Applied Economics Clinic
Economic and Policy Analysis of Energy, Environment and Equity

POLICY BRIEF

Joshua R. Castigliego, Tanya Stasio, and Eliandro Tavares

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Conditional Benefits of Sustainable Community Microgrids

This Applied Economics Clinic policy brief—prepared on behalf of GreenRoots, a resident-led organization working to achieve environmental justice in Chelsea, East Boston, and surrounding communities—presents ways in which microgrids, depending on their design, can provide opportunities for vulnerable communities to realize important benefits. We define characteristics of "sustainable community microgrids" that have the potential to enhance grid resilience, lower electric bills, improve public health and strengthen the local community when equitable outcomes are prioritized throughout the project.

What is a microgrid?

Microgrids are small, independently controlled energy systems that can operate together with—or independently from—the larger electric grid. While microgrids are normally connected to the regional grid, their ability to disconnect at will is important in maintaining uninterrupted electric supply. In the event of a service disruption or a power outage, a microgrid can "island" itself, or disconnect, from the larger grid and continue to provide power using its own energy generation and storage resources. (For a diagram, see Figure 1 on the next page.)

A microgrid is typically managed by a computer system that dispatches and distributes energy and storage to meet customer needs. Microgrids come in a variety of sizes, providing power to individual facilities, essential services, groups of customers, or even an entire community.

Microgrids can provide equity, health, and climate benefits, but these positive outcomes are not automatic. Without intentional design to achieve sustainability and community goals, microgrids may not be a good choice for investing community or electric customer funds.

A sustainable community microgrid

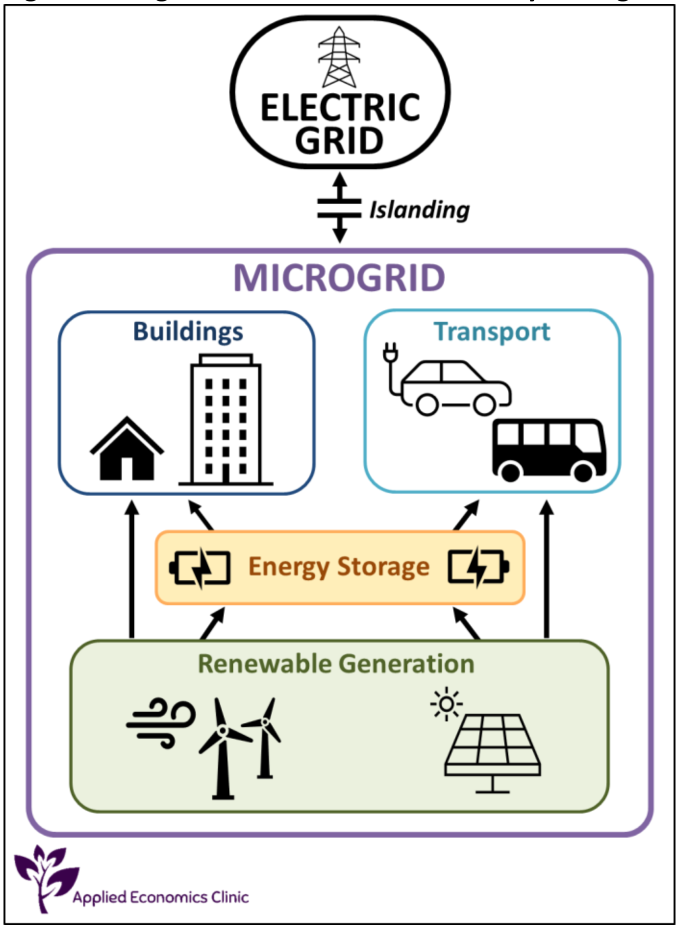
A ***community*** microgrid serves an entire neighborhood, town, or city rather than a single facility.

A ***sustainable*** community microgrid is powered by renewable energy and flexible resources like distributed generation and batteries, allows for meaningful community participation in its development, and endeavors to distribute its economic and environmental benefits to residents and local businesses in the most equitable fashion. Depending on their design, sustainable community microgrids have the potential to result in positive equity outcomes (see Table 1).

Table 1. Potential benefits of a sustainable community microgrid

Potential benefits	If a community microgrid…	Equity and sustainability outcomes
Enhanced grid resilience	…can seamlessly transition between operating modes.	Uninterrupted electric service during power outages achieved by "islanding" from the larger electric grid, providing benefits for vulnerable households such as those that depend on refrigerated medicines.
Lower electric bills	…employs energy efficiency and flexible resources to lower and shift energy use.	Lower energy burden of low-income households who pay a higher share of their income on energy bills than richer households.
Improved public health	…is powered by renewable energy resources.	Decrease in local air pollution for environmental justice communities that are disproportionately affected by poor air quality.
Stronger local community	…prioritizes equitable outcomes from start-to-finish.	Community members get a say in their energy sources, while creating local jobs and generating revenue that can be invested back into the community.

Figure 1. Diagram of sustainable community microgrid



To fully realize the benefits of a sustainable community microgrid, communities must prioritize their equity goals throughout the project. Each community is unique and requires a tailored and intentional approach to ensure that its most vulnerable populations are positively impacted not only during the development of a microgrid but also during its future operation. The benefits of a sustainable community microgrid are ***conditional*** on what elements are included in the design, how those elements are integrated into the project, and who is involved in the decision-making process. Although each community has specific needs and faces different challenges, a sustainable community microgrid must be powered by renewable energy (e.g., solar, wind, etc.), employ flexible resources (e.g., distributed energy, batteries, etc.), and prioritize equitable outcomes from start-to-finish in order to maximize the benefits for all community members.

Benefits of sustainable community microgrids

If designed with renewable energy, flexible resources, and community goals in mind, sustainable community microgrids have the potential to serve as a powerful tool for local participation in and control over energy decisions, which can result in positive equity outcomes for "Environmental Justice"[1] and other vulnerable communities. (We define "vulnerable communities" as populations that are disproportionately burdened by existing inequities and/or lack the capacity to withstand new or worsening burdens, which may include people of color, low-income individuals, people with disabilities, limited English households, children, and older adults.)

A microgrid may or may not result in positive equity outcomes. To achieve the best results for vulnerable communities and for residents and local businesses to fully realize equity benefits, equitable outcomes must be prioritized in the design and development of a sustainable community microgrid. Potential benefits include:

- Enhanced grid resilience,
- Lower electric bills,
- Improved public health, and
- Stronger local community.

Each of these equity benefits are conditional on different aspects of how a microgrid is designed and deployed into a community. Some equity benefits depend on overcoming barriers to microgrid development (discussed in detail below), while other benefits rely on intentional decisions to ensure inclusivity of residents and local businesses throughout the project.

Enhanced grid resilience: Sustainable community microgrids that can seamlessly transition between operating modes provide **enhanced grid resilience** by "islanding" from the larger electric grid to ensure uninterrupted electric service in the event of a power outage or natural disaster (thereby staying online when the rest of the grid may fail). This is especially important for vulnerable communities who tend to experience more service interruptions and are disproportionately affected by their impacts. When there are power outages, many businesses with hourly employees (e.g., restaurants or retailers) temporarily shut down—resulting in lost wages for those workers.

Older populations and those that depend on nebulizers, oxygen machines, or refrigerated medicines face increased risks from power outages. In Massachusetts, communities of color have lower incomes, higher rates of asthma-related hospitalizations and COVID-19 infections, and are more likely to have serious chronic medical conditions[2]—making these communities more vulnerable in the event of a power outage.

Lower electric bills: Sustainable community microgrids that employ flexible resources, such as distributed energy and batteries, can **lower electric bills** for residents and local businesses by lowering usage at peak times—a major source of electric costs. Massachusetts' *State of Charge* report states that "Energy storage is the only technology that can use energy generated during low cost off-peak periods to serve load during expensive peak periods".[3] The report also notes that the top 10 percent of hours from 2013 to 2015 accounted for nearly 40 percent of ratepayers' annual electricity spending in Massachusetts.

Microgrids can also reduce transmission costs that are paid for with customers' electric bills. Within the microgrid, generation sources and end-use customers are in close proximity to each other—thus avoiding the need for long, inefficient transmission lines that lose power (and money) in larger electric grid. In addition, energy efficiency measures can lower energy costs and create savings.

Lower electric bills help reduce the energy burden of low-income households who pay more as a share of their income for energy than those with higher incomes. In Boston, the median household pays 3 percent of its income in energy bills, while the median low-income household pays 10 percent. The energy burden among the bottom quarter of low-income households is six times higher than the citywide median—spending 19 percent of their income on energy bills.[4]

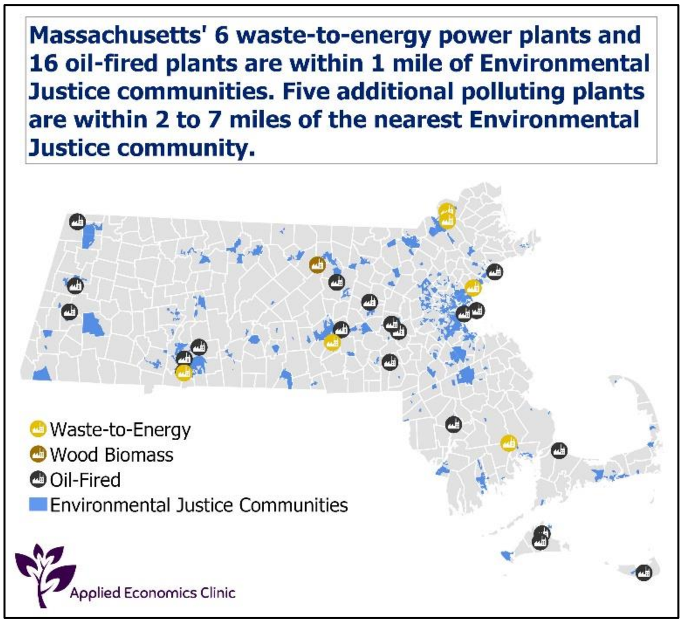
Improved public health: Sustainable community microgrids powered by renewable sources can **improve public health** by reducing local air pollution and greenhouse gas emissions. Microgrids enable communities to generate their own clean energy, reducing the need for polluting local generation (e.g., diesel generators) or locally polluting power plants. This is especially important for vulnerable communities that are disproportionately affected by air pollution and the impacts of climate change. (For community microgrids to successfully reduce the need for locally polluting power plants, they would need to be deployed at scale, in multiple communities, to offset the need of an entire power plant.)

At the time of writing, there are 22 polluting power plants located within 1 mile of Massachusetts' Environmental Justice communities, and 5 polluting plants located within 2 to 7 miles (For a map of these facilities, see Figure 2).

These 27 waste-to-energy, wood biomass, and oil-fired power plants are the Commonwealth's highest polluting electric generating sources. Massachusetts' oldest and largest waste-to-energy facility, Wheelabrator Saugus, has been running for over four decades—far longer than its intended lifespan of 20 to 30 years—during which it has been a continuous source of local air and water pollution for the residents of Saugus, Lynn, Revere, and other surrounding communities.[5]

Stronger local community: Sustainable community microgrids can also **strengthen the local community** when they give community members the opportunity to participate in and control energy decisions, create jobs(e.g., construction and maintenance), and generate

Figure 2. Locally polluting power plants and Environmental Justice communities in MA



revenue (by providing services needed by the larger grid) that can be invested back into the community. To ensure that these benefits are realized, communities must prioritize equitable outcomes from start-to-finish with inclusive planning and design, clear goals to benefit the community, and chances to adjust the program's design if outcomes are not as expected.[6]

Barriers to sustainable community microgrid development

Despite the potential benefits of well-designed microgrids, some communities may face challenges and barriers to their development. Obstacles to sustainable community microgrid development can be grouped into four categories: technical, regulatory, economic, and informational (see Table 2). If sustainable community microgrids are well designed, communities can alleviate the burden posed by some of these barriers.

Technical barriers due to challenges with islanding capability and microgrid operations can make it difficult to develop sustainable community microgrids. Microgrids can island from the larger electric grid in two ways: a "black start" (which requires a short outage) or a "seamless transition". A black start is not ideal for energy reliability since electric service is temporarily interrupted. A seamless transition between operating modes, however, can be challenging to achieve with current technologies employed in existing microgrids. Integrating flexible resources, such as batteries, in the design of a sustainable community microgrid could alleviate this issue since they can assume load instantly and seamlessly in the event of a power outage.

Regulatory barriers impede sustainable community microgrids when there is a lack of clear guidance on how they should operate in conjunction with the larger electric grid. The current regulatory framework fails to describe microgrid standards in any detail, causing ambiguity as to how microgrids should be regulated by state agencies. Regulatory ambiguity regarding whether microgrids are ways to generate energy or ways to move energy around pose legal challenges and has resulted in a disincentive to invest in the development of microgrid infrastructure.[7]

There are often very few incentives for utility companies to cooperate with communities to build community-led microgrids. Utility companies must be required to cooperate, otherwise they are reluctant to share data that may be needed to develop a microgrid. They also frequently claim that sustainable community microgrids interfere with their franchise.

Economic barriers, such as high upfront costs and lack of access to loans, make it difficult for many communities to invest in microgrid infrastructure. Funding for clean

Table 2. Barriers to microgrid development

Technical	Regulatory
Challenges with islanding and microgrid operations	Ambiguity on how to regulate microgrids
Economic	**Informational**
High upfront costs and lack of access to loans	Lack of sufficient information on benefits

energy projects may be especially constrained at a time when public funding has been essential in mitigating the effects of the COVID-19 pandemic. This barrier can be overcome if state agencies and local utility companies worked together to help provide communities with the necessary funding and/or technical assistance needed to invest in microgrid infrastructure.

Informational barriers include a lack of sufficient information and an abundance of misinformation regarding microgrid technology and its potential benefits. These obstacles can make it difficult for communities to get support from stakeholders. Communities can work to overcome these informational barriers by ensuring that equity is at the forefront of the decision-making process. By providing residents and local businesses with the opportunity to participate in and control energy decisions, communities can also ensure that accurate information is available to all regarding the conditions needed to create sustainable community microgrids and their potential benefits.

Microgrid efforts in Massachusetts

In response to a 2014 order by the Massachusetts Department of Public Utilities, the Massachusetts Clean Energy Center (MassCEC) established its *Community Microgrids Program* to "catalyze the development of community microgrids throughout Massachusetts to reduce customer energy costs, reduce greenhouse gas emissions, and increase resiliency of critical facilities and infrastructure."[8]

In February 2018, MassCEC announced $1.05 million in funding for 14 feasibility studies to advance prospective community microgrid projects in the Commonwealth. More than half of these projects determined that a microgrid is feasible in their community, including the microgrid feasibility studies in Chelsea and Chinatown, with initial funding as a barrier for development. Some municipalities, like Melrose and Palmer, found that regulatory and technical barriers made microgrid development infeasible for their communities. In addition, the Massachusetts Department of Energy Resources' *Community Clean Energy Resiliency Initiative* disbursed $40 million in grants between 2014 and 2017 to help municipalities enhance grid resilience by using clean energy technologies to address service interruptions caused by severe weather—a major step in the development of community microgrids.[9]

In September 2020, MassCEC launched the *Clean Energy and Resiliency (CLEAR) Program* as a successor to its *Community Microgrids Program* to "support community resiliency efforts that reduce [greenhouse gas] emissions, enable the integration of renewable energy sources, and provide energy resilience for critical facilities during electrical grid outages."[10] Three consultants were awarded over $0.8 million to work with communities to analyze the cost and system design for resilient facilities in Boston, Framingham, Cohasset, West Tisbury, Natick and Bedford. Although these projects do not explicitly mention the use of microgrid infrastructure, their goals of resiliency, cost savings, and greenhouse gas reductions are closely aligned with the benefits of sustainable community microgrids.

Every community faces different challenges and must take a tailored and intentional approach to ensure that microgrid development benefits vulnerable populations. Communities must prioritize equitable outcomes and provide opportunities for inclusive participation throughout the microgrid development process, while intentionally avoiding unintended consequences and adapting to changing circumstances as they arise.

Sustainable community microgrids can provide important benefits for vulnerable communities only if they are well designed to be powered by renewable energy, include flexible resources, and prioritize equitable outcomes and community goals. As Massachusetts works towards achieving its long-term climate goals of net-zero emissions by 2050, the development of sustainable community microgrids, especially in the state's most vulnerable communities, can provide an opportunity for energy justice that tailors solutions to meet the unique needs of each community.

Joshua R. Castigliego, Tanya Stasio, and Eliandro Tavares May 20, 2021

Notes

[1] Massachusetts' "Environmental Justice" designation is assigned to communities that meet any of the following criteria: an annual mean household income less than or equal to 65 percent of the state median; 25 percent or more residents identify as a race other than white; or 25 percent or more of all households have no one over the age of 14 who speaks English very well.

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[3] Massachusetts Department of Energy Resources and Massachusetts Clean Energy Center. 2016. *State of Charge: Massachusetts Energy Storage Initiative*. Available at: https://www.mass.gov/doc/state-of-charge-report/download pp.i-ii

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[10] Massachusetts Clean Energy Center. "Clean Energy and Resiliency (CLEAR)." Available at: https://www.masscec.com/clean-energy-and-resiliency-clear

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