

COMMUNITY MICROGRIDS:

Smarter, Cleaner, Greener

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Pace Energy and Climate Center
PACE LAW SCHOOL

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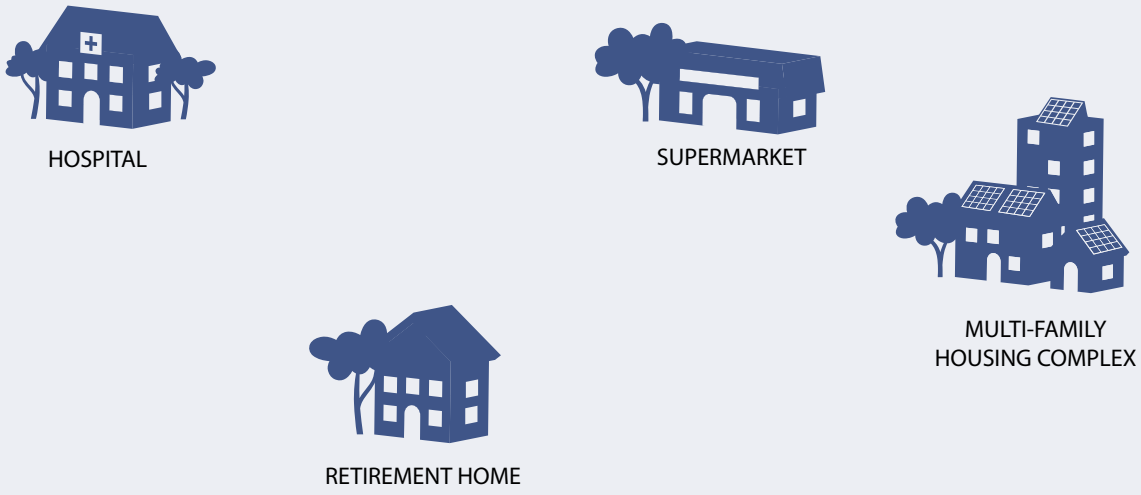
Introduction

A microgrid is an energy system specifically designed to meet the energy needs of a community in a smarter, cleaner, greener way.

COMMUNITY MICROGRIDS EMPOWER local leaders to serve community energy needs in a more economical, reliable, and environmentally friendly manner than the existing centralized electricity grid. A microgrid can bring together whole-building energy efficiency improvements, clean distributed generation, renewable energy, and smart energy management technologies at the local level to lower energy costs, boost resilience and reliability, reduce pollution, and attract new investment. Community leaders can seize the opportunities microgrids offer by conducting energy planning that sets goals, identifying potential sites that match those goals, and carrying out the necessary analyses that lead to financing and construction. State energy policy makers can create a friendlier environment for microgrids by providing regulatory guidance, establishing financial incentives, and adopting clear rules on the role of microgrids in our electricity system. This report helps to point the way.

Part 1 provides a primer on community microgrids and illustrates some of the various shapes a microgrid can take. Part 2 outlines the many benefits a microgrid can bring to a community, especially against the backdrop of the existing centralized electricity grid. Part 3 lays out a roadmap for communities considering microgrids from setting goals and identifying the vision for a project to choosing sites, completing analyses, acquiring financing, and getting approval to build. Part 4 considers the regulatory environment for microgrid development and offers recommendations for making the region friendlier to microgrids.

Figure 1 A Community Before the Development of a Hypothetical Microgrid



1 Community Microgrids: A Primer

A microgrid is an energy system specifically designed to meet some of the energy needs of a community. Microgrids can include facilities that: (1) generate electricity, heating and/or cooling; (2) distribute the energy generated; and (3) manage energy consumption intelligently in real time. A community microgrid thus puts local leaders in a position to transform a community's energy system.

Microgrid generation capacity can take the form of various distributed generation technologies, including solar photovoltaic arrays and/or combined heat and power units. Microgrid distribution facilities include the wires and transformers needed to deliver electricity, as well as the pipes needed to deliver useful steam and hot or chilled water to users on the system. Managing energy consumption begins with energy efficient buildings and equipment and also entails smart technologies that permit the microgrid system operator to quickly reduce, or "shed", demand on the system.

Community microgrids are usually connected to the larger electric grid in the normal course of operation. The connection to the larger grid allows the microgrid to obtain energy that is not economical to generate within the microgrid system. Microgrids are typically designed to operate detached from the grid in "island mode" as well. Island mode enables a microgrid to function when the main grid is down during an emergency. A microgrid that can curtail electricity demand may also participate in "demand response" or "ancillary services" markets where users receive monetary payments in exchange for curtailing energy use.[1]

Microgrids can continue to operate when the main grid is down.

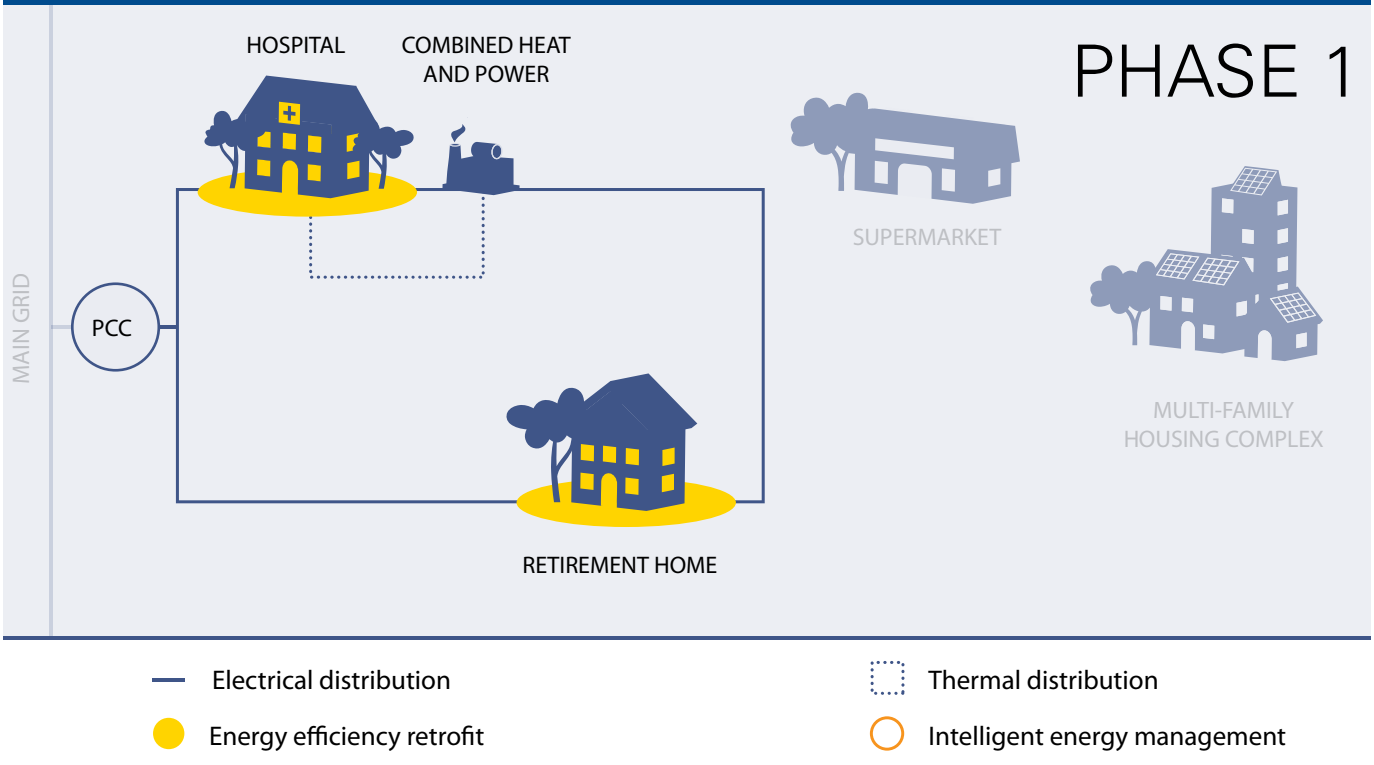
To help illustrate how a community microgrid might be designed, consider the hypothetical community depicted in Figure 1. The hypothetical community consists of a multi-family residential complex, a hospital, a retirement home, and a supermarket.

Phase 1: Shoring Up Critical Infrastructure

The first hypothetical phase, depicted in Figure 2, targets the community's critical infrastructure: the hospital and nearby retirement home. Critical infrastructure demands a reliable uninterrupted source of electricity. The retirement home in this example will serve as a center of refuge for the community during emergencies. The phase begins with deep whole-building energy efficiency retrofits to both the hospital

1 Demand response markets compensate energy consumers that reduce energy demand below normal levels when energy generation prices are high or grid stability is threatened. Ancillary services markets pay participants to have on-site generation capacity on standby or to shed energy demand quickly to respond to unexpected disturbances in the grid, such as the loss of a large energy generator or the rapid appearance of a large energy consumer.

Figure 2 Phase 1 of the Hypothetical Microgrid Connects Critical Infrastructure to a CHP Unit



and retirement home, followed by installation of a combined heat and power system.

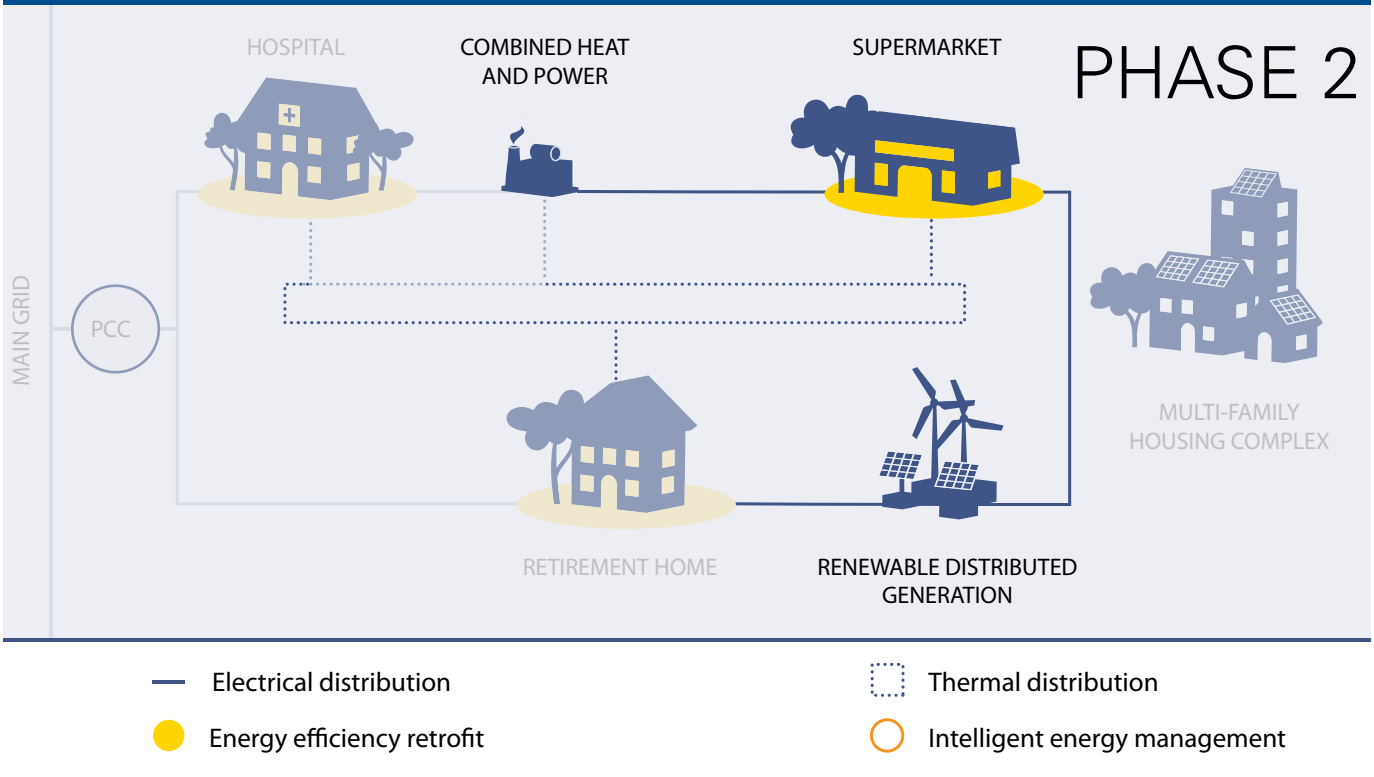
- **Whole-Building Energy Efficiency Retrofits.** Whole-building energy efficiency retrofits ensure that all cost-effective energy efficiency measures are installed so as to reduce energy consumption.
- **Combined Heat and Power (CHP).** CHP is the simultaneous production of useful thermal energy and electricity. Waste heat from the production of electricity is captured in the form of hot water or steam that can be used for heating and cooling in buildings. CHP is far more efficient than the traditional energy system configuration that draws electricity from the main grid and heating from an onsite boiler or furnace. CHP systems can achieve efficiency ratings of more than 80%, while generating heat and electricity separately is typically no more than 45% efficient.
- **Connection to Main Grid.** The microgrid connects to the local utility at a point of common coupling (PCC) where it can buy and sell electricity, as well as safely disconnect from the grid and operate independently in island mode.

Phase 2: District Heating Plus Renewables

The second phase in the hypothetical microgrid incorporates renewable generation and expands the CHP system by delivering the waste heat (in the form of water or steam) through a district heating and cooling network to additional nearby buildings. As depicted in Figure 3, the system also adds a new microgrid user—a supermarket.

- **Renewable Distributed Generation.** Renewable distributed generation is renewable energy sited at or close to where its energy is consumed. Microgrids can utilize previously or newly installed renewable distributed generation including solar photovoltaic, solar thermal, wind, hydro, geothermal, and biomass.

Figure 3 Phase 2 Incorporates Renewable Energy and Supermarket into the Hypothetical Microgrid



- **District Heating and Cooling.** District heating and cooling is a network of pipes that distributes thermal energy produced by a central plant—in this example a CHP unit—to nearby buildings. The central plant can also be a large boiler.

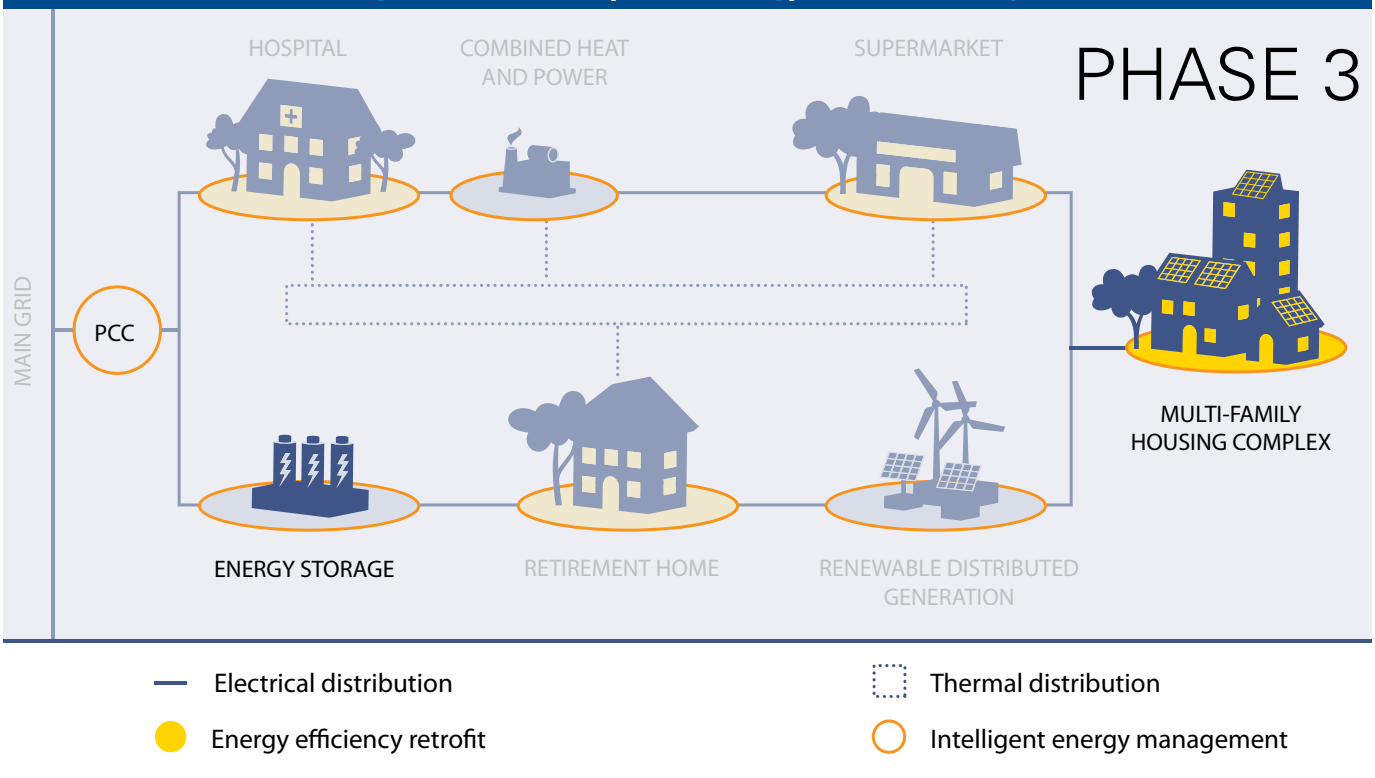
Phase 3: Residential Neighborhood and Managing Consumption

Depicted in Figure 4, the final phase in the hypothetical microgrid adds energy storage and upgrades all infrastructure to include intelligent energy management technology. A nearby multi-family residential complex with solar PV is also added to the microgrid.

- **Energy Storage.** Energy storage uses devices (e.g. batteries, flywheels) or physical materials (e.g. hot water, ice, hydrogen) to store energy—either electrical, heat, or mechanical—that can be used at a later time.
- **Intelligent Energy Management and Demand Response.** Sometimes referred to as the "smart grid," intelligent energy management uses technologies to monitor and control electricity consumption in real time. It allows the operator of the microgrid to reduce demand in the event that the microgrid can no longer acquire power from the larger grid and must switch to island mode, or when the main grid operator requests the microgrid operator to curtail consumption from the main grid as part of a demand response program. Intelligent energy management can also alter energy consumption patterns in the absence of any formal programs by responding to the price of buying energy from the main grid or the price of producing energy on the microgrid to manage the microgrid system cost effectively.

These three phases of a hypothetical microgrid represent only one possible community microgrid scenario. As discussed more fully in Part 3, microgrid design depends on the goals the microgrid developer seeks to accomplish. In the next section, the many potential benefits of microgrids are discussed.

Figure 4 The Final Phase Adds Energy Storage, Intelligent Energy Management, and a Multi-Family Residential Complex to the Hypothetical Microgrid



2 Community Microgrids: The Benefits

Microgrids can provide reliable energy to critical facilities and businesses, reduce energy costs, minimize carbon pollution, encourage economic development, and reduce costs on the main grid distribution system. These are welcome benefits in a region with some of the nation's highest electricity prices and in communities that experienced the impacts of extreme weather such as Hurricanes Sandy and Irene.

Microgrids Offer Reliable Energy

The Northeastern blackout of 2003 and recent extreme weather events such as Hurricanes Irene and Sandy demonstrated the fragility of the region's electrical supply system. Each event significantly disrupted the electrical grid—straining emergency responders and imposing steep economic costs. During Hurricane Sandy, hospitals relying solely on rarely used back-up generators were forced to evacuate after their generators failed and power was unavailable.[2] Rutgers University calculated that the loss of state gross domestic product in New Jersey due to Hurricane Sandy topped $11.7 billion in foregone output,[3] and the economic research firm Moody's Analytics estimated that nearly $20 billion in losses occurred due to suspended business activities after the hurricane.[4]

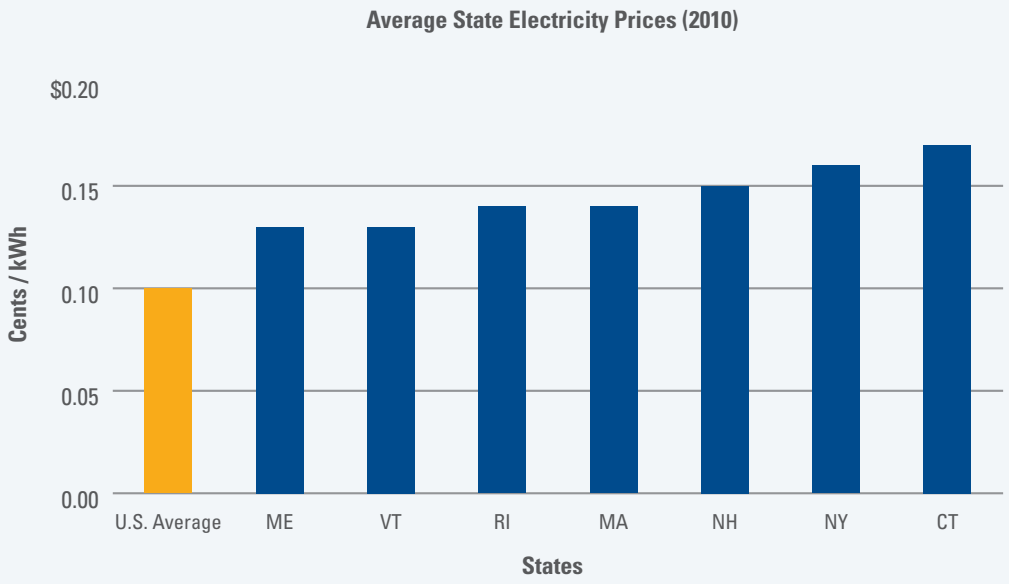
Community microgrids can ensure power is not lost at critical facilities and other buildings when the main grid is offline. When microgrids are strategically sited around critical facilities, such as hospitals, assisted living facilities, and police and fire stations, they can sustain vital operations during crises. With enough generation capacity, other microgrid users such as businesses and residences can also benefit from the resilient power supplied by microgrids.

2 *Sandy's U.S. death toll reaches 12; two N.Y. hospitals evacuated*, L.A. TIMES, Oct. 12, 2012, *available at* http://articles.latimes.com/2012/oct/29/nation/la-na-nn–sandy-update2-20121029.

3 Mantell, N. et al. *The Economic and Fiscal Impacts of Hurricane Sandy in New Jersey: A Macroeconomic Analysis*, Rutgers Issue Paper Number 34, *available at* http://policy.rutgers.edu/reports/rrr/RRR34jan13.pdf.

4 Mark Zandi, *The Economic Impact of Sandy*, MOODY'S, *available at* https://www.moodys.com/PublishingImages/MCO/ProductAttachments/Econ_Impact_of_Sandy.pdf.

Figure 5 Ready for Lower Costs: Northeast Region has Higher than Average Electricity Rates



Source: U.S. Energy Information Administration

Microgrids Can Lower Energy Costs

The Northeast suffers from some of the highest electricity costs in the nation with electricity prices 30% to 76% higher than the national average, as shown in Figure 5.[5] High electricity prices strain residents' budgets and make businesses less competitive. For energy intensive industries, even modest differences in energy prices can influence them to locate elsewhere.[6]

Microgrids can significantly reduce energy costs through whole-building energy efficiency retrofits and combined heat and power. After extensive energy efficiency retrofits in 2009, for example, the Empire State Building has reduced its energy consumption by over 30%, and it now saves over $2 million in energy costs per year.[7] New York University's recently upgraded CHP system saves the university a reported $5 million per year in energy costs.[8]

Other strategies, such as integrating distributed renewable generation or intelligent energy management into a microgrid, can also lead to considerable energy cost savings. Renewable energy is rapidly becoming price competitive with conventional fossil fuel energy.[9] By using renewable energy for some or all of its energy supply, a microgrid can provide cheaper energy that, unlike fossil fuels, is not vulnerable to volatile price changes. Intelligent energy management can spur further energy cost savings by shifting electricity consumption to times when microgrid-generated electricity is plentiful or energy from the main grid is less costly. Real-time control of electricity consumption also makes it possible for the microgrid operator to respond when the main grid operator calls on the microgrid to reduce consumption of electricity from the main grid in exchange for payment as part of a demand response program or ancillary services market.

Microgrids Reduce Carbon Pollution

Communities across the Northeast recognize the importance of reducing their carbon pollution. As shown in Figure 6, buildings are responsible for nearly half of

5 See energy price data *at* http://www.eia.gov/electricity/state/.

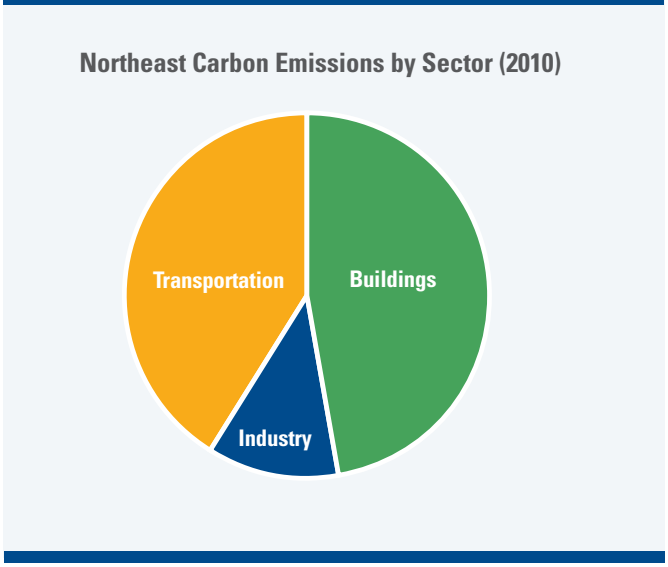
6 Kahn & Mansur, *How do energy prices, and labor and environmental regulations affect local manufacturing employment dynamics?* A regression discontinuity approach, National Bureau of Economic Research (Nov. 2010), *available at* http://www.nber.org/papers/w16538.

7 Press Release, Clinton Climate Initiative, Innovative Empire State Building Program Saves Millions, Establishes New Energy Efficiency Model Nationwide (June 24, 2013), *available at* http://esbnyc.com/documents/press_releases/2013_06_24_ESB_Year_Two_Press_Release.pdf.

8 *Case study: New York City,* Source One (2013), *available at* http://www.sourceone-energy.com/resources/case-studies/new-york-university-cogeneration-plant/.

9 Barbara Vergetis London, *Renewables could be cost competitive by 2025,* Fierce Energy (Aug. 27, 2012), *available at* http://www.fierceenergy.com/story/renewables-could-be-cost-competitive-2025/2013-08-27.

Figure 6 Ready for Less Pollution: Buildings are the Largest Contributors to Carbon Pollution in the Northeast



Source: U.S. Energy Information Administration

the region's carbon pollution.[10] Any effort to reduce carbon pollution, therefore, must address buildings.

Microgrids reduce carbon emissions from buildings by bringing together energy efficiency, renewable and clean local generation, and smarter energy management. Intelligent energy management can shift demand to when carbon-free generation, like solar and wind, are producing power. Additionally, energy efficiency and CHP can deliver significant carbon emissions reductions. For example, NYU's CHP system accounts for the "single largest reduction wedge in NYU's Climate Action Plan by avoiding 43,000 metric tons of carbon emissions annually, a 23% decrease from University-wide 2006 emissions."[11]

Microgrids Spur Economic Development

Many businesses and industries require high quality and reliable electricity to operate profitably. Even momentary power outages or deviations can result in large financial losses or damages to equipment. A Department of Energy report estimates that credit card and brokerage operations can lose $2.5 million and $6.5 million per hour, respectively, during power outages.[12] A case study of the now defunct Sun Microsystems "estimated interruption costs at up to $1 million per minute."[13] Businesses also desire clean and green energy to help reduce their environmental impact.

Microgrids can attract businesses that value reliable and clean energy. The combination of nearby generation and the ability to island provides a dependable back up when the main grid fails. In addition, microgrids can help bring and keep jobs and money within the community. Since microgrids are built and operated on site, local construction, maintenance, and operating staff will need to be employed. Microgrids also help keep energy dollars within the local community by reducing the money spent on energy imported from outside the community.

Microgrids Can Reduce Costs on the Utility Distribution System

The Northeast's energy transmission and distribution infrastructure is aging, and it is straining to deliver energy adequately in some areas.[14] Utilities are required to maintain the electric grid at safe standards and provide enough distribution capacity to support customer demands. Maintaining grid capacity requires utilities to invest in costly grid maintenance and equipment upgrades, the costs of which are charged to the utility's customers.

Microgrids reduce customer demand on the larger grid, and thus allow the utility to defer or avoid otherwise necessary investments in system upgrades for constrained areas of the grid. Strategically siting microgrids within areas that are close to maximum distribution capacity will benefit the broader community by delaying or reducing utility capital investments. This is an area where the interests of the utility's customers, and the clients served by the microgrid are aligned.

10 *See* CO_2 emission data from U.S. Energy Information Administration, *available at* http://www.eia.gov/environment/.

11 *Sustainability Progress*, NEW YORK UNIVERSITY (2013), *available at* http://www.nyu.edu/nyu2031/nyuinnyc/sustainability/sustainability-progress.php.

12 *Strategic Plan for Distributed Energy Resources*, DEPARTMENT OF ENERGY (2000), *available at* http://www.energetics.com/resourcecenter/products/plans/samples/Documents/dist_resources_plan.pdf.

13 P.J. Balducci et al., *Electrical power interruption cost estimates for individual industries, sectors and US economy.* Pacific Northwest National Laboratory (Feb. 2002), *available at* http://www.pnl.gov/main/publications/external/technical_reports/pnnl-13797.pdf.

14 *See* FAILURE TO ACT: THE ECONOMIC IMPACT OF CURRENT INVESTMENT TRENDS IN ELECTRICITY INFRASTRUCTURE, American Society of Civil Engineers (2011), *available at* http://www.asce.org/uploadedFiles/Infrastructure/Failure_to_Act/energy_report_FINAL2.pdf, and POWER TRENDS 2012: STATE OF THE GRID, NYISO (2012), *available at* http://www.nyiso.com/public/webdocs/media_room/publications_presentations/Power_Trends/Power_Trends/power_trends_2012_final.pdf.

3 Building Community Microgrids: A Roadmap

Microgrids require planning. A sound planning process ensures that all key stakeholders are at the table, an ideal site is selected, and that the project is adequately studied, permitted, financed, and built. This section lays out a possible roadmap for communities to navigate the microgrid planning process.

Step 1: Set Project Goals

Setting project goals is important for identifying valuable project sites, engaging relevant stakeholders, and completing a successful project. Microgrids can be deployed to suit a variety of needs and yield a variety of benefits. These goals may be economic, environmental, and/or reliability related. How the community frames its priorities will affect the target areas and users and also how a larger project may be phased. For example:

- If a goal of the microgrid is to ensure reliable supply of energy to critical infrastructure, the project should target these critical service providers.
- If a goal of the microgrid is to spur economic development, the project might focus on industrial and/or commercial areas, especially where manufacturers and companies requiring lower cost or high quality reliable power are located or would be more apt to locate.
- If a goal of the microgrid is to reduce carbon pollution, the project could target areas with significant rooftop or ground space for a solar photovoltaic installation, strong wind resources, or ample access to biomass resources, making renewable energy more cost effective.

In addition, the community may also want to consider phasing its microgrid development over time like Energize Ithaca in upstate New York. Ithaca's plan to develop a microgrid in "nodes" shows that, in setting project goals, it may help to anticipate future expansion of the microgrid or plan to break a large project into manageable segments.

Step 2: Organize and Inform Core Stakeholders

It is important to engage all key stakeholders from the earliest possible stage in a planning process. Good outreach strategies may include:

- Stakeholder interviews;
- Surveys of residents, business owners, property owners, and all other interested parties;
- Public workshops and hearings; and
- Marketing and promotion.

The Community Microgrid Roadmap

Step 1: Set project goals. Is the goal to maximize reliability? Cost savings? Business growth? Should the project be built in phases?

Step 2: Organize, educate core stakeholders. Who are the potential champions, stakeholders and authorities who will have a say in this process? Should a steering committee be appointed? How can these parties be educated and organized?

Step 3: Identify project site. Where are reasonably large pockets of consistent energy demand? Are there large energy users in these pockets who can anchor a project?

Step 4: Conduct 1st level screening study. Is this project technically feasible? Is this site appropriate?

Step 5: Conduct 2nd level screening study. What are the project site's daily and sub-hourly energy demands? What will be the capital costs and returns on investment?

Step 6: Conduct audit grade study. What will the business model, ownership structure, tax treatment, and payback period of this project look like? How thoroughly must the technical viability of the project be demonstrated in order to attract financing?

Step 7: Acquire financing. Will bonds, equity, leasing, third party ownership or some other type of financing work best for the project?

Step 8: Acquire necessary approvals and construct. Will this project require zoning variances? Building permits? Revocable consents? Excavation permits?

ASI Energy's Energize Ithaca project works from a "nodal microgrid" model, which allows multiple host buildings with microturbines — each able to come online independently — to eventually cooperate by selling heat throughout a hot water loop that will be built to serve the entire downtown.

Energize Ithaca, for example, formed a partnership with a local design and marketing firm to craft a strategy for public outreach and stakeholder engagement for their district heating plans that includes press releases, media interviews, advertising, and social media strategies.[15] A helpful complement to this process may be the creation of a community energy repository that includes key reports, as well as contact information of individuals with a stake in the microgrid planning process. The community may also consider forming a microgrid steering committee to be the central conduit for project outreach.

Step 3: Identify the Project Site(s)

An ideal microgrid might combine all of the following attributes: high demand users with consistent electric, heating, and cooling needs; a high density of energy users; critical infrastructure sites; superior exposure to solar and wind energy; long-term and stable access to biomass/biofuels; a site that is already engaged in another major construction process; and existing high energy prices. Few sites will have all of these characteristics, however. The following are possible tools and processes that may help municipalities identify those sites in a community with the best mix of these attributes to achieve their goals:

CONDUCT AN ENERGY PLANNING PROCESS

While community-wide energy planning is not necessary to find the optimal project sites for a microgrid, conducting an energy planning process can help secure the attention of high-level officials, coordinate activity across different municipal agencies, and integrate microgrid efforts into the community's broader development goals. In an energy plan, communities can better answer the following questions:

- Where and how is energy currently used today in the community, and how is that expected to change?
- Where does the community expect development to occur in the future? Would microgrid infrastructure be most economical to install at these sites as part of the larger development?
- What type of economic activity does the community want to attract?
- What critical infrastructure is vulnerable to regional power outages?
- How does the community want to address its carbon footprint?

A successful energy planning exercise will answer these questions and then follow-up with coordinated studies engaging business leaders, local government agencies, and key affected parties to identify the right project sites.

IDENTIFY ANCHOR ENERGY USERS

An anchor energy user at the heart of a microgrid can help drive its long-term success. Because microgrids require significant up-front investments in infrastructure with a long service life, it is helpful to have an anchor user who is likely to be at the location for many years into the future. The anchor energy user may take the lead in negotiating financing for

Energy Planning: Seattle

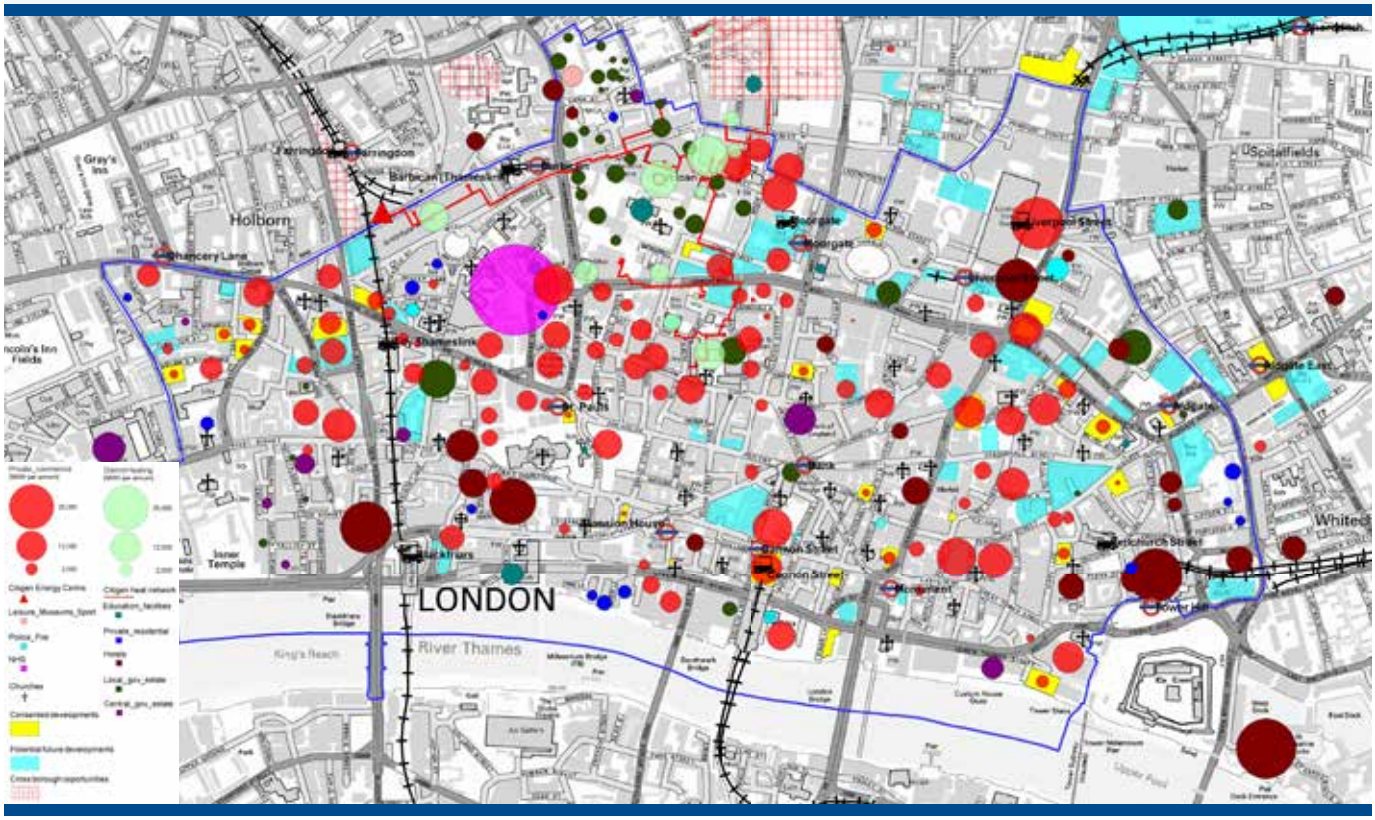
Seattle has engaged in several energy system planning processes to stimulate microgrid infrastructure. The latest, issued in June 2013, calls for carbon neutrality by 2030 through an alternative energy master plan. Previous planning processes served as the springboard for studies that measured the growth factor and heat density of ten promising neighborhoods, in an effort to identify good candidates for distributed generation.

15 See more about the Energize Ithaca at http://www.nyenergyhighway.com/Content/documents/52.pdf.

Planning Tools: Heat Mapping

Heat mapping, illustrated below in Figure 7, is one way to find groups of users that may be suitable for a microgrid. It can be included in a general mapping study that includes community development options and expected land uses. Heat mapping has been widely employed in Europe, and closer to home, Columbia University has developed a free tool for assessing energy usage in buildings in New York City called "Power Play: an Energy Map of New York City."

Figure 7 Heat Map of London



© PointX. All Rights Reserved. License Number 10034829. © Crown copyright. All rights reserved (LA100032379)(2010). Maps created by the Centre for Sustainable Energy. 2010.

the system and use its access to capital to procure advantageous borrowing terms. Additionally, microgrids will tend to be more economical when they serve users with large and constant energy demands, which suitable anchor users can help provide.[16] Examples of such tenants include hospitals, universities, convention centers, industrial parks, commercial office centers, and prisons.

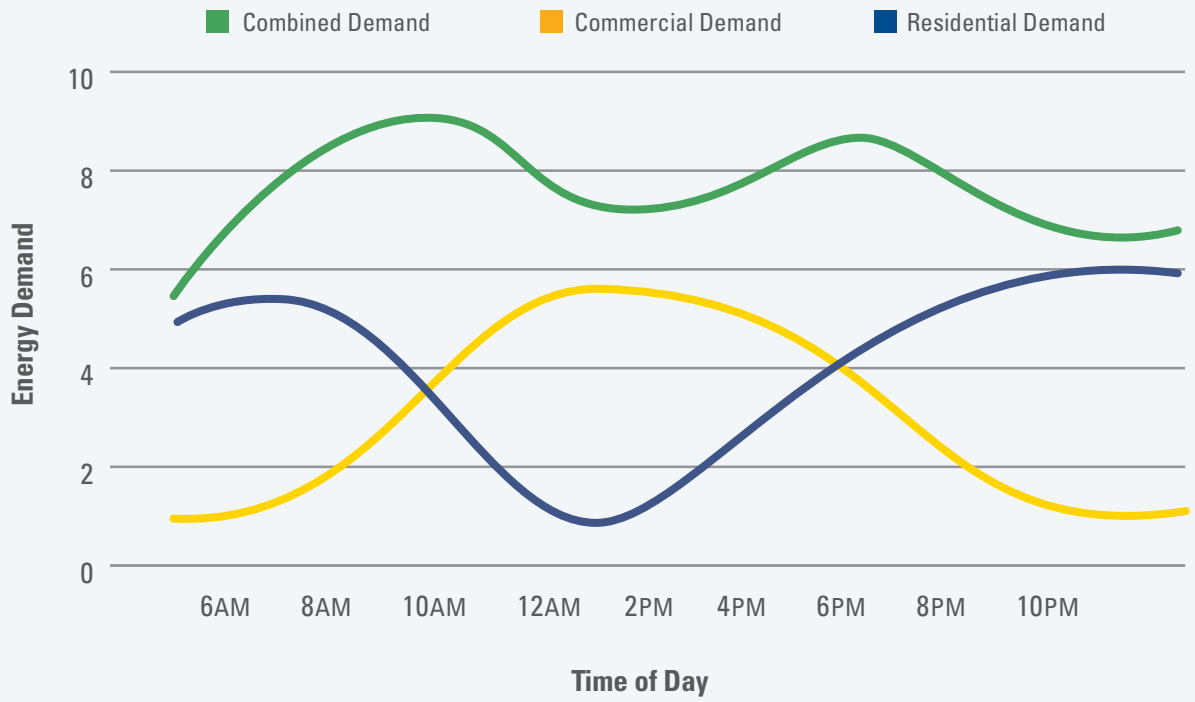
IDENTIFY COMPLEMENTARY ENERGY USERS

In addition to an anchor energy user, microgrids will be more economical when they target complementary energy users that together present a fairly constant energy demand. When users combine to provide a relatively constant energy demand over a 24-hour period, microgrid generators are used consistently and economically.

Consider the example of a commercial center next to a large residential area. As illustrated in Figure 8, the commercial building is used intensively between the hours of 8 AM and 5 PM, with demand increasing and decreasing quickly during the morning and evening, respectively. The adjacent residential area complements this load profile because it demands more electricity during early mornings and late evenings. The pair of users provides a combined daily demand profile that is steady. This complementary

16 This is because larger generators tend to be more efficient than smaller ones, and the costs associated with distributing that energy tend not to increase proportionately with additional generation. Likewise, a microgrid that services a relatively constant energy demand, both daily and yearly, can sit idle for less time than a system that serves users that only demand energy during certain times of the day or year.

Figure 8 Complementary Users Combine to Form a Single High and Steady Demand, Meaning Microgrid Generators are Less Likely to Sit Idle or Run Inefficiently



demand profile can be paired with a generator such as a CHP unit and ensure that the generator's capacity will be utilized consistently.

RECOGNIZING UNDERDEVELOPED LOCATIONS

In addition to identifying complementary users and anchor users, communities might also look for physical locations with untapped potential, such as:

- Existing energy generation sites that can be cost-effectively reconfigured or expanded to serve a microgrid. For example, a naval submarine base in Groton, Connecticut, has proposed integrating fuel cells and renewables with existing generators in order to serve buildings across the entire base.[17] In this case, existing generation can be expanded more cheaply than installing new generation.
- Sites already slated for significant development, like brownfield redevelopment areas, where microgrid infrastructure can be cost-effectively installed simultaneously with planned development.

Adding Energy to Planned Development

On the site of a former brownfield in Atlanta, GA, Atlantic Station represents a good example of building community energy in the midst of a larger capital project. Atlantic Station used Brownfield Tax Allocation District dollars to fund a 7,500 ton chilled water plant with 2 mile network of distribution pipes, providing cooling to an already-planned 140 acre mixed-use development where a steel mill once was. When ground is already broken for a related piece of construction, hot water pipes and other energy infrastructure can be added at a lower cost.

- Sites that already generate substantial waste heat not yet utilized, like the Bridgeport District Energy Project in Connecticut. Bridgeport is the home to an existing waste-to-energy facility that has no existing use for its waste heat. NuPower Thermal LLC has stepped in and plans to distribute 3 million cubic feet of heating through 1.5 miles of piping from the facility, bringing low cost heating to a large part of downtown Bridgeport.[18]

17 *SUBASE NLON Microgrid Grant And Loan Application*, CONNECTICUT DEEP, *available at* http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/1ded75bce941a68d85257b8e0069259c?OpenDocument.

18 *Bridgeport District Energy Project*, NUPOWER LLC, *available at* http://www.nupowerllc.net/projects/page8/page8.html.



Pace Energy and Climate Center houses tools that can help identify potential microgrid sites.

There are free tools available to evaluate project site feasibility before investing in more professional studies. The District Energy Screening Tool developed by the Department of Energy and International District Energy Association can provide a helpful early stage feasibility appraisal of a project. The screening tool analyzes energy load growth; capital and operating cost estimates; building energy needs; various system configurations; and timing sensitivities to provide a rough estimate of project costs and benefits.[19] The RETScreen Software Suite developed by Natural Resources Canada also allows users to estimate the technical and financial viability of potential renewable energy, energy efficiency, and cogeneration projects.[20]

19 See INTERNATIONAL DISTRICT ENERGY ASSOCIATION, COMMUNITY ENERGY: PLANNING, DEVELOPMENT AND DELIVERY 25, *available at* http://www.districtenergy.org/assets/pdfs/Community-Energy-Dev-Guide-US-version/USCommunityEnergyGuidehi.pdf.

20 The RETScreen Software suite is available for download at http://www.retscreen.net/ang/home.php.

Step 4: Conduct First Level Screening Study

Once a project site has been identified that meets desired goals, a first level screening should be undertaken.[21] At this stage, the study may produce a range of scenarios using different combinations of technologies and design arrangements in order to identify the best project plan or plans. A good first level screening study should include:

- An exploration of energy efficiency retrofitting options;
- A determination of CHP technical and financial feasibility;
- An engineering and financial model or spreadsheet that measures the demand profile of the buildings in as granular a view as possible (preferably hourly, half-hourly, or quarter-hourly);
- Electric rates and demand charges levied by the utility;
- Installation cost of the system;

21 For more information on this stage of the study process, see *Feasibility Analysis*, MIDWEST CLEAN ENERGY APPLICATION CENTER, http://www.midwestcleanenergy.org/support/feasibility.aspx.

- An estimate of key financial measures, such as the payback period, annual cash flows, and return on investment, for the microgrid project; and
- An overview of any permitting concerns that could impact the project.

The first level screening should aim to predict the proper sizing of the installation and the essential financial terms of the project within 10-30% of the actual amounts. If the project targets existing buildings, a basic walkthrough of the facility along with 12 to 24 months of electric and fuel bills will often provide much of the information required to conduct this stage of screening. The US Department of Energy's CHP Technical Assistance Partnerships provide free advice and technical assistance for this level of screening.[22]

Free tools are available to evaluate project site feasibility before investing in more professional studies.

Step 5: Conduct Second Level Screening Study

If the first level screening study indicates the project is technically feasible, a more detailed second level financial study should be conducted. Considerations that should be more thoroughly addressed at this stage include:

- Installation costs of the project, including the costs of items like engineering, permitting, land-use approvals, and acquiring rights of way;
- Operating costs, such as labor and fuel expenses, equipment operation and maintenance charges, annual debt services, insurance, taxes and other relevant expenses;
- Possible business model(s) addressing, for example, how different users might arrange and pay for service and installations between themselves;
- Project risks (e.g., poor equipment performance, fluctuating fuel prices, loss of customer revenues);
- Charges for standby service;[23]
- External funding sources (e.g., state and federal tax incentives, capital grants, payments for reductions in regulated emissions, like SO_2, NO_x, and CO_2); and
- Revenues from energy reliability services, net metering, or the provision of ancillary or demand response services to the utility.

Typically, the second order screening study should cost in the four figures for a large project. The first and second studies are often performed in a sequential process, as the technical questions answered by the first screening study will inform the second stage analysis. By the end of both processes, the project should be able to demonstrate its viability clearly enough to merit investing in an audit grade study in order to proceed.

Step 6: Conduct an Audit Grade Study

After the project has undergone some study of both its technical feasibility and economics, a robust audit-grade study is usually necessary to obtain financing. A professional engineering firm can perform an advanced version of the first two screening studies. This study will be substantially more expensive than either of the previous studies and may require its own financing to complete. For a large project, an audit grade study can cost into the low to mid six figures. The audit grade study will attempt to address most of the same questions that the previous two studies touched on, but in greater depth. By the time the study is completed, the project will have settled on:

- An appropriate design;
- Identified any contractors required to perform the work;
- Determined the ownership structure of the project;
- Identified sources of income and tax advantages; and

22 The Pace Energy and Climate Center and University of Massachusetts Amherst serve as co-managers of the Northeast center covering New York and New England. *CHP Technical Assistance Partnerships*, U.S. DEPT. OF ENERGY, http://northeastchptap.org.

23 Standby rates refer to the rate utilities will charge to customers for "standing by," prepared to meet the full electrical needs of the microgrid if its generation should ever fail. The cost of maintaining the necessary infrastructure to service the customer's full load is recaptured by the utility through its standby rates, so the rate will vary depending on the amount of infrastructure that must be maintained on account of the microgrid.

- Developed financial plans that take the project from the financing stage out to the end of the equipment's life cycle.

With this study in hand, the microgrid developer will have a strong basis to solicit financing.

A smartly designed and financed microgrid will pay for itself and provide years of future energy savings.

Step 7: Acquire Project Financing

At this stage, the project team should consider different vehicles for financing in light of the project sponsor's access to capital, credit-quality, and the selected ownership structure. Some options and considerations follow:

EQUITY FINANCING

In an equity financing arrangement, investors contribute to the project and acquire an ownership stake that entitles them to a share of the returns arising from the profits and increase in economic value generated over time by the project.

DEBT FINANCING

Debt financing is provided via loans from a private entity such as a bank, secured by the project, and repaid by a scheduled series of principal and interest payments made to the lender. The interest charges will depend on the credit rating of the project and/or its owners and any credit enhancement obtained by the borrower.[24] In the case of developments where a public entity is at least partially involved, the issuance of tax-exempt bonds may be used to raise funds. For example, Energy Improvement District Boards in Connecticut have the authority to issue bonds for the explicit purpose of financing microgrid technologies. Tax-exempt bonds typically offer a lower interest charge and in many instances are more advantageous than taxable borrowing.

24 Credit enhancement is, generally speaking, a promise by a third party to pay an obligation if the borrower defaults. The borrower will pay the third party for, e.g., a letter of credit or an insurance policy that effectuates this promise. The borrower is then able to take advantage of the third party's credit rating, lowering its borrowing costs.

LEASING

Authorized public benefit corporations, like the Dormitory Authority in New York, are permitted by the IRS to issue federally tax-exempt leases to non-profits for projects that may include energy efficiency and CHP equipment.[25] This tax-exempt treatment creates savings for the lessor that are passed on to the lessee in the form of lower interest rates.

THIRD PARTY SERVICE MODEL

In the third party service model, an energy service company owns and operates all or some part of the microgrid infrastructure and supplies energy services to users. In exchange, the company receives payments from users much like the utility currently is paid for electricity and natural gas. In some cases, no debt for the microgrid's energy generation and distribution equipment may appear on the users' balance sheet. The user benefits from having professional energy service providers install and maintain the equipment, saving significant time and money for users lacking the technical expertise to operate and maintain the system optimally.

GOVERNMENT GRANTS, LOANS OR TAX CREDITS

Many government programs offer financial incentives to spur clean energy and microgrid development via mechanisms such as grants, tax credits, and low-cost loans. For example, Connecticut recently initiated an innovative microgrid pilot project grant program that awarded $18 million to help fund feasibility studies and distribution infrastructure for microgrid projects in the state.[26] In New York, a residential homeowner may receive a tax credit equal to 25% of equipment and installation for solar energy up to $5,000.[27] Additionally, the federal government offers a 30% investment tax credit for qualifying renewable energy generating equipment and a 10% credit for CHP qualifying investments.[28] Connecticut and New York have also both established "green banks" that use public funds to incentivize private

25 See TAX EXEMPT EQUIPMENT LEASE PROGRAM, DORMITORY AUTHORITY OF THE STATE OF NEW YORK, http://www.dasny.org/telp/.

26 *See CT provides $18M for nine microgrids*, HARTFORD BUSINESS JOURNAL, July 24, 2013, *available at* http://www.hartfordbusiness.com/article/20130724/NEWS01/130729958/ct-provides-18m-for-nine-microgrids.

27 *New York Incentives/Policies for Renewables & Efficiency*, DSIRE, *available at* http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY03F&re=0&ee=0.

28 26 USC § 48 (2012)

capital investment via credit enhancement, loan loss reserves,[29] and interest rate buy-downs.[30]

Step 8: Obtain Necessary Approvals and Construct Microgrid

In many instances, the legal requirements for developing a microgrid will not be different from many other development projects. These may include building permits, zoning variances, excavation permits, engineering permits, and other approvals in compliance with state and local laws. Microgrids may also pose some different permitting requirements, such as municipal approval to run distribution wires across public rights of way. Also, if the microgrid will create emissions, it may be subject to permitting under the Clean Air Act. It is important to begin communicating to all the different permitting authorities required to approve a project at the earliest stage possible. A full review of potentially necessary environmental and land use approvals is outside the scope of this report.



4 Regulatory Context: Easing the Path Forward for Microgrids

State and local regulations can have a significant impact on a microgrid's prospects. There are several types of actions that state legislatures, public utility commissions and municipalities can take to improve the environment for microgrid development.

State Actions

REDUCE REGULATORY UNCERTAINTY

State utility regulation presents two distinct legal and policy questions for microgrid developments: (1) whether microgrids that serve multiple unaffiliated end-users should be regulated as public distribution utilities; and (2) whether the local distribution utility's exclusive franchise rights preclude a microgrid operator from serving multiple unaffiliated end-users. State legislatures and/or public utility commissions can foster microgrid development by clarifying these matters.

State legislatures and utility commissions should consider exempting certain microgrids from regulation as electricity distribution utilities. Microgrids that serve multiple separate users resemble utilities in that they deliver electricity to unaffiliated end-users. In most other respects, the rationale for the economic regulation of microgrids does not apply, however. Indeed, microgrids are much smaller than utility distribution systems, and end users voluntarily participate in their creation and decide on whether to connect their institutions, businesses, or residences.

29 A loan loss reserve is a fund from which lenders can take to offset their losses when borrowers (in this case, microgrid developers) fail to make payments. When lenders are insulated from the risk of loss, they will lend at lower rates.

30 See Press Release, Governor's Press Office, Governor Cuomo Launches New York Green Bank Initiative to Transform the State's Green Energy Economy, (Sept. 10, 2013), *available at* http://www.governor.ny.gov/press/09102013-green-bank-initiative. *See also* Press Release, Clean Energy Finance Center, Connecticut's Green Bank Begins to Develop Innovative Programs to Leverage Private Sector Investment in Clean Energy (Apr. 27, 2102), *available at* http://www.cleanenergyfinancecenter.org/2012/04/connecticuts-green-bank-begins-to-develop/.

Microgrids can bring together energy efficiency, renewable energy, combined heat and power and smart grid energy management — key compoonents of the 21st centrury grid.



Because microgrids remain connected to the utility's electricity distribution system, the end-users in a microgrid remain customers of the utility. Uncertainty around whether a microgrid project will be considered a utility by a state utility commission increases risk thereby dampening the desire to invest.

Similarly, legislatures and/or commissions should clarify that certain microgrids do not violate a utility's franchise rights. Utility companies are granted the exclusive right to supply power in their service territories. To avoid violating this right, some developers will try to avoid crossing public ways by running wires and pipes through adjacent parking lots or other surrounding facilities under private ownership, which may be less than optimal from an engineering perspective. Uniform state policies addressing when a microgrid may cross a public way would foster microgrid development.

PROVIDE FINANCIAL HELP

As discussed in Section 3, states may offer financing for public and nonprofit microgrid projects at federal tax-exempt rates. They do this by making an authorized public benefit corporation, like the Dormitory Authority in New York, the conduit through which tax-exempt debt is issued. Expanding the offerings of public benefit corporations to support microgrids will help the entities that can take advantage of these tax-exempt programs.

Alternatively, many states are exploring options such as green banks, loan loss reserves, and revolving loan funds to enhance microgrid development. These resources can help communities pay for the multiple studies needed before development begins. For example, the Microgrid Pilot Program in Connecticut is designed to provide resources to assist communities in conducting microgrid feasibility analyses and pay for much of the interconnection and distribution equipment necessary for the microgrid to operate in island mode. At the time of this writing, Connecticut's program is unique in the nation.

Municipal Actions

Municipalities can take a variety of legislative actions that improve the climate for microgrid development in their communities. This section will provide a survey of the types of actions that may be helpful, along with examples of where some of these laws have been applied successfully. The categories of action municipalities can take include removing regulatory barriers, creating incentives, removing infrastructure uncertainty, and creating procedural requirements.

REMOVING REGULATORY BARRIERS

Municipalities will often have laws on the books that unintentionally hinder microgrid development. A few examples include:



- Overly restrictive zoning restrictions on where generation can be sited;
- No limitations on homeowners' associations' ability to restrict the use of solar or small wind;[31]
- Height restrictions, lot coverage limitations, and setback requirements that may not allow for the placement of solar panels or small wind installations on existing rooftops or building sites; and
- Silence in "permitted use" sections of a zoning code that can, in effect, prohibit on-site generation or storage.

Municipalities should review applicable zoning codes and local homeowners' associations' covenants and consider removing or altering those that unintentionally impede microgrid development within the municipality's jurisdiction.

CREATE INCENTIVES

Without having to offer money directly to microgrid developers, municipalities can create a variety of incentives to encourage microgrid development including conditional zoning variances, flexible building standards, and streamlined permitting processes. These actions can help make microgrids more economical and the development process more straightforward.[32]

Municipalities should consider conditioning zoning variances for developments that incorporate microgrid infrastructure. Many zoning codes already include lists of development amenities for which developers may obtain density or floor area ratio bonuses. These incentives can improve the economics of a development project by offsetting the added cost of on-site generation or storage by allowing the developer to build more units on a parcel. Pullman, Washington, for example, grants five density bonus points to new planned residential developments for incorporating solar energy into 50% or more of proposed units.[33]

Municipalities should also consider increasing the flexibility of other standards in exchange for developments that incorporate microgrid technologies. Green building standards, for example, are a common municipal tool through which microgrids can be advanced. Many green building ordinances operate by assigning points to certain development features that help satisfy a cumulative requirement. Granting points in these codes for microgrid technologies can help incentivize microgrid development.

Finally, municipalities should consider simplifying and reducing the cost the various permitting processes required for microgrid development. Receiving the required permits to pursue major development can take months or even years in some cases. Municipalities can create an expedited permitting track for projects that advance microgrid infrastructure.

31 The Minnesota Environmental Quality Board has drafted model language for local ordinances to prevent homeowner's associations from blocking solar energy in particular. This example might easily be adapted to create a broader defense of microgrid infrastructure: "Restrictions on Solar Energy Systems Limited: No homeowners' agreement, covenant, common interest community, or other contract between multiple property owners within a subdivision of [Community] shall restrict or limit solar energy systems to a greater extent than [Community's] solar energy standards."

32 For a more detailed exploration of municipal incentives, see "Streamlining Portland's District Energy Regulations," The City of Portland, Oregon, *available at* http://www.portlandoregon.gov/bps/article/349827.

33 *See Integrating Solar Energy into Local Development Regulations*, AMERICAN PLANNING ASSOCIATION, *available at* http://www.planning.org/research/solar/briefingpapers/localdevelopmentregulations.htm.

In San Diego, for example, developers can qualify for expedited permitting by either achieving LEED certification or using solar photovoltaics to generate a certain percentage of their projects' energy needs.[34] Moreover, waiving the costs of permitting for microgrid projects can also create an incentive for microgrid development. Tucson, Arizona, for example, has passed resolutions waiving permitting fees for qualifying energy systems up to a maximum of $1,000 for a single installation or $5,000 for a larger project.[35]

REDUCE INFRASTRUCTURE UNCERTAINTY

A different kind of uncertainty sometimes confronts microgrid developers on a local level – uncertainty about where they can build. Not knowing the state of existing underground infrastructure that can impact the costs or technical difficulties of siting piping and wiring can pose significant obstacles at the initial stages of project conception and development. Municipalities should consider increasing informational access to underground infrastructure to reduce this uncertainty. A solution could include a central database of underground utilities that the municipality can prepare and provide to interested developers.

PLAN FOR FUTURE GROWTH

Municipalities should also consider the potential growth of district heating and cooling systems when planning the placement of underground infrastructure. For example, Cornell University, a self-contained microgrid site, created a master plan that addressed "maintaining utility corridors" on campus.[36] This plan called for the university to take anticipated growth into account when planning where to site heating and cooling pipework so there would be available underground corridors to connect additional buildings in the future. Similarly, Portland, Oregon officials discovered that the expansion of a

34 *San Diego County Solar Regulations*, DSIRE, *available at* http://www.dsireusa.org/solar/incentives/incentive.cfm?Incentive_Code=CA31R&re=1&ee=1.

35 *City of Tucson Building Energy Code*, DSIRE, *available at* http://www.dsireusa.org/solar/incentives/incentive.cfm?Incentive_Code=AZ26R&re=1&ee=1.

36 Cornell University Master Plan, *available at* http://www.masterplan.cornell.edu/doc/cmp_part_1/utilities_service/utilities_service.pdf.



district heating system was constrained by existing light rail lines. In response to this experience, Portland now works with the Department of Transportation to put casings in the ground to carry thermal and electric distribution at key intersections where district heating and cooling systems may be feasible in the future.[37] Bridgeport, Connecticut also reports that they are examining microgrids concurrent with other infrastructure plans.[38]

CREATE PERMITTING REQUIREMENTS

Municipalities should consider using their planning authority to require future developments to consider the inclusion of microgrid technologies by requiring permit applications for major new development to include a finding or a statement on the feasibility of including such technologies in the project. For example, New York City requires new developments above a threshold size to consider a district energy system in their plans These requirements should also be extended to municipal and other government development, such as road, rail, and sewer construction, to ensure projects do not miss or prohibit future opportunities for microgrid development.

37 Interview with Alisa Kane, Green Building Manager, City of Portland (June 2013).
38 Interview with David Kooris, Director of Economic Development, Bridgeport, CT (Sept. 24, 2013).

5 Conclusion

Community microgrids allow local leaders to take charge of their energy future. By bringing together whole-building energy efficiency improvements, clean distributed generation, renewable energy, and smart energy management technologies, microgrids offer more affordable, clean, and reliable energy than the old centralized system can deliver. Communities can capture these benefits by taking the concrete steps—from setting energy goals to securing project financing—presented in this report. Additionally, state and municipal policymakers can aid this process by reducing regulatory uncertainty and providing financial incentives for microgrid development. By enabling microgrid development, local and state leaders help to build the grid of the 21st century.





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About Pace Energy and Climate Center

More than a think tank, the Pace Energy and Climate Center turns ideas into action. We believe thoughtful engagement of government and key stakeholders leads to better public policy. We conduct research and analysis on legal, regulatory and policy matters because thorough, objective analyses are essential to finding solutions to today's complex energy and climate change challenges. We bring decision makers and stakeholders together because achieving results often entails learning together and finding common ground. We are lawyers, economists, scientists and energy analysts, committed to achieving real-world progress.

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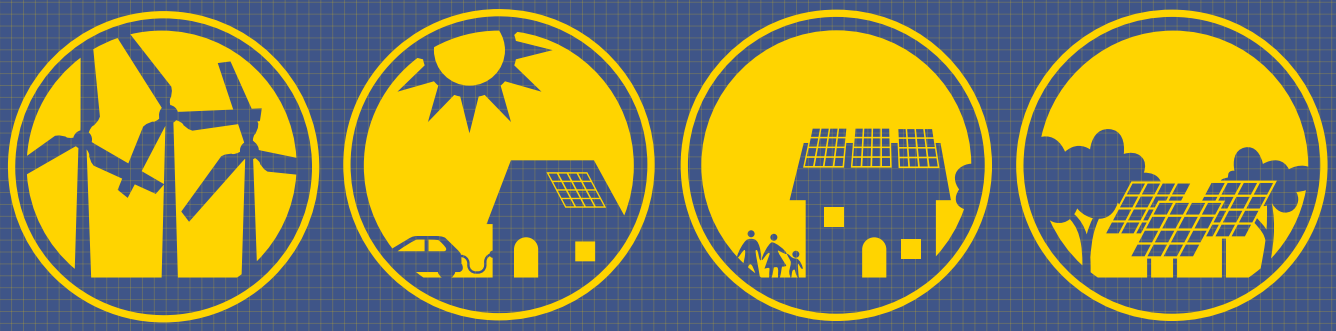
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