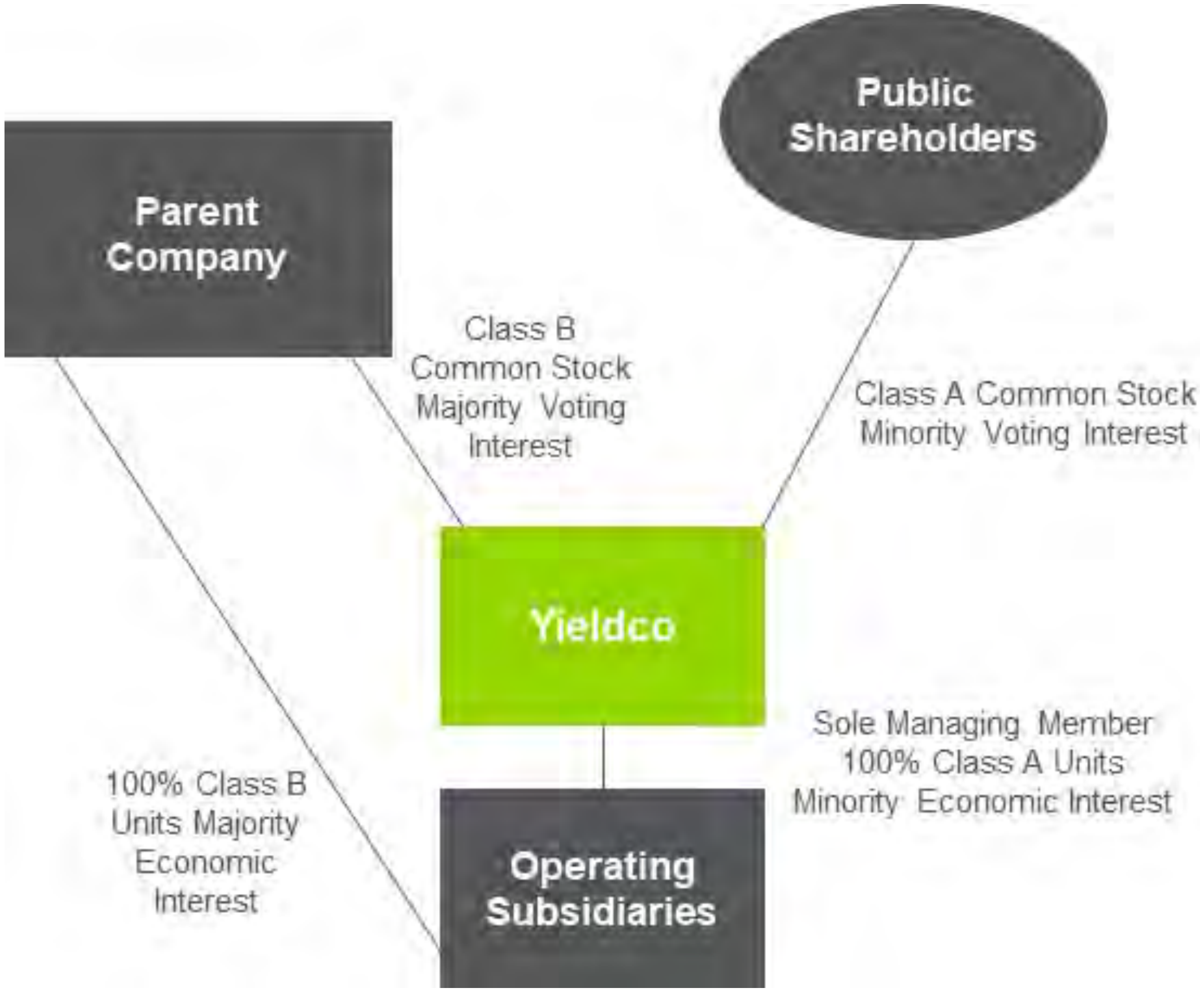
9.1.2 Back Leverage

Also referred to as a Holdco loan or mezzanine financing, a transaction in which a project sponsor or a project developer finances all or a portion of its equity contribution in the project company or holding company with third-party loans. To secure its obligations under this loan agreement, the sponsor pledges to its lenders:

- Its equity interest in the project company or the holding company that owns the project company.
- Its right to receive any distributions or other payments from the project company or the holding company, as applicable.

A back leveraged transaction allows the sponsor to access cheaper capital. Sponsor equity is typically the most expensive source of capital available to developers. Being able to finance the sponsor's contribution to the project is an effective way to secure a cheaper source of financing and lower the project's overall cost of capital.

Figure 9-1. Back Lease Structure

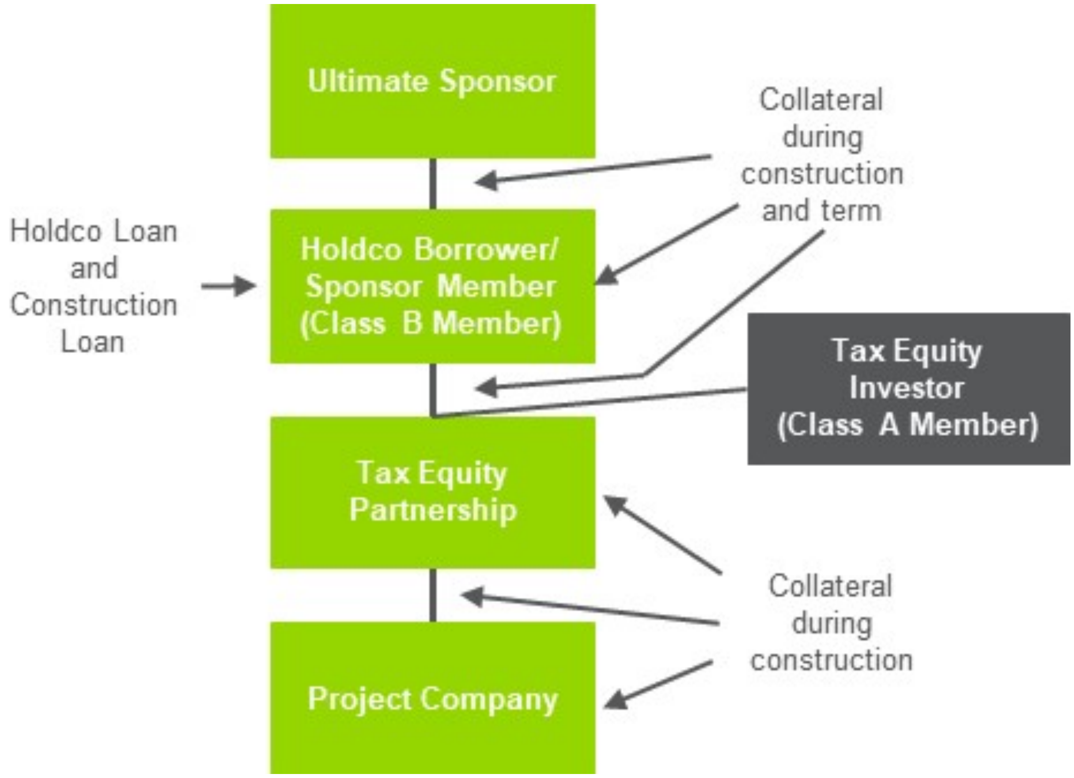


(Source: Navigant Research, National Renewable Energy Laboratory)

In a back leveraged transaction, the sponsors' lenders are structurally subordinated to the project company's lenders to ensure that lenders do not foreclose the project. This is a concession to tax equity investors.

If distributions to the sponsor are suspended for any reason, the sponsor may not have the cash necessary to meet its obligations under the loan. To address this issue, the sponsors' lenders try to negotiate provisions that allow them greater repayment certainty, including limited guaranteed distributions to amortize their loans, but that is not always possible and limited recourse to the sponsor.

Figure 9-2. Back Lease Structure



(Source: Navigant, James M. Berger, Norton Rose Fullbright[5])

9.2 Wind

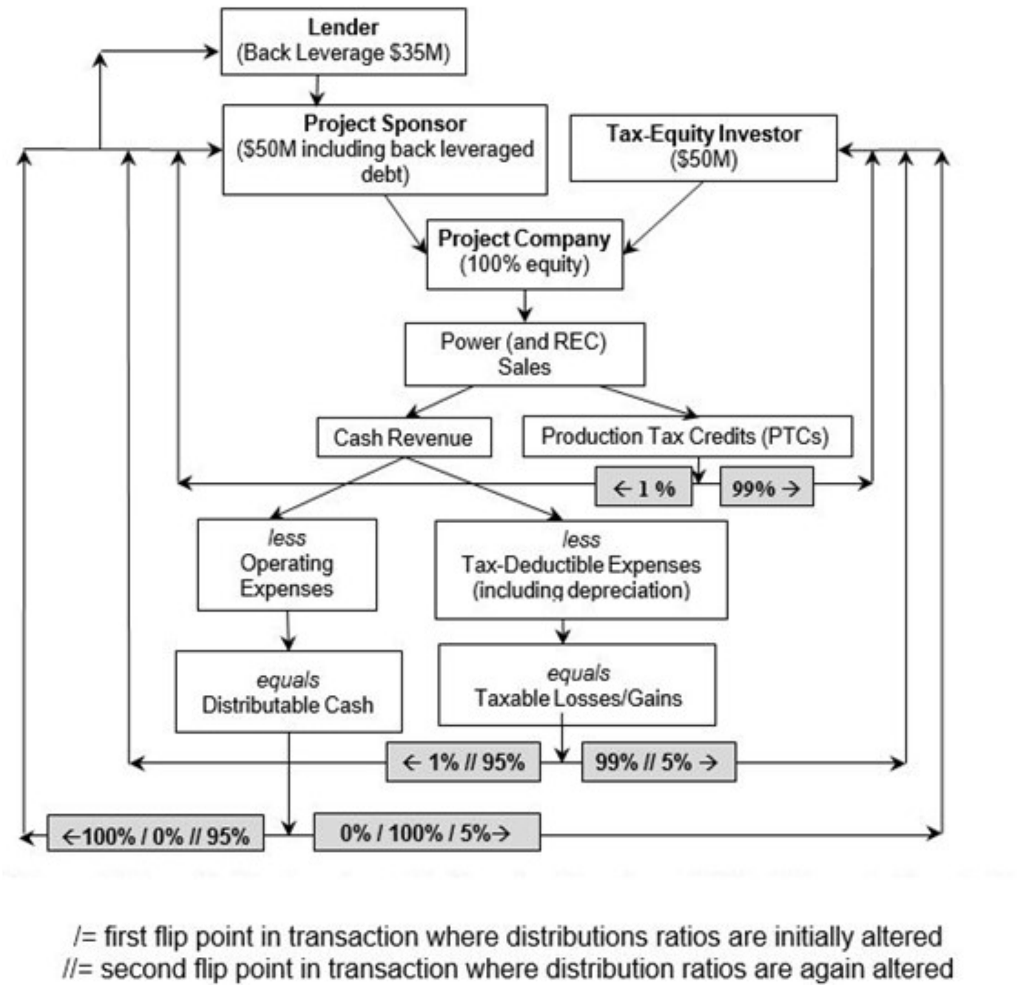
9.2.1 Partnership Flip

Most wind power plants built in the US are structured as a partnership flip. This allows a tax equity investor to own around 99% of a wind project during the 10-year PTC period (plus other tax benefits such as accelerated depreciation). The developer retains a minority equity stake, usually around 1%, operates the project, conducts O&M, and receives remuneration at various stages in the project life cycle. The reason for this structure is that most developers—even the large ones—do not have the annual tax liabilities to fully monetize all the tax credits. Many large financial institutions such as banks, private equity, insurance companies, and others do have large tax burdens and actively seek out tax mitigation strategies. Wind plants are a low risk option to reduce the tax burden. Therefore, the wind market has evolved with this partnership flip as a symbiotic financial arrangement between wind plant developers, wind plant owners, and the tax equity community. The diagram below courtesy of NREL's 2017 wind finance report depicts a hypothetical partnership flip structure for a $100 million wind project, and the following bullet points explain the stages of this structure:

- The wind plant developer (project sponsor) and a tax equity investor both contribute the upfront capital to finance the wind project. Project sponsor typically uses back-leverage debt to remove some debt from the project-level company.

- The two project-level sources of income or economic benefits are the distributable cash and tax-related benefits. The distributable cash is from sales revenue of electricity, any environmental revenue such as Renewable Energy Credits. Distributable cash is net after OPEX. The tax benefits are in the form of the PTC and accelerated tax depreciation (MACRS).
- Sponsor equity typically receives all or most of the project-level cash for a predetermined period while tax equity investor receives the majority of the tax benefits (PTC and MACRS).
- After a predetermined amount of time or until a financial return target is reached, the project equity ownership positions will flip, and the cash and tax benefits will shift to a second phase with different allocations of cash and tax benefits. This secondary post-flip phase will continue until the tax equity investor reaches a predetermined target rate of return. This is generally designed to end around the expiration of the 10-year PTC period.
- The project will then flip a second and final time to where the tax equity investor owns around 1% minority stake, and the project sponsor around 99% and the majority of project-level cash goes to the project sponsor once there are little to no tax benefits remaining.

Figure 9-3. Hypothetical Partnership Flip Structure for a $100 Million Wind Project



Source: Schwabe, Paul, Davide Feldman, Jason Fields, and Edward Settle. Wind Energy Finance in the United States, Current Practice and Opportunities. 2017. National Renewable Energy Laboratory (hereafter NREL Wind Finance 2017)

9.3 Storage

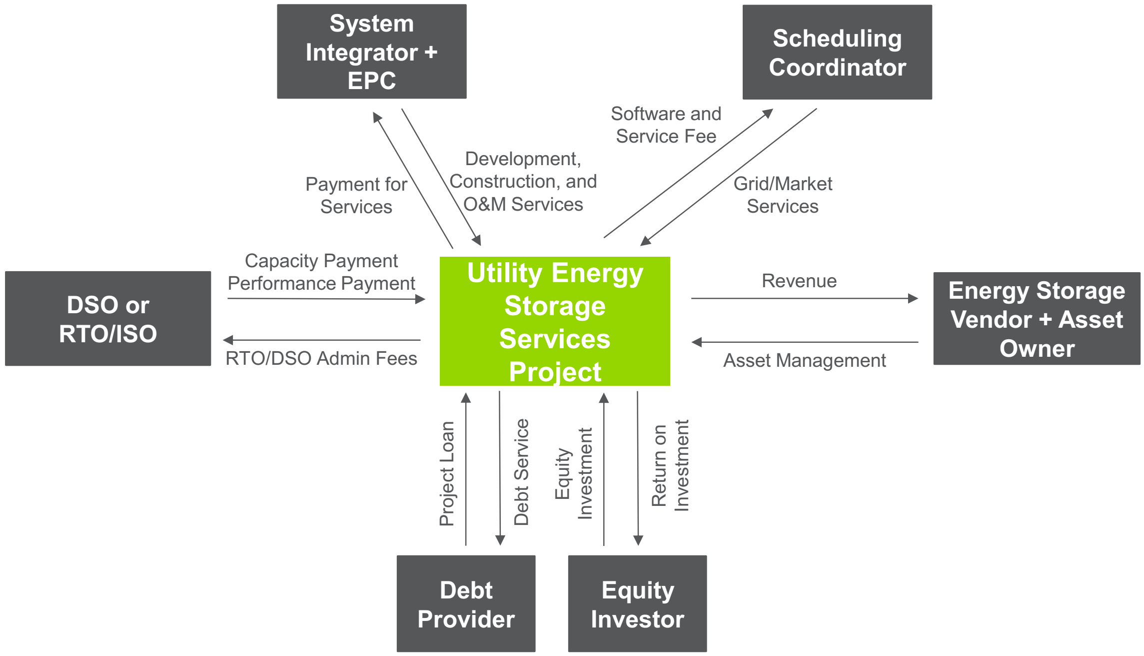
9.3.1 UESSA

A UESSA is executed in a regulated market where the local utility contracts with a third-party vendor to provide energy storage services. A BESS under a UESSA is compensated for meeting grid requirements for capacity availability should the utility anticipate the need for energy storage services and the actual energy storage services provided. These BESSs have capacity injection rights and charge and discharge from and to the grid while injecting power similar to a power purchase tolling agreement for conventional power. The third-party vendor will design, integrate, develop, permit, install, interconnect, finance, own, and maintain the BESS on behalf of the local utility. The local utility may or may not serve as the project's scheduling coordinator.

Key project performance requirements for UESSA financing include:

- A reliable battery pack and battery management system backed by a creditworthy battery supplier that can back the battery performance guarantee/warranty.
- Software that can evaluate utility use case scenarios and their impact on long-term battery condition to determine project financial performance.
- Software that can allow for system visibility and control by the local utility.
- Software system that can track real-time local utility capacity and performance signals and pricing.
- Ability to meet contractual capacity and performance charges based on system availability capacity and BESS round-trip efficiency targets.
- Predictability of capacity and performance payments from the local utility.

Figure 9-4. UESSA Project Costs and Revenue



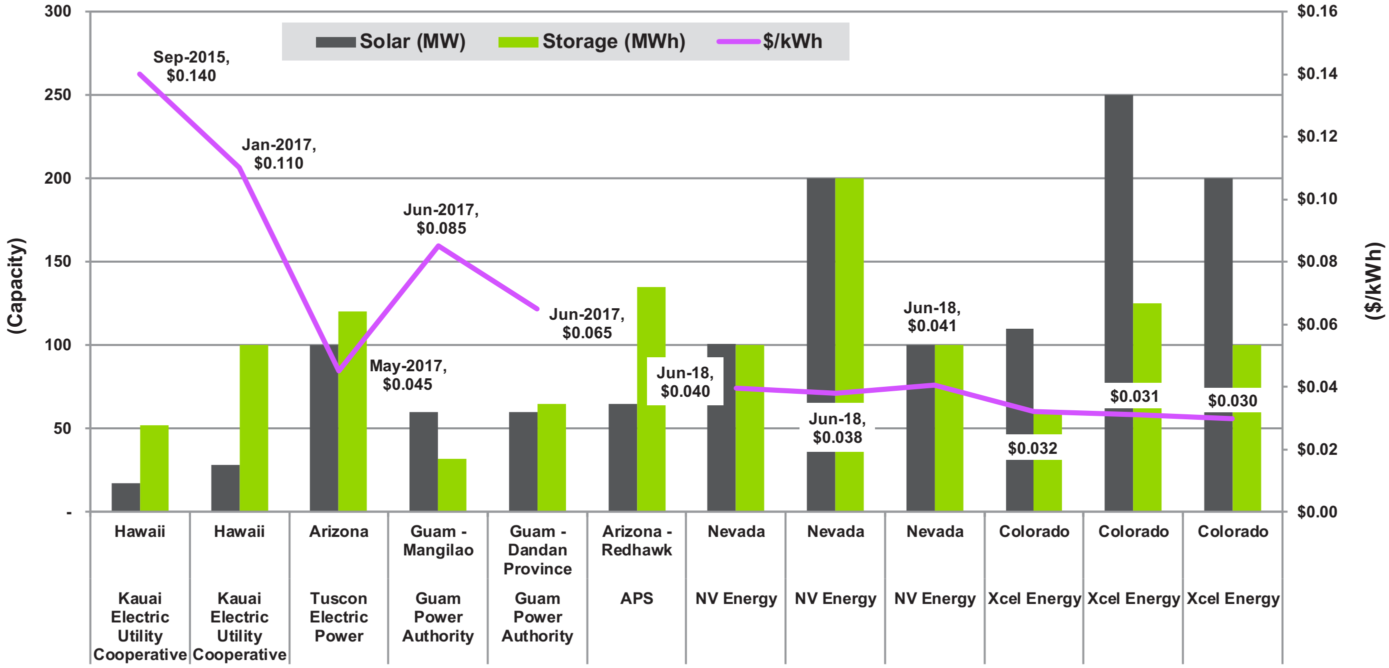
(Source: Navigant Research)

9.3.2 Utility Solar plus Energy Storage PPA

A utility solar plus energy storage capacity PPA mimics the contractual approach employed by solar PV developers to finance solar. In this case, however, the instrument is generally deployed in vertically regulated power markets where the utility makes a payment on a per-kilowatt-hour basis for firmed and smoothed dispatchable solar power provided to the grid by the project either during daytime or evening peak use periods. The utility typically engages with third-party solar storage plus storage vendor to design, integrate, install, finance, own, and operate the integrated solar PV and BESS system, which is interconnected on the local transmission and/or distribution grid. The business case for utility solar plus energy storage PPAs focuses on grid systems with strong solar intensity and high wholesale electricity prices during daytime or evening peak periods.

Pricing for utility solar plus energy storage PPAs has fallen dramatically in the past three years. This decrease has triggered a wave of new projects being announced in the US. Chart 9-1. tracks pricing for large-scale utility PPAs for solar plus energy storage projects from September 2015 to June 2018. While this does not show all utility solar plus storage PPAs, these projects are noteworthy for breaking records in terms of either price or project size.

Chart 9-1. Utility Solar plus Energy Storage Project PPA Prices: 2015-2018



(Source: Navigant Research)

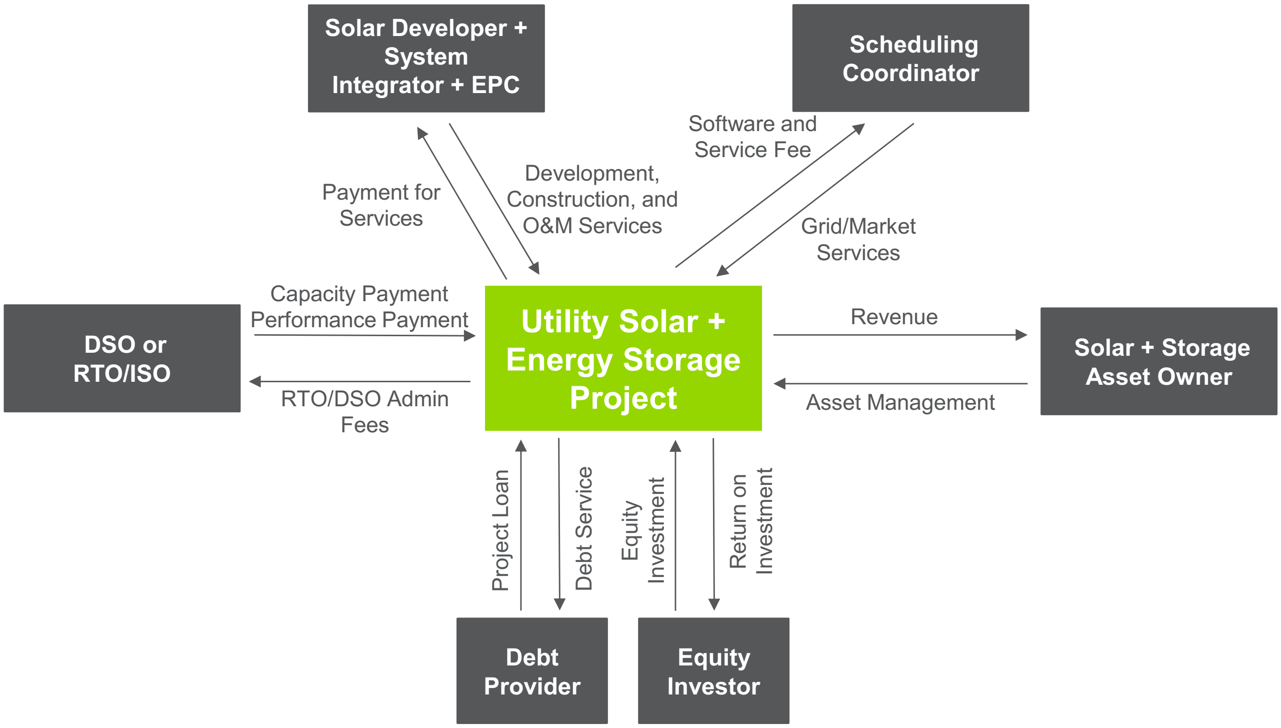
With a utility solar plus energy storage PPAs, the solar plus storage vendor provides access to a comprehensive software platform that integrates solar PV production with the BESS and the local power market dispatch requirements.

Key project performance requirements for utility solar plus energy storage PPA financing include:

- A reliable battery pack and battery management system supported by a creditworthy battery supplier that can back the battery performance guarantee/warranty.

- For projects in the US, the ability for the solar plus energy storage installation to take advantage of the 30% ITC under Section 48 of the IRS tax code.
- Software that can evaluate utility use cases and their impact on long-term battery condition to determine project financial performance.
- Software that can integrate solar PV production with the BESS and PPA requirements to ensure the project is optimized financially.

Figure 9-5. Utility Solar plus Energy Storage PPA Project Costs and Revenue



(Source: Navigant Research)

9.3.3 MESSAs

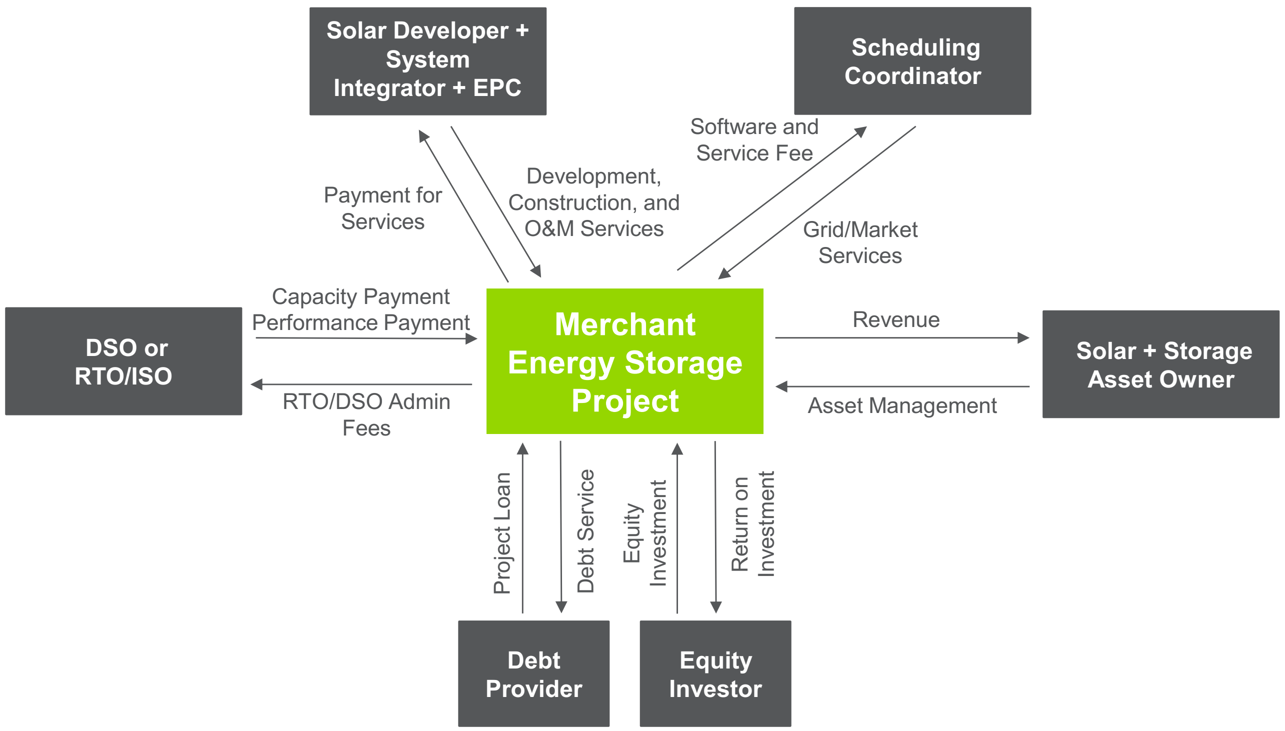
Driving MESSAs are RTO/ISO programs that created energy storage power market rules in wholesale markets to allow independent power producers with energy storage capabilities to design, integrate, install, finance, own, and operate the BESS on the local transmission and/or distribution grid. The business case for MESSAs has focused primarily on fast frequency response ancillary services projects in wholesale power markets like PJM in the US, where the power market price for slower responding energy storage assets or generation balancing services can create favorable energy storage compensation pricing. Like other merchant power projects, revenue for these projects is less predictable and subject to changes in power market prices, local power market rules, or dispatch requirements.

Key project performance risks for merchant energy storage financing include:

- A reliable battery pack and battery management system backed by a creditworthy battery supplier that can back the battery performance guarantee/warranty.

- Software that integrates predicted battery use case scenarios with mid- to long-term power market pricing forecasts for energy storage services to optimize projects financially.
- Software that can track and anticipate mid- to long-term battery life cycle limitations and warranty implications based on current and future use case scenarios.
- Access to a balance sheet-backed energy trading entity that can mitigate the merchant revenue risk inherent in these types of energy storage projects.

Figure 9-6. MESSA Project Costs and Revenue



(Source: Navigant Research)

Section 10
ACRONYM AND ABBREVIATION LIST

AMS	Advanced Microgrids Solutions
BEAT	Base Erosion Anti-Abuse Tax
BEMS	Building Energy Management Systems
BESS	Battery Energy Storage Solutions
BTM	Behind-the-Meter
C&I	Commercial and Industrial
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CEC	Clean Energy Collective
CHP	Combined Heat and Power
DER	Distributed Energy Resources
DR	Demand Response
EaaS	Energy as a Service
ESCO	Energy Service Company
ESPC	Energy Savings Performance Contracting
ESS	Energy Storage System
EV	Electric Vehicle
FERC	Federal Energy Regulatory Commission
FTM	Front-of-the-Meter
GHG	Greenhouse Gas
GW	Gigawatt
HVAC	Heating, Ventilation, and Air Conditioning
IoT	Internet of Things
IRS	Internal Revenue Service (United States)

ISO ....Independent System Operator

IT..Information Technology

ITC ....Investment Tax Credit

KIUC..Kauai Island Utility Cooperative

kWh ....Kilowatt-Hour

Li-ion...Lithium Ion

M&V ....Measurement and Verification

MACRS..Modified Accelerated Cost-Recovery System

MESSA ....Merchant Energy Storage Services Agreement

MW..Megawatt

MWh..Megawatt-Hour

NREL ....National Renewable Energy Laboratory

O&M ....Operations and Maintenance

OEM...Original Equipment Manufacturer

OPEX ....Operating Expenditure

OT ....Operational Technology

PTC ....Production Tax Credit

PV ....Photovoltaic

R&D ....Research and Development

RPS...Renewable Portfolio Standard

RTO ....Regional Transmission Organization

SaaS ....Software as a Service

T&D ....Transmission and Distribution

TOU ....Time-of-Use

US ....United States

VPP ....Virtual Power Plant

Section 11
TABLE OF CHARTS AND FIGURES

Section 12
SOURCES AND METHODOLOGY

Navigant Research's industry analysts utilize a variety of research sources in preparing Research Reports. The key component of Navigant Research's analysis is primary research gained from phone and in-person interviews with industry leaders including executives, engineers, and marketing professionals. Analysts are diligent in ensuring that they speak with representatives from every part of the value chain, including but not limited to technology companies, utilities and other service providers, industry associations, government agencies, and the investment community.

Additional analysis includes secondary research conducted by Navigant Research's analysts and its staff of research assistants. Where applicable, all secondary research sources are appropriately cited within this report.

These primary and secondary research sources, combined with the analyst's industry expertise, are synthesized into the qualitative and quantitative analysis presented in Navigant Research's reports. Great care is taken in making sure that all analysis is well-supported by facts, but where the facts are unknown, and assumptions must be made, analysts document their assumptions and are prepared to explain their methodology, both within the body of a report and in direct conversations with clients.

Navigant Research is a market research group whose goal is to present an objective, unbiased view of market opportunities within its coverage areas. Navigant Research is not beholden to any special interests and is thus able to offer clear, actionable advice to help clients succeed in the industry, unfettered by technology hype, political agendas, or emotional factors that are inherent in cleantech markets.

NOTES

CAGR refers to compound average annual growth rate, using the formula:

CAGR = (End Year Value ÷ Start Year Value)(1/steps) – 1.

CAGRs presented in the tables are for the entire timeframe in the title. Where data for fewer years are given, the CAGR is for the range presented. Where relevant, CAGRs for shorter timeframes may be given as well. Figures are based on the best estimates available at the time of calculation. Annual revenues, shipments, and sales are based on end-of-year figures unless otherwise noted. All values are expressed in year 2018 US dollars unless otherwise noted. Percentages may not add up to 100 due to rounding.

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ABOUT THE RESEARCHER

NAVIGANT RESEARCH

Navigant Research is a market research and advisory team that provides in-depth analysis of clean, intelligent, mobile, and distributed energy. The team's research methodology combines supply-side industry analysis, end-user primary research, and demand assessment, and deep examination of technology trends to provide a comprehensive view of these industry sectors.

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ENDNOTES

[1] World Wildlife Fund, Calvert Investments, CDP, and Ceres, *Power Forward 3.0: How the Largest U.S. Companies Are Capturing Business Value while Addressing Climate Change*, April 2017.

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[3] Schwabe, Paul, Davide Feldman, Jason Fields, and Edward Settle. *Wind Energy Finance in the United States, Current Practice and Opportunities.* 2017. National Renewable Energy Laboratory (hereafter NREL Wind Finance 2017)

[4] A Deeper Look into Yieldco Structuring Report https://financere.nrel.gov/finance/content/deeper-look-yield-co-structuring

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