

Development of Local Government Resilient Microgrids

Prepared for the
New Jersey Board of Public Utilities
with support from the U.S. Department of Energy

JULY 2021

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DISCLOSURES

This activity was funded by a U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy (DOE) Grant Award DE-EE0008613 to the New Jersey Board of Public Utilities (NJBPU) for “New Jersey-Financing Advanced Microgrids.”

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At the time of publication of this report, the Board has made no determinations in response to the modeling, analysis and recommendations contained herein. This information may be used to facilitate the development of microgrids in the future; however, this report does not represent the Board’s views or policies for microgrid development. The Board makes no warranties or representations, expressed or implied, as to the fitness of any proposed methods, processes or other information contained, described, disclosed, or referenced in this report.

This report was authored by Marc Pfeiffer, NJIT/Rutgers Principal Investigator. Comments on this report are welcome at marc.pfeiffer@rutgers.edu.

ACKNOWLEDGEMENTS

The Center for Building Knowledge of the New Jersey Institute of Technology and the Bloustein Local Government Research Center of Rutgers University thank the New Jersey Board of Public Utilities and the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy and their staff for their financial support of this initiative, as well as their insights that informed the development and scope of this report.

The author thanks Donna M. Attanasio, J.D. at GW Law for her subject matter expertise, legal guidance, encouragement, and editorial contributions to this report. Deane Evans, FAIA at NJIT is also thanked for his editorial contributions. Kiera Zitelman of NARUC, Samuel Cramer of NASEO, and Gregory Dierkers of USDOE made greatly appreciated technical and editorial contributions to the final report.

Karyn Olsen of the Bloustein School is thanked for her publication design efforts and Victoria Dollon of NJIT is thanked for her design work on the accompanying Fact Sheets and PowerPoint presentations and editing/proofreading of this report.

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The Project Team gratefully thanks and acknowledges the support of the fiscal and administrative staff of their institutions and the N.J. Board of Public Utilities. Special thanks are given to Frances Loeser of the Bloustein School of Planning and Public Policy at Rutgers and Bruce Goldberg of the Board of Public Utilities.

The Project Team also gratefully acknowledges the New Jersey Department of Community Affairs (DCA) for its support of the Community Microgrids Planning Academy project which preceded – and, in part, served as a basis for – the current work. Funded by a grant from the US Department of Housing and Community Development, the DCA contracted with the NJIT Center for Resilient Design to develop a new, online educational platform – launched in 2018 – to help jurisdictions across New Jersey create microgrid development plans to improve the energy performance and resilience of their communities.

The Project Team also thanks the following individuals for their advice during the research phase of the project:

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DEFINITIONS AND ACRONYMS

- Black start = The process of restoring power to the grid from a shut-down condition
- Blue sky operation = A normal, routine operating day for an energy utility
- CHP = Combined heat and power systems that generate electricity and capture heat that would otherwise be wasted to provide useful thermal energy that can be used for space heating, cooling, domestic hot water, and industrial processes
- Critical facility(ies) = Local physical assets that are essential for public health or safety
- EaaS = Energy as a Service.¹ For the purposes of this report, EaaS also includes Power Purchase Agreements (PPA) and Energy Supply Agreements (ESA). Each possesses unique attributes. The differences are not relevant to this report, save that each is a long-term energy supply agreement between an offtaker(s) and a provider.
- DER = Distributed Energy Resources, which are grid-connected or distribution system-connected devices that may include CHP or renewable energy systems such as solar, wind, biomass, or hydropower systems
- EDC = Electricity distribution company serving a local community (aka regulated, investor-owned, or municipally owned utility)
- EE = Energy efficiency
- GHG = Greenhouse gases
- Islanded or Islanding = The ability of a TC microgrid (or any microgrid) to operate independently of the local EDC grid
- NJBPU or BPU = New Jersey Board of Public Utilities
- Offtakers = Entities buying the power supply generated by a microgrid
- PV = Photovoltaic energy cells; aka solar energy panels
- Reliability = The ability of the electricity distribution system to deliver expected service
- Resilience = The ability of an electricity distribution system to prepare for, adapt to changing conditions, and withstand and recover rapidly from disturbances in supply or distribution
- RoW/Rights-of-way = Legal access to use governmentally owned land (often roadways) and related easements
- Town Center (TC) microgrid: A microgrid developed in an area of a community that delivers power to a physically non-contiguous group of critical facilities, often involving multiple distributed energy resources and crossing multiple public RoW. For purposes of this report, a TC microgrid is presumed to include DER that are capable of sustained operations in emergency or disaster scenarios under blue sky conditions and have black-start capability.

¹ EaaS, PPA, and ESA are often used interchangeably in different segments of the industry. They all represent variations on the theme of contractual requirements where a customer pays for electricity based on a pre-established formula. Provisions often include a combination of fixed and variable payments, some of which may be tied to industry benchmarks, minimum purchase requirements, and inflation.

Executive Summary

This report describes a research project undertaken by the NJ Board of Public Utilities with financial support from the United States Department of Energy through a State Energy Program competitive award. The original purpose of the project was to document and analyze successful approaches to procuring and financing “town center microgrids.” For the purposes of this research, town center microgrids are defined as “microgrids developed in downtown areas of communities that deliver power to a physically non-contiguous group of critical facilities, often involving multiple distributed energy resources and crossing multiple public rights of way.”

This report was initiated by the NJBPU to help inform the Board about New Jersey’s Town Center microgrid efforts. The study found significant value in looking beyond New Jersey’s efforts to consider challenges faced by other states. The report raises issues and recommendations that are broad but frame the issues for individual states as they consider their own energy regulatory, economic, resilience, and reliability needs. The report is expected to assist the Board as it continues its Town Center microgrid efforts.

Town center microgrids are distinct from two other common types of microgrids: 1) single-site microgrids that serve a single building like a hospital, school, or public housing building; and 2) campus microgrids that are deployed at institutional campuses in government, education, and business sectors to power multiple structures through onsite generation and that provide control to the owner. There are many examples of successful single-site and campus microgrids. Town center microgrids, on

the other hand, are far more complicated and are – at least to date – far less common.

CONTEXT, ASSUMPTIONS AND FINDINGS

When the need for the study was considered in 2017, enthusiasm for microgrids generally – and town center microgrids in particular – was extremely high across the US and remains so today. Consequently, the project team assumed that, over the course of the study, numerous town center microgrids would be under development or in operation and could therefore serve as case studies for documentation and analysis.

This proved not to be the case. Only one project meeting the definition of a “town center microgrid” was found to be operating during the study. Even though there were at least 10 examples of projects that had demonstrated their technical feasibility – and some had moved on to the design phase – in the end, the vast majority were put on hold or canceled for a variety of reasons, all of which are described in this report. A key consequence of these project postponements and/or cancellations was that only one of the proposed town center projects investigated by the project team ever reached the procurement and financing stages.

As a result, the project team conducted a detailed analysis of several serious issues that could have arisen – and that would have needed to be addressed – if any of the identified projects had proceeded to financing/procurement stages and identified some of the common challenges that impede the development of town center microgrids. Four key areas of concern emerged:

- Franchise rights that impede customer acquisition by entities that are not EDCs;
- Addressing costly regulatory burdens that may be unnecessary for a town center microgrid;
- Statutory rights granted to EDCs of preferred access to cross multiple rights of way and prevent others from doing so; and,
- Technical issues concerning management of distributed energy resources (DER).

These issues and concerns are discussed in detail in this report. This report also examines: the changes and implications of change that are driving the need for town center microgrids (Part 2); the findings of the study survey (Part 3); an overview of microgrid procurement and financing options (Part 4); and the range of technical, financial, and public policy risks faced by town center microgrids (Part 5). This report also makes recommendations for further research opportunities (Part 6).

WHAT'S NEXT

This study revealed that there are – to date – very few examples of successful town center microgrids in the U.S. While many projects have demonstrated technical feasibility, only one addressed the procurement and financing challenges identified in this study; the rest were postponed or cancelled before reaching this stage. That said, enthusiasm for town center microgrids remains very high as part of the ongoing national evolution of the delivery and management of electrical power. Town center microgrids can and probably will be right in the middle of this evolution.

Consequently, there is an important need for case study projects of town center microgrids that directly address both technical and, perhaps more critically, financing and procurement feasibility issues like the ones identified in this

**“...there are – to date
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report. The good news is that New Jersey is currently embarked on just such a program.

The NJBPU's Town Center Distributed Energy Resources Microgrid Design Incentive Program will provide \$4 million of support to 8 town center microgrid projects across the state. The funding will help each project move from technical feasibility (already established through a previous grant program) through a portion of the design phase. As they move forward, these projects will need to address the development, procurement and financing concerns identified in this report.

The New Jersey program provides a unique and very promising “living laboratory” for testing and validating various approaches to the financing and procurement of town center microgrids. Successful outcomes will provide tested and validated models for town center microgrid development and will establish New Jersey as a national leader in this emerging and rapidly evolving field. The outcomes of the New Jersey program will also serve as valuable use cases for states nationwide that wish to advance town center microgrid projects.



Part 1 – Conclusions and Observations

Today, the idea of a Town Center (TC microgrid) as an off-grid power supply for critical facilities is an aspirational one. Outside of specialized use cases, the traditional role of electricity distribution companies (EDC) and the existing regulatory and economic system under which they operate stymie the development of TC microgrids. While varying by state, this includes some potentially insurmountable barriers for public or private non-utility developers. This is reflected by:

- Franchise rights that impede customer acquisition by non-EDCs.
- As they serve many customers, EDCs are subject to regulatory burdens that may be costly and unnecessary for a TC microgrid that serves few customers.
- An EDC's preferred access, allowing it to cross multiple rights-of-way (RoW).
- Technical issues concerning the operation and visibility of Distributed Energy Resources (DER).

Taken together, these factors add uncertainty and risk to the costs of developing and maintaining a TC microgrid. Concurrently, these factors add uncertainty to investor cost-recovery.

Alternatively, successful non-TC municipal government microgrid projects are campus-based, with DER located behind-the-meter. These are often set up as Energy as a Service (EaaS) agreements with a private-sector developer and supported by one or more government or utility subsidies.

The study found that other successful use cases include the location-specific evolution of district heating systems to district energy

systems. These projects use combined heat and power (CHP) or other fuel sources, using the system's existing RoW and EDC alignment where necessary.

Single-customer behind-the-meter campus projects are the "easiest" projects to implement because they carry the least uncertainty and risk. They are more successful in attracting interest from developers and attracting capital than more complex projects such as TC microgrids.

Outside of campus or district energy projects, TC microgrid projects require the right time, right place, right technology, right incentives, and alignment with EDC concerns and interests.

Research also highlighted a range of public policy challenges that face all behind-the-meter DER, including TC microgrids. Additional research opportunities are highlighted.

TC MICROGRID STATE PILOT GRANT/INCENTIVE PROGRAMS ARE INCONCLUSIVE

Principal Finding: TC microgrids are one conceptual solution to the need for community emergency-power resilience and reliability. At this time, however, they face significant public policy-driven development hurdles.

The pilot and grant programs of several states (CT, MA, MD, and NY) over the last 5 years show that local government-driven TC microgrids cannot be readily developed under the current regulatory and financing regimes. The four barriers highlighted above were significant enough to halt development of these projects.

“Expectations for the immediate development of TC microgrids through these incentive programs appear to have been overly optimistic.”

Currently, New Jersey’s effort at developing TC microgrids is inconclusive as projects are just now entering the design phase. It is clear, however, that in the absence of a clear legal pathway, these projects are also limited as they are unable to reach the additional goal of increased resilience.

Expectations for the immediate development of TC microgrids through these incentive programs appear to have been overly optimistic. Regrettably, a reality of costs, engineering and EDC regulatory obstacles, and state policy conflicts resulted in projects that were delayed, reconsidered, or abandoned.

Completed projects or those with potential for success reviewed by the study included:²

- Technical issues concerning the operation
- Islanded government campuses fed by onsite DER operated by developers/contractors under EaaS contracts. These often reduce sponsor costs by accessing funding from a variety of state- or EDC-funded programs. Examples include [Woodbridge, CT](#), [Fairfield, CT](#), and [Bridgeport, CT](#).
- The addition of low-carbon or renewable generation capacity and new switching capacity for local government-owned EDCs. An example is [Freeport, NY](#).
- Low-carbon or renewable fueled

generation in neighborhoods that can support the area in blue sky and islanded modes. The prime example of this is the [Hartford-Parkville](#) neighborhood project in Hartford, CT, owned and operated by a third-party energy supplier. This turned out to be the only TC microgrid found by the study.

- District heating systems (generally combined heat and power – CHP) adding electrical generation capacity to their service areas. Sites that have the potential for success, but must overcome local obstacles, include the [Proctors Marquee](#) project in Schenectady, NY and the New Jersey [Trenton](#) and [Atlantic City](#) projects.

The interest of private sector developers in New Jersey led to proposals that, with several exceptions, consist of EaaS agreements. These projects would create behind-the-meter solutions that run primarily in an islanded mode.

Why are there so few successful examples of TC microgrid financing or procurement models? Under the existing regulatory and organizational structure of the electric grid, TC microgrids face numerous obstacles, as identified above. To elaborate, those obstacles include:

EDC franchise rights: Most states have a statutory or regulatory regime that may limit the ability of another entity other than an existing EDC from distributing energy to customers or accessing the RoW to do so.

Financial challenges: In cases where there is a legal workaround to the franchise issue, allowing the microgrid to serve at least a subset of the desired customers, the microgrid may find it too costly to do so. In addition to capital to fund the supply source and control system, challenges may include the cost of installing parallel (to the EDC) distribution lines to each critical facility. This increases the capital to be recovered in rates unless initially subsidized and may be

² Additional details about these projects are found in Part 7 of this report.

unnecessarily redundant to the existing grid.

- o Unlike an EDC that may be able to allocate these costs through rates over a large segment of its customer base, the cost of a non-EDC-owned microgrid must be recovered from a smaller pool, which may be much smaller than the number of persons benefited. An example would be a municipality using its operating budget for a microgrid to support emergency services that benefit the municipality's citizens but also benefit areas surrounding of the municipality. Regardless, in both approaches, it is difficult to quantify the benefits and design rate structures to allocate those costs efficiently among customers.
- o Alternatively, if a project can work with the EDC to underground otherwise above-ground lines, it adds ratepayer value through the added resilience it brings but could involve cross-subsidization of different customer classes. If the EDC can factor that value into its rate base for cost recovery of the improvement, there may be an intersection of interests for all parties.

The challenge is how to value resilience (See [Part 4, Section 4](#) of this report) without unduly shifting costs.

Regulatory burden: A microgrid serving more than one customer could result in the regulation of the microgrid owner as an EDC, even if serving a limited population. The cost and burden of regulatory compliance, unless waived or lessened, may make the project economically unfeasible.

Regulatory compliance: Each state has its own regulatory environment that affects DER ownership, controls, system revenue and cost implications, and technical matters. These issues complicate the financial challenges of TC microgrid design and financing, cost recovery, and customer service requirements.

Technical compliance: Both EDCs and microgrid designers advocate that electrical system safety is paramount. But agreeing on details can be challenging. Agreement on standards, controls, redundancy, and power supply reliability elements, particularly at the point of common coupling (where the DER enters the distribution system) is project specific. In addition, because of the ongoing evolution of DER, industry standards

TECHNICAL ISSUES
UNCERTAINTY AND RISK
REGULATORY BURDENS
MANAGING DER
PREFERRED ACCESS RIGHTS
INVESTOR COST RECOVERY
EDC CHALLENGES
FRANCHISE RIGHTS
CUSTOMER ACQUISITION
MULTIPLE RIGHTS-OF-WAY
MULTIPLE CUSTOMERS

(e.g., IEEE) are evolving and reasonable parties may have different approaches to addressing them.

Societal and public policy issues: While TC microgrids may add resilience and reliability in emergency situations, not all configurations will be consistent with balancing short- and long-term statewide policies of ensuring the fiscal sustainability of the grid, greenhouse gas (GHG) reduction policies, and funding of energy efficiency (EE) programs.

At the end of the day, policymakers and regulators are faced with a conundrum; If the notion of providing resilient and reliable power supply to TC microgrids is a vital public policy imperative, what are the choices?

If providing resilient and reliable power to communities is a public policy goal, what is the appropriate role of Town Center projects? What actions should policymakers and regulators take to reduce barriers to these projects and how should they compete with other resilience and reliability investment options?

If EDCs are not allowed or willing (legally or otherwise) to meet minimum levels of critical facility resilience and reliability that take advantage of new technologies and resources and do so cost-effectively, what are the remaining pathways to achieve it? What is the public policy rationale for retaining the barriers that limit the ability of non-EDCs to do so?

This report looks at the circumstances and issues facing policymakers and regulators. It attempts to help frame the issues for their studies.

Part 2 – Research Study Findings

A. ABOUT THE STUDY

ENGAGEMENT OF THE NJ BOARD OF PUBLIC UTILITIES

Superstorm Sandy and subsequent multiple extreme weather events focused public and policymaker attention on the impact of EDC outages that compromise vital civic and public safety facilities. These compromises occur during extreme weather events and the immediate and short-term post-event recovery efforts.

Subsequent public and internal discussion led New Jersey’s public utility regulator, the Board of Public Utilities (NJBPU) to consider the concept of TC microgrids as an answer to the impact of grid failure on critical facilities. A slice of the evolving DER and microgrid industry, the underlying purpose of a TC microgrid is to provide a non-grid alternative to the challenges of grid reliability and resilience in the face of weather-driven and other disasters.

These discussions resulted in a NJBPU staff researched Microgrid Report (2016). In it, the NJBPU referred to “advanced microgrids that provide DER systems to multiple critical customers at a local level as a Town Center DER microgrid.”³ By definition, these do not include behind-the-meter campus or single-user microgrids.

As a result of this effort, the NJBPU developed a competitive grant program to encourage development of TC microgrid models (discussed in more detail below).

While the grant project was evolving, the NJBPU applied to the DOE for a State Energy Grant to study the legal and fiscal processes

involved in the procurement and financing of TC microgrids to support the state’s development effort. That led to an initial award of a grant for a project initially named “Financing Advanced Microgrids.”

STUDY PARTNERS

The BPU asked the Center for Building Knowledge (CBK) at the New Jersey Institute of Technology and Bloustein Local Government Research Center at Rutgers University to conduct the study.

A Bloustein Local staff member served as the subject matter expert and Principal Investigator (PI) of the effort. This PI has a long and deep background in NJ public procurement, energy, and financing activities. He was assisted by a Rutgers graduate student in engineering, who provided valuable research and project support. Additional subject matter expertise was provided by an energy subject matter expert attorney at the George Washington University Law School.

NJIT contributed its *Community Microgrid Planning Academy* (www.microgrids.io) as a home for the research. CBK staff developed webinars and related deliverables, coordinated outreach, and provided overall contract management. CBK supplemented their full-time staff with students who provided valuable support to the project.

A stakeholder group of interested NJ government agencies and their professional advisors, EDC staff, and other interested parties was created. Several stakeholder meetings were held to discuss microgrid technology, procurement, and financing practices. A

³ Extracted from the USDOE State Energy grant to the NJBPU, Statement of Project Objectives.

separate advisory committee of industry experts was established to provide technical information to the project team as needed.

The project commenced in the last half of 2019. The project plan was subsequently modified to reflect the impact of the COVID-19 pandemic on government operations and limitations on attending conferences and in-person meetings. Additional details on the research process can be found in Section 7 of this report

Materials dedicated to this project are being posted to the NJIT-managed www.microgrids.io website, where visitors will find this report, project collateral material, including separate Fact Sheets summarizing the findings in each section, presentations as they develop, and related material. Other material related to government microgrids will be posted on the site.

B. OVERVIEW OF MICROGRID TECHNOLOGY-DRIVEN CHANGE AND DISRUPTION

Microgrid technology is a fundamental element in the evolving change and disruption being experienced in energy supply and distribution, both nationally and globally. The technology is implicated as a disruptive market influence, a solution, and an investment opportunity in our current energy supply and distribution environment. The following are examples of that change and disruption; these examples are inherently interrelated.

There is a clear need for resilience and adaptation of public services in the context of climate change and socioeconomic impact. These include how changes in weather patterns affect development and design of communities, alter commuting practices, and how we move and store goods. Climate change also affects socioeconomic policies affecting the unhoused and mental health service dependent (shelter facilities and

RESEARCH PROCESS OVERVIEW

The project team developed several approaches to conducting research:

1. **Extensive online research involving gathering and review of contemporary academic papers, industry white papers and marketing material, conference presentations, regulatory reports, government agency program websites, industry and local press reports, and case studies.**
2. **Research to identify potential TC microgrid (aka benchmark) projects as candidates for an online survey.**
3. **Developing and conducting the survey of benchmark TC microgrid projects.**
4. **Attendance at industry conferences (in person and virtual) and discussions with industry participants.**
5. **Discussions and meetings with Stakeholder and Advisory Committee members.**
6. **Communications with relevant state agency personnel.**
7. **Analysis of the foregoing to reach conclusions and develop deliverables.**



policies), public education (heat days replacing snow days), and location specific issues such as the impact of sea level rise on affordable housing.

Non-carbon power generation technology advances have led to increased supplies of solar, wind, hydrogen, and biofuel (e.g., renewable natural gas), where new supplies are available at price points that are lower than or competitive with carbon-based fuel supply, depending on location.⁴ The role of battery storage and advances in storage makes zero-carbon generation more valuable and competitive against fossil-fueled generation.

Both incremental and substantive technological advancements in engineering (CHP, fuel cells, PV, battery storage) and digital technology (controls, switching, voltage/frequency management) have facilitated growth of DER supplies, behind-the-meter solutions, and the ability to interconnect supply with transmission and distribution grids.

The availability of investment capital attracted by potential returns from the lower cost of DER-generated power coupled with behind-the-meter solutions. Customers are looking for price competitive and resilient delivered power supply, and creditworthy projects are attracting potential investors. As these projects often have a minimum life of 15 years, the credit worthiness of the offtaker(s) are significant determinants of investor decisions.

Public concern over environmental, health, and social equity/environmental justice issues. This is driving state-level government policymakers and regulators to adopt new policies. These policies focus on reducing carbon-based energy supplies and replacing them with environmentally cleaner supply. The goal is to minimize cost increases, encourage EE, provide equity of service and costs among users, train and upskill workers for jobs in the green jobs sector, improve energy resilience and reliability, and do it in

a way that ensures the financial stability of their local EDCs. At the same time, projects are asked to address the health impact of carbon-based air pollution generally and specifically in overburdened communities, and to meet international public policy requirements to reduce atmospheric carbon.

Energy supply markets and government incentive programs provide financial encouragement for DER participation in supply transactions at the federal, regional, state, and local levels. Previously, investor and regulator decisions were based on a regulated distribution grid fed by large-scale competitively priced remote power generation. Today, the markets are dealing with changes driven by FERC Order 2222, net metering, and grants for microgrid development and EDC-owned resilient community microgrids in rural areas, often with particular emphasis on renewables (e.g., solar renewable energy certificate (SREC) requirements or renewable energy supply targets).

EDCs are evolving. During the 1990s, state and federal power supply regulators were driven by investor and public policy goals to reduce power supply costs. This was to benefit consumers with lower prices by increasing competition in the power supply market. In many states, incumbent public and investor-owned electric utilities were restructured into market-driven (unregulated) energy suppliers and regulated distribution companies. With the advent of DER, EDCs are wrestling with new technical, regulatory, and financial challenges of managing local supply on their grids.⁵

Customer preferences for green power supply are playing a more important role in decision-making. Customers, including corporations and individuals, are beginning to express a preference for purchasing clean power and products with green supply chains. Microgrids generally provide customers with greater control over the type of generation used. They also provide the customer with

⁴ Forbes: [Solar And Wind Costs Continue To Fall As Power Becomes Cleaner](#), 4/30/2020.

⁵ An overview of the deregulation of the 1990s and its effects can be found at: www.rff.org/publications/explainers/us-electricity-markets-101/

the ability to island from the grid. This self-sufficiency is advantageous to many customers.

Together, these disruptions affect the financial underpinnings of the investor-owned EDC utility model differently in each state. Depending on local circumstances, they are forcing utilities to respond, innovate, adapt, and become more customer-centric.

In turn, these challenges are forcing EDC corporate parents to relive the utility deregulation challenges of the 1990s. Those times resulted in reorganization, restructuring, divestment, reinvestment, adoption of new cost recovery policies, and, generally, adaptation to a new legal and market-driven environment. While those changes were market driven and in response to new laws, today's disruptions have multiple, diverse, and more organic causes, leaving laws and policies in place while institutional structures scramble to adapt. These activities have uncertain financial and technological implications for microgrid development and the relationship of the corporate parent to their regulated EDC.

WHY CLEAN MICROGRIDS FOR MUNICIPAL RESILIENCE?

- Islanding the microgrid from the central grid during an outage can help keep crucial public services running and providing essential services to the community during an emergency.
- Diesel generators, when deployed for backup power, create particulate and other health-related pollutants, and are expensive to operate and maintain. They are also not as reliable and resilient as expected. Most facilities only have a two-day supply of diesel fuel on hand, which may be impossible to replenish during major disasters. Some generators may become inoperative due to lack of regular maintenance and testing. Thus, use cases for diesel generation should be carefully evaluated.

“...these challenges are forcing EDC corporate parents to relive the utility deregulation challenges of the 1990s.”

- When used under blue sky conditions, microgrids with high renewable generation can provide reliability, cost-savings, and benefits to health and the environment. However, under emergency conditions, microgrids that are dependent primarily on renewable resources may not provide the needed resilience. A microgrid that:
 - 1) integrates multiple energy resources, including renewables and storage, and/or fossil fuel generators; and
 - 2) integrates the needs of multiple customers for power and heat that can enable economies of scale can better meet municipal resilience needs under both blue sky and emergency conditions.
- Microgrids can help the local EDC grid recover from a system outage either indirectly, by supplying services needed by restoration crews, or directly with the possibility to help the grid re-energize as a black-start resource.
- Long-distance natural gas infrastructure can be susceptible to ground disruptions from earthquakes, supply disruptions, physical damage, and related disasters. Microgrids supplied by reliable, renewable energy supply co-located with customer loads can reduce this risk.
- Microgrids make use of energy that would otherwise be lost. Locally generated power reduces energy losses due to long-distance transmission. Local cogeneration allows the

Types of Microgrids Used for Municipal Resilience

What makes a microgrid a microgrid? A microgrid is:

- 1) a local energy distribution grid with its own distributed energy resource power supply, e.g., combined heat and power, natural gas-powered fuel cell, solar PV with or without storage;
- 2) equipped with control capability;
- 3) within a defined electrical service boundary that includes the critical facility loads to be supported;
- 4) sited behind-the-(EDC-grid) meter; and
- 5) generally designed to work independently of (islanded) or in parallel with the EDC grid under blue sky conditions and can also black start without access to the grid.

Taken together, this structure means the power supply can disconnect from the traditional grid and operate autonomously within the boundary, take power from the area distribution grid, or supply power to the grid. It also means that microgrids can supply both electric supply resilience and reliability. In this context, reliability means that the lights work when they are turned on. Resilience means electricity is supplied when the grid is under stress from weather events, security, and other forms of disruptions.

Microgrids can be classified in many ways. As the technology evolves, new models and variations are regularly developed. As of this report, the following is a useful classification.

Level 1 or single-customer microgrids include:

- **Single site:** A single-site microgrid serves a single building load such as a hospital, school, or public housing building. It reduces energy load for the site owner and is controlled so that it can operate in islanded mode and supply excess power to the grid when called upon.

- **Nano/neighborhood microgrids:** Nanogrids can be quickly deployed in housing developments and are pre-furnished with original construction using solar generation and battery storage serving small residential loads. Multiple homes or buildings can then be aggregated to create a coordinated response to support a larger microgrid or utility grid.

Campus microgrids are classified as Level 2 microgrids. Campus microgrids are deployed at institutional campuses in government, education, military, and businesses sectors to power multiple structures through onsite generation, providing control to the owner, energy cost savings, and resilience benefits. A campus can be considered as a single site that is generally (but not always) behind a single meter, has no or limited RoW crossings, and may have multiple DER or facilities served by the microgrid.

Level 3 or multiple-customer microgrids include:

- **Town Center (TC):** these focus on critical facilities in downtown areas or neighborhood centers of communities, supply a group of independent facilities, cross multiple RoW, and often involve multiple DER.
- **Community:** Community microgrids serve thousands of customers in a neighborhood, village, or town served by one or more distribution substations and can include both centralized transmission and local DER. They are designed to provide indefinite backup power to prioritized critical facility load while providing peak load shaving during blue sky operations.

(continued pg. 18)

Types of Microgrids Used for Municipal Resilience

(continued from pg. 17)

Electricity Distribution Company (usually an investor-owned, regulated public utility) owned microgrids of any level are an alternative technological approach to providing traditional services with the added benefits of resilience and efficiency. If owned or operated by an EDC and with the EDC as the supplier (and microgrid owner), the microgrid could be funded by added charges to the rate base of affected customers if the EDC can justify the need and costs to its regulators.

There are several variations on these themes represented by the overall categories. Direct current microgrids, though not common in North America, generate electricity for consumers that can use the DC-generated power of renewable energy sources (e.g., solar with battery storage) without conversion to AC power. These are more efficient than traditional alternating current distribution grids, since energy is not lost in conversion from DC to AC.

District Heating/Energy systems traditionally use a CHP system with thermal energy distributed in the form of water or steam through a network of pipes to nearby buildings. To create a microgrid, an existing district energy system is expanded with the addition of a steam-driven turbine or renewables to supply customers with electricity for added reliability and resilience benefits.

Resiliency Hubs are a new concept currently being tested in Baltimore, Maryland and other places. These are local facilities powered by a microgrid where community members can access reliable power for their essential devices, receive information as emergency situations develop, store medication sensitive to temperature, and safely congregate until emergency response services restore general electric service.⁶

use of heat generated during production to create electricity. District heating systems that heat and cool nearby buildings can add electrical generation capacity to their portfolio of energy supply resources.

- Microgrids offer the opportunity to deploy more zero-emission electricity sources by balancing renewable energy with controllable distributed generation, flexible load, and storage, which facilitates carbon reduction.
- When operating under blue sky conditions, microgrids can improve system reliability and efficiency during peak use periods by reducing electricity demand and grid congestion. This can help avoid, forestall, or eliminate expensive system upgrades in central generation, transmission, and distribution systems.
- Microgrids can be designed for blue sky operation: to supply power at a lower cost than grid-delivered power supply.⁷ These are the most cost-effective designs.
- Another use case type places DER near the need for resilience, tied into a neighborhood EDC circuit, and then run by or under contract to the EDC. This can be advantageous where grid assets are insufficient to meet stressed circumstances with adequate reliability and resilience and critical facilities are on the circuit. The Hartford, Connecticut “Hartford/ Parkside” project is an example of this (and is discussed below).

Combining the foregoing, a microgrid can operate in blue sky mode to reduce grid-supplied energy costs; operate in islanded mode when the grid is not delivering supply; connect during blue sky and sell excess supply to the grid operator in support of grid needs; make use of lost energy in heating and reduce transmission losses; reduce system upgrade costs; and reduce carbon emissions in the region. By combining these values, microgrids make compelling resilience, reliability, economic, and environmental arguments for agencies deciding to employ them.

⁶ The [Urban Sustainability Directors Network](#) and the [Clean Energy Group](#) are two organizations leading this concept.

⁷ See Part 4, Section C.

Part 3 – Findings of Town Center Microgrid Survey

A. SURVEY OVERVIEW

The research process focused on learning how TC microgrid projects are developed and operated.⁸ The first step was to conduct online research to identify locations of planned or operating TC microgrids. An online survey was developed and administered to learn details about the projects generally and procurement and financing specifically. Conclusions and guidance would flow from that process.

The survey defined a TC microgrid as a microgrid that is owned or contracted for by a municipal government. It must provide, at minimum, power supply reliability or resilience to critical facilities. Other possible use cases might be considered as well.

Potential TC-type projects were found in the northeast. These were primarily the result of state programs providing development incentives. In addition to New Jersey's effort, incentive programs were found in Connecticut, Massachusetts, and New York. These efforts are discussed below.

The survey was divided into Project Planning, Ownership, Financing, Procurement, and Operating sections. After respondents defined their project's stage of development, they were asked to complete the sections of the survey relevant to their projects.

Once developed, the survey was deployed in August of 2021. Most NJ respondents completed their surveys with only one or two general or personal reminders. All of these projects were in the planning phase.

Responses from projects in other states were disappointing, as only one of 25+ potential projects in CT, NY, and MA responded. Outreach to encourage responses, or to understand why there was no response, was conducted via emails and personal phone calls.

Based on feedback from the follow-up process, the team concluded there were several reasons for the lack of responses. A primary one was a combination of limited time and attention of municipal staff given the challenges of the pandemic. Other issues were survey distribution timing that overlapped with an August hurricane in the region, employee vacation schedules, the press of regular business, and lack of interest ("What's in it for my organization?").

Some locations did not want to participate because their projects were stalled, cancelled, or had political sensitivity. In these cases, potential respondents simply did not want their status publicly acknowledged.

The team then turned to internet resources to track down details about the potential TC projects. This was invaluable as it provided understanding about the types of projects and their status. For example, projects that were thought to be TC microgrids turned out to be campus microgrids. Additional understanding came from discussions with state officials. Here, state program staff observed that many of the projects had been found to be impractical and were not funded for economic, regulatory, and policy reasons.

⁸ Team members had previously studied microgrid procurement and financing in the New Jersey context. Material on that effort is posted on the NJIT managed www.microgrids.io website.

B. SUMMARY REVIEW AND OUTCOMES OF STATE INCENTIVE PROJECTS

The following summarizes the incentive projects in the four northeast states that ran microgrid incentive programs. Section 7 contains additional detail and information on each program.

These state efforts received substantial industry attention from the energy/microgrid press, along with local coverage in places that applied for and received grants. Projects were recognized in local and microgrid industry trade press as they took steps on the road toward potential success.

NEW JERSEY TOWN CENTER DISTRIBUTION ENERGY RESOURCE (TCDER) MICROGRID INCENTIVE PROGRAM

In 2017, the NJBPU authorized a financial incentive program to encourage the development of TC microgrids. In 2018, thirteen local government agencies throughout New Jersey qualified and received funding for an [initial round of feasibility studies](#). Twelve of those applicants (one voluntarily withdrew) were eligible for a second round of funding for design support. Eleven applications were submitted (one chose not to submit an application). Ten of these responded to the survey.

In March of 2021, eight of these applicants were [awarded shares of \\$4 million to fund design studies](#).

NY STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY: THE NY PRIZE COMPETITION

No survey responses were received from eight potential NY Prize applicants. The following information was gleaned from the NYSEDA and other websites and telephone conversations with potential respondents and program staff.

[Two rounds of competitive projects](#) provided planning and feasibility funding for a wide variety of projects. Many studies were produced exploring financial and technical viability. A third and final round was eventually suspended as a state policy decision was made to limit funding to renewable supply projects. As a result, no projects were found to be financially viable.

Three projects were separately funded through grants from the [Governor's Office of Storm Recovery](#). Other projects were referred to the state's Green Bank, but to our knowledge no project has been funded through the Green Bank. There were no TC projects funded by the NY Prize. One non-government project funded by the Governor's Office with a TC-type configuration is still in development. There was little or no public acknowledgement or data regarding the limited success of the program.

CONNECTICUT DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION - MICROGRID GRANT AND LOAN PROGRAM

The Department of Energy and Environmental Protection (DEEP) program was very successful and was designed to help support local distributed energy generation for critical facilities. A TC configuration was not required.

No survey responses were received from Connecticut DEEP program participants. Information was obtained from the DEEP program website, various local and press websites, and telephone conversations with potential respondents and program staff.

Four rounds of grants and loans were distributed over seven years. Thirteen projects were funded and successfully completed. These are campus-sited microgrid projects, half of which were for local government projects, with the remainder a variety of non-profits, US Department of Defense facilities, and higher education projects. There was one successful TC-type project ([Hartford/Parkville](#)).

MASSACHUSETTS INITIATIVES

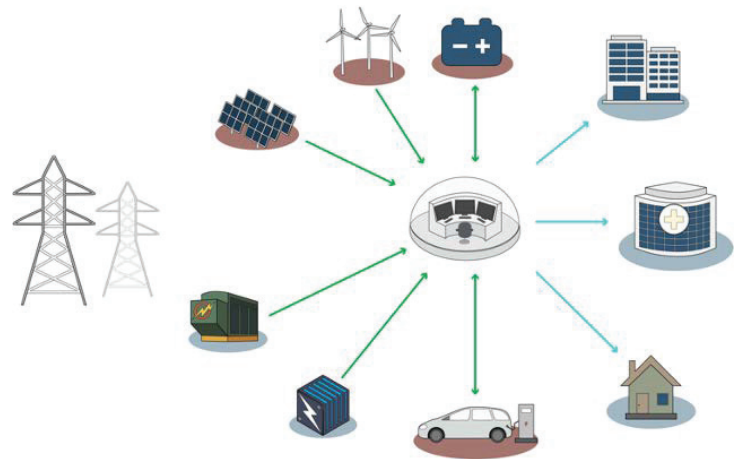
Two initiatives were operative in the state: one administered by the state's Department of Energy Resources (DOER), the other by the Massachusetts Clean Energy Center (MassCEC), a state-funded economic development agency focused on developing clean energy projects through various investment strategies.

No survey responses were received from Massachusetts program participants. The following information was gleaned from various websites and telephone conversations with potential respondents and program staff.

[DOER - Community Clean Energy Resiliency Initiative \(CCERI\)](#). This \$40-million five-year program offered grants to cities and towns to use clean energy technologies to protect citizens from service interruption caused by severe weather due to climate change.

Three rounds of grants were made to what were mostly campus, specialized, or local EDC microgrids. Some were successfully developed and implemented; others were supported but unable to move to successful development. There were no successful TC projects.

MassCEC's [Community Microgrids Program](#) was designed to "catalyze the development of community microgrids throughout Massachusetts



to lower customer energy costs, reduce greenhouse gas (GHG) emissions, and provide increased energy resilience."

[\\$1.05 million was awarded for feasibility studies](#) of 14 projects in communities across the Commonwealth. The program closed without any program receiving further development funding. A report is pending.

An interview with MassCEC staff resulted in an observation that their projects were unable to move forward as they were not financially viable given costs, utility connection challenges, and EDC RoW issues. There may be portions of projects that eventually proceed given unique local circumstances.

There was little or no public acknowledgement or data regarding the limited success of the programs.



Part 4 – Developing a TC Microgrid

A. PLANNING AND PROCUREMENT

PLANNING FOR ENERGY RESILIENCE AS A RISK MANAGEMENT OPPORTUNITY

A TC microgrid is a solution to a community resilience problem defined by local officials. This implies that the community needs to go through a study process that concludes they have a problem to solve. That problem can have many variables: the facilities to be covered, risks to mitigate, and goals that may include a reduction in electricity costs and carbon emissions, updated facilities, decisions on off-site critical facilities to be covered, alternative solutions, etc. A decision to develop a TC microgrid comes at the end of the process.

Planning precedes and drives the development process. Planning processes vary and must often be designed to fit the needs of the specific community or entity being served. A planning process organizes the variables, determines priorities, assesses and evaluates options, and makes recommendations. A solution to achieve critical facility resilience may include a microgrid, but there are likely a range of solutions and technologies that may achieve the goal.

By their nature, decisions concerning the development of a microgrid or the purchase of DER in any form comes with risks that are dependent on how the resource is obtained. While going through planning, procurement, and financing activities, public agencies are obligated to ensure risks are identified before undertaking the project.

Once identified, mitigation strategies consistent with the risk must be part of project development. Managing risks is an essential part of the project development process.

Project development elements include specification development, construction management, system operation contracts, energy supply agreements, and public communications. Contracts with third parties are often needed for these services as very few government agencies possess the skills. These contracts need to be negotiated by experts who understand the energy supply industry, can develop risk mitigation strategies, and assure these strategies are reflected in contracts between the parties.

PLANNING A RESILIENCE SOLUTION

The process to develop a solution to the defined resilience problem warrants a situational or use-case appropriate analysis to understand the options available to the community.

The unique nature of meeting resilience goals may warrant the use of consulting services and a local civic engagement process to consider the scope of the problem, understand the range of possible solutions, evaluate them based on needs and values, and make recommendations on how to proceed. Understanding the range of solutions that may be available is often accomplished through a *Request for Information (RFI)* process.

Today's contemporary energy supply and development market is unique as the industry



is developing new technology that can be solutions to existing problems and unrecognized opportunities. There are cases where an independent energy development company or existing CHP facility may approach a government agency with answers to questions the agency may not have considered. In other words, a third party may point out a previously unrecognized opportunity.

Regardless of how it happens, sound planning and procurement practices call for an appropriately defined RFI process or independent evaluation of an unsolicited proposal. This should be conducted to ensure the proposal is appropriate, technically sound, and financially feasible. A sound planning process may also highlight other technologies, competitors, or different approaches that can provide a better solution. The process is facilitated by having a well-informed team that not only understands the community but has a robust and contemporary understanding of energy supply policies, technology, markets and finance.

However, the public expects and deserves transparent processes from government agencies. Public procurement activities and a contracting process are expected to be performed in a fair and open manner.

PROCURING THE SOLUTION

Having gone through a thorough planning process consistent with a community's needs, if a TC microgrid solution is called for, there are a variety of approaches a government agency can take. Three of the most common include:

- Public development, ownership, and operation. This may be appropriate in cases where the agency also serves as, or has a legal relationship with, a local EDC that has the authority to develop and manage these projects.
- The agency contracts to buy DER-based supply and facilitates development of a distribution grid that is privately developed,

owned, and operated for the specific purpose of creating a TC microgrid.

- Agreements with local institutions that possess DER generation capacity that exceeds their needs and can make it available to the public entity and other critical facilities (e.g., a hospital with CHP sells excess supply to the microgrid). The development and management of a TC microgrid can be done directly by the agency through a contract with the energy source or local EDC.
- There is also the potential for development of a hybrid model where a public owner partners with a private developer and engages the EDC to provide operational or related services.

Some use cases may warrant engaging a third party (aka developer) to perform services. These cases include:

- Where a developer designs, builds, operates, and maintains (or any combination thereof) a TC microgrid that will ultimately be owned by the agency; or
- A developer develops the desired DER for the agency to purchase supply and the developer designs, builds, owns, and operates the TC microgrid. Because the energy supply can be greater than what the agency may need, the developer may contract with other critical facility offtakers.

Individual circumstances of a community such as their fiscal condition, location, state laws, EDC ownership, and services can affect different approaches. These different solutions could be mixed and matched to create a hybrid that meets a specific set of circumstances.

In these cases, the lead government agency may serve as an aggregator of additional demand for other government agencies (a form of cooperative purchasing) and take on the responsibility to make supply payments under an EaaS agreement. This relieves the microgrid owner or operator of the financial risk of dealing

“Agencies should avoid situations where they are pressured to act fast to meet an arbitrary deadline.”

with multiple customers but transfers that risk to the lead agency.

An agency would then consider the range of solutions and ownership/operation structures and make a decision on a preferred approach or, perhaps, explore several approaches. The next step would be a competitive process for interested and qualified organizations to propose how they would implement the TC microgrid project. This process is commonly known as a Request for Proposals (RFP).

The agency may contract for assistance in this process or otherwise assemble a hand-picked team to advise it. That team may be composed of energy development professionals along with agency personnel (or borrowed from sister agencies). Active participation by the agency is indispensable to the project as it assures that agency concerns are met. The process must also keep senior decision-makers informed to facilitate approval of the final contracts.

Regardless of whether they are staff or consultants, team members are to represent the agency's interests. Those interests include a range of finance, legal, technical, procurement, and public communications issues. Where necessary, they should have experience in the specialized nature of energy procurement. This will be essential when reviewing proposals or negotiating with developer representatives who will be knowledgeable of the field and the developer's financial interests. Too often in government procurement, government personnel are outmaneuvered by the developer, whose team brings more experience to the table. The agency must ensure their team can competently represent themselves.

The RFP package must be sufficiently detailed to allow competing proposals to be evaluated in comparison to one another on defined outcome and related criteria. A package might include lists of expectations or goals that the agency desires to be met. A scoring or ranking process is also necessary to evaluate the strengths and weaknesses of competing proposals. Sufficient time must be allocated to this process in both the time given to proposers and the time the agency will need to evaluate them.

The RFP will likely need to be publicly posted (or as otherwise permitted or required under local procurement rules). Efforts to circulate it to the largest possible audience of qualified developers can help assure a robust response. In some cases, where the agency has specific expectations in mind, the process can include a pre-qualification process to narrow down the number of developers by assessing their capabilities.

After evaluating the proposals, the agency can choose how it will proceed to implement the chosen project. Once the choice is made, the agency negotiates and enters into an agreement with the developer. Allowing sufficient time for negotiations is a necessity in complex projects. Agencies should avoid situations where they are pressured to act fast to meet an arbitrary deadline.

Complex projects may warrant a phased project with stopping or “exit ramps” that permit the project to be modified, suspended, or abandoned. In these cases, a contract with a developer may include a project phasing process that involves a feasibility study, an initial design study (often tied to a percentage of design completion), and final design study. The completion of each stage may provide rights or impose obligations on the parties. Expectations regarding phasing should be set forth in the RFP. Having experienced energy counsel working for the agency will help it work through these issues.

The outcome may be a contract with detailed terms and conditions to buy energy supply and delivery through an EaaS. An EaaS could also include a project development agreement addressing development of a site owned by the

energy buyer and leased to the energy supplier. That lease could house the generation equipment and appurtenant distribution and control equipment. There could be variations where the equipment is owned or financed by the agency and leased to or owned by the energy provider.

For example, microgrid equipment suppliers and financing organizations are developing the capacity to design, develop, finance, build, and operate systems through variations of EaaS agreements. The implications of this evolution are reviewed in the next Section, Contracting for DER.

When complete, these agreements may be complex documents that address the calculation of power supply and delivery rates paid by offtakers (i.e., the agency, if it is not the owner of the system, and perhaps others). They also need to address the myriad of contingent circumstances that can occur during the life of the contract. This also reflects the importance of the agency engaging an attorney with experience in energy supply issues to represent them.

If the plan is for the agency to own and operate a TC microgrid, it will need to arrange for its design, construction, operation, and maintenance. That can be accomplished in a variety of ways using a combination of agency employees, professional services, service contracts, and public bidding resulting in construction of a project. The specific approach will be very dependent on the nature of the project, capacity of the agency, nature of the financing, and laws regulating the agency's procurement processes.

While these are generic procurement steps, each agency must assess its own conditions and develop a process consistent with its needs and its local or state laws. Further, the financial implications of the project discussed below may warrant modifications of this process to ensure procurement and financial dynamics are properly integrated.

THE FRAMEWORK HAS MANY VARIATIONS

The microgrid industry has developed various approaches to identifying the resilience needs in a community. These recommendations include steps such as "Assessment of Resilience Enhancing Investments," "Evaluate Strategic Microgrid Deployment Scenarios," "Develop Solutions," and "Implement Resilience Enhancement Options." These exist in various permutations on consultant, designer, and manufacturer websites, often focused on the role the organization plays.⁹

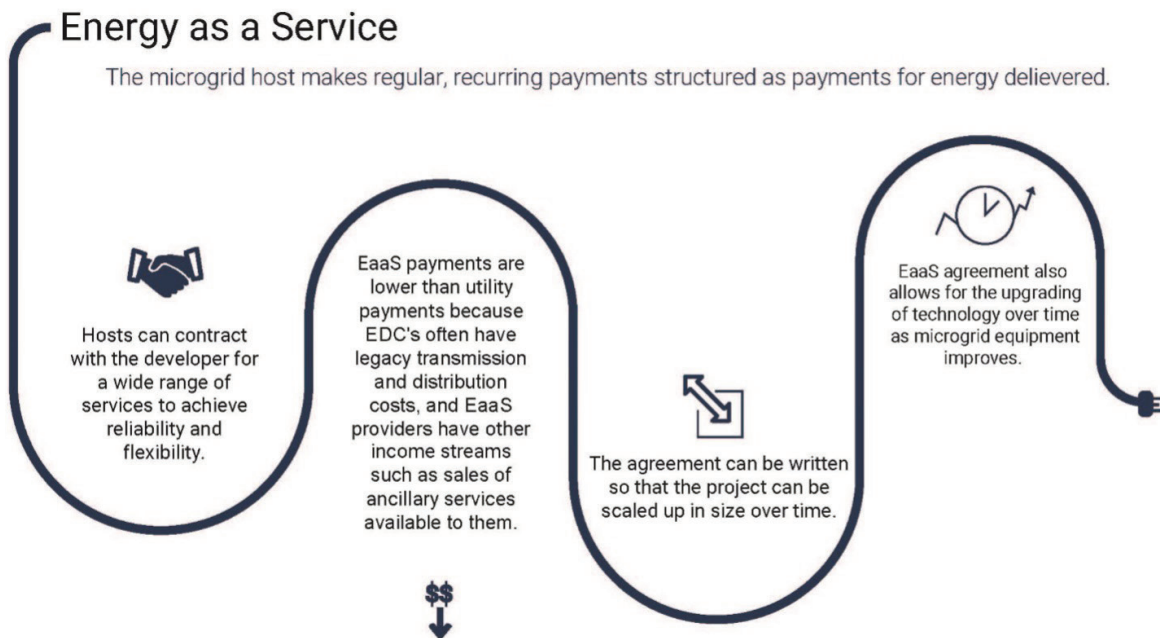
As a guide to assist agencies in developing their procurement approaches, agency officials may want to consult an infrastructure model procurement process that can be applied over the range of energy opportunities and solutions. The [Atlas Toolkit for Procuring Resiliency](#) was developed with consideration of energy resilience options as a use case.

B. CONTRACTING FOR DER

Energy supply contracts are generally sophisticated legal documents and should be prepared by lawyers with experience in the field. The intricacies of these contracts are beyond the scope of this report. However, the case of town center and similar DER projects (i.e., single-site or campus projects), warrants special attention to two forms of agreements: energy supply purchase agreements (by whatever name) and public-private partnerships.

This discussion excludes projects where the public agency will have sole ownership and responsibility to operate and maintain a project, such as when a government utility serves as the EDC. Those projects are more straightforward public construction or development projects (similar to municipal redevelopment projects) than energy-supply agreements.

⁹ The NASEO and NARUC [Microgrids State Working Group](#) released a paper in January 2021 that provides a technical analysis of the design decisions that go into a microgrid, once one is determined to be a solution. See [User Objectives and Design Approaches for Microgrids: Options for Delivering Reliability and Resilience, Clean Energy, Energy Savings, and Other Priorities](#)



POWER SUPPLY AGREEMENTS

These agreements are known by several industry terms: EaaS, Power Purchase Agreements, and Energy Service Agreements. Virtually all successful microgrids reviewed by the study were campus-based EaaS agreements between the government agency as the offtaker and a developer.

The project must have an investor willing to pay the capital costs in exchange for a return on the investment. This requires the investor to perform a thorough risk analysis of the project, a crucial portion of which is assurance of return of the investment through offtaker payments. Similarly, the agency offtaker must be assured that the developer has a firm financial underpinning for the project, as well as the technical capability to execute its responsibilities under the contract.

For the agency, assurance of developer capacity can be documentation of investment capital in hand or its assured availability, demonstrating that the business is an ongoing concern and that the management team has experience to see the project through. The developer/investor wants

assurance that the offtaker has firm credit history and will pay their power supply bills over the life of the agreement.

Generally, a contract with a government agency provides greater payment security to an investor than a commercial project, though that does not make a project risk free. Political risks always exist when public agencies are involved.

To help make a project economically viable, the offtaking government agency may be able to offset the developer's costs with capital or in-kind contributions. This can be in the form of contributed capital or resources (e.g., rent-free land), which can reduce the cost of supply.

The financing of the development can be enhanced by the agency taking on some of the credit risk by borrowing capital directly or guaranteeing repayment of borrowing the developer may need to do. This can reduce the developer's costs directly or reduce the interest cost of the borrowing. An example would be the agency providing the investor (if allowed under the agency's laws) a pledge of the full faith and credit of the government to meet its

obligations under the EaaS agreement. This effectively commits the agency to purchasing the contractually agreed amount of energy even if the needs of the agency are reduced or a new technology results in lower costs. An alternative would be to compensate the developer/operator via buy-out costs as specified in the agreement.

A larger project serving multiple offtakers can have advantages, such as better cost-effectiveness than a smaller project. At the same time, however, a larger project adds complexity and different risks must be addressed and mitigated. Each project has different advantages and disadvantages that require a careful risk assessment and the development of appropriate risk mitigation strategies. The accompanying graphic on EaaS provides a conceptual view of the process.¹⁰

Government agencies have their own rules (along with state laws) on how the agency can enter into an agreement. Some may require public advertising and submission of competitive proposals from potential developers; some not. Others may have limitations on lengths of contracts or rules affecting construction labor. This challenge is also discussed below under Public-Private Partnerships.

Supply agreement risks to the agency are increased when there is little senior management expertise or limited 3rd party/impartial expert review of supply contracts and risk assessment. This reinforces the earlier notion that entering into energy supply agreements requires the support of knowledgeable legal counsel. This can help offset the greater degree of project development knowledge possessed by the developer. In the contracting world, this is known as “[asymmetric information](#).” It is a significant issue for offtakers to consider in today’s environment.

Examples of supply agreement risks include:

- Contract provisions that do not adequately address the range of potential future



circumstances and risks. This could run from changes in energy markets that could affect formula or index rate pricing (e.g., day-ahead energy market rates), to technology innovations and upgrades (improved battery storage at lower costs), to ownership changes (original developer sells to a third party).

- Where a critical facility would lie on the EDC’s priority list of reconnections when the microgrid was islanded in an emergency situation and when it could reconnect to the grid. This may affect microgrid technology and storage capacity decisions and, in turn, energy supply charges.

THE P3: PUBLIC-PRIVATE PARTNERSHIP

In the world of public construction, a P3 is a variation on construction contracting practices that are intended to improve how public infrastructure projects are designed, constructed, and, if desired, operated. The concept is an alternative to the traditional government design, bid, build approach. It allows a more negotiated/less

¹⁰ Content from Sapling Financial Consultants presentation at Microgrid Knowledge 2021 Conference.

competitive and less rigorous initial design and procurement process.

It has a mostly positive track record of success in European countries. US experiences are generally acknowledged to be mixed. Many of the negative experiences can be attributed to politically driven decisions or contracts that favored the developer/contractor over the public agency (see the issue of asymmetric information above).

Today, P3s are often promoted by sophisticated investors and project developers as a cost-saving transfer of responsibility of public liability to the private sector for public projects. In some cases, however, they are traditional contracts for services, procured through a less transparent process, but can result in similar or less successful outcomes. The outcome is generally driven by the attention and skill involved in negotiating the contract and then managing the development process.

While they can vary greatly, P3s have a common element; a P3 generally involves a more flexible design process and a less competitive procurement process than the traditional government design, bid, build model. It includes the proposition that the developer/contractor is taking on more risk that reduces the government owner's risks and therefore deserves a more flexible procurement, contracting, and operating process. A P3 financial structure may include elements of EaaS agreements.

The use of the term "partnership" lends the appearance that risks are equitably shared between the parties. In a typical P3, the developer takes on responsibility for bringing projects in on a fixed budget and time schedule. As an incentive to reduce costs and risks, the developer is often granted greater flexibility and incentives on design, technology, workforce rules, permitting, and reduced levels of project transparency than a traditional government project.

The government usually assumes the financial responsibility through debt issuance or guarantees and liability to make payments on what are believed to be fixed and fair formulas. Regrettably, they may have unanticipated fiscal or political consequences when unanticipated events come to

light during development or once in operation.

Contract provisions may involve incentive payments where the contractor receives an added benefit for completing a project ahead of schedule or beating pre-set performance benchmarks. These are not so much a sharing of risk, but performance incentives that can be part of any contract.

Similar arguments can be raised for energy performance contracting where guarantees are made that system performance will exceed specific benchmarks, but where the calculation relies on variable, hard-to-measure, or unprovable standards.

Ensuring a fair partnership requires well-considered contractual provisions. Among a wide range of legal provisions, contracts should include strong project management oversight by the owner to ensure that all agreed upon provisions are being met. P3 contracts also require an efficient and equitable dispute resolution process to resolve the invariable disagreements. Finally, if the agreement is to reflect a true partnership, there should be a sharing of both risks and rewards that benefit both the public being served and the private contractor.

Today, the P3 proposition has become a challenging one. A successful P3 requires a great deal of attention to contractual details and negotiation by individuals experienced in the specific field. Organizations considering a P3 or variations on the routine construction and development process must carefully assess their options, engage competent advisors, and be transparent with the public on the project.

C. FINANCING PROJECTS

Financing microgrids generally and TC microgrids specifically is an evolving commercial activity. This is, in part, due to the challenges reflected in this report. However, if other obstacles are overcome, there remain a range of TC project financing issues that must be considered.

CHALLENGES OF PROJECTS BECOMING GOOD INVESTMENTS

The first challenge is that investment decisions **must** be based first on the investor's expectation to be paid back with interest. If there is more than a small risk that this or an insufficiently high enough return on the investment to offset that risk will not be achieved, financing is unlikely. Next comes an assessment of the project owner's ability to manage the financial and public policy risks, who bears the risks, and how they are reflected financially. The greater the risk borne by the developer, the more expensive the project's financing cost, as the investor will expect a higher return for taking on greater risk. Greater risk absorbed by offtakers can reduce the costs of financing, but this shifts the risk to increased long-term costs for the offtaker.

Projects that are more complex or require more time and attention, technical expertise, and increased investor risks will require greater rewards and will be harder to finance than those that are less so. Microgrids using existing DER can benefit from the reduced need to add new generation; but using DER that is not sized for the microgrid or that is otherwise difficult to integrate can add complexity and risk to the project.

Several other factors can affect the financing of projects. The development of industry standard agreements and processes to package deals would make projects more attractive to investors. Clear regulatory structures reduce risks and project delays. In most cases, the availability of multiple competing bids will lower the costs to

This section assumes that the project will be developed by third-party developers with outside investor financing and, as in most cases, include some form of EaaS agreement.

The study revealed few TC microgrid projects that were designed to be developed directly by or financed with the agency's debt. These projects were primarily locally managed, financed, and developed by a government-owned EDC serving a single municipality.

These projects are less a TC microgrid and more sound energy supply enhancements to their local grid. While there may be other use cases that warrant direct (non-EDC) public agency development and financing, such projects would be address unique circumstances.

offtakers; reduced competition or relying on a single vendor can increase financing costs (this often relates to more complex projects).

Financial feasibility will be affected by all these factors. The more financially feasible and viable microgrids generally, but not always, are those that supply more power (generation capacity) than smaller ones (other factors, such as project technical complexity being equal).

This suggests that, for a specific use case, the price of local generated microgrid energy is generally higher per megawatt than large scale generation. However,

1. with a larger microgrid project, the fixed costs (e.g., land, interconnection) and "soft" costs (e.g., design, procurement process expenses, financing due diligence, etc.) are spread over more units of production, generally reducing the per-unit cost of supply. Then, with all other things being equal,

Microgrid Financing



Main Concerns

- Match technological attributes with monetary value streams
- Demonstrate operational benefits
- Demonstrate viability as microgrids are viewed as new technology
- Compare data across several microgrid projects



Key Factors

- Track records
- Creditworthiness
- Revenue streams
- Capital stack
- Risk allocation
- Ownership

2. locally generated power eliminates wired transmission costs and transmission line losses, and reduces distribution (EDC, taxes, etc.) costs from grid-based power, ([See also below Risk #2: Impact of “Cream Skimming” on EDCs and DER Projects](#))

Subject to the varying conditions of location and project, the factors identified above suggest: 1) that the larger a local project is, the greater the opportunity for savings over a smaller project and from remotely generated, local EDC-delivered supply; and 2) eliminating the transmission and distribution costs of remotely generated power generally makes the more expensive but locally generated supply less costly.

Each circumstance, however, is different and requires careful and thorough analysis of each use case.

Another challenge is ensuring the parties understand the full financial picture of a microgrid project through the financial pro forma document. The pro forma is an accounting of all estimated project revenues and costs. This is usually based on an Excel worksheet that permits running various

scenarios of costs and revenues. These scenarios can vary revenues, development, operational and maintenance costs, and investor returns. They can test the robustness of the financial projections by identifying weaknesses and risks.

Both developer and offtaker attorneys, engineers, and experts must understand the business and electrical supply needs of the parties. Considering the public environment, a developer selection process that addresses the issues raised in the procurement section above are key to ensuring a fair process. The accompanying graphic on Microgrid Financing amplifies these points.¹¹

Folk wisdom suggests that an investor should never invest in something they cannot explain to someone else. That advice holds true here, particularly as it applies to government officials speaking to their constituents. Thus, due diligence, careful analysis, and understanding proposals are essential for decision-makers. This is important because a developer has a better grasp of financial and supply issues (asymmetry of information!) than government representatives. Government decision-makers cannot abdicate their understanding to their experts and need to

¹¹ Content from Sapling Financial Consultants presentation at Microgrid Knowledge 2021 Conference.

fully understand and be capable of explaining a contract to others.

The next challenge is understanding that successful projects require resolution of EDC issues. This involves regulatory constraints, technical compliance, RoW rights and restrictions, fees, DER access, market-access, interconnection costs, and related site-specific issues. These must be understood and resolved early in the process and public policy issues (decarbonization incentives) understood so financial pro forma statements can be reliably developed.

The final element is the implication of microgrid design on offtakers. If a microgrid requires installing parallel or undergrounding of distribution lines, switches, and controls, it adds to the capital to be recovered in rates paid by the microgrid's offtaker(s), unless initially subsidized.

These costs may be fully or partially offset if they can be absorbed and rate-based by the EDC and shared across a wider group of ratepayers. Rate-basing costs may be appropriate if the elements of the microgrid (e.g., parallel lines and switches) add resilience or reliability to other EDC customers.

These costs may also be offset if the microgrid's excess power or ability to provide other products (e.g., frequency regulation) can reach markets or other buyers that will provide fair compensation. Therefore, the EDC must be willing to either purchase these products at fair prices or provide a means to transmit them to a buyer who will.

These circumstances warrant consultation with the EDC and potentially regulators to develop a strategy that can be mutually beneficial. In some cases, regulatory policy changes may be necessary to facilitate these actions. As this report is drafted, several states have started to address these issues by developing microgrid tariffs ([CA](#) and [HI](#)). Updated interconnection policies, customer acquisition, equal access to RoW, and infrastructure sharing protocols (to avoid duplicate facilities), are among the areas that merit attention.

Pro Forma Financial Statement				
		Year 0	Year 1	→ Year 20
Sources and Uses of Funds	Sources			
	Uses - Direct & Indirect Development Exp.			
Project Pro Forma Financial Statements	Total Revenues and Benefits			
	Total Operating Expenses			
	Operating Income - EBITDA			
	Non Operating Expenses			
	Project Pre-Tax Profit			
	Tax Expense			
	Project Net Income (Loss)			
	Less Debt Repayment, Plus ITC & Deprec.			
	Project Cash Inflow (Outflow)			
	Appropriate Discount Rate			
	Project Net Present Value (NPV)			
	Project Internal Rate of Return (IRR)			

STRATEGIES TO OFFSET CAPITAL AND OPERATIONAL COSTS

Access to multiple revenue streams mitigates risk and adds cost-stability for any project. Developers can take advantage of several strategies to offset development costs and lower or moderate the cost of supply to offtakers. These include:

- Revenues from supply sales to third-party offtakers
- Sale of excess power or grid services (e.g., frequency regulation) to the EDC or independent system operator (ISO)
- Ancillary revenues, such as from the sale of renewable energy certificates (RECs), or extra conduit capacity to third parties such as telecommunications providers
- Taking advantage of EDC-avoided costs programs (by keeping demand off the grid) and demand response program management

Another important element is incorporating EE (using less energy to perform the same task) strategies to reduce energy supply needs. While not specific to microgrids, the process of considering a microgrid can provide incentive for an owner to take advantage of EE incentives [offered by their state government](#) or EDC.

Because EE has the effect of lowering power supply needs, this can have a confounding impact on the project pro forma. It depends on when offtakers engage in the practice. If planned ahead of time or alongside the TC microgrid, the practice results in less energy to be generated and can result in a smaller, less expensive project or sale of supply to additional offtakers.

If the original offtakers engage in EE programs after the project is underway, depending on project design and use projections, the resulting available supply could be sold to other offtakers or the grid, if practicable. EE considerations should be part of the initial design assumptions

and negotiations. This is important to avoid the uncertainty that reduced offtaker consumption stemming from EE savings may create.

For government agencies, EE initiatives can include Energy Performance Contracting (EPC/ESCO) programs. Private sector offtakers (commercial and residential) may be able to leverage programs such as [C-PACE](#) (Commercial Property Assessed Clean Energy) if available in their state.

More sophisticated projects could involve energy supply price-hedging strategies. These add price risk and may not be well suited for local government and other offtakers or developers.

Costs can also be offset if there is state government support for feasibility and design studies, direct development cost contributions, or financing preferences for low interest loans (e.g., Green Banks).

Finally, there are additional evolving cost considerations and values. These include leveraging any cost spread between local DER and long-distance transmission-based delivery, the former costing less and the latter costing more. There is also incentivizing other proactive actions such as promoting building automation and accelerating electrification of traditional natural gas-based activities (i.e., replace gas-fired furnaces and hot water heaters with heat pump-based systems).

FINANCIAL CREDIT, SECURITY, AND CAPITAL INVESTMENT

Credit security is vital to investors given long-term supply contracts. The security of payment provided by an offtaker is a decisive element of investor risk calculation. It affects the rate of return on the investment, which feeds into offtaker supply charges.

When permitted by state laws, government agencies may have tools that can support projects with lower costs or risk absorption. For governments, this may require them to



bear long-term risks by agreeing to make payments regardless of circumstances to ensure the developer/owner gets repayment of their investment. Here again, it is important that the parties have full understanding of the risks they are taking on.

Generally, for microgrid projects where the public agency is an offtaker, private sector capital comes through developer cash, a bank loan (commercial or green), or private investment financing. As this is written, a thriving and varied ecosystem of national and regional investors who see these projects as investment opportunities is developing. This has particular relevance to government facility campus sites and large public and non-profit facilities (i.e., airports and hospitals).

Different types of investors have different investment strategies. A given project may be more attractive to some investors than others, depending on its nature. One important element that drives investor decisions is the potential effect of utility rate regulation that might be part of a project. Such regulation can add risk to or limit the return on investment; or remove risk, such as where the utility is permitted to add to its rate base some of the infrastructure that supports the microgrid.

Government agencies can also use their own financial resources through capital spending. These resources can include capital debt as bond issues or “pay as you go” through annual budget appropriations. They can also include leases, grants, or assuming responsibility to finance and operate their own projects. As noted earlier, these can be tied to energy performance contract projects to leverage cost savings.

Municipal debt generally needs to be tied to projects owned by the agency. To ensure financial solvency and integrity, state governments often set statutory limitations on use and the process of issuing local government debt. For example, a state may limit a local government from pledging its full faith and credit as part of an offtaker credit guarantee that supports developer investment in a microgrid.

Another approach is to take advantage of state policies that leverage government energy incentive programs. Many states offer combinations of grant and loan programs through direct programs, green or infrastructure banks, or government-issued bonds to support government projects. By working with a state government program, a local agency may be able to take advantage of a lower interest rate than it would receive on its own.

As found in this study, state governments in the northeast developed microgrid grant and loan programs in the years following Superstorm Sandy. Today, these programs are effectively closed, being closed, or being refocused based on the experiences of the period.

Some EDCs have programs that can reduce the agency’s supply costs, which in turn can free up cash flow for debt service payments. These include subsidies provided through demand reduction programs, peak-shaving cost savings, waiver of fees, and unintended state support by the elimination of front-of-meter fees (e.g., state taxes or societal benefit charges).

A recent NASEO/NARUC white paper titled [Private, State, and Federal Funding and Financing](#)

[Options to Enable Resilient, Affordable, and Clean Microgrids](#) provides a more expansive view of funding and financing microgrids in general.

D. OTHER CONSIDERATIONS

THE MATTER OF VALUING RESILIENCE

Not all TC microgrids will reduce energy supply costs or be the most cost-effective solution to the problem identified by the municipality. In fact, a TC microgrid can increase costs. To offset the added cost, it is argued that a well-designed TC microgrid can bring added resilience to a community during outages, and the added cost of that resilience can offset added supply costs. But an integral part of that calculation is how resilience is valued and distributed to the beneficiaries. This poses a question that has challenged policy analysts and scholars.

First, there is the range of definitions of resilience. From a [USDOE presentation](#) extracted from a Presidential Policy Directive, resilience is defined as:

“the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.”

This more specific version is [found on the web](#): *“Energy resilience is about... a reliable, regular supply of energy and contingency measures in place in the event of a power failure.”*

Using these as a starting point, to set a value on resilience for a given use case, energy users need to determine:

1. How much energy resilience do they need?
2. How much do they want?
3. How much can they afford?

These general elements highlight that putting a price on the value energy resilience provides is

harder than defining it. Reaching value or pricing decisions involves a range of issues:

- The length of time power is out and the impact it has on services the agency provides. Public safety responses, urgent personal needs of citizens, agency costs of recovering from an outage, losses to affected critical businesses (e.g., pharmacies) without or with insufficient backup supply, and loss of economic activity in the community must be considered.
- The value and risks of buying, running, and maintaining traditional generators, including indirect costs related to carbon emissions and health impacts.
- The consideration of essential public services and their dependence on power supply.

These issues become more complicated when narrowing them down to determine the impact on a specific Town Center microgrid, and when there are multiple critical service oftakers with their own needs and who may value resiliency differently.

Regardless, the first two elements are clear on the surface: the third warrants elaboration.

The Challenge of Energy Interdependence and Government

How dependent are operational systems on reliability of power supply? Government agencies have many interdependencies within the electrical distribution system. Interdependencies go beyond the basic use case of how information (computer) systems are integrated into most public service activities.

In addition to managing voice communication systems (wired and wireless), the burgeoning world of operational technology or the Internet of Things provides mission critical examples. These include the impact of an outage on electric fleet vehicles, water supply treatment and wastewater management, traffic control signals, security

devices, and the electronic communications systems that connect these otherwise disparate systems. While a backup generator can provide power supply to computer systems in buildings, supporting these remote devices is a separate challenge.

In addition, measures such as beneficial electrification,¹² which may be undertaken to reduce GHG, may include the transportation sector or other key sectors. Such measures place a greater importance on reliable electricity, in part by reducing access to alternatives (e.g., gasoline or diesel transportation). Electrical outages can be particularly severe for denser population centers with high-rise buildings dependent on elevators (particularly affecting people with mobility impairments who may be unable to use stairs); the [2021 Texas outages](#) illustrated the impact of loss of pumping capacity on water supply.

These interdependencies complicate the resilience decision-making process and cannot be ignored. Considering a local government critical facility microgrid warrants careful assessment of the impact of outages on these other systems. At the end of the day, they have explicit and implicit costs to be assessed and may be vital elements of developing a TC microgrid.

CALCULATING THE VALUE OF RESILIENCE

Academics and DER advocates have developed various models that place a value on DER resilience so policymakers can then decide how to buy it. A [NARUC publication](#) from 2019 analyzed various approaches. They concluded that:

“Each of these options has its own sets of tradeoffs and potential limitations. The difficulties involved in valuing resilience relate directly to the challenges inherent in analyzing high-impact, low-probability power interruption events. Regulators seeking to evaluate resilience investments will need to grapple with these challenges against the backdrop of increasingly severe threats to the electricity grid.”

In practice, there is a big difference in the market for microgrids and the value of resilience given the type of offtaker. Most critical facilities have already invested in a level of resilience (e.g., generators), so there is a cost to offset. Outages pose high business/reputational risks for offtakers like hospitals, plus the cost of recovery of staffing time, equipment reset, loss of revenues, etc. Critical government services outages, (e.g., public safety communications, water supply and treatment systems) have a wide range of impacts (e.g., traffic light outages, water quality issues) and are hard to measure and quantify.



¹² [Beneficial electrification \(or strategic electrification\)](#) is a term for replacing direct fossil fuel use (e.g., propane, heating oil, gasoline) with electricity in a way that reduces overall emissions and energy costs.

As this report was being prepared, a good deal of industry attention had been placed on a model developed by the Clean Coalition in California. The Coalition is a major advocate of renewable energy and microgrids for communities in California. Their [VOR123](#) model has attracted a lot of industry attention.

In the context of financing a project, one investor group advised the study that they didn't think valuing resilience has use in most cases. They assert that adding the value of resilience to the offtaker's alternative supply cost (e.g., the cost of replacing supply lost from its existing supplier or the cost of a diesel backup generator, either of which would be replaced in some degree by the microgrid) adds risk to the project investor, thus requiring a greater return on top of the added supply costs to the owner.

This investor calculation highlights a challenge. Once a value is put on resilience, how is it used? For the developer, it means the offtaker will spend more for power supply, meaning more can be spent on capital to provide a greater degree of resilience and reliability than would otherwise be spent. The added capital has its own costs, which adds risk. These elements add to the return on investment that becomes part of the pro forma that drives the fees charged to the offtaker.

For the offtaker, it means paying a higher amount for supply than otherwise warranted. The increment is the value of resilience – more certainty of energy supply when it might not otherwise be available.

Alternatively, if there is a compelling reason to reflect resilience as a cost, incorporating that value as part of the rates can improve the financial value of the project for the owner. This reason could be reducing a climate-driven risk such as outages from wildfires or flooding. Otherwise, to an investor, the value of resilience is not enough to resolve cash flow problems. Investors suggest it could be accomplished if added costs are socialized (rate-based).

However, cost of supply aside, the value could be used in a cost-benefit analysis or for comparative purposes, for example, comparing a project that

“Once a value is put on resilience, how is it used?”

can function as an island indefinitely to one that relies on a two-day fuel supply. Similarly, the real and social cost of high-impact, low-frequency events, such as evacuating residents of a senior citizen housing complex in anticipation of a weather event can be placed against the value and costs of having a microgrid that allows them to shelter in place instead. Exploring the value of the two options to the community can help illuminate the differences and help support a sound decision.

In the end, valuing and paying for resiliency is an insurance premium used to mitigate a risk. The premium is simply part of the cost of power supply. The challenge, as with all insurance policies, is understanding the protection (the level of added resilience) the insurance covers, the relationship the premium has to the risk, and the availability of other alternatives to mitigate the risk.

MICROGRID OWNERSHIP CONSIDERATIONS

In December of 2020, the Pacific Energy Institute released a report inventorying [Community Microgrid Ownership Models](#).

This report discussed different models of microgrid ownership that generally serve more than one offtaker. The major takeaway from the report is that ownership models can and will vary by owner, EDC status, community or client(s) served, investor preferences, and technology.

The report noted that “Greater regulatory flexibility for utilities, communities, and private developers to pursue various ownership and operational models will allow innovation to determine the best approach to community microgrids.”

The report highlighted five key considerations:

1. "Regulatory oversight should be considered for the safety and service quality performance of privately-operated community microgrids
2. Regulatory oversight of non-utility provided resilience services and pricing to consumers should be considered to avoid price gouging
3. Effective microgrid service tariffs, including costs and compensation need to be implemented equitably between utilities, microgrid operators, and private generation owners
4. Enable greater flexibility for utility ownership-operational opportunities to foster community microgrid development
5. Consider community-based microgrid funding mechanisms to address the societal value of resilience from a microgrid project"

MICROGRIDS, DER, AND SOCIAL JUSTICE/EQUITY

Over the last few years, [New Jersey has become a national leader](#) in developing policies that address social equity. This has been in response to concerns raised by the environmental justice community and others. But [New Jersey is not alone, as social equity issues](#) that connect development of DER and support of low-income and environmental justice communities are becoming a consideration in public policies in other states.

These communities are often more severely affected by blackouts. Residents have fewer financial resources available to them to deal with power supply loss response and recovery efforts. The impact can include losses of job-related income, refrigerated food, pharmaceutical losses that stem from power supply outages and the loss of medical aids such as oxygen supplies and electric wheelchairs.

They also have the least financial capacity to take advantage of DER opportunities as they often lack the financial capital to invest in local supply resources. DER and TC microgrids are more accessible to organizations that have access to capital to build and operate DER-generated supply. These resources often have a lower GHG and emissions profile than grid supplied power.

This effect is amplified because these communities have a greater percent of individuals who suffer compromised health from living near air pollution emitting facilities. Many states are developing DER-based programs to deal with these challenges. For example, [New Jersey](#) is one of several states that has developed [Community Solar projects](#) focused in this area.

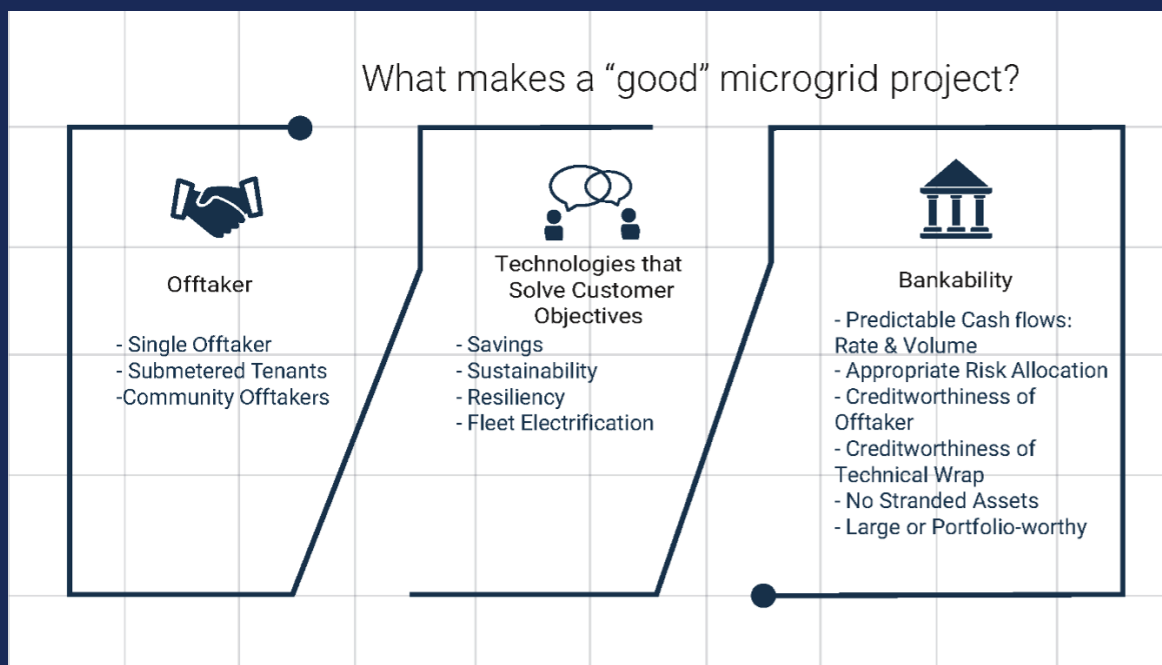
Regulators and investors need incentives to ensure that public and private DER and TC microgrid developments that reduce emissions include and emphasize these communities in their planning. These plans need to ensure that the benefits and values brought by DER are not limited to wealthier segments of society. DER benefits should be shared and made available across all segments (see sidebar, What Makes a Good Microgrid Project?).



What Makes a Good Microgrid Project?

Microgrids can come in many configurations to serve a wide variety of use cases. Use cases vary by timing, location, cost, financing, state regulations, offtakers, EDC and government incentives and subsidies, and technical and public policy issues.

For a TC microgrid to succeed, an almost perfect alignment of regulations, EDC practicalities, economics, and local government needs is required. These issues overlap with the previous discussion on Microgrid Technology Change and Disruption ([Part 2, Section B](#)).



As depicted in the accompanying graphic*, these circumstances make defining what is a “good” microgrid from a financial market viewpoint a highly variable undertaking.

* Content from Sapling Financial Consultants presentation at Microgrid Knowledge 2021 Conference.

Part 5 – Microgrid and DER Risks and Public Policy

This section examines the concept of risk management. It aggregates, reflects upon, and expands the findings previously discussed.

A. THE VALUE OF RISK MANAGEMENT

At the core of any commercial transaction is an assessment and acceptance of the risks the agreement presents to the parties. Private and public investors (including investors in municipal debt) inherently consider risk when they decide to invest in the development of a microgrid of any kind. Every investor or owner wants to maximize the rate of return on their investment and to minimize any risk of an offtaker not making payments as expected.

Typically, the more risk the investor assumes, the higher the rate of return they will expect; the lower the risk, the more assured repayment will be, the lower the return they can accept. Similarly, the offtakers want to reduce their risk of the project failing and to keep energy rates consistent with their expectations. Unmitigated risks contribute to future uncertainty. This can incentivize the parties to negotiate provisions to mitigate them.

Through their negotiations, the parties will seek to strike a balance that allocates the risks, balanced by the rewards, between the parties and document the result of their negotiation in their agreement.

It is the negotiation where the parties propose and consider strategies to mitigate their risks. It is the negotiation process where the parties (ideally) come to conclusions on how much risk each side accepts. These conclusions reflect each party's ability to accept or control risks and determine the costs of accepting them and are reflected as contractual provisions.

Many books, scholarly articles, and industry white papers and promotional material cover the field of risk management. This research study led the team to observe several categories of risk related to TC and related microgrids. They include technological, financial, and public policy risks.

While the three categories are separately explained, they overlap depending on the project. These are not user survey-based observations, but ones made through the course of the study's research. While they would affect most projects, different projects will have different risks based on the specifics of each project.

B. OVERVIEW OF TECHNOLOGICAL RISKS

THE ONLY CERTAINTY IS CHANGE

The race to integrate advanced digital technology and to manage the data it generates are at the crux of today's technological change. The technology that goes into developing and managing microgrids and their interfaces with offtakers and EDCs has been evolving at remarkable rates.

We are also at a time when technology continually moves ahead of the regulatory community's capacity to absorb and integrate new technologies into existing policies and regulations. Contemporary cybersecurity challenges are a primary, but not the only, example.

Microgrids also are part of a larger ecosystem that includes the evolving world of wholesale and retail markets, regional supply, data management, distribution grid management, climate policy, EE, and the technical side of managing electricity.

Technological change occurring after a microgrid

is installed can result in disruption that can affect its operation, cost structure, and thus the agreement. Some change drivers include:

1. Control technology at the intersection (aka point of common coupling) of the microgrid and the EDC must continue to work seamlessly over time, even as other smart grid enhancements occur.
2. Efficiency improvements in local generation capacity (CHP/Cogeneration, fuel cells, PV panels) that may change the relative economics of the microgrid to alternatives.
3. EDC management of multiple sources of DER on their networks. Microgrids may currently be few and small, but they are a significant and growing contributor of distribution grid power supply. As microgrids specifically and DER generally increase in quantity, they require new technical and digital tools to integrate and regulate the supply. These tools include the category of Distributed Energy Resource Management Systems ([DERMS](#)), which EDCs have already started to acquire and integrate into their networks.
4. Improved behind-the-meter microgrid and building management controls to manage the usage of the electricity generated can improve efficiency (e.g., EE programs). Lower battery storage costs, charging characteristics, and improved battery efficiency can also disrupt cost projections and operational and upgrade plans.
5. The trend toward increasing electrification of buildings and transportation along with improved EE practices adds uncertainty to capacity and distribution planning. Managing increased or reduced demand for electricity from new technology adds uncertainty.
6. Collecting, storing, managing, and using the massive quantities of data generated by digital technology is its own developing industry. It has technology management implications, drives market decisions, and raises related social policy issues, such as

personal privacy concerns. In this regard, the electrical supply industry faces the same challenges as other sectors of society.

7. Several of these elements have the effect of reducing energy needs and supply costs to the offtaker, while others can result in increased supply needs. Both possibilities add risk that may affect ongoing maintenance and refurbishment costs.

INNOVATION CARRIES RISK

Microgrid technology and its use cases are still developing. A microgrid design may include components that have not yet been used in a wide array of commercial settings or may include combinations of resources for which experience is still limited.

Innovation risks must be assessed. Equipment suppliers may cover some of this risk with warranties. Risk for individual use cases varies; risks may be lower if the use case requires proven, off-the-shelf technology. This reduces the risk but can sacrifice improved efficiency and cost savings.

Alternatively, the risk might be higher if it is a new application or would deploy a new generation of technology. In such cases, an agency will most likely want to shift this risk to the equipment suppliers or microgrid designer and developer, as they are better able to manage it than the offtaker.



C. FINANCIAL RISKS

SUPPLY AGREEMENTS

Supply agreements may have offtaker rates tied to regional or state price indexes that are influenced by energy market elements that affect price calculations. How these risks are managed in supply agreements is indispensable to all parties. Some of these risks include:

1. Changes in regional generation supply and costs, e.g., solar PV and wind, and early-stage evolving fuel supply (e.g., renewable natural gas, hydrogen, and small nuclear).
2. Changes in independent system operators/ regional transmission organizations (ISO/RTO) and the state and federal regulatory environment, particularly regarding competition-related supply incentives and subsidies and changes in market rules.

Climate-driven uncertainties need to be reflected in supply agreements to reduce potential uncertainty and volatility. It is also important that regulators in market-driven transactions provide flexibility and provisions that can address uncertainties that consider public policy priorities and risks.

ENERGY SUPPLY TRENDS VARY IN DIFFERENT PLACES

There are several ways supply risks can be managed. Unpredictability in energy source costs can be hedged by sophisticated financial analysts. Since the investor or offtaker is assuming the risk of supply costs, rate formulas that have fixed and variable rates are often a strategy. However, the offtaker needs to fully understand the implications of using industry or regional benchmarked pricing (i.e., ISO/RTO day-ahead markets), especially when used in conjunction with inflation or supply-based formulas.

Not to be ignored is taking into account potential modifications or renegotiating cost components based on changes in technology and public policy. For example, adding contemporary and

ever-improving battery storage can flatten the supply cost curve during peak generation times. How does that phenomenon affect offtaker pricing?

OPERATIONAL RISKS CAN USUALLY BE MANAGED

Operational risk requires sound and attentive management with a good track record and inflation protection practices/formulas. Still, unanticipated changes in operating costs – labor, fuel, taxes, safety or environmental regulation – can adversely impact project finances and are difficult to mitigate or prevent. Alternatively, generation fuel supply cost uncertainty can be managed through industry specific hedging practices.

Other risks include the potential of stranded investments from technological and supply market change, investment time horizon changes, and replacement/retirement costs.

Government offtakers can only take on so much risk before political risks become an issue. This highlights the importance of a knowledgeable and competent team and the diligence that goes into the negotiations and the contract. The speed and overlapping nature of these changes adds to uncertainty that will affect public and private capital investments.

D. PUBLIC POLICY RISK #1: CLIMATE CHANGE

The evolution of public policies and perception since Superstorm Sandy and Hurricane Maria has added challenges and opportunities to the TC microgrid concept that can be combined with the increase of societal and political attention to climate change. Together, the initial post-Sandy goals of resilience and reliability are tied to sustainability and decarbonization goals.

At this time, it is generally accepted but subject to dispute that, with the exception of existing

nuclear generation, non-fossil fuel supply technology is in varying states of development, reliability, or comparability to the cost, resilience, and reliability attributes of carbon sources. But they are evolving as technology and markets evolve.¹³ These non-fossil fuel, lower carbon power source replacement technologies include PV (with or without storage), wind, a variety of renewable gas fuels, biomass, hydrogen, small/modular nuclear, and others; but these are not evolved to fully replace carbon-based fuel sources in the short-term. That is expected to change over time based on changing public policies and cost reductions as technologies mature and scale.

The mismatch of energy supply cost and technology with the advocacy of decarbonization policies presents a current policy conundrum for public officials and the public. Examples of this include the [NY Prize](#) (suspended 3rd Stage awards) and the [NJ TRANSITGRID](#) (currently re-considering a plan for a gas-generated microgrid). While both efforts were deep into their respective programs, state officials ultimately decided that the development of natural gas-based generation was not acceptable for these uses.

As a result, microgrid industry practices and investments relying on natural gas as fuel for electric supply generation such as CHP and fuel cells can become undermined as being inconsistent with decarbonization policies. The conflict also adds uncertainty to EDC capacity and distribution planning.

“The mismatch of energy supply cost and technology with the advocacy of decarbonization policies presents a current policy conundrum for public officials and the public.”

At the same time, decarbonization concerns are aligned with adverse climate change driven weather events. These often highlight the value that microgrids bring to emergency circumstances generally and TCs specifically. Superstorm Sandy was a predicate to the TC microgrid discussion in the northeast. Hurricane Maria (Puerto Rico, 2017) spawned the first regulatory structure for microgrids in the US. Similarly, the 2017 rural wildfires in California prompted state regulatory and EDC responses that have resulted in community microgrids in high-risk areas.

The February 2021 winter ice storm event that severely compromised the Texas ERCOT grid and its supply chain was a current event when this report was drafted. The aftermath of the event will undoubtedly result in regulatory and market-driven actions that will encourage industry advocates to promote microgrids as part of solutions to the state’s challenges.

This implies that microgrid projects may need to address the risk of local climate change and decarbonization policies. This may require a trade-off of short-to-medium term localized resilience risk for the longer-term benefit of CO2 reduction. Alternatively, it may warrant a trade-off of more stable, longer term resilience for a smaller amount of carbon reduction. Policymakers, regulators, and local officials need to engage in serious, multi-faceted discussions on how to address the conflict.

E. PUBLIC POLICY RISK #2: IMPACT OF “CREAM SKIMMING” ON EDCS AND DER PROJECTS

Industry advocates, offtakers, and microgrid energy supply agreements do not normally address the public policy implications the projects present. For example, they do not reflect issues beyond the project’s EDC interconnection (point of common coupling) and technical management/controls.

As discussed earlier, supply policy disruption is evolving as the industry gains understanding and

¹³ Regarding cost, there is clear evidence that new renewable sources are [becoming comparable in price to fossil-fuels](#).

WHEN DER PROLIFERATES

1) While not specific to TC microgrids, proliferation of in-front-of-the-meter DER might parallel the early days of electricity distribution where many individual actors developed their own supply and distribution networks.

Utility historians will point out that multiple local grids were found to be inefficient, leaving everyone with higher costs. The private companies that owned these grids sought state protection from competition in exchange for submitting to public utility regulation. This permitted the privately owned companies to expand their footprint without concern for competition, in exchange for public oversight to prevent monopoly abuse.

The current regulatory model can thus be traced to the economies of scale inherent in the technology available during the early part of the 20th century.

The cost-effectiveness of a distributed grid that uses modern technology is not yet fully known. A distributed system can offer some reliability and resiliency benefits that a centralized grid lacks, although a decentralized system lacks some of the redundancy and “pooling” value that comes with centralization. A key issue for the 21st century is whether, and if so how, the current business and regulatory organizational models will need to evolve in response to new technologies and customer demands.

2) Under the state-sanctioned monopoly model, states have granted their EDCs and municipalities various degrees of authority over the public RoW, both above and below ground. The advent of lower cost DER and greater investor interest is leading to increased demand for *in-front-of-meter* DER development efforts that require RoW access. TC microgrids are but one example of this.

An unanticipated consequence of poorly regulated DER is its use as a government economic development tool. Here, DER market-driven installations can generate new municipal government revenue through RoW access fees or taxes.

3) To the extent that DER proliferation is allowed to happen by regulators or enabled via unintended legal loopholes, cream skimming could challenge an EDC’s economic and financial model if enough microgrid-advantaged customers leave and pay reduced rates. This can raise rates to customers who cannot afford to leave and wind up paying unsustainable rates. Those who can afford to make private investments are benefitted at the expense of smaller users. This will inevitably have disparate impacts on disadvantaged communities and increase social inequality unless addressed proactively.

Cream skimming undermines the general societal purpose and system of EDCs, either investor or publicly owned. While remote, this remains a possibility if policymakers and regulators fail to address the disruptive influences.

“Cream skimming undermines the general societal purpose and system of EDCs, either investor or publicly owned.”

responds to its implications. The recent FERC Order 2222 allowing distribution grid access by DER is an example. This challenge is like the [disintermediation](#) challenge created by internet-based services (e.g., the impact of Amazon.com on bookstores).

WHEN CUSTOMERS LEAVE THE GRID FOR DER

Consider the economic impact of customer-owned behind-the-meter DER on the regulated EDC-owned and operated grid. When the DER offtaker leaves the grid as its primary energy supplier, the EDC is deprived (albeit marginally for a single offtaker) of customer payments that were part of the rate calculation used to support grid-related regulated operations. That action can be complicated if the offtaker DER's supply is also configured to sell available supply back to the grid.

Economics of microgrids generally incentivize DER investments by those who can economically or environmentally benefit in replacing their grid-based supply. These projects can lower a facility owner's costs and provide added income for supply sold to the grid. This is observed by a developing market of investors seeking reliable (if not lucrative) TC and other microgrid investment opportunities. They are finding these in low-risk at-scale DER projects (i.e., the larger the microgrid, the lower the energy costs). For reasons discussed above, developers may be particularly attracted to strong, credit-worthy customers with significant loads and less so to those that are less creditworthy or costlier to service. In this respect, microgrids and DER are a form of economic "cream skimming."¹⁴

A TC or government campus microgrid is a public good and there is public good and value for the EDC to reduce overall grid load. If DER becomes more affordable and accessible to more customers, its value is amplified. Unless carefully managed through the regulatory process (i.e., rate reform), customers reducing their use of the grid lowers their payments to the EDC and concurrently lowers their contribution to a wide range of public services, such as paying societal

benefit charges or fees for the EDC's use of the public RoW.

The practice has the economically/societally perverse effect of spreading fixed grid costs over a smaller rate-payer base and contributing to higher rates. The same or a more pronounced problem can result from complete departures from the grid.

The concern is that increasing numbers of marginal changes add up to significant impacts for those remaining on the grid.

When faced with these market-driven actions beyond their control, EDCs may not be able to respond with competitive tariff-based solutions. They may face statutory prohibitions on owning or operating generation assets, regulatory rate controls, and management and regulatory lag. At the same time, an EDC may have some legacy control of TC microgrids and other microgrids that are in front of the meter. Ultimately, the defection of DER users affects profitability and return to investors and can lead to higher rates or reduced services to those remaining on the grid.

DER generally and microgrids specifically present an additional challenge to EDC grid operators when a usually off-grid microgrid requires grid supply. This can happen during DER maintenance, price fluctuation periods, and emergencies (which could affect both parties).

This problem is presently largely a hypothetical one in most regions of the country but could become more pronounced with increased market penetration of DER and microgrids. However, it merits additional regulator and industry research and consideration. Fortunately, this is being recognized. During the winter of 2020-2021, the [California Public Utility Commission](#) commenced serious research on this issue. Other regulators should monitor their work and consider their own circumstances.

When citing the advantages of a microgrid, developers may suggest that an EDC gains value by foregoing or limiting grid upgrades when a microgrid is present on a circuit. Microgrid-based DER can, under controlled circumstances, support the grid by providing added capacity and ancillary services such as voltage support. Microgrid supply capacity may also be able to support the EDC

¹⁴ [Wikipedia defines "cream skimming"](#) as "providing a product or a service to only the high-value or low-cost customers of that product or service, while disregarding clients that are less profitable for the company."

during an outage. At the same time, the grid must respond to those times when the microgrid needs grid supply. These are not offsetting circumstances, but different circumstances planners need to address. The use cases will vary.

POLICY ISSUES AND SOLUTIONS

There are potential regulatory solutions to some of these challenges. Mechanisms to assure DER and microgrids continue to contribute to the system costs may include exit/standby fees,¹⁵ connection fees, DER or critical facility tariffs, charges for developing behind-the-meter supply, or EDC authority to develop or maintain DER. However, these fees can also have a detrimental impact on microgrid development.

Solutions also need to recognize the contributions that DER and microgrids make to the grid with appropriate compensation. These might include payment structures to facilitate microgrid development that complements and enhances grid operation or otherwise makes valued, cost-effective services available to the grid. Failing to impose such fees and to develop such policies may shift the burden of grid costs and/or impose stranded investment costs on those remaining in the EDC system or deprive microgrids of the compensation needed to incentivize their contributions to the grid.

Having grid costs offset by the value that renewable-based DER can add to the grid may be a solution. This can reduce demand and the concomitant need for the EDC to secure capacity. The microgrid also may be able to provide excess supply to the grid in times of need. The end result can reduce the need for long- and medium-distance transmitted power. The challenge is how to calculate and incentivize these competing benefits.

Regulators, consumers, and utilities need to find new balances. Balance must be struck:

1. between incentives for rate base investment and incentives for customer-owned or other privately held investments;
2. so that cost-allocation policies and rates for grid-access and back-up supply are not punitive or anti-competitive;
3. ensure that costs are not inequitably shifted to disadvantaged communities;
4. policies are developed to address the risks and rewards these new use cases present; and,
5. that EDC capacity planning and operational managers have policies to integrate and serve DER users as well as other, more traditional, customers.

Some of these phenomena are long-term effects of market and technological evolution, some of which began with the deregulation of the industry in the 1990s (1998 in New Jersey). Considering the technological and financial innovations, reconsideration of some of these policies may be in order.

If microgrids are to proliferate, an informed regulatory regime or grid policy guardrails are pre-requisites. Without them, we can easily foresee that the power supply decisions of many individual actors will amplify grid management disruption. Grids must be able to develop the managerial, financial, and technological capacity to address these risks.

At present these challenges have few if any ready responses; the industry is in the middle of a disruption. The dilemmas facing policymakers and regulators include ongoing marketplace changes and opportunities, and the disadvantages facing those without the financial capacity to lower their energy costs. The next step (already started in some states) should be deeper research into how these issues are addressed.

F. PUBLIC POLICY RISK #3: MICROGRID ADVOCACY

An ecosystem of microgrid advocacy has developed in recent years. In addition to websites maintained by microgrid manufacturers, suppliers, services, and consultants, there are the following types and examples of organizations:

- Industry news reporting/supplier content linking: microgridknowledge.com
- Profession/Industry Association: [International District Energy Association \(IDEA\)](http://InternationalDistrictEnergyAssociation.org) and its

¹⁵ In this case, an “exit” fee is paid to the EDC by a microgrid operator to compensate the EDC for the embedded investment made to support the grid service previously provided to the facility; a “standby” fee would enable the microgrid to become an intermittent off-taker from the grid when islanding is not available. States vary in their current approaches to the matter. These will require more regulatory attention as microgrids gain traction.

affiliated advocacy group, the [Microgrid Research Coalition](#)

- [US Department of Energy](#)
- State [government agencies](#)
- Non-profit research [organizations](#)

This microgrid ecosystem actively promotes the consideration and adoption of microgrid technology and policies. It also researches, finances, tests pilot programs, and analyzes approaches to understand their value, strengths, and weaknesses. In some cases, this can result in enthusiastic promotion that can lack clarity or lack disclosures that accurately reflect the downside or challenges that face non-standard projects (e.g., front-of-meter campus, community, or TC projects) or the larger, big picture challenges.

With respect to the DOE and state agencies, promoting pilot programs and sponsoring research (such as this report) is part of their mission and is an important element of how TC microgrids specifically and microgrids in general become part of our energy infrastructure. While not all approaches or experiments will have positive results, that is how we learn what works and what does not.

Despite its ongoing evolution, advocacy and promotion should not prevent policymakers and potential customers from developing a full understanding of the evolving environment for microgrids of all varieties and their implications. Policy needs to be built on fact and experience.

In the case of TC projects, advocates have engaged in passing discussions about the risks and challenges presented by regulatory and public policy issues. Looking at the projects observed in this study, public investments, time, and energy have been spent working through the development process only to find that obstacles stopped the project from moving forward. Either successful or unsuccessful, these projects are valuable as efforts that provide policy researchers guidance on the range of risks beyond promotional advocacy.

“Policy needs to be built on fact and experience.”

G. PUBLIC POLICY RISK #4: STATE GOVERNMENT POLICY AND REGULATORY RISKS

At this writing, *Hawaii* and *California* are leading state efforts to bring the disparate microgrid advocacy and EDC groups together. Federal and state laws and regulations are fundamental to how the industry will develop. Following the general guidance and evolving direction of the federal government, given their regulatory differences, each state needs to assess their circumstances and develop a clear-eyed approach to moving forward.

Policymakers looking for additional background on policy issues facing state regulators may want to review a comprehensive overview of the regulatory policy challenges facing DER development. It was prepared by long-time microgrid champion and expert, Tom Stanton, Principal Researcher at the National Regulatory Research Institute (NRRI). NRRI serves as a research arm to NARUC.

The presentation, [Microgrid Policy Progress in the States](#), was delivered at the 2020 HOMER International Microgrid Conference (free registration may be required).

Microgrids and DER are one slice of the power grid modernization issues the country (and world) is working through. Much has been learned about challenges to microgrids through pilot programs and industry and academic research, particularly over the last five years. Advocates, EDCs, and regulators need to accelerate their efforts to assess the values microgrids bring to the grid and GHG reduction. The task of finding pathways for their development is necessary as part of an overall approach to managing DER and grid modernization.

Part 6 - Recommendations and Additional Research Opportunities

This research project was not intended to solve the challenges and opportunities of the expanding marketplace for DER, either behind or in front of the meter. It was intended to address the opportunities of the TC microgrid concept. It makes clear that the market and regulatory environment do not provide clear pathways for most TC microgrids.

The research does, however, provide ancillary benefits of being able to frame opportunities for additional research in the field. The following summary highlights those matters ripe for additional effort.

For energy supply purchase projects:

the development of best practices of how government offtakers can conduct research, engage developers, address risks, and develop model contract provisions that serve the life of the agreement.

Working with regulators: EDCs and the DER industry should develop regulatory models that address the technical and fiscal impact DER has on EDCs. These models should include, but are not limited to, DER access to the public RoW, regulating EDC interconnects (points of common coupling), and technical management/controls (e.g., voltage regulation and switching).

Examination of the effect of cream skimming DER, where economically advantageous islanded microgrids benefit the owner and negatively affect the economics of the EDC, and developing rate reform strategies to assure that needed grid services are financially supported and the costs equitably distributed.

Examination of the impact projects may have on reduced state or local revenue streams from taxes (i.e., taxes based on delivered power supply) and fees (i.e., social benefit program funding).

Understanding and addressing the effect of state/local decarbonization policies on microgrid development. The trade-offs of the benefits of resilience and reliability placed against GHG reduction entered the dialogue in 2020. This challenge also requires balancing time frames of carbon reduction against the technological maturity of solutions, and with connected public policies.

Regulatory efforts to improve EDC baseline reliability and redundancy: these could be tied to the ongoing EDC evolution of accepting and managing DER on their grids.

Finally, ending this study where it began with the **New Jersey TCDER Microgrid program:**

- The state should consider legislation that would remove regulatory hurdles such as RoW limits and develop public agency contracting practices and financing models for projects that would otherwise be financially viable and meet the goals of resilience and reliability if the barriers were lifted.
- This may best be accomplished through individual project tariffs that balance the justifiable technical and financial concerns of the EDC with the public interests achieved by the projects.
- Such a program would serve as a demonstration of how to address the differing circumstances of these projects. The lessons learned from facilitating their development would educate EDCs, developers, manufacturers, investor communities, and local officials on the viability of projects and how to approach future ones.
- This approach may also work in other states where interests overlap.

Part 7 – Background Research

A. STATEMENT OF PROJECT OBJECTIVES

NJBPU applied for and received a DOE State Energy Program Grant. The initial goal of the project was to describe the TC microgrid development process by providing procurement guidance that includes funding and financing options suitable for local communities. The grant was originally titled the *“Study of Public Procurement, Financial, and Legal Authorities Necessary to Facilitate the Development of Town Center Distributed Energy Resources (Microgrids).”*

Once enabled, the project team worked with DOE to develop a Statement of Project Objectives (SOPO) to define the parameters and deliverables. Deliverables were focused on providing government agencies in New Jersey and other states guidance on processes government agencies could use to procure and finance these projects. The effort did not consider determinations of need, microgrid technology, technical, safety, or cybersecurity issues, or public policies concerning energy choices.

The research effort launched in 2020. Like many other projects that commenced that year, the schedule was affected by the COVID-19 pandemic. This was recognized by the

Department of Energy by granting a six-month schedule extension.

The central element of the work plan was a survey of potential and active TC microgrid projects. The survey process and its outcomes are described below.

As the project moved into the Fall of 2020, research findings were found to be inconsistent with initial project assumptions and warranted changes. The details are explained below.

PROJECT TASKS

As findings evolved, the project was retitled the *“Development of Local Government Resilient Microgrids.”* Deliverables for Task 2 (described below) were revised to reduce the focus on TC microgrids and to address local government use of microgrids generally.

The project was initially divided into several Tasks. The following represents the Project Task List with the *practical modifications made as the research evolved*:

- Task 1 – Stakeholder and Planning
- Task 2 – Ownership, Funding, and Financing Guidelines was revised to reflect the general findings of this research.

Original Task 2 Deliverables	Revised Task 2 Deliverables
Identify and Evaluate Ownership Models	Explain range of local government microgrids
Identify and Evaluate Funding Sources	Describe findings of Town Center Microgrid survey
Evaluate Potential Revenue Streams	Identify procurement/finance characteristics of local government microgrids
Identify Design, Construct, Operate, & Maintenance	Identify risks to be managed in the development of local government microgrids
Identify and Evaluate Policy and Regulatory Issues	Review additional research opportunities

Task 3 - Organize, integrate, and finalize preliminary findings was reconceived as this Report.

Task 4 - Present findings in webinar(s) or in-person conference. Revised as Fact Sheets based on the report and posted on the [Community Microgrid Planning Academy](#) website.

Task 5 - Develop an online toolkit. This will be represented on the website by webinars and video content on the Community Microgrid Planning site.

The research deliverables were revised to reflect the new observations. These deliverables are reflected in the structure of this report and the Fact Sheets.

B. DEVELOPMENT OF THE SURVEY TOOL

ABOUT THE SURVEY

The Qualtrics-based survey was designed to collect information from TC microgrid projects that were anywhere between the planning phase and routine operation. The survey asked for detailed information about the project, its status, implementation, successes, and challenges. A PDF of the survey questions [can be accessed here](#). Individuals desiring more information on the survey should contact the author directly.

The questions took multiple forms, including multiple choice, tabular, Fact/Choice (Short Answer) and Opinion/Analysis (Detailed Response).

Most of the questions were kept optional and survey takers were permitted to answer long answers via either audio recording or an online interview with a team member.

The survey started with instructions and an academic research confidentiality statement to gain the respondent's agreement to participate in or decline the survey. The survey was broken

down into the following seven sections:

1. **Project Planning:** Asked details about the elements of the agency's microgrid, project initiation, involved individuals and public agencies, and pre-project assessments, including financial feasibility and risk assessments.
2. **Ownership:** Focused on the ownership model, who would own the microgrid, the selection process, ownership issues, and resolution plan.
3. **Financing/Revenue Analysis/Streams:** Asked respondents to provide a financial pro forma (if there was one) and details about revenue streams, sources of investment capital, financing risks, challenges faced, and energy supply user rates.
4. **Microgrid Procurement/Contracting Options:** Asked for details on organizations involved in the design, building, construction, ownership, maintenance, and development process, how they procured services, and the challenges they faced. Also asked for details about project management.
5. **Completed Projects:** This section addressed projects in operation, asking if the intended purpose of the project changed throughout the implementation cycle along with changes in other aspects of the project.
6. **Public Policy and Regulatory Issues:** Focused on how legal, operational, and political issues impacted the project and how issues that arose were resolved.
7. **"Anything Else You Want Us to Know?"** This allowed the respondent to inform the researchers about other potential issues.

SURVEY RESPONSES

Through internet research, the team initially identified 35 potential projects that appeared to reflect TC-type microgrid projects. These were found in New York, Connecticut, Massachusetts,

and New Jersey. For reasons described below, the survey had limited value, as 35 potential projects were identified, and 27 surveys were distributed. 12 Massachusetts projects were held back pending consultation with state program administrators. Responses were ultimately received from only 12. The responses broke down as follows:

- New Jersey: 10 of 12
- Connecticut: 1 of 7
- New York: 1 of 8

Efforts to encourage responses included:

- An initial email from the PI introducing the project, asking for their participation, and advising them that a follow-up email with instructions from Qualtrics would be forthcoming.
- A Qualtrics-generated email about the project with a link to the survey.
- After two weeks and no responses were received or the survey acknowledged, a follow-up email from the PI was sent reminding them of the survey, suggesting that they check email spam folders, and to let us know if they had not received it. No responses were received. Qualtrics did report that some surveys were opened, but no action was taken by the respondent.
- After another two weeks, phone calls were made to the recipients. Contact was made in several offices with commitments (by the principal or their assistant) to take a look at the survey and get back to us.
- After two weeks and little response to the phone calls, follow-up email and telephone outreach was conducted with little feedback.
- To obtain responses from New Jersey respondents, the PI sent personalized emails or made phone calls to the individuals, all of whom had previously worked with or knew of the PI. This resulted in the 10 of 12 potential New Jersey responses.

POTENTIAL REASONS FOR THE LIMITED RESPONSE

The following explanations are based on the results of the repeated efforts to contact respondents. They are based on limited phone conversations and team conjecture based on their own experiences in government.

- *Inopportune Timing:* The survey was circulated during a pandemic where agency municipal employees were involved in other significant efforts and time could not be spared to participate in research that was not perceived to have value (one respondent made this point very clear as a reason they did not respond).
- *Reluctance to describe an unsuccessful effort:* It was later found that many of the projects were not successful (described below). It is understandable that officials would not want to advertise a failed project.
- *Projects still in planning:* Respondents were reluctant to publicly discuss the status of projects that were incomplete or were part of competitive efforts that they did not want to compromise.
- *Projects that were not TC microgrids:* Initial research efforts were unable to distinguish different types of microgrid projects from each other. The first question the survey asked was if the project was a TC type and, if not, there was no need to proceed.
- *Survey was intentionally comprehensive* to maximize understanding of the individual projects: In retrospect, it was perhaps too much so and should have been divided into two phases.
- While these issues were not a problem for NJ respondents (83% response rate), the fact that this was perceived as a New Jersey project may have been a factor in the lack of responses from the CT, MA, and NY agencies.

- Recognizing that the complexity could reduce full completion, the survey developers and project team worked hard to simplify the response process. This included encouraging respondents to use computer dictation features and the availability of an online interview with program staff (two NJ respondents took advantage of the latter option).

TC MICROGRID BENCHMARK
PROJECT SUMMARY

Despite the limited survey results, readers may find value in a summary of the benchmark projects found by the program. The following table is based on the survey responses from New Jersey and online research conducted into the projects of the other states.

Key to Table Abbreviations		
Status		
Plan-C = Completed planning	Fin-C = Completed financing	UC = Under Construction
DES = Design Phase	Ops = Operational	

Participant Types:		
P = All public	PR = Private	P-M = All public, multiple agencies
P-NP = Public and non-profit	P-PS = Public and Private Sector	

Technical Type (Generation Supply Source)		
B = Black-start	HEG = Hydroelectric Generation	NG = Natural Gas Generator
CHP = CHP	I = Islandable	SG = Steam Generator
DG = Diesel Generator	ICE = Internal Combustion Engine	SOL-ST = Solar+Storage
FC = Fuel Cell	NFC = Natural Gas Fuel Cell	TH = Thermal System
WP = Wind Power	SOL = Solar	WWT = Wastewater Treatment Plant

Table of Benchmark Project Details					
TC Microgrid Project Place/Name	State	Status	Participant Types	Technical Type	Confirmed Status
New York					
Huntington	NY	Fin-C	P-PS	FC, CHP, SOL-ST, TH, WWT, NG	Stage 3 app I process; TC type; no update
Rockville Center Village	NY	Plan-C	P-M	NG, SOL	Utility owned supplemental powers but abandoned
Village of Freeport	NY	DES	P-PS	NG, SOL-ST, WP	Looking for completion in June 2021 using alternative (NY state GOSR) funding via Governor's office)
East Bronx	NY	DES	P-PS	CHP, SOL, DG	Healthcare microgrid; TC type; no update
Binghamton City	NY	DES	P-PS	ICE, SOL, CHP, HEG, NG	Stage 2 study completed; TC type
Syracuse City	NY	DES	P-PS	NG, CHP, DG, TH	TC type; Special purpose partnership between utility and asset owner
Connecticut					
Woodbridge	CT	Ops	P	FC	Govt campus project; completed in 2018
Hartford-Parkville	CT	Ops	P	FC	Utility owned supply and distribution with TC microgrid characteristics
Fairfield	CT	Ops	P-PS	NG, SOL	Downtown muni complex campus
Bridgeport	CT	Ops	P	CHP-NG	PPA govt campus
Milford	CT	UC	P-PS	CHP, NG, ST	Mostly campus
Coventry	CT	Plan-C	PR	CHP, SOL-ST	PPA. Mostly campus plus residential - looking for completing in 2021
Massachusetts					
Taunton/Berkley Community Microgrid	MA	Plan	P	SOL-ST, CHP, DG	TC type. Status unknown
Boston	MA	Plan, Ops	P	SOL-ST	Two microgrid grants were sought under DOER's program. Boston Medical Center microgrid, which is a single-facility microgrid, is complete
Holyoke	MA	Plan	P	SOL-ST, WP	TC-type microgrid. Status unknown

Table of Benchmark Project Details					
TC Microgrid Project Place/Name	State	Status	Participant Types	Technical Type	Confirmed Status
Massachusetts					
Medford	MA	Plan	P-PS	SOL-ST	Single-facility microgrid designed for Department of Public Works. Granted RFP for solar asset construction in 2019. No current information
Northampton	MA	Plan	P-PS	SOL-ST, CHP	Campus microgrid. No status update
Sterling Municipal Light Dept.	MA	Ops	P-PS	SOL-ST	EDC critical facility supply
New Jersey - projects funded by the state's March 2021 award of engineering design (ED) grants have their information in italics. ED percentages are what was proposed to be achieved with Phase II TCDER awards.					
Atlantic City	NJ	Plan	PR	CHP, DG	TC microgrid; 30% ED funded
Camden County MUA	NJ	Plan	P-PS	CHP, NG, SOL	TC microgrid; 30% ED complete
Galloway Township	NJ	Plan	PR	CHP, SOL-ST, DG	TC microgrid
Highland Park Borough	NJ	Plan	P	SOL, NG, DG	TC microgrid; 20% ED funded
Hoboken	NJ	Plan	P-NP, P-M	SOL-ST, NG, CHP	Distributed municipal govt. campus; 20% ED funded
Hudson County	NJ	Plan	PR	SOL-ST, NG, CHP	Distributed government campus shared between county and township; 30% ED funded
Middletown Township	NJ	Plan	P-PS	WP, SOL, DG, NFC	TC microgrid; 5% ED phase complete
Montclair	NJ	Plan	PR	CHP, SOL, NG/DG	TC microgrid; 30% ED funded
Neptune Township	NJ	Plan	PR	CHP, SOL	TC microgrid; 30% ED funded
Paterson	NJ	Plan	P-M	CHP, SOL	TC microgrid; 50% ED complete
Trenton/State of New Jersey	NJ	Plan	P-PS	CHP, NG, TH	Multiple microgrid zones; 10% ED funded
Woodbridge Township	NJ	Plan	P-PS	CHP, SOL	Distributed government campus. Does not cross RoW; 10% ED funded

C. OVERVIEW OF STATE INCENTIVE PROGRAMS AND THEIR OUTCOMES

NEW JERSEY TOWN CENTER DER PILOT PROGRAM

New Jersey has a state-financed pilot TC microgrid development program. The project survey resulted in responses from 10 of the 11 participants in the design phase round of the program. What follows are observations gleaned from the survey responses. The responses were filed during the time the NJBPU was reviewing the latest round of grant applications to fund design studies (8 awards were made in March of 2021, see the preceding table).

Projects are generally creative, responding to very local needs and unique circumstances. This makes drawing broad conclusions difficult but highlights various common elements and concerns.

TCDER Microgrids appear to include the following elements:

- TCDER microgrids are being designed to provide resilience for critical facilities located in or near downtowns. Examples of critical facilities include town halls, schools, fire stations, senior housing, police and fire facilities, hospitals, transit stations, and other private or public buildings that serve as emergency shelters.
- Some proposals include supplying power and EV charging stations in privately owned facilities that provide food, medical services, and transportation.
- The majority of proposals cross only one EDC RoW; this permits them to remain in compliance with state RoW requirements.
- Multiple DER are employed including solar, CHP, hydroelectric, natural gas generator, biogas, and battery storage. Diesel generation is a source in one project.
- Some, but not all, projects incorporate technologies to reduce GHG emissions.
- Two applications proposed adding power supply generation to existing district heating systems. One is planning a unique multiple facility/multiple zone microgrid. The proposal is driven by an inaccessible EDC grid circuit, which requires each zone to be connected to a generation source.

Reported impediments to development:

- State regulations on utility interconnection, crossing public RoW, and the public contracting process. The contracting issue focuses on the process of engaging a developer and investor to develop and run the microgrid (New Jersey has a state-directed legal regime guiding local government procurement and financing practices).
- The potential of duplicating EDC distribution infrastructure limits the financial feasibility of some projects unless EDC grid use is permitted.
- Technical challenges connecting the microgrid to the grid at multiple access points to allow islanded operation.

Contracting practices that may enable development:

- Recent regulations for [Public Private Partnerships \(P3\)](#), though they may have limited potential due to the complexity of the process.
- Contracting through EaaS agreements.
- Shared Service agreements between government agencies. New Jersey's state government has long encouraged intergovernmental contracts for local agencies to provide contracted services to each other.
- Possible use of municipal redevelopment power to circumvent other obstacles.
- Participation of the EDC in the project.

Financial viability dependencies:

Financial viability may be dependent on successful alignment of various factors, including NJBPU project funding, resolution of EDC-related issues, contractual arrangements with developers and investors (including credit guarantees), grants from federal programs (FEMA resilience-driven hazard mitigation grants were highlighted), and specialized NJBPU-approved microgrid tariffs.

It is suggested that third-party investors in these projects may require a level of financial security or collateral that may not be within the legal authority of the government agency.

Risk Assessment

The survey asked if the applicants had conducted an assessment of the financial, operational, environmental, and reputational, etc. risks involved in developing and deploying a TC microgrid.

Risk assessments were not performed on most projects. There was an underlying belief that engaging private developers is a way of mitigating government risk. This assumes the private sector will assume those risks. However, this may be a belief based on speculation.

What would you have done differently?

In various contexts, the survey asked “Knowing what you know now about <an aspect of> the microgrid, what would you have done differently? Responses included:

- Encouraged legislators to address the issue of crossing multiple public RoW before reaching out to investors.
- Involved the EDC earlier to overcome obstacles.
- Thought practically about the extent of the project and how many facilities should be considered.
- Performed an energy audit to leverage EE practices.
- Developed model procurement strategies

for energy service agreements and PPAs as there is a lack of expertise in this area.

- Looked at alternative sources of funding. The reliance on BPU grant funding was not fully understood at the start.
- Early engagement with the development team to move the studies and other requirements along on time.

NYSERDA AND THE NY PRIZE

The [NY Prize](#) was initiated in 2016 as a generally statewide, three-stage competitive process for local governments and related agencies to develop microgrid resiliency/reliability proposals. The award plan included three stages:

Stage 1 funding was to conduct engineering assessments that evaluate the feasibility of installing and operating a community microgrid. The awards [represented a range of simple and sophisticated PPAs](#) and local government-owned EDC supply or switching enhancement projects. [83 feasibility studies](#) were funded and evaluated.

Stage 2 funding was for audit-grade engineering design and business planning studies. [11 projects were funded](#).

A Stage 3 design competition assessed potential buildout using +/- 10% cost projections and a business/commercial plan, and required a positive benefit/cost analysis. No awards were made for this stage.

No Stage 3 NY Prize awards were made because of a late change in state policy to focus on decarbonization goals. That policy required renewable-based projects, while applicants were using natural gas as a supply source. Several projects could have used hybrid PV storage, resilience, and renewables, but they were costly and would have required substantial state support to be economically feasible. Other projects involved technical and regulatory challenges with the local EDC.

Separately, the Governor's Office of Storm (Sandy) Recovery had its own grant program. Toward the end of the NY Prize program in 2018, three storm recovery projects were funded to agencies that had competed in the Prize competition.

- [Freeport](#): current status is uncertain. The project was a local EDC project to develop a separate downtown energy supply, new circuits, and a controller to provide the connections to critical facilities. It would have replaced a 60-year-old backup diesel generator.
- [Schenectady/Proctor's](#) (see page 21): This would expand a privately owned existing district heating and cooling system to provide electricity through CHP, but its status is uncertain.
- [Greenport, Long Island](#) proposed adding power supply to the municipally owned EDC via a gas generator and non-carbon DER. This would supply a local hospital and several hundred government and non-government customers.

CONNECTICUT AND THE MICROGRID GRANT AND LOAN PROJECT

From 2013-2017, Connecticut, through its Department of Energy and Environmental Protection, ran a successful multi-year microgrid development program. Over [\\$30 million in grants and loans were awarded to 13 recipients](#) to support a wide range of critical facilities. Projects were generally split between small, medium, and large municipalities, higher education, and federal government agencies.

While there was one TC project, there were several other municipal government projects of note:

[Hartford-Parkville](#) – focused in the Parkville section of Hartford, this project represents a TC microgrid. It is a dedicated natural gas-driven fuel cell (Bloom) generator developed by a local retail energy provider (Constellation) with state aid and cooperation

from local officials and the EDC (CT Light and Power) to serve key local educational and community facilities. It will normally run these facilities in blue sky mode and will operate as needed in emergency islanded mode for these and additional local critical facilities.

[Woodbridge](#) – this a government campus/EDC project developed by the local EDC. A high school-located fuel cell pushes power to the grid but will island for the school and nearby municipal facilities in an emergency. It is effectively a DER on the EDC (United Illuminating) grid. State grant supported.

[Fairfield](#) – is a Schneider Electric project financed through a PPA. It powers a multiple-user government campus system. The system replaced diesel emergency generators. The two microgrids are powered by a CHP gas generator, solar, and microgrid controls intended for emergency use. All facilities are behind the utility meter.

[Bridgeport](#) – is a [municipal campus-like](#) multiple-building microgrid funded by a PPA with private owners. It also includes an adjoining senior citizen center and an adjacent building. Natural gas is the fuel source for several reciprocating engines and a cogeneration distribution system. The project necessitated a complicated and time-consuming route to development and full financing, requiring multiple state incentives and private investment to reduce the supply cost.¹⁶ The fully developed project was recently [sold to a new set of investors](#), an intriguing development in microgrid financing.

[Milford](#) – Schneider Electric built this project owned by the town. It [connects a middle school](#), senior center, senior apartments, and city hall with underground connections as a downtown government campus. Full operation is behind-the-meter.

[Coventry](#) – is a municipal campus microgrid funded through a PPA. It is privately owned and operated by a local company. The PPA

¹⁶ The buildings are closely spaced, separated by several short RoW crossings. The crossing arrangements with the EDC complicated the development process.

is with the municipality and a private senior housing facility adjacent to the campus. At this writing, it is under contract negotiations with operation expected in 2021.

MASSACHUSETTS – DOER AND MASSCEC

The following are findings relayed to the study through interviews with program officials from both the Department of Energy Resources and the [Community Energy Center](#) (a funding agency). An official report of their outcomes has not yet been completed.

The agencies ran grant projects between 2014 and 2019 to study various community microgrids. None were funded to development as the projects were not financially feasible, sufficiently green, and able to work out EDC issues.

The programs found it was difficult to get substantially more resilience with a microgrid as compared to a diesel generator for all but the most extreme outages (e.g., Superstorm Sandy), although there were carbon reduction benefits. The program found that a microgrid positioned behind-the-meter makes the most sense as long as the owner controls all aspects. Geography and ownership are also important elements.

Navigating the state's EDC franchise laws are critical to success but adding EDC interconnection requirements costs to project financial pro formas made projects cost prohibitive. The program also brought to the surface regulatory questions about the extent to which EDCs could own and operate microgrids. They found that significant changes to the utility regulatory model are necessary for the TC microgrid concept to work.

A significant element of EDC interest concerned interconnections. Under their regulatory limits, EDCs are not comfortable with dispatching private power as there is no regulatory pathway for it. They are interested in owning storage as an asset, but regulatory complexity challenges EDCs selling into capacity markets. Unless resolved, the policies will limit EDC interest in solar generation.

Crossing RoW and controlling dispatch are other key issues. In Massachusetts (and many other states), any electrical distribution elements in the RoW must be owned and operated by the EDC. Laws and regulations were cited as one issue, but electrical management issues are a real problem (energized, voltage, dispatching, etc.).

Officials also considered the value of resilience and the viability of agencies paying more for microgrid-supplied electricity than electricity from the competitive market. They concluded that valuing resilience has little use in most cases, unless the specific use case had particularly compelling justification. Otherwise, resilience was not enough to supersede a cash flow problem, unless the added costs were socialized into grid rate recovery or the owner's cost of doing business.

They found the proposed projects could not work financially if they were not competitive with grid rates. In other words, they concluded that microgrid projects would be "nice to have" but are very hard to finance as they will cost more than grid supply, unless customers were prepared to pay higher rates. They also noted that EDCs may be interested in developing projects, if they can be rate based.

As MassCEC serves as a funding agency, they had detailed insights on financing. They noted that development financing is challenging for the private sector. Alternatively, government agencies could finance projects they owned and bond markets were comfortable with the debt and repayment structure. Another issue concerned municipal procurement authority and how the developer/contractors/operators are chosen. New Jersey has found similar issues.

They see a potential pathway where private entities own and operate a microgrid, the government agency can be an offtaker (EaaS), and the project is independent from the grid (campus projects). To go off campus, a district energy model could work if RoW issues are resolvable.

Appendix

A. RESEARCH SOURCES AND ANALYSIS

The limited value of the survey effort led the team to rely on a wide range of industry, press, academic, and government publications, promotional material, news stories, and press releases found on the web and at conferences. The prevalence of advocate-generated resources required analysis and exercise of judgment and professional expertise to understand offsetting viewpoints and marketing hyperbole to reach observations and conclusions. The analysis was also challenged by the rapid evolution of the microgrid industry and vigorous commercial advocacy to achieve balanced viewpoints.

The research process included reviewing dozens of websites representing federal and state government agencies, local governments, microgrid industry businesses, microgrid advocacy groups, and news organizations. These resources contributed to the knowledge and understanding developed by the author. These printed and web-based resources were supplemented with a small number of select interviews with industry participants and regulators.

The research tried to focus on contemporary information that was less than five years old, unless a resource provided historical context. To our knowledge, none of the material has been represented as confidential and are generally freely available via the internet.

Over 150 of the web-based resources are listed below as Section C. The items are sorted by **topic** heading. Please use the topic heading as a general guide. They are assigned to articles in a logical way, but many articles cover multiple topics.

B. EXTERNAL PROJECT RESOURCES AND ACTIVITIES

STAKEHOLDER GROUP

As with other elements of the study, the intended use of a Stakeholder group was substantially modified. The group was originally intended as a review body and to introduce staff to organizations of interest to the research. The group's primary membership included the original New Jersey TCDER applicants and advisors and was expanded to include representatives from the state's EDC community.

While an aggressive schedule of meetings and activity review was projected as part of the project plan, those plans were upended by the delays and adjustments incorporated into the project. Nonetheless, the two in-person and one virtual meeting of the Stakeholder group were very helpful to the research effort. The time and attention provided by the municipal attendees and industry professionals is great appreciated. We hope the outcome of the project has value to them.

The three meetings (with links to their agendas) took place on:

1. [October 19, 2019](#)
2. [January 16, 2020](#)
3. [October 14, 2020](#)

The Project Team thanks the following Stakeholders for their participation and contributions to the project:

John Anderson First Energy Corp	Abraham Antun Hudson County's Administrator's Office	Gianfranco Archimede City of Paterson
Christina Bevilacqua City of Atlantic City	Joseph Blackwell Leidos, Middletown/Montclair	Gayle Brill Mittler Highland Park Mayor
Fred Brody Brody Business Development, LLC, Montclair	Tom Brys Greener by Design, LLC, Neptune/Hudson County	Charlene Burke Hudson County Office of Grants
Susan Coan Atlantic City Electric	Marilyn DePice Hudson County Administrator's Office	Daniel Desalvo Hudson County Law Department
Fred Desanti MC2 Public Affairs, Atlantic City	Roman Dionisio DCO Energy, Atlantic City	David Drumeler Hudson County Administrator's Office
Michael Duffy Greener by Design, LLC, Neptune	Caroline Ehrlich Woodbridge Township	Tim Fagan PSEG
Fred Fastiggi Shoreline Energy Advisors LLC, Montclair	Gearoid Foley Integrated CHP Systems Corp., Montclair	Cheryl Fuller Hudson County Dept. of Finance & Admin.
Vito Gadaleta Township of Neptune	Francesca Giarratana Hudson County Division of Planning	William Golubinski State of New Jersey, Trenton
Edward Gray PSEG	Norman Guerra Hudson County Improvement Authority	Paul Heitmann IEEE Stds. Assoc. Businovation, Middletown
Lory Hubbard Township of Middletown	Justin B. Incardone PSEG	Robert Jackson Township of Montclair
Chris Johansen Galloway Township	Teri Jover Borough of Highland Park	Dan Keashen Camden County
Andy Kricun Camden County	Lauren M. Lepkoski First Energy Corp (JCP&L)	Mark A. Mader First Energy Corp
Mike McGuire Orange & Rockland Utilities	Anthony (Tony) Mercantante Township of Middletown	Tom Nyquist Princeton University
Brian O'Reilly Hudson County Improvement Authority	Elizabeth Pasaniello Woodbridge Township	Philip J. Passanante Pepco Holdings
Robert Preston City of Atlantic City	Don Richards JCP&L	Bradley Rosenthal Cape May County Municipal Utilities Auth.
Gary Russell Township of Montclair	James M. Rutala Rutala Associates, Atlantic City	Ralph Sax Hudson County Dept. of Roads & Public Prop.
Maisha Scudder-Moore Atlantic City	Ben David Seligman City of Paterson	Timothy Stafford Township of Montclair
Sarah Steindel New Jersey Division of Rate Counsel	Caleb Stratton City of Hoboken	Joe Sullivan Concord Engineering, Hoboken
Genevieve Tarino Greener by Design, LLC	Robert Thomas City of Newark	Paul C. N. Van Gelder CHA Design/Construction Solutions
Mark Warner Gabel Associates, Highland Park	Joe White Orange & Rockland Utilities	James Woods Hudson County Office of Emergency Mgmt.
Adam Zellner Greener by Design, LLC	Emily Zidanic Cape May County Municipal Utilities Auth.	

ADVISORY GROUP

The Stakeholder group was paired with an Advisory Group of microgrid industry experts. The advisors were intended to be a resource of technical expertise and a means of finding other experts based on their industry contacts. While several members were contacted and provided valuable engagement, as with the Stakeholder Group, the project's modifications reduced the need for their engagement.

The Project Team thanks those who participated along with those who agreed to make themselves available if needed. We also note with regret that industry veteran Bahman Darynian of GE Energy Consulting agreed to participate but passed away during the course of the project

William Agate NZ Solutions	Nathaly Agosto Fillion Newark Sustainability Officer
Sam Kramer NASEO	Dave Crudele NYSERDA
Albert Gilewicz Purdue University (Alt)	Anne Hampson ICF (Alt)
Barry Korn Barrett Capital (Alt)	Brian Lipman NJ Division of Rate Counsel
Patrick Morand Duane Morris LLP	Benjamin Parvey Blue Sky Energy
Arthur Pearson Barrett Capital/Barret Green Management	Andrea Ruotolo Advisian/Worley
Sarah Steindel NJ Div. of Rate Counsel	Dan Ton USDOE
David Weinstein Archer & Greiner P.C.	

STAFF CONFERENCE ATTENDANCE

The timing of the completion of the report did not synchronize with industry events and the expiration of the contract. As a result, project team attendance at events to present findings is not anticipated. The project's PI/Author and other team members will attempt to participate in subsequent events where possible upon request.

The team was able to make a presentation of preliminary findings at a meeting of the NASEO/NARUC State Microgrid Working Group in October of 2020.

Team members were able to attend and participate in several events that were found to be excellent opportunities to gain knowledge about industry practices and talk to industry

leaders. The following events were attended by team members:

- 2019 Microgrid Knowledge
- IDEA 2019, Pittsburgh
- Roosevelt Security Council DERS Conference, August 2019
- 2020 HOMER Microgrid Conference (Virtual)
- 2020 Microgrid Knowledge Conference (Virtual)
- IDEA Campus Energy and Microgrid Conferences (Virtual), February/March 2021
- Microgrid 2021 Conference, Virtual, May/June 2021

C. PRIMARY RESOURCES (SORTED BY TOPIC)

References	Author/ Corporate Author	Topic	Resource
Propelling the transition: Green hydrogen could be the final piece in a zero-emissions future	Herman K. Trabish	DER	Article
Estimating the Regional Economic Resiliency Benefits of Community Microgrids	Brian Morrison	Economics	Report
Camden, N.J. Looks to Innovative Bonds to Expand Microgrid Project	Microgrid Knowledge	Financing	Article
Deep Dive on Microgrid Financing (see page 9)	Siemens	Financing	eBook
Finance and Resilience Initiative Part 2: Taking Action to Improve Resilience & Disclose Performance	Joe Indvik	Financing	Presentation
Financing Microgrids in the Federal Sector	Chuck Kurnik, Phil Voss	Financing	Report
Funding Microgrids: CAPEX versus OPE	Yasmin Ali	Financing	Article
How to Get Your Microgrid Projects Financed	Scale Microgrid Solutions	Financing	White Paper
Microgrid finance, revenue, and regulation considerations	Rima Kasia Oueid	Financing	Journal
Public-Private Partnership (PPP) Financing Model for Micro-Grids	Mohsen Jafari, Kaveh Gharieh	Financing	Research
Think Like a Financier to Win Funding for Your Microgrid Project	Peter Maloney	Financing	White Paper
Can We Really Reach These Big Green Goals?	Elisa Wood	Market	Article
Clean Jobs New Jersey: 51,852 Clean Energy Jobs Across New Jersey	E2	Market	Report
Deloitte 2019 power and utilities industry outlook	Scott Smith	Market	Report
Meeting the challenge of modernizing the grid to stabilize the integration of renewable energy	ABB	Market	White Paper
Microgrid Knowledge Names 'The Home Microgrid' as Person of the Year 2020	Microgrid Knowledge	Market	Article
New Year's Resolutions for the Microgrid Industry from 4 Leading Companies	Microgrid Knowledge	Market	Article
PG&E is betting heavily on microgrids. But can it move away from fossil fuels?	Kavya Balaraman	Market	Article
PSE&G and Highland Park to build solar storage system	NJBIZ	Market	Article
Putting Distributed Energy Resources to Work in Wholesale Electricity Markets	Advanced Energy Economy	Market	White Paper
UL Acquires Microgrid Software Company Homer Energy	Elisa Wood	Market	Article
Utilities See Future Profits in Microgrids: Survey	Microgrid Knowledge	Market	Article
Varied Business Models for the Varied Regulatory Landscape (Click here to request access, then click link)	Katie Bell	Market	Presentation
What Electrification of Transportation and Buildings Means to Microgrids: Interview	Elisa Wood	Market	Article

References	Author/ Corporate Author	Topic	Resource
What Schneider Electric's Recent Move Reveals about the Microgrid Market	Microgrid Knowledge	Market	Article
What the Schneider/Autogrid Deal Signals about the Future of Microgrids	Microgrid Knowledge	Market	Article
What's Driving Microgrids toward a \$30.9B Market?	Elisa Wood	Market	Article
Wisconsin Utility Proposes Microgrid Resiliency Program with up to 22 projects	Microgrid Knowledge	Market	Article
The Short and Long Term Care of Your Microgrid	S&C Electric Company	Operations	Report
Community Microgrid Ownership Models	Brittany Blair and Paul De Martini	Ownership	White Paper
Independents and Utilities at Odds Over Who Builds Microgrids in Maryland	Elisa Wood	Ownership	Article
Power Purchase Agreements — Navigating the Complex Accounting Landscape	Bruce Blasnik	Ownership	Report
Are Microgrids Expensive?	Elisa Wood	Planning	Article
Community Microgrid Suitability Analysis A GIS Approach to Modernizing the Electric Grid	Gregory Young	Planning	Report
Cost-Benefit Analysis: Case Studies of Community Microgrids	Dean Weng, et al.	Planning	Report
DERMS: A Term Gone Too Far? DER Lifecycle Management Is Not Limited to DERMS	Ben Kellison	Planning	White Paper
Distributed Generation for Resilience Planning Guide	U.S. DOE	Planning	Webpage
Here's what the key figure in any community microgrid looks like Greenbiz	Sara Harari and Nate Grady	Planning	Article
How New Microgrid Technologies Enable Optimal Cooperation Among Distributed Energy Resources	Veronique Boutin, et al.	Planning	Report
How to Build a Microgrid	S&C Electric Company	Planning	Report
Microgrid 2019 Proceedings: Presentations, Photos & Polls	Microgrid Knowledge	Planning	Conference
Microgrid Analysis and Case Studies Report -California, North America, and Global Case Studies	Peter Asmus, Laura Vogel, et al.	Planning	Report
Microgrid Implementation Challenges and Key Technologies	Jacques Philippe, et al.	Planning	White Paper
Microgrid Investment Under Uncertainty – A Real Option Approach Using Closed Form Contingent Analysis	Farnaz Farzan, Mohsen Jafari, et.al.	Planning	Research
Microgrids for Fun and Profit: The Economics of Installation Investments and Operations	Farnaz Farzan, Mohsen Jafari, et al.	Planning	Research
NASEO NARUC Microgrids State Working Group: Microgram Planning & Deployment for Community Resilience	NASEO	Planning	Video
National Efficiency Screening Project (NESP): Value of DERs	Nat. Energy Screening Project	Planning	Website
One Size Does Not Fit All	Gene Wolf	Planning	Article
Phase I Microgrid Cost Study: Data Collection and Analysis of Microgrid Costs in the United States	Julieta Giraldez, Peter Asmus, et al.	Planning	Report
Reimagining the Grid	Southern California Edison	Planning	White Paper

References	Author/ Corporate Author	Topic	Resource
RU-LESS Micro-grid Optimal Design and Planning	Rutgers University	Planning	Report
The transition to renewable energy: Drivers, goals, and strategies	Delloite	Planning	Report
The Value of Resilience for Distributed Energy Resources: An Overview of Current Analytical Practices	NARUC/Converge Strategies	Planning	Report
Three Phases in Designing Successful Microgrid Projects	Energy Central	Planning	Article
Building a Microgrid: Understanding Your Microgrid Life Cycle & Design	S&C Electric Company	Planning	White Paper
VOR123: Value-of-Resilience	Clean Coalition	Planning	Article
Watch out for these Roadblocks to California Microgrids	Microgrid Knowledge	Planning	Article
2021 Outlook: Greening natural gas while planning for service reliability	Microgrid Knowledge	Policy	Article
California Considers Lifting Microgrid Standby Charges	Ethan Howland	Policy	Article
California Lawmakers Approve Bill to Bolster Microgrid Development, End Lengthy Wait	Elisa Wood	Policy	Article
Massachusetts Close to Finalizing a Clean Peak Standard. Good News for Microgrids	Peter Maloney	Policy	Article
FERC Tariff Approvals Open Way for Energy Storage in Wholesale Markets	Lisa Cohen	Policy	Article
If Regulators Had a Magic Wand, How Would They Encourage Microgrid Development?	Microgrid Knowledge	Policy	Article
Local Governments Want Communities — not Utilities — to Control Microgrids in California	Microgrid Knowledge	Policy	Article
Long Beach, Calif., Urges Regulatory Reforms to Overcome Microgrid Delays	Ethan Howland	Policy	Article
Microgrid Policy: What Really Needs to be Done?	Elisa Wood	Policy	Article
Microgrid Tariff Proposed by Hawaiian Electric Faces Industry Criticism	Microgrid Knowledge	Policy	Article
Microgrids Benefit from New Jersey's Push for More Renewables and Energy Storage	Microgrid Knowledge	Policy	Article
Modernizing the Energy Delivery System for Increased Sustainability	Smart Electric Power Alliance	Policy	Report
Modernizing the Grid in NJ Vital to Achieving Clean-Energy Targets	Tom Johnson	Policy	Electric grid
New Jersey Board of Public Utilities Microgrid Report	NJBPU	Policy	Report
New Jersey Board of Public Utilities Proposed Solar Rules - 2018	Microgrid Knowledge	Policy	NJ Adm Code
SOCALGAS Overview of Distributed Energy Resources Services (DERS) Tariff - Petition for Modification	SoCalGas	Policy	Presentation
Reps. Estes, Thompson and Sens. Coons, Moran Introduce Bipartisan Bill to Expand Renewable Energy Tax Advantages	Greg Steele	Policy	Article
State Net Metering Policies	Nat. Conf. of State Legislatures	Policy	Webpage
The Green Book Central Government Guidance on Appraisal And Evaluation	HM Treasury, Govt. Finance	Policy	UK Guidance

References	Author/ Corporate Author	Topic	Resource
The Regulatory Path Forward for Networked Microgrids	Anabelle Pratt	Policy	Article
What California's Microgrid Bill Means to the State – and Everybody Else	Lisa Cohen	Policy	Article
Who Pays on a Decentralized Grid? New York Tackles the Equity Problem with New Rates	Microgrid Knowledge	Policy	Article
Why Pennsylvania Utilities Want to Build Public Purpose Microgrids: Legislative Hearing	Elisa Wood	Policy	Article
Will New Jersey Lawmakers Step up for Microgrids before the Next Disaster?	Microgrid Knowledge	Policy	Article
A Toolkit for PROCURING RESILIENCE	re:focus Partners	Procurement	Article
Decision Adopting Short-Term Actions to Accelerate Microgrid Deployment and Related Resiliency Solutions	California PUC	Rulemaking	Document
Order Instituting Rulemaking Regarding Microgrids Pursuant to Senate Bill 1339	California PUC	Rulemaking	Document
Grid Modernization: Hosting Capacity Analysis and Distribution Grid Security	Synapse Energy	Services	Website
Translating DER and Microgrid Complexity into Simplicity & Bankability	Microgrid Knowledge	Software	Article
California Names 10 Winners for \$51.9 Million in Microgrid Grants	Microgrid Knowledge	State Pgm.	Article
Connecticut Microgrid Pilot Program TRC	TRC Solutions	State Pgm.	Article
DEEP: Microgrid Grant and Loan Program	CT Dept. Energy and Env. Protect.	State Pgm.	Webpage
Details on the 14 Massachusetts Community Microgrid Projects that Won Funding	Microgrid Knowledge	State Pgm.	Article
Evaluation of New York Prize Stage 1 Feasibility Assessments Final Report	Brookhaven National Lab.	State Pgm.	Report
Funding Opportunity Announcement (FOA) Resilient Maryland Program	Maryland Energy Administration	State Pgm.	Document
NY Prize Stage 1 winners	NYSERDA	State Pgm.	Document
Arizona commissioner cites 'unacceptable risks' from lithium-ion batteries for large-scale projects	Iulia Gheorghiu	Technology	Article
Blockchain microgrids are reshaping the energy sector	Power Technology	Technology	Article
Burning the Gas 'Bridge Fuel' Myth: Why Gas Is Not Clean, Cheap, or Necessary	Lorne Stockman, et al.	Technology	Report
Decades-Old Technology Offers a Greener Way to Cool Buildings	Will Mathis	Technology	Article
How residential energy storage could help support the power grid	Jason Finkelstein, et al.	Technology	Report
Mobile Energy Storage Study	Massachusetts DOER	Technology	Report
New Jersey Energy Storage Analysis (ESA) Final Report	Rutgers University	Technology	Report
Novel Waste-to-Energy Microgrid Aims to Provide Resilience in Camden, New Jersey	Lisa Cohen	Technology	Article
Reality check: Gas is not needed as bridge in N.J.	Richard Lawton	Technology	Article

References	Author/ Corporate Author	Topic	Resource
These Internet-Connected Batteries Are Helping Light Up Part of Puerto Rico	Michael Belfiore	Technology	Article
Thin, Flexible New Solar Cells Could Soon Line Your Shirt	Amelia Urry	Technology	Article
The Smart Grid	U.S. DOE	Technology	Webpage
Without the right policies, energy storage could increase emissions	Andy Bilich	Technology	Blog
California Tribe Explores What Some See as the Future: Networked Microgrids	Microgrid Knowledge	Type	Article
Microgrids Are Everywhere: The key to the future of the grid is understanding microgrid technologies.	Gene Wolf	Type	Article
Nanogrids: A New Opportunity for the Solar Industry & Its Customers	Microgrid Knowledge	Type	Article
The Name Game: Is 'Microgrid' Correct?	Gene Wolf	Type	Article
\$100 Million Microgrid Proposed for Downtown Cleveland	Microgrid Knowledge	Use case	Article
A Ready-Made Microgrid at Zero Cost? Yep. A Nebraska Utility Did It	Microgrid Knowledge	Use case	Article
Adapting to fire: How cities can enhance resilience with distributed energy	Madeline Tyson, et al/	Use case	Article
Beyond the Buzzwords: Making the Specific Case For Community Resilience Microgrids	Derek Jones, Emily Paris, et al.	Use Case	Presentation
Borrego Springs: California's First Renewable Energy-Based Community Microgrid	Hilal Katmale, et al.	Use Case	Report
Bracing for Multiple-Day Outages, Another California City Advances Microgrid Project	Microgrid Knowledge	Use case	Article
Building Blocks of Community Microgrids	Sara Harari and Nate Grady	Use case	Article
Building the Business Case for Fire Station Microgrids in California	Peter Asmus	Use case	Article
California's Critical Facility Challenge: The Case for Energy-as-a-Service Municipal Microgrids	Peter Asmus	Use Case	White Paper
Camden County utility authority first in NJ to create microgrid to power institutions	David Hutter	Use case	Article
Community Energized: City of Hartford, Constellation and Bloom Energy Power Up Microgrid in Parkville Neighborhood	Bloom Energy	Use case	Press release
Community Microgrids in the Spotlight	Rosana Francescato	Use case	Article
Community Resilience Planning and Clean Energy Initiatives: A Review of City-Led Efforts for Energy Efficiency and Renewable Energy	Dan York, Alexander Jarrah	Use Case	Report
Comparing America's grid operators on clean energy progress: PJM is headed for a climate disaster	Miles Farmer, Amanda Levin	Use case	Article
Curbing Energy Sprawl with Microgrids	Sara Bronin	Use case	Research
Dawn of the Utility Microgrid: The Path to a Profitable Future	Microgrid Knowledge	Use case	White paper

References	Author/ Corporate Author	Topic	Resource
Earthquake Worries Prompt Oregon Cities to Install Microgrids for Resiliency	Microgrid Knowledge	Use case	Article
Eight Projects Proposed in Round 4 of the Connecticut Microgrid Grant Program	Andrew Burger	Use Case	Article
Energy Storage: The New Efficiency - How States Can Use Efficiency Funds to Support Battery Storage and Flatten Costly Demand Peaks	Clean Energy Group	Use case	Report
Engineering Group Sees Increase in Power Outages, Costs	Microgrid Knowledge	Use case	Article
Lessons Learned from CEC EPIC Microgrid Research Activities	California Energy Commission	Use Case	Presentation
Eversource Takes Local Energy Concept to New Level with New Hampshire Microgrid Plan	Elisa Wood	Use case	Article
Facing rougher weather, A.C. Electric bolsters South Jersey grid	Lauren Minore	Use case	Article
First-of-a-Kind, Triple-Tasking, Front-of-Meter Microgrid in Sonoma, California	Microgrid Knowledge	Use case	Article
Former Obama Sustainability Chief Seeks Microgrid Resilience for Vulnerable Communities	Microgrid Knowledge	Use case	Article
Green Mt. Power's pioneering steps in transactive energy raise big questions about DER's value	Herman K. Trabish	Use case	Article
History of Microgrids in the US: From Pearl Street to Plug-and-Play	Microgrid Knowledge	Use case	Article
How cities and electric companies can unlock a powerful partnership	Jesse Berst	Use case	Article
Identifying optimal locations for Community Microgrids	Clean Coalition	Use case	Report
Is a Microgrid right for you?	S&C Electric Company	Use case	Report
Key Players Shed Light on Why the Microgrid Market is Growing	Microgrid Knowledge	Use case	Article
Making Microgrids as Simple to Deploy & Finance as Rooftop Solar	Microgrid Knowledge	Use case	Article
Microgrid Guide for Publicly Owned Critical Infrastructure	Rima Kasia Oueid	Use Case	Document
Microgrids: What Every City Should Know	Doug Vine, Amy Morsch	Use Case	White Paper
Microgrids as a Non-Spinning Substitute for Spinning Reserves	Kevin Normandeau	Use case	Article
Microgrids Can Protect Public Health. So Why Aren't We Using More that Way?	Lisa Cohen	Use case	Article
Microgrids State Working Group	NASEO	Use case	Webpage
Microgrids, major changes: Professor leading effort to redesign power grid	Sarah Small	Use case	Article
Neighborhood Microgrids would Provide Resilience under Sunrun Plan	Microgrid Knowledge	Use case	Article
Next-gen demand response is coming online, and utilities are calling on it more often: SEPA	Robert Walton	Use case	Article

References	Author/ Corporate Author	Topic	Resource
OPINION Microgrids: A new hope for New Jersey's energy future	Gail Lalla	Use case	Article
Outsourcing utility climate goals: Energy as a service reduces risk while increasing energy savings	Brett Feldman	Use case	Article
Pathway to Smart City Resiliency: The Microgrid Platform	Peter Asmus	Use case	Report
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The Resiliency Continuum	N. Placer and A.F. Snyder	Utility	White Paper
Utilities' failure to plan for DER surge promises missed opportunities, increased costs, analysts say	Herman K. Trabish	Utility	Article

BLOUSTEIN LOCAL GOVERNMENT RESEARCH CENTER

New Jersey is served by more than 1,500 distinct local government agencies: municipalities, school districts, utilities, counties, and more. Yet, even with this wealth of opportunity, precious little substantive research has been done within the local government environment to inform some of our state's most pressing policy issues.

The [Bloustein Local Government Research Center \(Bloustein Local\)](#) serves as a focal point and engages in a range of services, including:

- Encouraging and conducting applied and academic research on local government fiscal and administrative issues, emphasizing application and support to New Jersey local government.
- Developing resources that can assist others in conducting research and analysis.
- Organizing, hosting and supporting conferences and symposia on New Jersey local government fiscal and administrative issues.
- Supporting New Jersey local government fiscal and administrative policy development, implementation, and analysis through contract research and on-call advice for organizations and institutions that engage in local government policy setting and policymaking.
- Promoting and increasing public understanding of local government issues by partnering with and supporting civic and media organizations that inform and educate the public on local government matters.

A list of the Center's current projects may be found online at <http://blousteinlocal.rutgers.edu/projects/>.

THE CENTER FOR BUILDING KNOWLEDGE

The [Center for Building Knowledge \(CBK\)](#) is a 30-year-old research, training, and technical assistance institute affiliated with the Hillier College of Architecture and Design at the New Jersey Institute of Technology. CBK's mission is to help stakeholders make better-informed decisions about the performance, sustainability, and resilience of their buildings and their communities, with a specific emphasis on developing online educational resources and tools that demystify technical concepts and make them accessible to – and understandable by – nontechnical audiences.

CBK's services include: building science research; technical assistance; outreach and promotion; online training; and analytical tool development. CBK created and currently maintains [microgrids.io](#).

THE CENTER FOR RESILIENT DESIGN

The NJIT [Center for Resilient Design \(CRD\)](#) was established in late 2012 – in the immediate aftermath of Super Storm Sandy – and is directly affiliated with the NJIT Center for Building Knowledge. The Center's founding mission was to serve as a resource to help New Jersey communities recover from the effects of Sandy – first as a special program within the Hillier College of Architecture and Design and then as a full-fledged center within the university.

These activities soon evolved into broader explorations of how these same communities could become more resilient in the face of future events. Building on lessons learned in New Jersey, the Center has become a research, technical assistance, and training institution focused on improving the resilience of buildings and communities in the face of natural disasters and other stresses.



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