

The Bankable Microgrid: Strategies for Financing On-Site Power Generation

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Executive Summary

On-site power generation potentially confers many economic advantages to the savvy project developer, and microgrids have the capability to optimize these advantages. However, where entrepreneurial project developers see opportunity, many financiers see risk. Successfully capturing the myriad potential value streams of a microgrid often necessitates exposure to a number of technology, counterparty, and regulatory risks. While financiers experienced with power generation investments are typically familiar with these risks, microgrids add a degree of novelty that—so far—has discouraged investment by institutional financiers. The availability of institutional investment, such as commercial bank debt financing, is crucial for the microgrid industry to reach commercial maturity. The purpose of this paper is to explore the risks associated with on-site power generation using microgrid technology and present strategies that project developers, financiers, and utilities can use to mitigate these risks – ultimately enhancing the financial attractiveness of microgrid projects.

To address this challenge, we first examined the concept of a microgrid’s “bankability.” Bankability is financial and commercial viability, including not only attractive financial returns but also the ability to address all commercial risks that could threaten those returns. One aspect of the current challenge is for financiers to fully understand the monetary value streams from islandable, resilient, and optimized microgrids integrating a variety of DER—and price the package accordingly. Overall, to attract institutional investors, a microgrid project or portfolio of projects must be large enough to provide a worthwhile investment value, be proven from a technological and regulatory standpoint, and be standardized by a replicable framework to manage various risks and cover debt service associated with the diverse mix of generation assets.

Finally, we analyzed the following risks and mitigation strategies:

- 1. Does the product work as expected?** Proper structuring of the financial agreements for a project can help limit or isolate this technology risk. Additionally, projects can primarily use proven technologies, while financing the newest, least-proven components of the microgrid with grant or government funding.
- 2. What is the track record of the vendor/developer?** In the early stages of this market, it is wise for small developers to team up with more established companies that have larger balance sheets (e.g. large ESCOs or engineering companies). Or, third-party vendors can form a financial partnership with the local utility, as investment-grade utilities typically have access to the lowest cost of capital.
- 3. What risks are present in the development process?** Obtaining permits and interconnection agreements is a balancing act—upfront work is needed to ensure there are few surprises, yet it is difficult to find funding for significant work prior to obtaining the interconnection agreement.
- 4. How can the contract be structured to minimize risks?** Developers in early stages should target investors with a higher risk tolerance, and structure power purchase agreements with conditions that provide counterparties an opportunity to exit. Microgrid developers should also choose host facilities with permanent electricity demand. Finally,

the microgrid can be designed around an “anchor” offtaker, an established customer able to bear the most risk.

5. **Has the developer planned to support the microgrid after it is activated?** Wise investors should seek developers capable of properly maintaining equipment for maximum lifetimes, testing reliability and islanding protocols, and training human resources. They should also hedge fuel price risks with future fuel purchase agreements, energy storage, fuel storage, or increasing reliance on renewable resources.
6. **Are sources of revenue stable?** Developers should target markets with high electricity prices and low fuel prices, demand charges, and time-varying rates, and valuation of ancillary services.
7. **Did the developer choose the appropriate business model and financial structure based on project constraints?** Developers can package projects into sufficiently large securities that can be sold to institutional investors. Portfolio aggregation can also enhance a developer’s ability to quickly tap into the relatively novel YieldCo market to monetize assets.

Introduction

As distributed energy resources (DER) in the form of on-site generation, energy efficiency, and demand response become increasingly prevalent in our electricity system, developers are seeking to optimize their project economics using microgrids. Despite the potentially significant value streams provided by microgrids relative to typical DER installations, microgrids have not attracted much investment beyond public grants and other specialized financial solutions—largely due to microgrid project risks and complexities. While some of these risks are familiar to power project financiers, there are novel nuances to microgrid projects (such as how to value resilience) that are not yet sufficiently understood by the market, and not sufficiently well-vetted to attract larger institutional investors.

This paper explores why microgrid projects are not yet “bankable” from the perspective of certain financiers, and the risks associated with on-site power generation using microgrid technology. Our discussion focuses on the various strategies project developers and financiers may use to mitigate these risks—ultimately enhancing the financial attractiveness of microgrids.

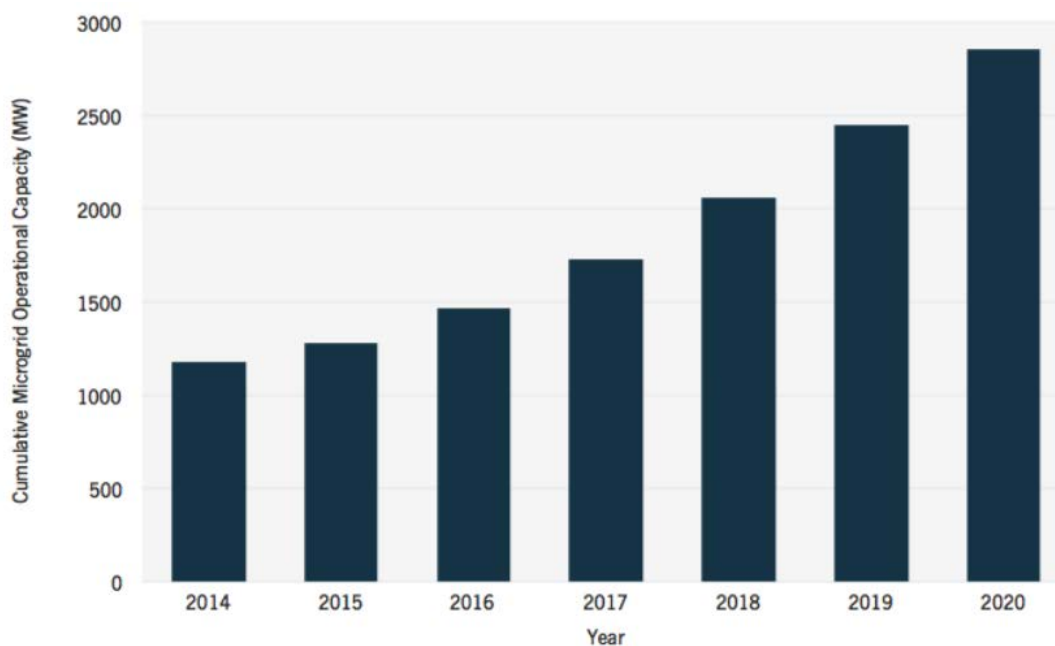
We are motivated to address financial challenges for microgrid projects because microgrids will play a key role in the power sector’s transition from centralized generation to distributed generation. The emergence of grid-connected microgrids is one important manifestation of this broader trend. A microgrid, as defined by the Department of Energy (DOE) is:

“...a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.”

Essentially, a microgrid is a platform for coordinating various, potentially disparate DER into a single load- or generation-shape that can intelligently interact with the modern electricity grid. Microgrids have the potential to be the most adaptable, customizable, and sophisticated of all DERs by aggregating load and generation to provide any number of services to the macrogrid (the larger electricity grid). Microgrid islanding capability enables local energy service resilience, and the aggregate nature of a microgrid enables easier valuation of costs and benefits from all associated DER. Additionally, microgrids can be effective testing grounds for the latest smart grid technologies, such as advanced distribution automation, integrated volt-VAR control, and grid-scale energy storage.

Because of these myriad potential value streams, state governments are incentivizing microgrid development by providing funding for electric resilience programs, reforming utility franchise rights, and permitting new electricity rate structures. These factors all contribute to a strong outlook for the microgrid industry in the short and medium term, according to GTM Research (Figure 1).

Figure 1: GTM Research Cumulative Operational Microgrid Capacity, Base Case Forecast



Source: GTM Research¹

But despite a strong market outlook, microgrid development remains risky and difficult to finance. Successfully capturing all potential microgrid value streams often necessitates exposure to risk. Additionally, to date most microgrid applications are highly-specific and therefore not scalable, making them more difficult to finance. In fact, the microgrid industry is currently in a situation similar to the Independent Power Producer (IPP) market of the 1980s and 1990s. Facing the same technology, cash-flow, and regulatory struggles as IPP developers, microgrid developers are in a position where they must convince banks and investors to provide financing for an emerging energy enterprise.

We hope that the risks and recommendations discussed in this paper will provide a framework through which developers can enhance the financial attractiveness of their projects and unlock a wealth of private capital.

The paper is organized as follows:

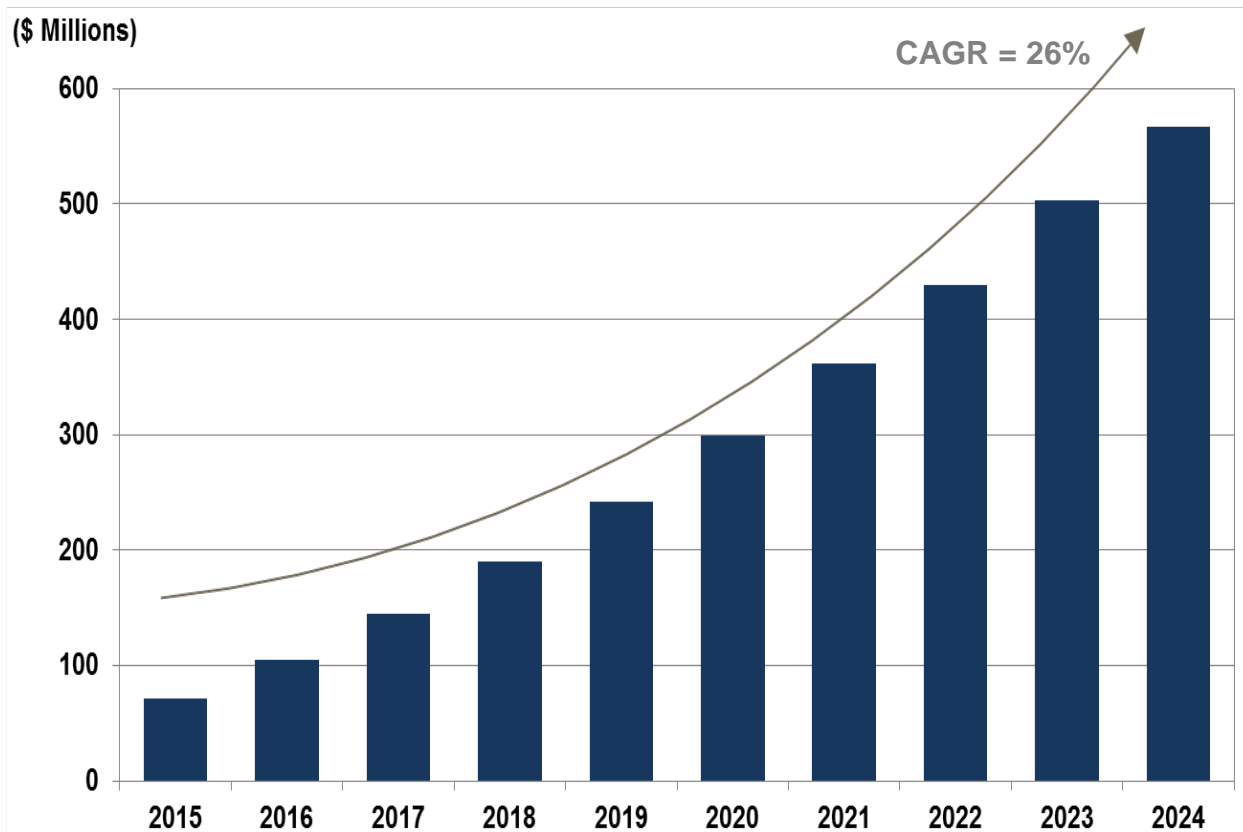
- We begin by limiting the discussion to a subset of microgrids with the most market promise and therefore the greatest appeal to financiers and developers;
- We define the term “bankable” in the context of microgrids;
- We discuss categories of financiers who may present the highest value to the microgrid market; and
- We propose recommendations for microgrid developers to mitigate risks, appeal to appropriate financiers, and scale the industry.

¹ Saadeh, Omar. *North American Microgrids 2015: Advancing Beyond Local Energy Optimization*. GTM Research. July 07, 2015. <http://www.greentechmedia.com/research/report/north-american-microgrids-2015>.

Microgrid Segments with Market Promise

Significant future microgrid market growth is expected in the grid-connected utility and community microgrid segments (Figure 2). Drivers of this growth include the need for resilience in the face of outages caused by extreme weather events,² decreasing DER costs, and the many potential value streams that can be derived from interactions with the macrogrid. These drivers indicate that the grid-connected segment is most promising for private investors. For these reasons, this paper focuses on grid-connected microgrids that serve multiple buildings or end users (e.g. not permanently islanded microgrids or nanogrids, as classified in Figure 3).

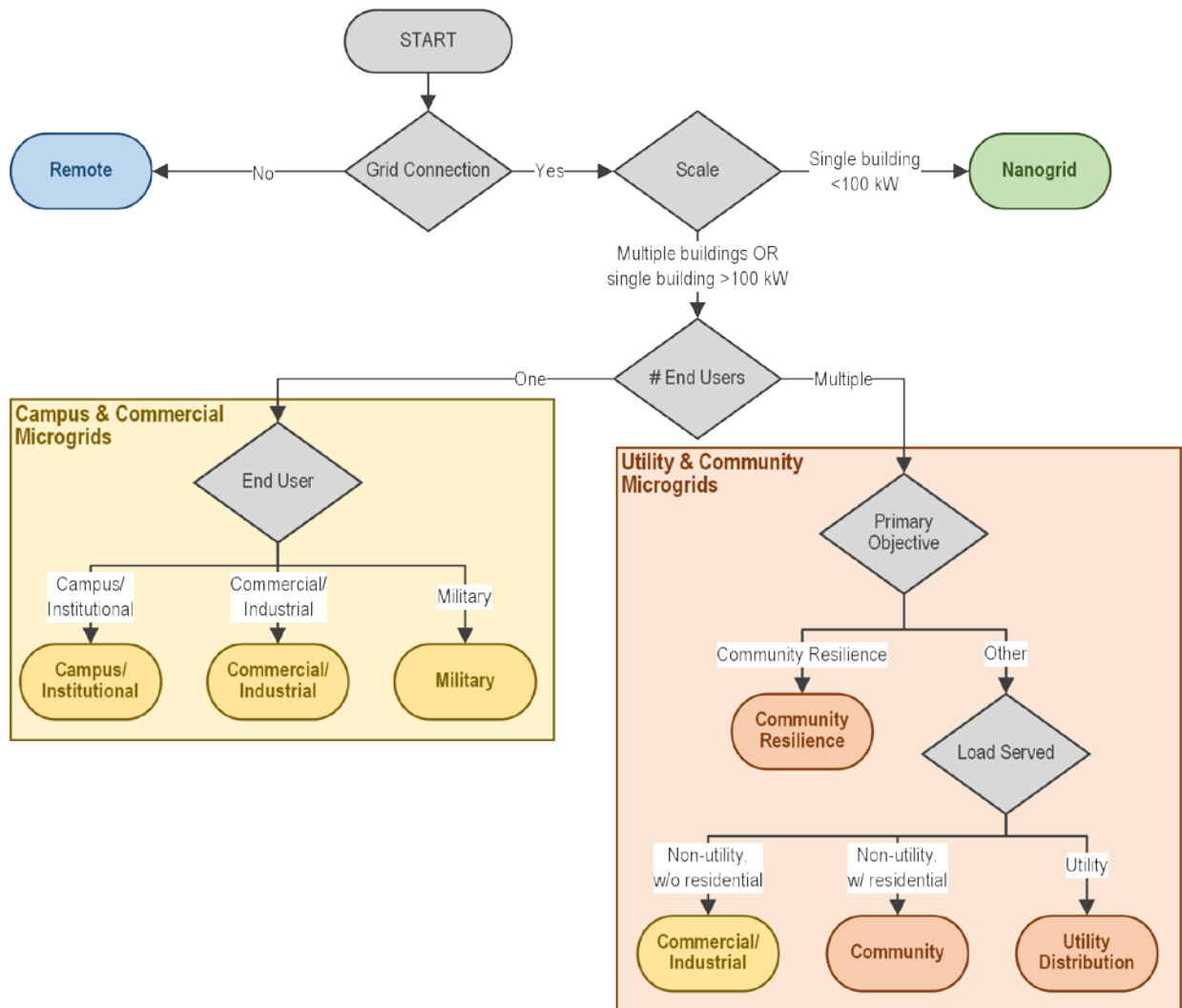
Figure 2: Community Resilience Microgrid Market Revenue Forecast, North America: 2Q 2015



Source: Navigant Research

² The value of resilience is expressed through customer demand for microgrids, regulatory policy, and government incentives for resilient electricity services.

Figure 3: Microgrid Classification Methodology



Source: Navigant Consulting

We also focus geographically on the North American microgrid market because it is a promising market for growth in grid-connected microgrids, and is relatively well-understood by the industry. Finally, because we are interested in examining the market for private financial support from institutional investors, we focus on third-party owned microgrids or those that are developed by the unregulated arm of utility companies. In our discussion of strategies to mitigate risk, we do not include demonstration projects, military campuses, or utility-owned microgrids which are funded through grants, government support, or the utility rate base.

By confining the scope of the paper in this manner, we have highlighted the segments of the microgrid industry with promising growth prospects, and those that provide the most insights regarding the financial viability and scalability (i.e. “bankability”) of the industry.

Bankable Microgrids

Today, few projects are viewed as “bankable”—financially and commercially viable—from the perspective of institutional investors. Investors do not yet recognize a microgrid asset class. The existing grid-connected market largely comprises a series of standalone projects funded by government grants; however, financial support from institutional investors will be necessary to sustainably scale up the market.

To demonstrate bankability on a project-by-project basis, microgrid projects must be both financially and commercially viable. Financial viability (i.e. securing an acceptable rate of return on capital) is the minimum threshold for consideration, but to be truly bankable, the project must also address all commercial considerations or risks that could threaten financial returns. Due to the highly-specific application of microgrids, evaluating a return on investment requires a robust understanding of generation and load characteristics, utility structure, energy markets, regulatory environment, and risks associated with an individual project. Investors will evaluate these factors in conjunction with potential ownership models and financing structures, which can significantly alter a project’s economics.

The complexity of proving a microgrid project’s bankability actually inhibits the financial attractiveness of the project. As the industry matures, players will need to develop a programmatic approach to financing, with clearly defined standards to enable investors to compare the bankability of projects relative to each another. Increasing investor familiarity with the risks and mitigation strategies discussed in this paper, along with transparent performance metrics reported by existing projects, will help move the industry toward a collective understanding of how to value microgrids. Ideally, microgrids will eventually develop into an “asset class” from the perspective of potential investors, and the financiers within the industry will develop a schema with which to evaluate potential new investments.

What distinguishes a bankable microgrid from bankable DER?

A microgrid differs from a typical DER project because its islanding capability provides energy service resilience. Islanding for uninterruptible power requires significant investment. Similarly, the technological capability to re-synchronize and reconnect to the grid after an islanding event is very costly. Furthermore, disconnection and reconnection procedures must be extensively tested, as there are severe consequences if the system fails to island as expected during an emergency. In addition to its high costs, a microgrid’s islanding ability provides benefits that are difficult to monetize and are only periodically realized (grid outages are typically infrequent). Investors are therefore more interested in DER projects than microgrid projects, as they are reluctant to pay for the incremental ability to island.

However, investment in islanding capability can create substantial value during “blue sky” (normal macrogrid) operation. Islanding requires technology to balance generation and load (telemetry, load control, and other smart grid capabilities) which enables revenue streams other than the sale of electricity (ancillary services, demand response, and others discussed in more detail below). Given these benefits, a microgrid should be characterized as an energy project designed to capture multiple value streams—which also happens to be able to function independently of the macrogrid during outages.

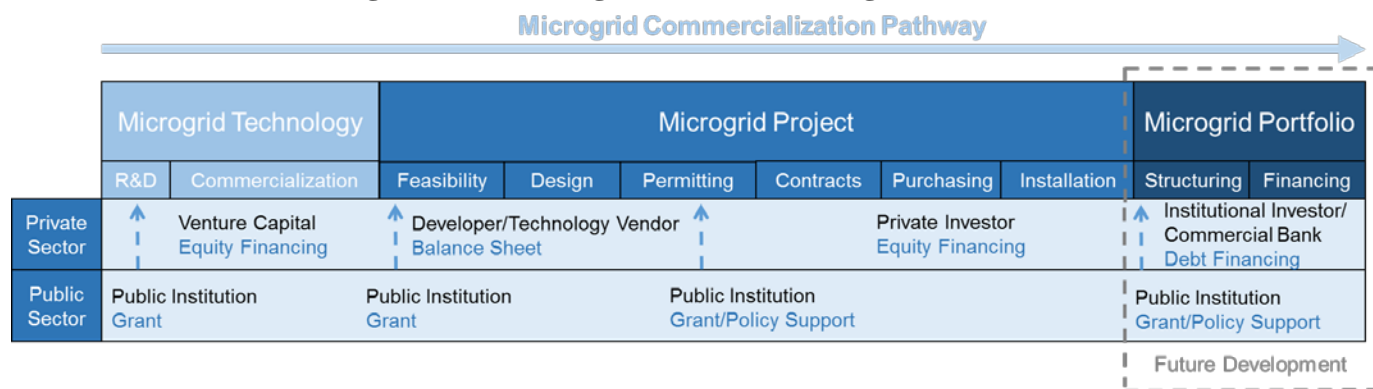
Finally, there are cases in which the ability to island is valuable enough to the host customers to effectively monetize. For example, the owner of a data center may be willing to pay upfront costs

or an annual fee for uninterruptible power. At the community scale, funding from municipalities and governments can be interpreted as a payment for the societal benefit of energy resilience, rather than a one-time government giveaway. Financiers will need to understand the nuanced value of the islanding capability before they are willing to consider microgrid investment over standard DER project investment.

Microgrid Financiers

A variety of different investors and sources of funding are involved during the course of microgrid technology development and project and portfolio development. A simplified model of these interactions is shown in Figure 4, below. Note that from left to right in the figure, the commercial maturity of microgrids increases. It is depicted in this manner to highlight the various market stages at which different financiers come into play. The figure does not illustrate a single linear project development process, as the stages (Microgrid Technology, Microgrid Project, and Microgrid Portfolio) are not necessarily connected, and in reality many other technologies and components would precede a complete microgrid project.

Figure 4: Financing Sources for Microgrids



Source: Navigant

Public Funding

Today, government grants are the largest source of microgrid project funding. As shown in Figure 4, public funding currently enters the microgrid project lifecycle at several different stages—technology R&D, project feasibility studies, and project permitting. The U.S. Department of Energy, the U.S. Department of Defense, certain state agencies, municipalities, and universities have been the largest supporters and customers of microgrids deployed with assistance from public grant funding. These sources of funding have been crucial in the nascent market and have produced a variety of valuable microgrid projects. In the near term, public funding can play a role in attracting institutional investors to the market by engaging in public-private partnerships or potentially funding development of some of the first bundled microgrid project portfolios.

In the long term, public funding may continue to play an essential role in financing the distinguishing characteristic of microgrids—the ability to island to provide more resilient energy services. Without islanding capability, a microgrid is only a collection of local DER, which can be financed based solely on the financial merits of that DER. The addition of islanding capability necessitates a payment for back up generation services—this payment can be made by an individual facility with critical loads (such as a data center or hospital—which commonly pay for

backup diesel generators), higher electricity rates (not common), or grants offered by municipalities and government agencies that see the intrinsic value in a more resilient electricity supply. In this case, the grant funding can be thought of not as a handout, but as a payment from the government to the microgrid developer for resilience services. This is another reason why the public-private partnership model of project development is promising in this sector.

Private Funding

Private funding indirectly supports microgrid projects through investment in start-ups offering innovative new technology and solutions related to microgrids. These investors are typically venture capital firms with an emerging technology or clean technology focus, or venture investing arms of large companies. For example, Constellation Technology Ventures is the venture investing organization within Exelon Corporation focusing on innovative energy technologies and business models. Aquion Energy, which designs batteries for microgrids and other applications, is part of the Constellation portfolio.³ Venture capital enables newer companies to execute initial demonstration projects in order to gain traction in the market.

Private investment is still much more limited than public investment, and comes primarily from vendors also functioning as project developers and financiers to prove their proprietary technology in the early-stage market. As noted, partial grant funding is still a typical prerequisite for the success of these projects. One example of this combination of financing is the California Energy Commission Electric Program Investment Charge (EPIC) program which awarded grants in February 2015. Trane U.S. (a brand of Ingersoll Rand) and Robert Bosch were awarded \$5 million and \$2.8 million respectively for microgrid demonstration projects, and the companies will match \$2.2 million and \$1.8 million.⁴

At the moment, large vendors (such as Siemens and Schneider Electric) are able to finance various portions of the microgrid project development process from their large balance sheets. Still, these companies understand that finding third-party financiers willing to take on the risks of microgrid projects would establish a stronger market for microgrid products. For example, Schneider Electric is undertaking further work to identify investors in the commercial microgrid space for both equity and debt financing solutions and offer a standard tool to facilitate investment decisions. Using federal and national laboratory clean tech investment tools – and the Navigant energy storage valuation tool – investors may come to agreement on how to value a microgrid project.

Banks may issue debt to finance microgrids as a “pure play” based on the DER technology (typically Combined Heat and Power) used in the microgrid and the terms of the power purchase agreement. These deals are technology-specific and do not involve the integration of multiple DER with an advanced control scheme and islanding capability. That is to say, commercial banks issue debt to DER projects, though not microgrids specifically.

The current challenge is for financiers to recognize other monetary value streams from islandable, resilient, and optimized microgrids integrating a variety of DER—and price the whole package accordingly. Microgrids are systems rather than discrete assets. The incremental portion of the equipment that is not specifically for power generation (e.g. control, communications, islanding, and resynchronization equipment) is more difficult to securitize, as

³ <http://technologyventures.constellation.com>

⁴ <http://microgridknowledge.com/california-awards-27-3m-microgrids-ev-charging-projects>

these portions of the project have substantial costs not directly associated with electricity revenue generation.

Future Developments

In Figure 4 above, bundled microgrid project portfolios financed through debt from institutional investors are highlighted as a future development for the microgrid industry. To expand beyond the current demonstration projects into full market commercialization, microgrids must attract institutional investors such as retirement and insurance funds. As in the project finance market for independent power producers, it is the lower-cost debt financing offered by institutional investors which is most critical for establishing a scalable and robust microgrid industry. Because microgrid projects are typically small, and transaction costs for institutional debt financing are high, bundling similar projects into a project portfolio or YieldCo may be a promising avenue for securing financing.

Interestingly, in order to avoid the complexities of project finance, other companies such as SolarCity and SunEdison are moving toward microgrid and nanogrid platforms through “solar + storage” turnkey solutions. These established solar development companies have vast experience financing projects in-house (PPA, lease, and loan financing). The lease and loan business models popularized by SolarCity and other residential solar firms achieved scale by aggregating projects into large portfolios for their investors. SolarCity is now offering a turnkey "microgrid as a service" model with installation and financing options similar to its other products, and in early 2015 reported having built a microgrid system located on an island.⁵ This is a development to watch, as PPA, lease, and loan options for commercial nanogrids and microgrids through these players could make a significant impact on both the grid-connected and remote microgrid markets.

Mitigating Risk and Appealing to Financiers

To attract institutional investors, a project or portfolio of projects must be large enough to provide an investment value worth financiers’ time and consideration, familiar enough from a technological and regulatory standpoint, and standardized through a replicable framework to manage various risks and cover debt service associated with the diverse mix of generation assets.

Size requirements will infrequently be met by a single project, but developers can bundle multiple projects to provide a total asset value attractive to financiers. Technological and regulatory barriers are best addressed through time and experience. The use of proven technologies or strategic partnerships can also help alleviate investor concerns.

An investor is typically attracted by low-risk projects or projects with well-understood risks and higher returns. This section is organized into the key risks that investors expect project developers to address with their project. Each risk is accompanied by insights on how a microgrid developer may be able to mitigate these risks.

⁵ www.greentechmedia.com/articles/read/SolarCity-Combines-its-Skills-to-Finance-Microgrids-as-a-Service

Technology

Does the product work as expected?

- Is it a proven technology?
- Will the technology's performance degrade as expected? What are the implications on revenue?
- What is the product's lifetime?
- What product certifications does it have?
- What level of cybersecurity does it have?
- What is the warranty coverage? How have past warranty claims been handled?
- Has the technology had historical failures or field performance tests?
- Do the mix of technologies operate in an efficient and complementary manner?

Revenue from microgrids relies on provision of thermal or electric energy services in a reliable fashion. Unlike traditional power generation assets, microgrids involve integration of local demand and grid demand with supply. This often leads to implementation of novel or unproven technologies such as controllers, inverters, software load/generation management systems, sensors and distribution automation switches. Because all of these technologies must operate together to deliver the full range of energy services offered by the microgrid, the entire system bears the technology risk if any one of the elements in the microgrid is unproven.

While operating in different contexts, many of these technologies may be proven and have a strong track record of performance. However, operating in concert as a microgrid may sufficiently change the context of the technology application, so the track record no longer applies. For example, in a grid-connected context, a CHP plant may be considered a proven, reliable asset with a long life. However, in a microgrid with solar PV, a CHP plant must consistently modulate its power output to match load alongside intermittent generation for the PV. This can shorten the typical lifetime of the CHP and affect the power output quality. In this case, the common solution is to allow the macrogrid to balance the output of the PV and to run the CHP on a consistent basis. In islanding mode, when the macrogrid is not present to balance the PV, for both of these resources to operate in concert to serve the islanded load, developers should consider an intermediate resource to balance the PV (such as energy storage) so as not to adversely affect the performance or lifetime of the CHP.

Proper structuring of the financial agreements for a project can help limit or isolate this technology risk for certain investors. Investors have a learning curve—novel technologies and combinations of technologies need experience and time to be trusted by the market. In the meantime, projects can use mostly proven technologies, while components of grant funding or government funding can be used to finance the newest, least-proven components of the project. Ideally, funding from that grant could be reserved to fix any issues with the technology that may arise during operations.

Technology should be selected to maximize resource utilization. Additionally, because it can be difficult to produce power at a lower marginal cost than the utility, the economics of a project often hinge on the ability of a microgrid to monetize multiple value streams (e.g. electric, thermal, ancillary services, and the ability to provide backup power). In Hamden, CT, there is a microgrid under development that exemplifies this philosophy. Developers conducted a cost and benefit analysis to examine two technology scenarios. The first scenario was a backup generator

to serve the critical load (a high school emergency shelter) in emergencies only. This option had lower upfront costs yet a much higher cost per kilowatt-hour as the generator would rarely be utilized (\$3.3 million upfront; \$0.95 per kWh when used over a 20-year lifetime). The second scenario was a microgrid option that offered the ability to serve multiple loads continuously, though it required a much higher upfront cost (\$7.7 million). In this scenario, approximately 86% of the microgrid customer load served come from generation assets owned by the developer, and 14% come from the utility. This split is considered a “sweet spot” for economical operations, with the utility primarily serving shoulder operations in the late morning and early evening. By promoting higher resource utilization achieved through “active management” of generation and loads, the 20-year lifetime cost of the electricity was only \$0.115 cents per kWh. Given the electricity rates in the Hamden area, the microgrid provided a more economical option. Furthermore, the developers expect the cost per kilowatt-hour will continue to decline as more resources and customers are added to the microgrid⁶.

Vendor/Developer	What is the track record of the vendor/developer?
<ul style="list-style-type: none"> ○ What is the vendor’s financial strength? ○ Does the vendor have references from other financial institutions? ○ What is the performance history of the vendor and any subcontractors? 	

The microgrid industry is not kind to startups. The selling cycle in the energy asset development industry is 18-36 months. This long selling cycle is very hard on new businesses, such as new battery technologies seeking commercialization. A typical financier wants to ensure that the company executing the project has a long, strong track record, and will still be a reliable partner throughout the investment lifetime (~20 years). This is especially true if the vendor plans to own, operate, and maintain the microgrid under a design-build-own-operate-maintain (DBOOM) model. This is a strong reason why large stable companies with large existing customer bases such as Siemens and Schneider Electric have seen early success in this emerging industry.

This concept is well-illustrated by the Burrstone Energy Center in Utica, New York. When the original developer had difficulty securing financial backing for the project, Burrstone stepped in and bought the rights to the project. Although Burrstone had no previous experience developing or operating CHP or microgrid projects, they were able to secure financial support and approximately \$1 million in funding from NYSERDA based on the credit record and backing of their parent company⁷.

In some cases, developers might finance microgrids by leaning on a host customer’s balance sheet at some phase of project development – through a lease or a build-own-operate-transfer (BOT) arrangement. If the developer plans to pass ownership and operation to a third party, such as a customer, the developer needs to have the credibility to adequately train the new owners so they may implement an effective O&M plan.

In the early stages of this market, it is wise for small developers to team up with more established companies that have larger balance sheets (e.g. large ESCOs or engineering

⁶ "Hamden Microgrid - Interview with Steve Pullins-Green Energy Corp." Telephone interview. October 23, 2014.

⁷ "Burrstone Energy Center – Interview with John Moynihan-Cogen Power Technologies." Telephone interview. August 14, 2015.

companies). Ideally, third-party vendors can form a financial partnership with the local utility, as investment-grade utilities typically have access to the lowest cost of capital. The local utility can also assist with many logistical aspects of project planning and development, adding more credibility and minimizing risk for the project as a whole. Of course, the utility would need permission and motivation to fill this role as a project partner and co-investor.

Development/Regulatory	What risks are present in the development process?
<ul style="list-style-type: none">○ What are the necessary permits and can the project developer get them?○ How long will the interconnection application actually take? What will the final costs be?○ Does the local utility support the project? Does the regulatory environment encourage utility support?○ How mature is the project in the development cycle?	

Obtaining utility support can be difficult for microgrid developers, and utility reactions can be difficult to anticipate. At the moment, throughout the United States there is a mixed landscape of utility support and opposition to third-party microgrids. The most supportive utilities are in turn supported by a regulatory environment (e.g. states such as NY, CT, or CA) that sees microgrids as a viable, cost-effective alternative to grid upgrades. On the other hand, there are many jurisdictions where utilities may be implicitly or passively opposed to microgrid development due to a lack of awareness of microgrids or a lack of incentives to accommodate microgrid development. These areas can be dangerous for third party developers, as utility interconnection is a new process that will take stakeholder education and significant time. Finally, in certain regulatory environments, utility franchise rights prevent multiple buildings from being connected across public right-of-way. In these cases, third party developers need to actively secure the support of franchised utilities, and/or an exception from the regulator. Project developers can also consider crossing public rights of way with thermal energy services only, as thermal loops are typically subject to less stringent regulations.

Permits and utility interconnection costs are significant and often uncertain. Obtaining interconnection agreements is a balancing act—upfront work is needed to ensure there are few surprises, yet it is difficult to find funding for significant work prior to obtaining the interconnection agreement. At Burrstone for example, although the developer had a strong partnership with the local utility (National Grid) they had to make several concessions throughout the design phase of the project. The concessions of the agreement would ultimately have repercussions for the microgrid’s design and Burrstone’s bottom line. At National Grid’s request, Burrstone designed the microgrid so that power would be supplied to each customer from dedicated engines. Burrstone installed three sets of prime movers and three independent interconnections to the grid. Burrstone built a 0.7 mile, 15kV underground line from the location of the engines to the college, and two shorter underground lines to the home and hospital. Consequently, as opposed to a single interconnection application, Burrstone filed and paid for four separate applications; two for the engines serving the hospital, and one each for the college and home. These complications (e.g., additional applications, time and equipment) were

estimated to have increased interconnection costs by close to a factor of three compared to initial planning estimates.⁸

Contractual	How can the contract be structured to minimize risks?
<ul style="list-style-type: none">○ Is the energy output / performance guaranteed?○ For contracting structures with availability requirements, will the technology and operator meet requirements?○ What is the PPA or feed-in tariff term? What deadlines and expiration dates exist? How could these terms affect revenues and costs?○ How reliable is the offtaker for energy services?	

Because of these permitting, regulatory, and contractual considerations, the maturity of a project greatly influences its financial attractiveness. Obtaining PPAs, permits, and partnerships takes a lot of time and money before there is any steel in the ground. Developers can target grant funding or investors with a higher risk tolerance to fund these early development stages. Policymakers seeking to jumpstart the market for microgrids could develop a microgrid project feasibility grant fund, to help a project overcome these hurdles, become “shovel ready” and attract private investment. Preliminary PPAs can be structured with conditions that provide counterparties an opportunity to exit the agreement if certain conditions and milestones are not met during the development process.

All aspects of a developer’s contract with utilities and loads served by the microgrid will be closely examined by potential investors. To the extent possible, it is beneficial for the developer to rely on templates and standard approaches to contracts, which will require less time to review and hold fewer surprises from the investor’s perspective.

Unique to the microgrid sector, developers must anticipate risk from two offtakers – the utility and the islandable load. Utilities are not typically perceived as risky offtakers, but the economics of the microgrid can be adversely affected if load is reduced on the microgrid. Retail customers can be unreliable offtakers, they generally have the ability to change their operations or move locations which could erode the load served by the microgrid. To mitigate this risk, microgrid developers should choose host facilities with permanent electricity demand. Otherwise, lenders will want to see a departing load charge paid through rates to the offtakers, or issued as a penalty to the departing customer, meant to cover the cost of load reduction. Finally, the microgrid can be designed around an “anchor” offtaker, the most established customer who bears the highest percentage of offtake risk mitigation.

⁸ Ibid.

Operational

Has the developer planned to support the microgrid after it is activated?

- Will the project owner's O&M budget be enough to meet availability requirements and handle unforeseen issues?
- Can staff be trained to operate/maintain the microgrid in the case of ownership transfer?
- Is there significant fuel supply or fuel price risk?

Because microgrids are novel, rely on the latest technology, and often involve partnerships between multiple vendors; unforeseen operational challenges emerge frequently. Wise investors will seek developers that have sufficient budget to properly maintain equipment for maximum lifetimes, test reliability and islanding protocols, and train human resources adequately. Operations staff need to actively manage the microgrid during grid-connected mode to capture all potential value streams. Simultaneously, operators must plan for islanding mode by developing communication, training, safety procedures, and operational requirements in advance.

A steady and reliable fuel supply is critical for microgrid operations. In the case of renewable resources, fuel supply is asset-specific and depends on environmental conditions. For fossil-fuel based resources, the fuel delivery infrastructure can be just as vulnerable as the macrogrid's electric delivery infrastructure during emergencies. If long-term resilience is the goal, the developer should consider fuel storage, energy storage and/or using renewable generation resources.

Fuel price risk should be hedged by future fuel purchase agreements, energy storage, fuel storage, or increasing reliance on renewable resources. A spark spread analysis is the core of the economic potential for energy arbitrage and this analysis should include the certainty of fuel market conditions persisting over the lifetime of the project.

Market

Are sources of revenue stable?

- For projects selling into open markets (e.g. ancillary services), how will revenue vary by month and year? Are there any guarantees on these revenue streams?
- Are value streams diversified and reliable?

Grid-connected microgrids are naturally more bankable in advanced energy markets that value the services a microgrid can offer to its local customers and the macrogrid. Markets that possess the following characteristics are ripe entry points for the bankable microgrid:

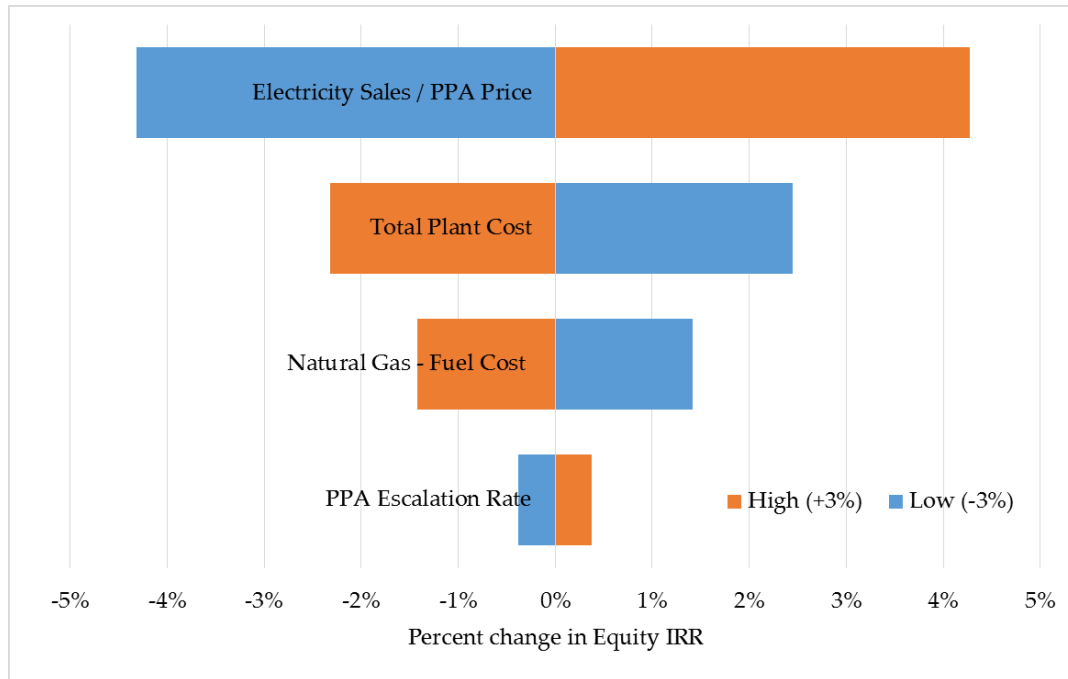
- *High electricity prices and low fuel prices resulting in a favorable spark spread.* The business case for the development of a microgrid generally relies on the most basic measures of arbitrage profitability; the spark spread. The spark spread is a metric used to estimate the gross margin of profitability of generators. It is a measurement of the difference in price between electricity purchased and electricity produced. Markets with

high electricity prices, low natural gas prices, and abundant renewable resource potential are likely to yield a more favorable spark spread for microgrid developers.

Price is a function of location. Microgrids are more viable in areas with high retail electricity rates. In markets with locational marginal electricity pricing (LMP), microgrids selling a portion of their output to the macrogrid are best located where the costs of electric service are substantially above average for the area. Similarly, in urban areas, natural gas can be more expensive than wholesale or distribution-level gas due to transportation fee markups. Buying gas at the retail level will make it difficult for a microgrid to compete with the economics of electricity generated by the macrogrid—as utilities typically buy gas in bulk at wholesale rates.

To illustrate the effects of price on the economics of a project, we performed a sensitivity analysis using real financial data from a CHP-based microgrid project in New York State. The results of the analysis are shown in Figure 5.

Figure 5: Illustrative Sensitivity Analysis for a CHP-based Microgrid in New York State.



Source: Navigant analysis of CHP-based microgrid financials

Each of the four parameters in the sensitivity analysis were varied by +/-3% in the high and low scenarios respectively. A variation of 3% in the electricity sales price yielded an outsized impact of 4.3% variation in the calculated internal rate of return on equity. Other important factors include the total cost of the plant itself, as well as the cost of fuel to operate the plant. The escalation rate terms of the PPA contract did not significantly affect the IRR.

- *Demand charges.* One of the main drivers of value in the microgrid market is demand charge reduction. In markets like New York, a large portion of the electric service charge is based on peak demand, so there is a large incentive for users to reduce demand. This

can be accomplished through active management of onsite resources to ensure the demand from the macrogrid is minimized.

- *Time-varying rates and/or net metering.* By the same token, thermal and electric energy storage can be used for price arbitrage in markets with differential rates throughout the day, by storing energy when the rates are low and discharging when high. Net metering allows microgrids to sell excess generation at higher retail rather than wholesale rates.
- *Ancillary services.* In markets that value frequency regulation, voltage control, or other ancillary services, these benefits can be monetized by the microgrid developer. However, it is difficult to construct a bankable business case from these revenue streams, as they are highly variable, condition-dependent, and potentially short-term. On the other hand, as more variable renewable energy enters the grid, there may be an increased need for the ancillary services a microgrid can provide. The market for ancillary services could be hardened through price hedging contracts.

Certainly, a market that includes all of the above monetized value streams would be attractive to the microgrid financier due to the sheer diversity of revenues—some more reliable than others. Other value streams available to a microgrid that are independent of market context include:

- *Diverse energy services.* A microgrid is more bankable if it provides more than just electric energy services. With current technology costs, it is difficult to produce onsite power at a lower cost than the macrogrid. However, the addition of thermal energy for conditioning spaces, process heating, or water desalination results in more reliable revenue streams from the microgrid by virtue of their diversity. Thermal energy loops have the added benefit of being subject to fewer regulations than electric service infrastructure.
- *Tax credits.* On the development side, cost savings for certain technologies such as solar and battery storage (for taxable equity investors) are tax driven through the 30% federal investment tax credit until the end of 2016.

Strategic	Did the developer choose the appropriate business model and financial structure based on project constraints?
<ul style="list-style-type: none">○ Is the project the right size to appeal to target investors?○ Does the perceived complexity and novelty of the project scare investors?○ Is the financing vehicle compatible with the project and business model?	

The question of choosing the appropriate business model and financing structure boils down to scale. Third-party project finance comes with high transaction costs, so investors are attracted to large scale projects that provide an investment value worth their time. Microgrids in this early stage market do not fit the bill. The industry has seen, and will continue to see, lots of small microgrid projects. The majority have been funded through government grants but, increasingly, large companies such as SolarCity, SunEdison, and Siemens are financing smaller projects on their balance sheets. Once these companies can develop a replicable model that can be bundled

and offered as a securitized solution, they can move from their balance sheets to institutional financing.

Developers can similarly package projects into sufficiently large securities that can be sold to institutional investors. While this strategy has been widely used in mortgage lending and other commercial loan obligations, it has not yet been used for microgrid projects. Successful aggregation of transactions that share a similar structure and underwriting standards could make for lower cost financing and mitigate risk through diversification.

Portfolio aggregation can also enhance a developer's ability to quickly tap into the relatively novel YieldCo market to monetize assets. In March, FuelCell Energy sold a microgrid project at the University of Bridgeport to NRG Yield. The university pays NRG Yield for the clean power and NRG in turn locks in a sustained cash flow through which it can pay out a relatively high percentage of its earnings to its shareholders as dividend yield.

The industry is also poised to see a surge in large-scale project development in the \$50 million and above category. While the space is new and has few players, these projects can be approached in the same fashion as any other large scale infrastructure project. Energizing Co. and partner Stonepeak Infrastructure Partners are leading developers in this size class. They have established a special purpose vehicle (SPV) and work with municipal and investor owned utilities through a standard public-private partnership approach to project financing. The SPV takes on all development costs and manages all construction and long-term O&M contracts in return for a monthly fee for their services. This structure offloads a significant amount of risk and hassle from the city/utility as the SPV finances the project and handles all contracts. This large scale market is likely to become increasingly competitive as institutional investors looking to decarbonize their investment portfolios turn to green infrastructure projects.

Aside from the issue of scale, microgrids are highly complex and relatively new in the eyes of institutional investors. Novelty is primarily a function of time, but can be counteracted by open reporting and increased transparency.

Conclusion

Microgrids are a promising enabling technology for grid modernization, integration of DER, and community resilience. Growth opportunities from industry forecasts are significant. But even with these merits, the industry cannot yet stand on its own without substantial financial support from the public sector. For this young industry to realize its full potential, developers need to adopt strategies to mitigate risks and accurately quantify value streams in order to attract mainstream financing from institutional investors and qualify microgrids as a bankable asset class.

It is our hope that the ideas and suggestions presented herein will further the conversation within the industry on how to consistently achieve and demonstrate microgrid financial and commercial viability. Proving the bankability of microgrids, thereby securing widespread investment, will enable this technology take on an important role in the modern electricity service ecosystem.

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