Thinking Small: How can solar microgrids facilitate an equitable transformation of the US energy system?

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Abstract

As energy burdens continue to impact vulnerable households in the US, climate and energy solutions must prioritize transformative change over solutions that uphold the distributional inequities of our energy system today. Energy justice literature has argued that the foundations of our energy system today, rooted in fossil fuel extraction and the exploitation of low-income communities and communities of color, manifests today in the inequities in energy affordability and access to renewable energy solutions. Renewable energy transitions that operate within this foundation will continue to perpetuate such inequities; researchers argue that we must transition towards a decentralization of energy generation and ownership that ensures renewable energy benefits reach front-line communities. This paper explores the potential for solar microgrids to facilitate this transformation. Solar microgrids have emerged as a solution to increasing grid reliability in face of storm events and blackouts. More recently explored is their power to increase community ownership and access to renewable and affordable energy. This paper examines two case studies that have or are planning to implement solar microgrids with a community empowerment focus: St. Peter Apartments Microgrid in New Orleans, LA and Oakland EcoBlock in Oakland, CA. As this paper will show, these case studies not only demonstrate the ability for solar microgrids to lower energy costs, but also reinforce that the success of equitable renewable energy solutions depends on the strengthening of community networks and visibility in decision-making.

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CHAPTER I: Making the case for solar microgrids

In August 2021, the landfall of Hurricane Ida in Louisiana brought extremely harsh wind and rainfall conditions to the state's residents. Although Ida's overall storm severity differed from that of Hurricane Katrina in 2005, its destruction and lasting impacts recalled the devastation of the 2005 storm. The energy sector took an especially hard hit from Ida in August, with the power grid failing for several weeks in Louisiana.

However, one affordable housing complex in New Orleans was able to restore its power soon after the hurricane hit the city. The St. Peter, an affordable apartment complex, possesses a unique on-site solar panel system known as a microgrid that could return power to the apartment's residents while the area's central power grid shut down (Peters, 2021). The solar microgrid uses battery storage to store energy for later use, and in this case, it automatically drew upon the stored energy during the grid's failure. But the microgrid isn't only used in emergencies; the stored energy also reduces daily energy demand from the central power grid and thus reduces the building's energy costs. SBP (formerly Saint Bernard's Project), the nonprofit behind this project, has successfully harnessed a decentralized source of energy in the form of microgrids to increase energy reliability, energy affordability, and renewable energy access for its residents.

Microgrids are not new concepts, but they have been traditionally used in the United States to provide backup generation for disturbances or grid failures. However, projects such as The St. Peter reveal another potential of microgrids that the energy justice field has just started to explore—the potential of microgrids to increase community access to affordable energy and decrease energy insecurity (RMI and REOS, 2015; Garascia and Scheu, 2016). To assess the potential for microgrids to equitably distribute renewable energy program benefits, this study will examine two case studies in the US: The St. Peter Microgrid in New Orleans, LA and Oakland EcoBlock in Oakland, CA.

Energy insecurity in the United States

In 2015, one in three US households reported facing any kind of energy insecurity and one in four households reported having to avoid purchasing necessary food and medicine to pay energy bills (U.S. Energy Information Administration [EIA], 2015). Scholars broadly understand energy insecurity as an inability to meet basic energy needs, but researchers have used different indicators of energy use and reliability to measure insecurity. For example, Graff et al. (2021) measure energy insecurity as an inability to pay energy bills, receiving a disconnection notice, or experiencing electricity disconnection. In addition, researchers have drawn on several explanatory factors of energy insecurity such as race, income, energy prices, homeowner status, and house/building energy efficiency. One commonly measured indicator of energy insecurity is energy burden, or the proportion of income spent on energy bills. Having a high energy burden is generally recognized as spending at least 6% of income on energy bills, and a severe energy burden as spending at least 10% of income on energy bills (Drehobl et al., 2020, p. iii).

Energy security is a crucial factor in economic, physical, and mental well-being. Unfortunately, households experiencing energy insecurity have often turned to harmful coping mechanisms, including enduring unsafe temperature conditions, foregoing daily purchasing necessities to pay energy bills, or relying on unsafe heating methods such as stoves or space heaters (Drehobl et al., 2020). Not only does using gas equipment for heating pose an immediate fire hazard but using it for periods longer than intended has longer-term health risks from worsening indoor air quality. These compounding impacts of energy insecurity constitute a severe health risk to affected households.

Risks of energy inaccessibility, however, are not felt equally across the US population. Many researchers have found that low-income Black and Hispanic households disproportionately face energy insecurities. In a sample study of low-income households in Indiana, Graff et al. (2021) test different predictors of energy insecurity to understand racial disparities in energy access and housing conditions. Their study agrees with the pattern that low-income Black and Hispanic households are more likely to have difficulties paying energy bills and more likely to face utility disconnections. The study also found that households with higher energy burdens and poor housing conditions are more likely to be energy insecure.

As pressure for renewable energy transitions heightens nationwide, it is clear that a transition without considering energy burdens and inequities will leave behind key portions of the US population. In practice, researchers have found that existing renewable energy programs continue to fall short in distributing program benefits to underserved communities. A survey analysis of Vermont energy transition programs found that non-white household respondents are seven times less likely to own solar panels than are white households, and renters three times less likely than homeowners (Keady et al., 2021, p. 7). The researchers suggest that Vermont's rooftop solar incentive programs do not address solar installation barriers of homeownership status and disposable income; thus, they are more accessible to white, generally high-income households. Access to financial assistance for residential energy upgrades are not equally distributed either. In a study of this “energy efficiency financing coverage gap” in Michigan, Forrester and Reames (2020) find that high-income individuals with high credit scores are most likely to receive energy efficiency loan approval. They further find that low-income individuals with low credit scores require higher credit scores than high-income individuals to obtain the same chances of approval.

The avenues for energy insecure households to participate in energy transitions remain scare. There is much room for renewable energy programs to distribute benefits more equitably. The impacts of the COVID-19 pandemic have increased the urgency of addressing unequal access to energy security. Energy insecure households have received short-lived protection from utility disconnections throughout the pandemic (Baker et al., 2021). As the pandemic has taken a toll on energy burdened households, and in the long term, as climate change increases risks of unpredictable weather events and temperature changes, protection of at least basic energy needs is crucial.

Energy “resilience” and justice

The idea of a “just energy transition” has gained considerable traction within the renewable energy community advocating for a community and equity-based approach to decreasing reliance on the fossil fuel industry. Goals include supporting workers in the energy industry, targeted financial support for vulnerable communities, and increased community engagement. Government agencies have adopted these visions too. For example, in August 2020, the New York State Energy Research and Development Authority (NYSERDA) announced the launch of a Just Transition Working Group to “ensure New York’s workforce is prepared for and stands to benefit from the State’s transition to renewable energy" through the representation and collaboration of community stakeholders (NYSERDA, 2020).

Digging deeper into discussions of energy transitions, one might find a few words used repeatedly and even sometimes interchangeably: energy justice, energy resilience, and sustainability. These terms, though related, do have key differences in their meanings and implications for energy policy. Although my study primarily relies on discourses in resilience theory and energy justice, it is important first to pick apart some of the nuances in meaning given their close associations to one another in popular energy discourse.

"Sustainable energy" and "energy resilience" have both been used to advocate for the social, economic, and environmental benefits of green energy technology. A high-level glance the definitions of sustainability and resilience shows a key difference between the two concepts.

> *Sustainable: (a) able to be used without being completely used up or destroyed; (b) involving methods that do not completely use up or destroy natural resources; (c) able to last or continue for a long time* (Merriam-Webster, n.d.).
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> *Resilience: (a) the capability of a strained body to recover its size and shape after deformation caused especially by compressive stress; (b) an ability to recover from or adjust easily to misfortune or change* (Merriam-Webster, n.d.).

Both sustainability and resilience are future-facing. Sustainability seeks to ensure that development and resource consumption today do not endanger the balance of resources tomorrow. On the other hand, resilience is concerned primarily with the ability to recover from shocks and disturbances. Discussions of sustainable energy are especially pertinent in thinking about the transition away from fossil fuels to renewable energy; not only is fossil fuel energy a finite resource, but its consumption also has a direct impact on future social and environmental health. I choose to focus my study of energy security in the realm of resilience theory to construct issues of energy insecurity as significant *disturbances* to households. My study also fits as an extension of existing literature on energy systems and resilience theory.

Unlike its dictionary definition, the consensus on resilience theory literature is less straightforward. Scholars have developed different meanings of resilience for different fields of study and have further debated its effectiveness in addressing social and environmental inequities. Resilience theory originated as an ecological concept, referring strictly to the ability of ecological systems to return to a state of normal (or an equilibrium) following an ecological or environmental disturbance (Brown, 2014). In other words, it was not originally conceptualized to address topics in the social sciences. Instead, over time, scholars began to adapt ideas from resilience theory to issues in the social sciences, such as the impacts of financial shocks and natural disasters on social systems. Socio-ecological resilience, for instance, conceptualizes socio-ecological systems as interconnected human and environmental activities that should act together in response to vulnerabilities and environmental change (Cinner and Barnes, 2019).

With time resilience has come to take on several meanings. Discourse on the resilience of energy systems has distinguished four definitions of resilience following a disturbance: the ability for an energy system to (a) undergo minor damage or change; (b) return to its original state; (c) adapt to prevent further change; or (d) transform into a new system better suited to handle disruptions (Erker et al., 2017; Cinner and Barnes, 2019).

Baker (2019) argues that ideas of energy resilience have largely centered the first three definitions, when measures to address inequities in the energy system should prioritize the fourth. The dominant idea of resilience has only reinfornced existing inequities in the energy system. Throughout the history of our energy system's development, black and brown bodies have been placed in positions to bear the environmental, health, and economic consequences of energy production. The author cites historical patterns of limited worker mobility in the coal mining industry and the proximity of toxic waste and polluting industries to black and brown communities as the root of persisting energy injustices. In other words, the rendering of black and brown communities as 'disposable' has ingrained the uneven distribution of energy benefits and harm into the energy system. Thus, rather than advocating for the resilience of a structurally unjust energy system, Baker (2019) says we must push for the transformation of the system—what they refer to as the *"anti-resilience"* of the system (p. 6). Baker's theory of anti-resilience argues for policies that identify energy insecure households as the primary recipients of program benefits and that equitably redistribute ownership over energy systems to communities. By decentralizing control over energy production to consumers and community-based organizations, currently energy insecure households could have a more dependable and affordable access to energy.

I base my argument for the potential socio-economic benefits of solar microgrids and community shared solar upon this theory of anti-resilience. Baker (2019) clarifies that these ideas of resilience and anti-resilience focus on the energy system, separate from community or individual responses to shocks. There is an important distinction to be made between the resilience of energy systems and the resilience of communities and individuals. Whereas the resilience of energy systems perpetuates energy insecurity and inequities, the resilience of individuals concerns one's ability to respond to high energy burdens, utility disconnections, and green energy transitions. The resilience of energy insecure households, as demonstrated thus far, depends on *anti-resilience*—the transformation of our current energy system.

It would be difficult to discuss transforming energy systems without engaging with the energy justice field. Many researchers have taken strides to address energy injustices by exploring methods of redistributing energy benefits, empowering marginalized voices, and decentralized energy. Energy justice researchers call for targeted energy programs that engage meaningfully with community actors to answer questions of who the program should primarily serve, context-specific goals and timelines, and the necessary socio-political systems to support such transformation (Jenkins et al., 2020). These steps work to re-center the role of political and social power dynamics in distributing energy program benefits that researchers say are lost in discussions of non-transformative resilience (Brown, 2014).

Newer discourse in resilience theory has sought to take similar steps by introducing understandings of social, political, and historical contexts. Regional resilience studies see a region's ability to respond to shocks due to interactions between local community structures and larger spatial and temporal contexts (Christopherson et al., 2010). For instance, national inequities in housing conditions have placed disproportionate energy burdens on low-income Black and Hispanic households (Baker et al., 2021). At the same time, Keady et al. (2021) find that a lack of explicit inclusion of underrepresented communities in local Vermont energy discussions unevenly distributes renewable energy program benefits within local communities. Such interactions between national policies and local power dynamics should inform localized, rather than generalized, policy responses.

In sum, the resilience of energy systems has historically referred to preserving our current system in the face of natural disasters, grid outages, or other disturbances. Ideas of system transformation and anti-resilience argue that the distribution structure of our current energy system leaves little room for the stability and empowerment of energy-insecure households. The combined social and technological energy system must make strides to redistribute program decision-making power, energy program benefits, and ownership of energy itself. A possibility could be government and community initiatives to implement distributed generation programs.

Distributed energy generation

Distributed energy generation is a decentralized system that produces energy closer to the site of consumption. The current US power grid is largely centralized around utility distributors who sell electricity to consumers. Examples of distributed energy include rooftop solar, battery energy storage, community solar, and microgrids. Although distributed energy generation is not a necessarily novel idea, energy programs have more recently been taking steps towards decentralizing the energy sector for several reasons. For one, centralized energy distribution is prone to widespread outages in the face of severe weather events or other disturbances. Transmitting electricity over long distances from the central source is also not only more costly, but energy inefficient as power is lost during the travel (New York State Energy Research and Development Authority [NYSERDA], n.d.; Environmental and Energy Study Institute [EESI], n.d.). The power for utilities to disconnect customers, too, holds severe consequences for the safety of energy-insecure households. As such, distributed generation is receiving more attention in facilitating renewable energy transitions. For example, the New York State Energy Research and Development Authority's "Reforming the Energy Vision (REV)" includes initiatives to distribute energy generation through solar energy projects and microgrid development.

Though the US is seeing more interest in distributed energy for various reasons, decentralization of the energy sector is still early in its development. In a survey of energy justice programs in the United States, Carley et al. (2021) find that only around 8% of programs fall into the category of "democratization" programs, or programs that increase community voice and ownership of energy resources (p. 4). Thus, there is much room for research and innovation in creating equity-minded energy programs. I aim to study solar microgrids and community shared solar as a potential pathway toward changing the ownership and accessibility structure of our energy system towards more of a *commons*.

Microgrids can be considered smaller versions of the power grid, created for local energy generation. Unique to microgrids is the option to "island," or disconnect, from the main utility grid. This islanding ability has been used to protect local power distribution in a utility-wide outage or disruption. Microgrids can be powered by natural gas, combined heat and power, wind energy, fuel cells, and more. Since solar is a more common on-site renewable used in the residential sector, this study focuses on a microgrid powered in part by solar energy.

The traditional function of microgrids in the United States has been to provide an emergency backup energy source and reduce the energy demand of high-consuming facilities on the grid. For instance, the SUNY New Paltz microgrid in New York powers the university's gymnasium to reduce greenhouse gas emissions and serve as an emergency shelter (New Paltz, 2018). Case studies in other countries demonstrate alternative functions of solar microgrid projects. For example, a combined natural gas and solar microgrid increases energy reliability and lowers greenhouse emissions for the residents of Onslow, Western Australia. In May 2021, the microgrid completed a successful 80-minute period run on solely renewable energy and solar storage (Horizon Power, 2021). In Yemen, the United Nations Development Programme and Enhanced Rural Resilience in Yemen collaborated to introduce solar microgrids to communities facing high energy burdens. The program partnered with female and young small solar business owners to provide training and business opportunities to install solar microgrids within their communities. More recently, the goals of microgrid projects have been expanding in the United States to consider energy affordability and accessibility, although in-depth research on the social benefits and financial benefits for energy insecurity communities remains limited.

My analysis draws upon literature on energy justice, anti-resilience, and regional resilience theory to compare the potential for microgrids versus community shared solar programs to redistribute energy benefits and empower energy-insecure households.

Methodology

I center my analysis around two case studies in the US: The St. Peter Microgrid in New Orleans, LA and Oakland EcoBlock in Oakland, CA. Since solar microgrids in their applications to community empowerment are still in the early stages, I examine these case studies through a "theory of change" approach—understanding the goal of each project and the path to achieving that goal. In other words, rather than arguing whether these cases succeed in achieving a complete energy system transformation, I will use the lessons learned from these case studies to make recommendations on how future projects may successfully transform the energy system. In this way, I hope to provide a fair analysis of the case studies that is true to the projects' visions, while still projecting lessons learned onto a future of energy transformation.

Chapter 2 provides some background on the political contexts of distributed and renewable energy in my two case study regions. First, I discuss the incident of the controversial New Orleans Power Station, in which the local utility, Entergy, hired actors to voice support for a new gas plant. Second, I discuss the criticism Pacific Gas and Electric has faced in California for its delays in upgrading power distribution infrastructure and for ultimately causing several deadly wildfires in the region. I use these two cases to contextualize the receptiveness of regional policy to decentralized and renewable energy generation. This chapter also introduces an energy democracy policy framework from "Energy Democracy: Advancing Equity in Clean Energy Solutions," (Fairchild and Weinrub 2017) that I use to draw lessons learned from my case studies.

Chapter 3 begins my analysis of the potential links between solar microgrids and energy transformation with The St. Peter Microgrid, the project discussed at the beginning of this chapter. Opened to residents in 2020, this affordable housing complex prioritizes both access to affordable energy and education on energy efficiency. The 178-kW rooftop solar microgrid project was funded by a grant from Entergy, the region's utility provider, and installed by a regional solar company, Solar Alternatives. Equipped with high efficiency appliances and encouraging residents to consume energy efficiently, this is Louisiana's first net-zero apartment building. I decided to study this case for several reasons. In its goals, the project explicitly states an interest in both recovery during disaster events and daily cuts in energy costs. The project has also been operational for some time, so it can also present tangible results. Finally, the project has a vision to work specifically with New Orleans communities that have been strongly impacted by energy insecurity—veterans and low-to-moderate income individuals and families. As I will argue in this chapter, this project has the potential to demonstrate how the benefits of solar microgrids can extend beyond disaster mitigation.

I conduct both a quantitative and qualitative analysis of how The St. Peter Microgrid meets its stated goals. Using monthly data of residents' energy bills, shared with me by the SBP team, I compare the energy costs for residents of The St. Peter to regional energy costs, in Orleans Parish. I conduct a statistical analysis using a one-sided t-test to determine if The St. Peter's energy costs are significantly lower than energy costs paid across the parish (Appendix A). Then, I discuss my takeaways from a conversation with Ashley Thompson, SBP Low-Income Housing Tax Credits Program Manager in New Orleans, about the development of the project and its engagement with residents. I contextualize my findings from this conversation in an energy democracy framework to demonstrate the value of community engagement and ownership in renewable energy projects.

In Chapter 4, I move to my next case study, Oakland EcoBlock. This project has not yet been implemented but plans to begin construction in 2022. The goal of the EcoBlock is to take a holistic approach to building sustainable communities by installing solar, promoting water and energy efficiency, and providing electric vehicle charging. Whereas The St. Peter Microgrid was contained to one property, EcoBlock envisions community residents sharing solar energy generated on-site across property lines. Further, the research team hopes to create a "scalable model," whose framework can be applied and customized to communities across the US. Since quantitative data is not yet available for analysis but the project has a robust online presence through website pages and webinars, I take a qualitative approach to understanding the goals of this project and how the team plans on achieving these goals. The concept of a "community microgrid" that spans across several residential properties is still a developing concept and will be one focus of my learning.

Chapter 5 situates my findings in the context of a national movement for distributed solar programs. The chapter first discusses the findings I take away from the two case studies and argues for diversity in renewable energy transitions to address the needs of different social and political contexts. I look specifically at the diversity of initiatives within the Washington DC Solar for All program and Sustainable Westchester to propose how solar microgrids can network with other solar initiatives to increase visibility in local and national energy policy. This allows for programs to adapt to a locality's geographic, socio-economic, and political contexts.

CHAPTER II: Political receptiveness to decentralized energy

In *Short Circuiting Policy: Interest Groups and the Battle Over Clean Energy and Climate Policy in the American States,* Leah Stokes (2020) examines the ways in which utility companies have exerted their monopoly power over energy distribution and their political influence to resist renewable energy policies. Stokes explore several direct and indirect ways in which utilities have altered energy policies, promoted climate denial, resisted innovation in energy technology, and shaped policy implementation. While it is true that several creative solutions, such as solar microgrids, have the potential to curb emissions and lower energy burdens, their success is dependent on a political climate that is receptive to change. As such, it is important to this study to understand the transformative potential of solar microgrids and contextualize this potential against the existing policy trends and pathways for change in the renewable energy sphere. Here, I apply some of Stokes' (2020) theories of policy enactment to draw connections between energy policy developments in my case study cities, New Orleans and Oakland, and the potential success of decentralized renewable energy. New Orleans is unique in that it is served by a city-specific utility entity, Entergy New Orleans, a subsidiary of the larger regional utility, Entergy. Oakland, along with much of Northern California, is primarily served by Pacific Gas & Electric (PG&E). Given Entergy New Orleans' particular service area, I focus specifically on the effects of this utility on New Orleans. Since PG&E serves a much larger area, I focus on both state-wide and Oakland-specific developments in renewable energy.

Entergy New Orleans: The New Orleans Power Station and resisting renewables

The story of The New Orleans Power Station demonstrates how a utility company such as Entergy New Orleans can exert its political influence to construe fossil fuel plants as a "resilience" tactic and resist decentralized renewable energy. The $210 million natural gas electrical power plant became very controversial in 2017 when it was discovered that a public-relations firm contracted by the company to garner support for the power plant hired actors to attend public council meetings in support on the matter, a tactic known as "astroturfing" (Stokes, 2020). The power plant had already been sparking opposition from New Orleans residents. Many of these residents were unable to attend the meeting due to limitations on the number of attendees from the public. The city has long been facing power outages during several storm events, and Entergy claimed that the power plant was a necessary construction to provide backup power during outage events. Opponents argued that the gas plant would add unnecessary costs to customers and disrupt the environmental health of the nearby neighborhood, an area in New Orleans East with a high Vietnamese and Black population; they argue that grid reliability could simply be improved by upgraded transmission lines (Stein, 2017). The city council decided against rescinding its approval of the plant and instead fined Entergy $5 million, after the utility company argued that it had already invested too much money to halt construction (Stein, 2019). Though the Orleans Parish Civil District Court ruled that the council prevented fair public meeting processes by limiting the number of residents able to enter the council meeting building, construction of the power plant was still carried out and Entergy only received a $5 million fine from the City Council (NBC 2021).

Since beginning its operation in May 2020, the plant has not met the expectations of many city residents. I adapt Stokes' (2020) theory of "the fog of enactment" to interpret the language Entergy used to advocate for the plant's potential to improve grid reliability. The fog of enactment refers to ambiguity in policy communication that creates expectations that may be different from the actual policy outcomes. When proposing this plant, Entergy claimed that it would provide much-needed relief in times of grid instability and outages during storm events. The company emphasized that the plant would significantly add to their power outage recovery plan with its "black start" capability, or the ability to restart without support from the main power grid (Entergy 2017). When 2021 Hurricane Ida struck power from a damaged transmission line, residents were surprised to see that the black start plan was not implemented. Entergy officials later said that the black start is more practical when a passing storm does not damage lines within the city; in this case, the utility opted for repairing the damaged transmission line (Kasakove, 2021). Stokes discusses the fog of enactment specifically in enacting policies and laws. Still, I believe the concept of ambiguity underlying the "fog of enactment" can be seen too in Entergy's advocacy for the plant's approval. Entergy emphasized the plant's black start capability prior to its construction; though the utility may not have planned to use the black start function during all power outages, its emphasis created a perception among the public that the plant would be a staple in future recovery plans.

This reliance on discourse on the supposed necessity of fossil fuel generation for community safety and energy reliability is a commonly used tactic to resist decentralized and renewable energy technology. One renewable energy program offered by Entergy, the ReNEWable Orleans Rooftop Solar Program, offers utility customers free rooftop solar installations. Entergy owns and maintains the panels, and generated energy is supplied to the main grid. In exchange, customers receive a $30 monthly credit on their energy bills (Entergy New Orleans, 2020). The prospect of no-cost solar panel installations appears attractive, but it also appears that the benefit to the customer is low. Since Entergy owns the panels and all generated energy goes into the main grid, customers themselves do not experience all the benefits that distributed, on-site energy generation has to offer.

Entergy has attempted to resist or weaken mandates for renewable energy transitions in other ways. In 2021, the city passed a Renewable and Clean Portfolio Standard (RCPS) that requires Entergy to supply net-zero carbon emissions energy by 2040 and zero carbon emissions energy by 2050 (Resolution and Order Adopting a Renewable and Clean Portfolio Standard, 2021). During the development process of the standard, Entergy attempted in several ways to resist providing 100% renewable energy by proposing unrealistic alternatives such as technology to capture emitted carbon before reaching atmosphere or proposing weaker action such as gaining credit for electrifying home and appliances or including nuclear energy into the mix (Stein, 2021). Of these, the only amendment accepted by the council was to include nuclear energy as an acceptable stride towards reaching the standard. In spite of the hurdles crossed to pass the mandate, local advocacy groups—such as Energy Future New Orleans, a coalition of environmental justice organizations and leaders that spearheaded advocacy for the RCPS—still celebrated the RCPS as a valuable win for the future of the city's environmental action. These advocacy groups continue to work towards holding Entergy and the New Orleans City Council accountable in passing equitable environmental policy.

Oakland, California: Wildfire threats and aging infrastructure

In comparison to New Orleans, developments in the history of California's energy policy have been more open to adopting renewables and restructuring energy distribution. Researchers have shown how the state's commitments to a renewable energy transition have already set up a more accessible pathway for the adoption of microgrid and other distributed energy technology. In 2020, the state succeeded in reducing greenhouse gas emissions to 1990 levels and passed a more rigorous Renewable Portfolio Standard (RPS) in 2018 to 100% renewable energy by 2045 (Mazmanian et al., 2020). California's increasingly rigorous renewable energy standards is an example of positive "policy feedback," (Stokes, 2020, p. 23) or progressive growth in policy goals. California has leveraged common interests in clean energy development between communities, academic institutions, and businesses to justify passing stronger energy policy targets (Mazmanian et al., 2020). One way the City of Oakland has approached decarbonizing energy consumption is by partaking in regional coalitions with other local governments. East Bay Community Energy (EBCE) brings together eleven cities in Alameda County to purchase and deliver primarily renewable energy to city residents at lower rates than PG&E (East Bay Community Energy, n.d.). Through support from Bay Area regional coalition, BayREN, Oakland also implements policies and programs to reduce the energy consumption of the city's building sector (BayREN, n.d.). This alignment between California and Oakland energy policy suggests that California's statewide renewable energy targets tend to set a foundation upon which local governments implement context-specific energy programs.

Like in Louisiana, natural disasters—in this case, wildfires—threaten energy reliability in California. PG&E has come under much criticism for its inability to prevent several wildlife-related disasters in the past. The company faced $30 billion in fines for causing deadly wildfires related to faulty transmission lines, causing it to file for Chapter 11 bankruptcy in 2019 and reemerge in 2020 with a restructured leadership (Penn, 2020). The worst of these incidents was the 2018 Camp Fire, which left 85 dead and burned down almost 14,000 homes in its path (Penn, 2019a). News reports revealed the company's prior knowledge of risky, aging electrical equipment near the fire's origin and their decision to forego replacing or updating the infrastructure (Penn, 2019a). Updated infrastructure and governance structures are necessary to preventing such large disaster in the future. Californian utilities have turned to Public Safety Power Shutoffs (PSPSs), or shutting off portions of the grid susceptible to fire during higher-risk conditions, as one method of mitigating equipment-related wildfires. Customers have not always felt comfortable with utilities' use of PSPSs since they pose a significant disruption to households, and a survey of 804 California residents found that residents who have experienced more PSPSs tend to have more intention to adopt distributed solar energy resources that would protect them during PSPSs (Zanocco et al., 2021). Indeed, as wildfire risks increase with changing climate, Californian utilities and governments have started turning to microgrids as a solution to reducing wildfire risks and the disruptions caused by PSPSs. In 2020, PG&E received approval from California Public Utilities Commission to implement the Community Microgrid Enablement Plan, or a program to provide financial and technical support to community microgrid projects, to initially provide support to communities under threat of wildfires and related power shutoff

(PG&E 2020). Such existing support for microgrid projects could create a stronger foundation for the development of affordable, community-centered microgrid projects for the future. Chapter 4 will discuss the role this program has played in the development of Oakland EcoBlock.

A pathway towards anti-resilience

Examining the political barriers to decentralized renewable energy in New Orleans, LA and Oakland, CA leads us to the question of how to create more democratic generation of energy to ensure reliability, affordability, and accessibility. In their book, “Energy Democracy: Advancing Equity in Clean Energy Solutions,” Fairchild and Weinrub (2017) bring together the thoughts of various community leaders on transforming the energy system into one centered around community empowerment and energy equity. The authors discuss several case studies highlighting the work of community leaders in democratizing the energy system. Energy democracy as a concept resonates strongly with Baker’s idea of anti-resilience. It calls for the transformation of the energy system to look beyond carbon emissions. Energy democracy centers on an anti-racist and equity lens to advocate for a socio-political transformation of our energy system (Fairchild and Weinrub 2017).

In their chapter, “Energy Democracy Through Local Energy Equity,” Cervas and Giancatarino offer a policy framework for developing what they refer to as “Green Zones,” which emerge out of programs to empower communities with more autonomy over energy consumption and resources. The authors provide five steps to work towards equity and accessibility in energy policy development, stressing that these should be adapted to the local socio-political contexts (p. 59, 60):

1) “Identifying overburdened and impacted communities,”
2) “Prioritizing identified communities for public investment,”
3) “Advancing on-the-ground models,”
4) “Providing resources and assistance to impacted communities,” and
5) “Establishing community governance and democratic decision-making process.”

Together these steps work ensure that resources are being equitably distributed to most impacted communities and equip community members with the power to sustain transformative action. Although this framework targets policy development, the values within this framework can still resonate at the program level. In my two case studies, I follow Cervas and Giancatarino’s framework to analyze where the projects align with each step. Our energy system's complete transformation and democratization cannot be achieved overnight, nor through one initiative alone. Instead, the steps we take from now on to support a renewable energy transition should increasingly align with an equity framework to ultimately pave a pathway for future projects to take greater strides towards anti-resilience and democracy (Baker 2019). Thus, I do not place an expectation on my case studies to embody every step of this Green Zones framework. I draw upon this framework as a guide for how future similar projects can build off of my two cases to steadily bring more attention to the injustices within our current energy system and the motivations to ground projects in community needs.

CHAPTER III: Affordable energy and community building at The St. Peter Microgrid

Located in the Mid-City neighborhood of New Orleans, LA, The St. Peter apartment complex has a vision of providing safe, affordable, and enjoyable housing to low-to-moderate income (LMI) city residents, families, and veterans. The project was envisioned and carried out by SBP (formerly the St. Bernard Project), an organization focused on community aid and rebuilding from disasters. The affordable housing complex, which opened to residents in February 2020, is unique to the city in that it is also Louisiana's first net-zero apartment building (SBP 2021). With a grant from Entergy, the region's utility company, SBP equipped each apartment unit with energy-efficient appliances and installed a 178-kW rooftop solar microgrid and battery storage system (Solar Alternatives, 2020).

The complex's ability to "island" from the primary energy grid is an especially important feature of the microgrid and solar storage system for its geographic location. The region has suffered numerous hurricanes, tornadoes, and storms—each with devastating impacts on residents' safety and long-term security. The impacts on housing and financial security have been severe. New Orleans residents have also struggled with rising rents and property values, compounded with the financial and health toll of the COVID-19 pandemic (A. Thompson, personal communication, February 25, 2022). The St. Peter complex and microgrid aims to tackle housing and energy security from a holistic financial and community empowerment standpoint for the city's vulnerable populations. In this chapter, I will begin by setting the context for Hurricane Katrina's impact on housing and energy security in New Orleans and later assessing the impact of SBP's work on St. Peter to combat energy insecurity.

Housing and energy insecurity in a post-Katrina New Orleans, LA

In Chapter One, I explore discourse on "energy resilience" as a conduit for perpetuating structural inequities in affordable and reliable energy access. The discourse around energy resilience has often fallen into the trap of prioritizing the urgency for renewable energy transitions and technological development without considering the need for transformation at the root of the issue—the configuration of our energy system. This issue resonates with much discussion around the idea of "urban resiliency," which has also fallen into the trap of only prioritizing infrastructure development in the past. When residents face housing insecurity or poor housing quality, the impacts of energy insecurity increase. Inefficient use of energy is a widespread problem in older or lower quality housing, leading to higher energy costs.

Researchers have long explored the disaster of Hurricane Katrina as socially constructed through structural inequities in access to safe, quality housing and disaster recovery and mitigation programs. Though the storm hit all communities, communities vulnerable to shock faced far more devastating and long-term impacts on safety and security. Analyses of impact disparities have shown that areas with more low-income, non-white, and renter populations saw high levels of uninsured damage (Kamel, 2012). Disparities in felt impact are even more evident when considering recovery paths among the community. Highly socially vulnerable communities—which Finch et al. (2010) measure through factors of racial, age, gender, economic, education, and health and housing disparities—returned to homes after the storm at lower rates than communities lower on the social vulnerability scale. Vulnerable census tracts in Orleans Parish saw return rates as low as less than one-third of their pre-Katrina population (Finch et al., 2010, p. 194).

Community advocates have criticized federal and Louisiana state government relief programs for their limited accessibility and impact for vulnerable populations. Louisiana's 2006 Road Home Program, for instance, offered grants to homeowners looking to return to their home in Louisiana, sell their home and relocate within Louisiana, or sell their home and relocate out of the state (US Department of Housing and Urban Development, n.d.). The program's impact was limited by its late implementation (one year after the hurricane), complicated participation process, and grants based on pre-storm home value, which places low-income neighborhoods and older homes as a disadvantage (Kamel, 2012). Housing assistance and re-development programs had notable harmful impacts on affordable housing developments. Many redevelopment programs saw Katrina as an opportunity for "resilience" and "revitalization," which often came at the expense of communities reliant on affordable and public housing communities. The US Department of Housing and Urban Development (HUD) implemented several post-Katrina programs to demolish affordable housing units and build mixed income housing, thereby displacing many low-income, African American, and female-headed households (Finger, 2011).

These aspects of post-Katrina recovery have kept vulnerable populations in vulnerable positions, especially in face of subsequent disasters. Severe power outages due to an outdated power grid during the most recent 2021 Hurricane Ida are evidence to this. The power distribution equipment managed by Entergy New Orleans (ENO), the region's investor-owned utility, were not fit to withstand the wind damage brought upon by

Hurricane Ida. The utility installed the distribution lines were built over 20 years ago and are not fit to withstand the wind speed of Category 4 hurricanes (McCullough Research, 2021, p. 4). Researchers argue that the frequency with which the region faces severe storms should call for more frequent updates of energy infrastructure (McCullough Research, 2021). During Hurricane Ida, these failures to withstand damage had deadly consequences. In Orleans Parish, the Louisiana Department of Health reported nine deaths from excessive heat during the power outage and two deaths from generator use-resulting carbon monoxide poisoning (Louisiana Department of Health, 2021). Investigations by the New Orleans City Council, which regulates ENO, found that the utility has reduced investments in upgrading equipment and has pushed back against plans for renewable energy transitions (Blau, et al. 2021).

Outside of extreme storm events, Orleans residents face high energy costs. As discussed in Chapter One, these costs pose significant burdens particularly for low-income and Black and Brown households and have been magnified by the financial toll of the COVID-19 crisis. My analysis of energy costs by race in Orleans Parish indeed shows that energy burdens are felt disproportionately by Black or African American and Hispanic or Latinx households in comparison to white households. In almost three-quarters of the census tracts, less than 40 percent of white households face a high energy

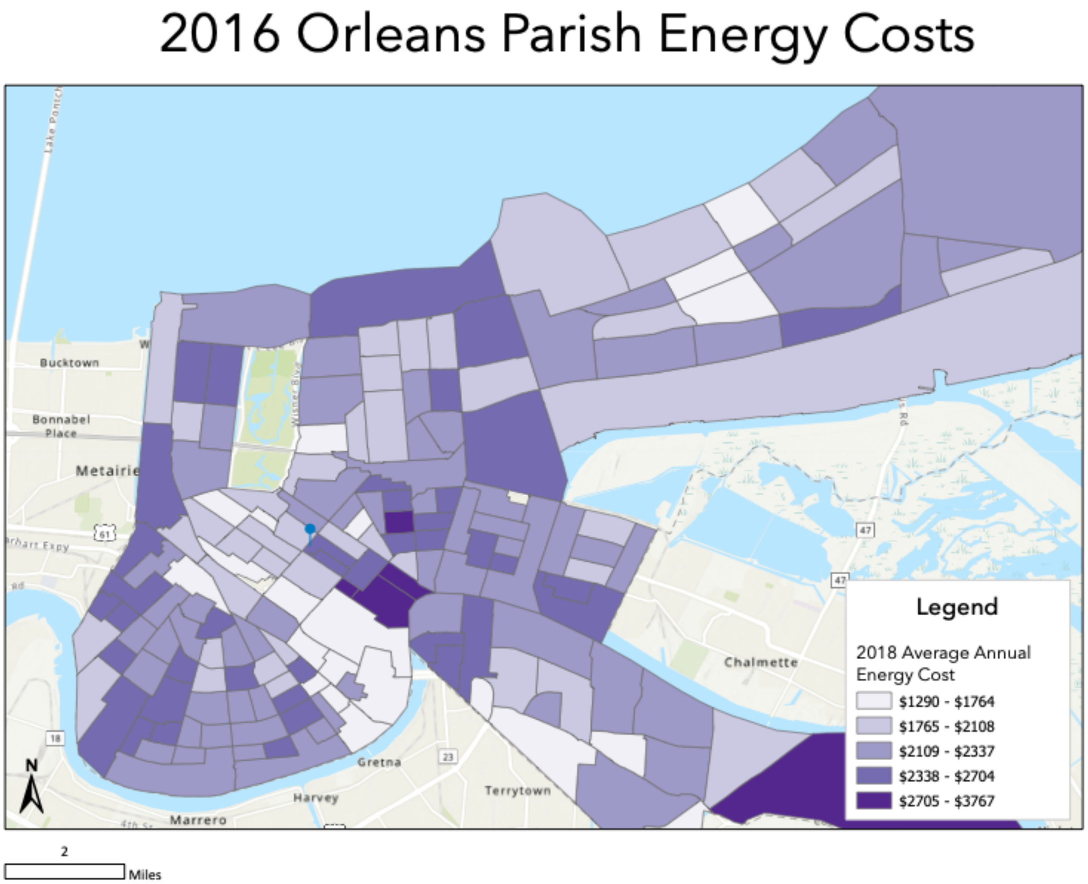

Figure 1. Map of average 2016 annual energy costs in Orleans Parish.

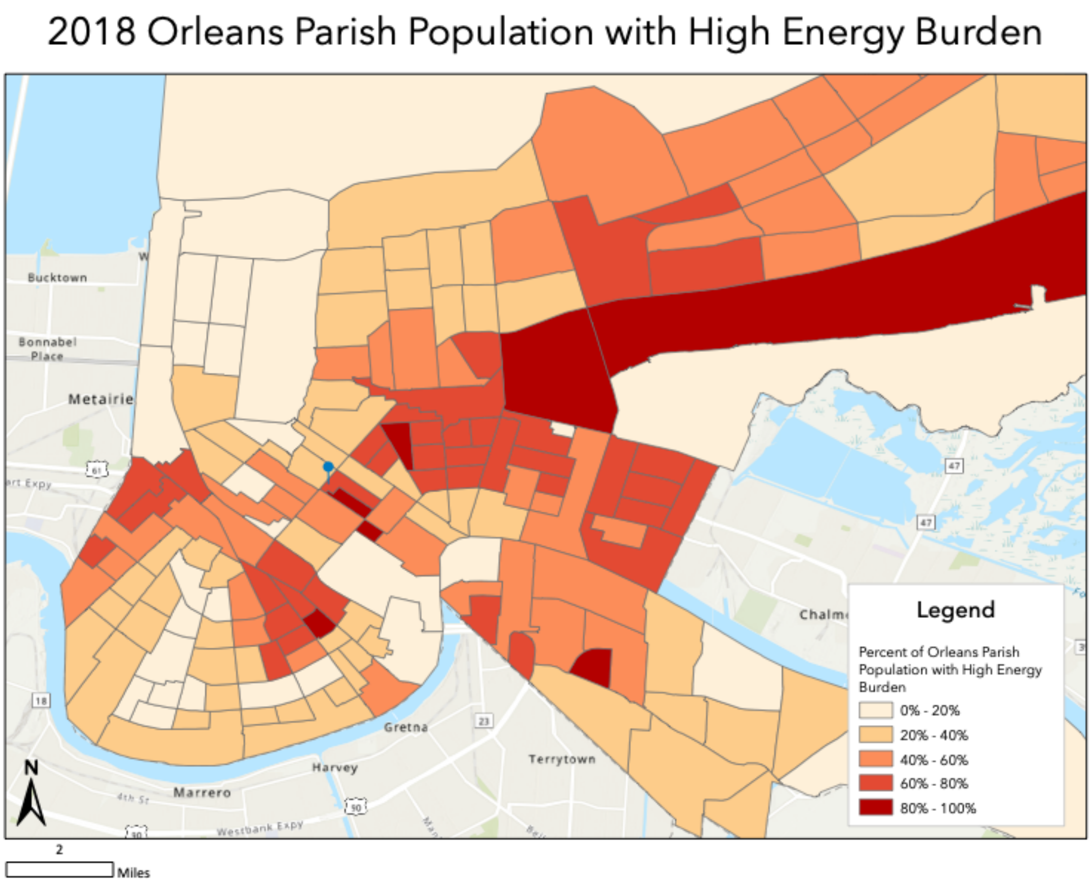

Figure 2. Map of percentage of Orleans households with a high energy burden.

2018 Orleans Parish White Population with High Energy Burden

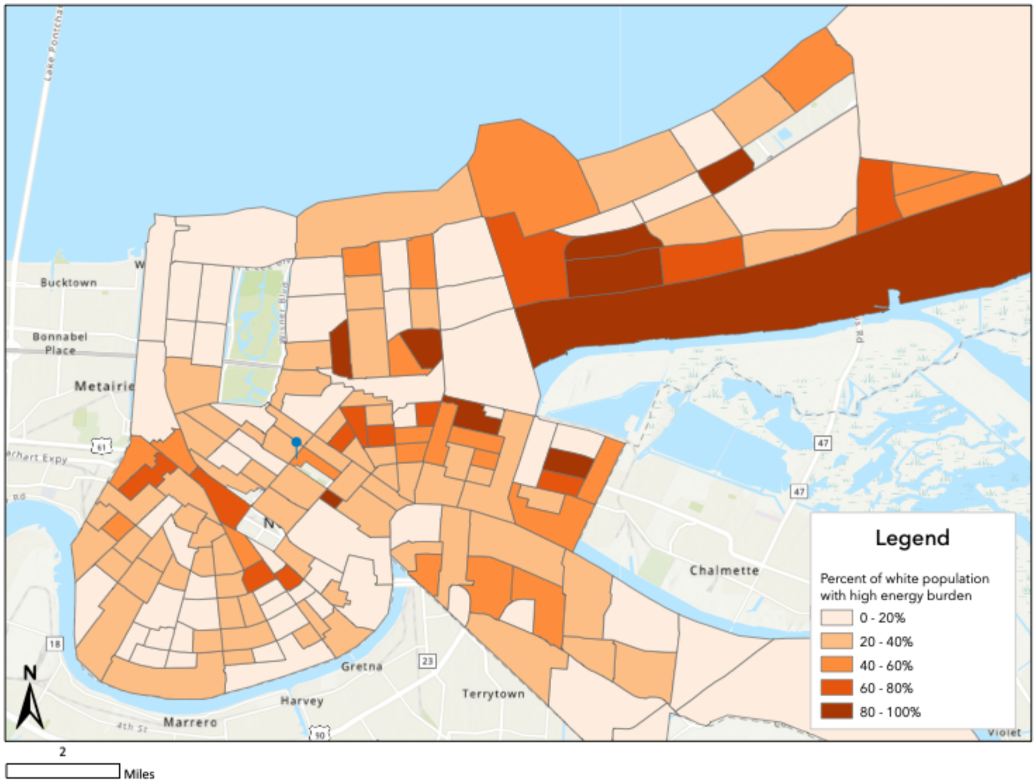

Figure 3. Map of percentage of white Orleans households with a high energy burden

2018 Orleans Parish Black Population with High Energy Burden

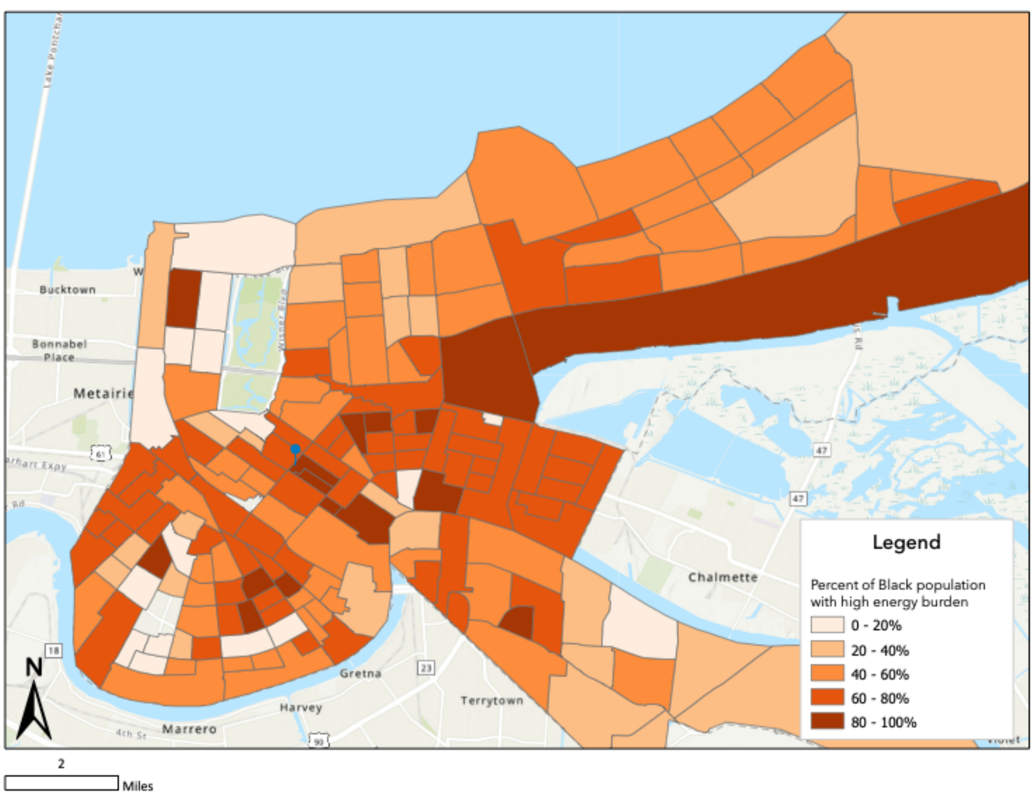

Figure 4. Map of percentage of Black or African American Orleans households with a high energy burden

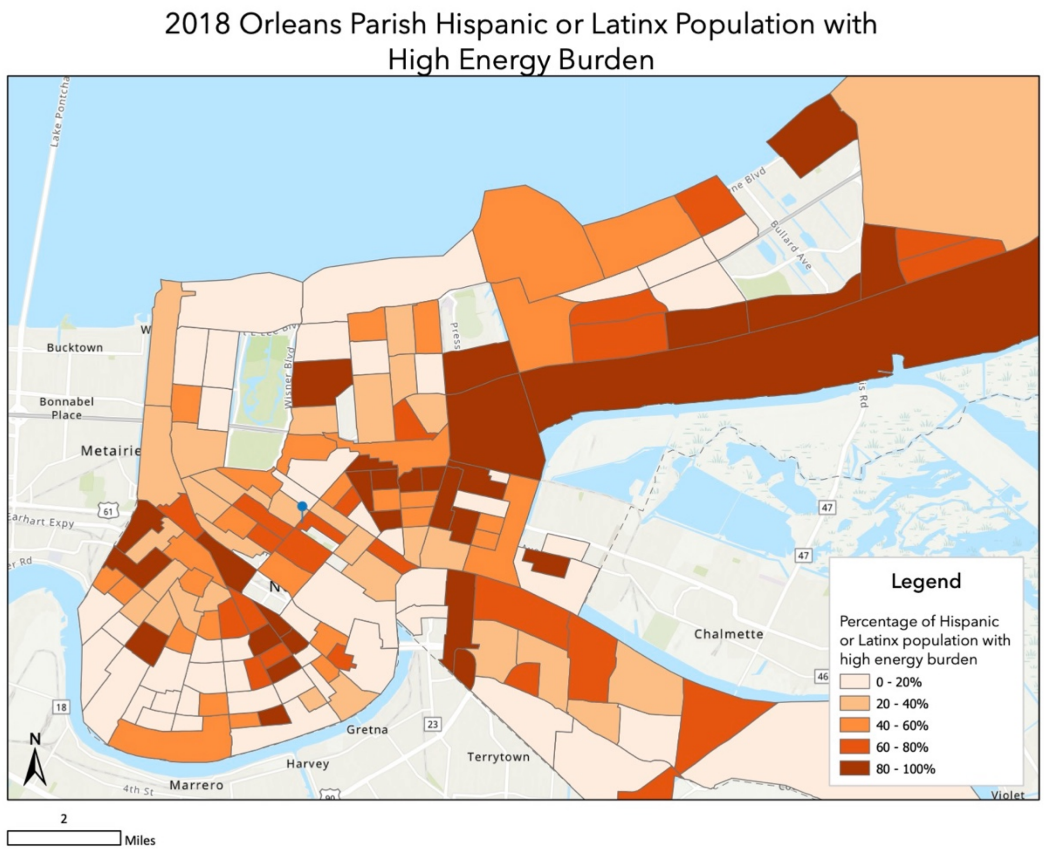

Figure 5. Map of percentage of Hispanic or Latinx Orleans households with a high energy burden

Figures 1-5. Maps visualizing energy costs and racial disparities in energy burdens in Orleans Parish. A "high energy burden" is calculated as energy costs equaling 6% or more of annual income. These maps demonstrate that in Orleans Parish, there are higher percentages of Black and Brown Households facing high energy burdens than white households. The blue pin marks the location of The St. Peter.
Energy costs data sourced from NREL (National Renewable Energy Laboratory). (2019). *Low-Income Energy Affordability Data (LEAD) Tool*. https://lead.openei.org. Census tract income data is sourced from US Census Bureau. (2018). *2018 American Community Survey*. https://data.census.gov/cedsci/.

**Since census income data was provided in set increments, calculations of percentage of households with high energy burdens are sometimes slight underestimates*

burden (Figure 3). In contrast, between 40 percent and 80 percent of black households face a high energy burden (Figure 4). The percentage of Hispanic or Latinx households with a high energy burden is dispersed across percentiles, though the small number of Hispanic or Latinx homes in some census tracts (some as low as four households) makes it difficult to identify reliable patterns across the parish. However, it remains visually apparent that a higher number of Hispanic or Latinx households face high energy burdens than white households in Orleans Parish (Figure 5). In Census Tract 44.01, marked with a blue pin where The St. Peter is located, energy costs are high, at an average of $2,473 annually, as are energy burdens (Figures 1-5). Energy costs are of concern in Orleans Parish, particularly among low-income households and households of color. The burdens of energy costs are amplified in the face of rising rents and other costs of living. SBP recognizes this and hopes to ease these burdens for the residents of The St. Peter.

Affordable energy for The St. Peter residents

The apartment complex's 178-kW rooftop solar microgrid operates daily through a submetering and credit system for residents (A. Thompson, personal communication, February 25, 2022) The apartment is sent one master energy bill by Entergy for the whole building's energy consumption and is credited for the energy generated through the microgrid. This credit is distributed across all apartment units and lowers the energy bill each unit is charged for their personal consumption, measured through submeters. For example, a one-bedroom unit is credited 100 kWh in the winter months and a two-bedroom unit is credited 150 kWh. In the summer months, when energy needs for air cooling are higher, SBP credits a one-bedroom unit with 150 kWh and a two-bedroom unit with 200 kWh. The credit system means that if a resident's energy consumption costs remain below the credit received, they could live with no energy costs.

Table 1. Summary of energy cost differences between The St. Peter and Orleans Parish. Data sourced from shared SBP's data records.

	Average Annual Energy Cost	*Minimum Annual Energy Cost*	*Maximum Annual Energy Cost*
Orleans Parish 2016 N = 172	$2,180.08	$1,290	$3,767
The St. Peter 2021 N = 50	$367.52	$0	$1,132.49
Difference in Average Annual Energy Costs	$1,812.56		
One-sided t-test for significance of difference in energy costs	*t(110.62) = -43.531* *P < 2.2e-16*		

Table 1 summarizes how energy costs in The St. Peter compare to the rest of Orleans Parish. In 2021, the average annual energy cost paid by apartment residents was $367.52 and the maximum paid was $1,132.49. In comparison the average annual energy cost in 2016 in Orleans Parish was $2,180.08 and the highest was $3,767. The average annual energy cost of The St. Peter is significantly lower than that of Orleans Parish at large (*P < 2.2e-16)*. Further, 29 out of the 50 units in The St. Peter experienced at least one month in 2021 with $0 energy costs.

The data demonstrate a considerable difference in what residents of The St. Peter pay for energy on a monthly basis compared to other residents of Orleans Parish. In 2019, the average annual income for census tract 44.01 was $43,660/year. An average yearly energy cost of $367.52 would take up only 0.84% of the region's average annual income. In comparison, energy costs take up 3% of income for residents statewide in Louisiana (NREL 2019). SBP's model for a solar microgrid meets its promise for lower, more affordable energy costs on a daily basis.

During emergencies, the solar microgrid provides relief to its residents using its battery storage system. For example, during storm events, such as the recent hurricanes, residents may only lose power for the brief period it takes for the complex to recover power for essential functions, such as light and temperature regulation. It does so by "islanding," or disconnecting from the main grid to draw from battery-stored energy and placing residents on a rotating system of providing power to preserve the sustained power (A. Thompson, personal communication, February 25, 2022). This ability to operate without relying on the central power grid has been crucial for the safety of residents.

When opening applications for The St. Peter, the SBP team wanted to prioritize units for vulnerable populations; half of the units were set aside for veterans and many for low-to-moderate-income individuals and families (SBP 2021). In addition, to ensure that news about this project reached target communities, SBP posted advertisements at housing agencies, on social media, and held local flyer drives at barbershops, schools, and grocery stores (A. Thompson, personal communication, February 25, 2022). Such forms of targeted outreach are critical in building accessible energy programs that directly benefit community members.

Building renewable energy communities

For the residents of the St. Peter Apartments, getting to know your neighbors is pivotal to the experience. In my interview with Ashley Thompson, Low-Income Housing Tax Credits Program Manager in New Orleans, tenant support and community building stood out as a primary engagement tactic for SBP (A. Thompson, personal communication, February 25, 2022). As part of her role in managing this rental housing program, Thompson works closely with tenants to identify methods of reducing energy consumption and bills. SBP hopes to build tenants' skillsets and knowledge base in efficient energy consumption so they can continue to maintain their energy bills at an affordable level even if they move to a different housing complex.

The team provides educational content on efficiency tips through community meetings, monthly newsletters, and magnets with common tips listed. These recommendations aim to demonstrate the impact that smaller changes in daily energy consumption can have on maintaining a steady energy bill, such as unplugging unused surge protectors and regulating indoor temperatures. In addition, these recommendations aim to be accessible and straightforward for daily practice. Thompson also engages closely with tenants in identifying and solving issues with energy bills. If tenants approach Thompson with questions on why their most recent bill is higher than usual, she works with the tenant to identify any recent changes in consumption behavior, such as new visitors or an increase in the use of a certain appliance. Such minute changes to daily life are often not recognized as having a noticeable impact on our energy bills, but Thompson hopes that this process of analyzing daily consumption patterns will equip residents with the tools to maintain affordable energy bills.

But at the St. Peter Apartments, community means more than simply advising residents. It also means facilitating meaningful and dependable relationships with and between apartment residents. Many of the community interactions start with the complex's Community Center. Equipped with refreshments, a TV, and a computer, residents can stop by the Community Center to chat with Thompson and get to know each other. This natural gathering space facilitated stronger bonds among the residents, with neighbors often checking up on and meeting with each other. When asked about the importance of building these community bonds in renewable energy projects, Thompson strongly agreed about their value in creating an environment that is conducive to mutual aid, learning, and growth. This form of engagement builds trust, but it also has the potential to empower community members with the comfort of voicing their visions for and shaping the future of a project.

Lessons learned through an energy democracy framework

SBP's current 50-unit model of The St. Peter is not the end of the organization's vision for affordable and energy secure housing projects. The team is looking to expand this project close by in New Orleans as well as carry out a similar project in Houston, TX. According to Thompson, facilitating strong community networks in the apartment complex was not difficult due to the fewer residents. But she is confident that this model can be scaled up as more SBP staff are placed on the project. One of the main barriers she anticipated to success was pushback from tenants on adopting energy-efficient habits and becoming involved in The St. Peter community. On the contrary, she found tenants to be very enthusiastic at the prospect of lower energy bills, responsive to advice on reducing energy consumption, and naturally seeking of relationships within the community.

The St. Peter's model of community building in local energy generation has much alignment with Cervas and Giancatarino's (2017) principles for energy democracy through "Green Zones":

1) "Identifying overburdened and impacted communities,"
2) "Prioritizing identified communities for public investment,"
3) "Advancing on-the-ground models,"
4) "Providing resources and assistance to impacted communities," and

5) "Establishing community governance and democratic decision-making process."

I identify several lessons learned from this project in pushing for energy democracy and system transformation:

- **Identifying and reaching out to the communities that have been strongly impacted by energy insecurity in local history** *(aligning with Green Zone recommendation one)*: SBP had a clear vision of providing relief for veterans and low-to-moderate income residents of New Orleans. Looking at the local context, these communities have struggled with the financial and health impacts of repeated storm events and the COVID-19 crisis. In addition, many current residents of The St. Peter previously faced rising, unaffordable costs of living or homelessness (A. Thompson, personal communication, February 25, 2022; SBP 2021). By setting aside half of the apartment units for veterans and advertising the apartment's opening at high-traffic establishments in local communities, SBP prioritized impacted communities. The first step in administering local clean energy programs should be to understand the local histories of energy insecurity and what communities have experienced higher resulting burdens.
- **Generating solar energy on-site through a solar microgrid** *(aligning with Green Zone recommendation three)*: The St. Peter solar microgrid provided residents crucial power relief during recent storm events. Another aspect of on-site generation is ownership over the installed project. SBP owns The St. Peter microgrid instead of a utility or company-owned microgrid. In this way, The St. Peter microgrid works to redistribute ownership over energy generation from centralized utility forces. SBP's ownership over the system can also work to

ensure that the project continues to fulfill its initial vision: offering safe, affordable housing and equipping residents with the tools to maintain affordable energy bills. Keeping close ties to the community, such as through a community-based organization like SBP, is important in redistributing control in the energy system.

- **Prioritizing community education and involvement** *(aligning with Green Zone recommendations four and five)*: One of SBP's end goals for The St. Peter project was to equip tenants with valuable knowledge in energy efficiency that can be carried forward into the future. This accessible sharing of technical expertise ensures that tenants may sustain energy bills to a reasonable level, even beyond living in The St. Peter. This is one step to reducing the impact of energy burdens on low-to-moderate income households. Another pillar of the residents' experience in the apartment complex has been the facilitation of community relationships. Although residents do not necessarily participate in making decisions for the complex's future development under the current structure of the project, SBP's techniques to facilitate community involvement still hold lessons in encouraging community governance. The team naturally promotes a sense of belonging and community through shared community spaces and gatherings. This creates feelings of trust, which is instrumental in conversations with impacted communities about energy justice and renewable energy transitions (Cervas and Giancatarino, 2017).

SBP's The St. Peter started out as a vision to promote affordable housing and accessibility to renewable energy. Its demonstrated relief for New Orleans' energy insecure populations provides many lessons on how solar microgrid projects could work towards energy justice. In this chapter, I have highlighted the importance of community building in renewable energy transitions. To transform our current energy system into one that provides more autonomy to community members, it is vital that we work primarily with those who have borne the burden of inequitable energy distribution.

CHAPTER IV: Scalable community microgrids through Oakland EcoBlock

One of the biggest questions that emerge from the study of microgrids is larger-scale feasibility—the Oakland EcoBlock is looking to answer this question with its community microgrid plan. The EcoBlock aims to build sustainable communities by strengthening sustainable energy and water-use capacity, with a primary focus on energy efficiency, electrification, and solar power. Although the project is not in place yet, the EcoBlock team aims to administer a pilot project beginning in 2022 in the Fruitvale neighborhood of Oakland (EcoBlock, n.d.a).

The EcoBlock is different from the St. Peter Apartments microgrid in that it envisions a network of rooftop solar panels across houses in the chosen neighborhood as a community microgrid (Stanford ENERGY, 2021). Through partnering with Pacific Gas & Electric (PG&E), the region's leading utility company, the project hopes to find ways to allow homeowners within the EcoBlock to share generated solar energy across and isolate from the main grid when necessary (Stanford ENERGY, 2021). The overarching goal of the EcoBlock team is to create an affordable and scalable model applicable to different areas across California and the US.

Histories of redlining and housing costs in Oakland, CA

Existing geographic disparities in access to safe and affordable associations have strong ties to the history of racial discrimination and redlining practices in Oakland. Today, the city's lower income residents struggle with surging housing prices, loss of affordable housing units, and threats of evictions. Existing financial impacts of housing insecurity magnifies the burden of energy costs. Further, not only does low-quality construction pose a health hazard to residents, but it can also increase a home's energy costs when not using energy efficiently.

Unequal homeownership rates, housing quality, and mobility today tie back to histories of redlining in Oakland, a tactic to disinvest from low-income Black and Brown communities. Schwarzer (2021) explores the impacts of redlining and inequitable housing on housing disparities today. The Homeowner Loan Corporation's redlining tactics denied homeownership and other financial opportunities to redlined communities by designating predominantly Black and Brown communities as' risky' investments. During this time and even after the government outlawed the practice, public housing complexes in Oakland far from met the needs of city residents. During World War Two, the government transformed many complexes into temporary war housing; they were either not built to high standards or later demolished. Later efforts to improve the quality of public housing transitioned towards mixed-income developments and left fewer affordable units for low-income city residents than existed prior.

Fruitvale, where Oakland EcoBlock is located, experienced the consequences of disinvestment and white flight like many neighborhoods in Eastern Oakland, as Maly (2005) explores in the history of Fruitvale and San Antonio. White middle class migration to the surrounding suburban areas drew out key financial institutions and hurt these districts' economic activity and opportunity. Following this, from the 1980's, Fruitvale saw rises in ethnic diversity as new Latinx and Asian residents moved in. However, waves of gentrification have made evident that racial divides still exist within the city. Areas of higher elevation in Oakland (commonly referred to as the "hills") see more white and high-income populations than lower elevation areas (the "flatlands");

Fruitvale mirrors these geographic trends with differences in “Upper Fruitvale” and “Lower Fruitvale.”

Indeed, rising rents and housing prices continue to threaten low-income communities of color with displacement and evictions. Despite the outlawing of discriminatory housing practices and the implementation of rent controls, property owners and banks still engage in unjust practices. For example, displacement financing is a significant problem for tenant and homeowner rights in Oakland (California Reinvestment Coalition and Anti-Eviction Mapping Project, 2018). In this practice, speculation raises property values and rent to unaffordable prices for tenants, which property owners and banks use as a cause for evictions and further increases in housing prices (California Reinvestment Coalition and Anti-Eviction Mapping Project 2018).

Struggles with rising property values and rents can amplify the burden of energy costs, particularly for energy insecure households. Compared to Orleans Parish, average annual energy costs in Oakland are lower (Figure 7), the highest cost being $2,330 compared to $3,767 in Orleans Parish. However, it still constitutes a sizeable cost, particularly when added on to other high costs of living. For instance, the California Reinvestment Coalition (2018) finds that 62.5% of African American households and 58% of Latinx households are burdened with housing costs (p. 3).

In the majority of census tracts Oakland, less than 20% of white households face a high energy burden (Figure 9). Among the city’s Hispanic or Latinx population, and especially among the city’s Black population, more tracts see between 20% and 40% of households with a high energy burden (Figures 10 and 11).

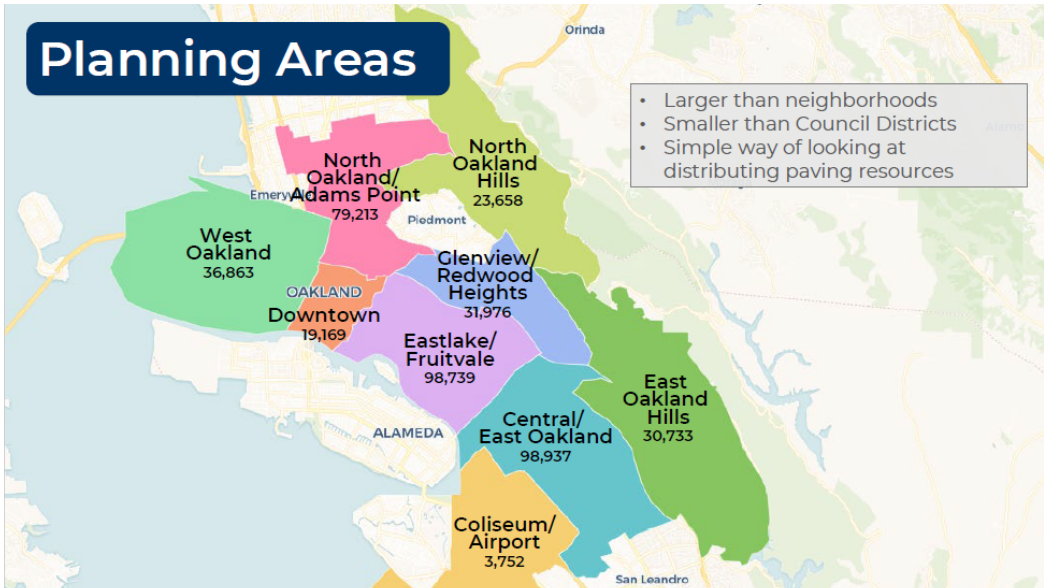

Figure 6. Map of divisions in Oakland, CA. Map from City of Oakland Department of Transportation (n.d.). Planning Areas*. Accessed 5 March, 2022. Retrieved from https://datasmart.ash.harvard.edu/news/article/equity-urban-improvements-oaklands-great-pave.*

2016 Oakland Average Annual Energy Cost

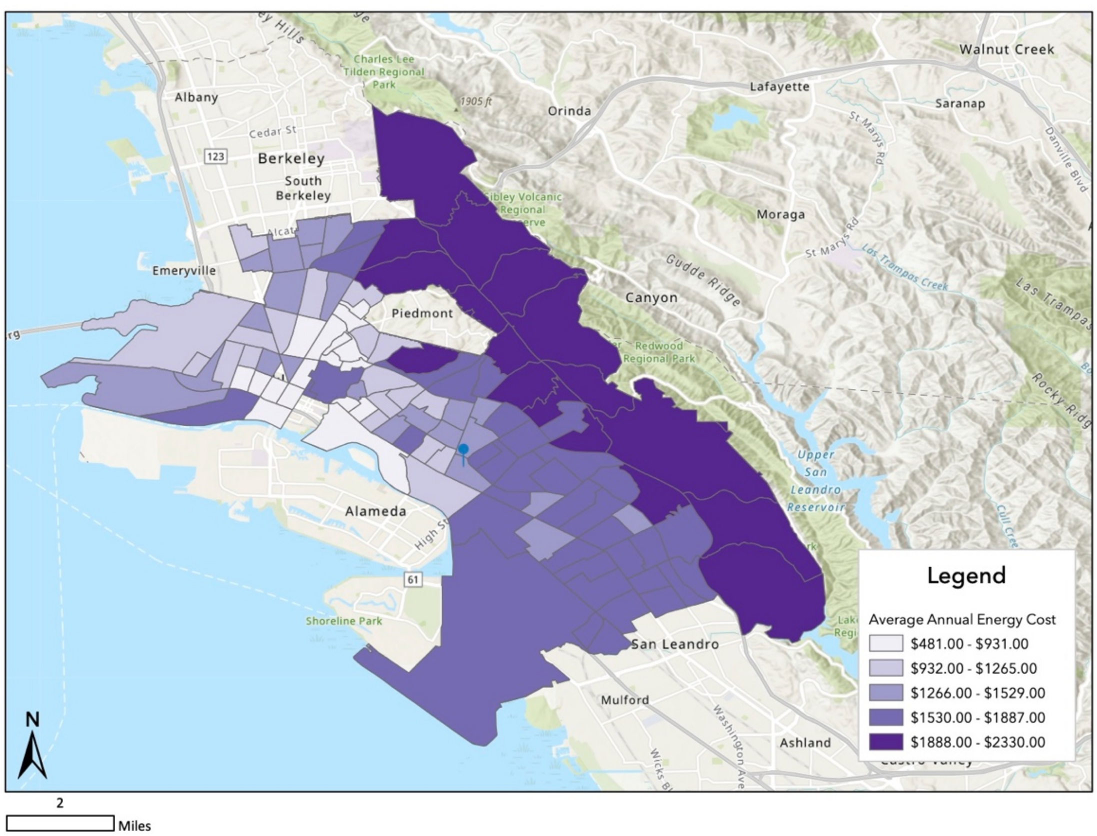

Figure 7. Map of average 2016 annual energy costs in Oakland, CA

2018 Oakland Population with High Energy Burden

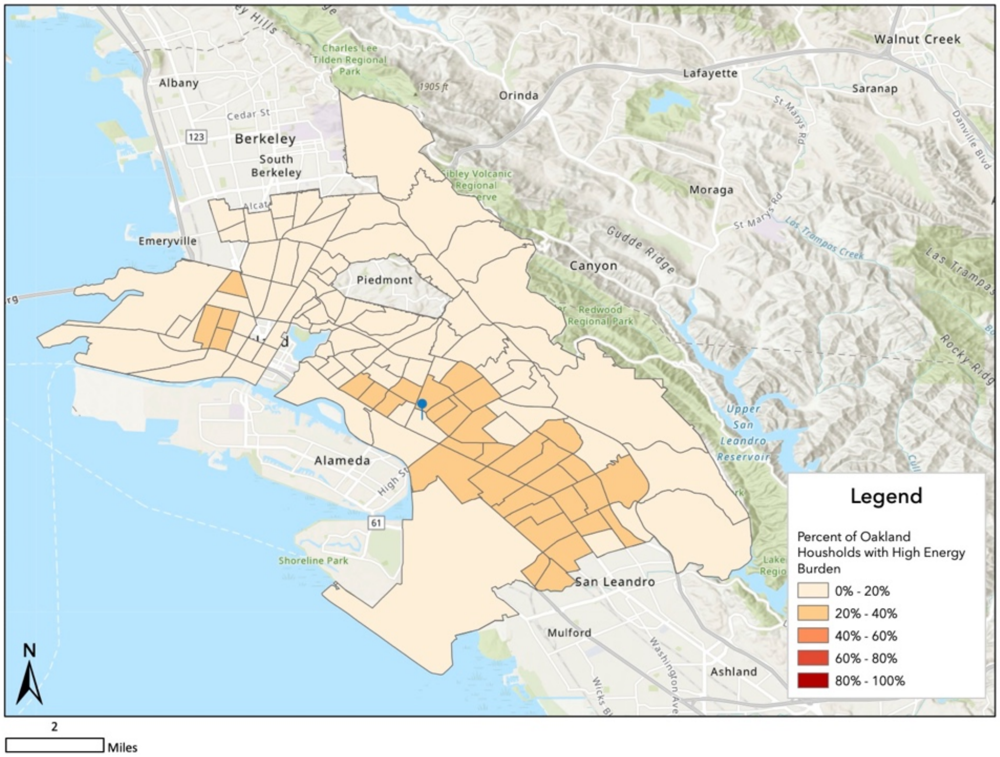

Figure 8. Map of percentage of Oakland households with a high energy burden.

2018 Oakland White Population with High Energy Burden

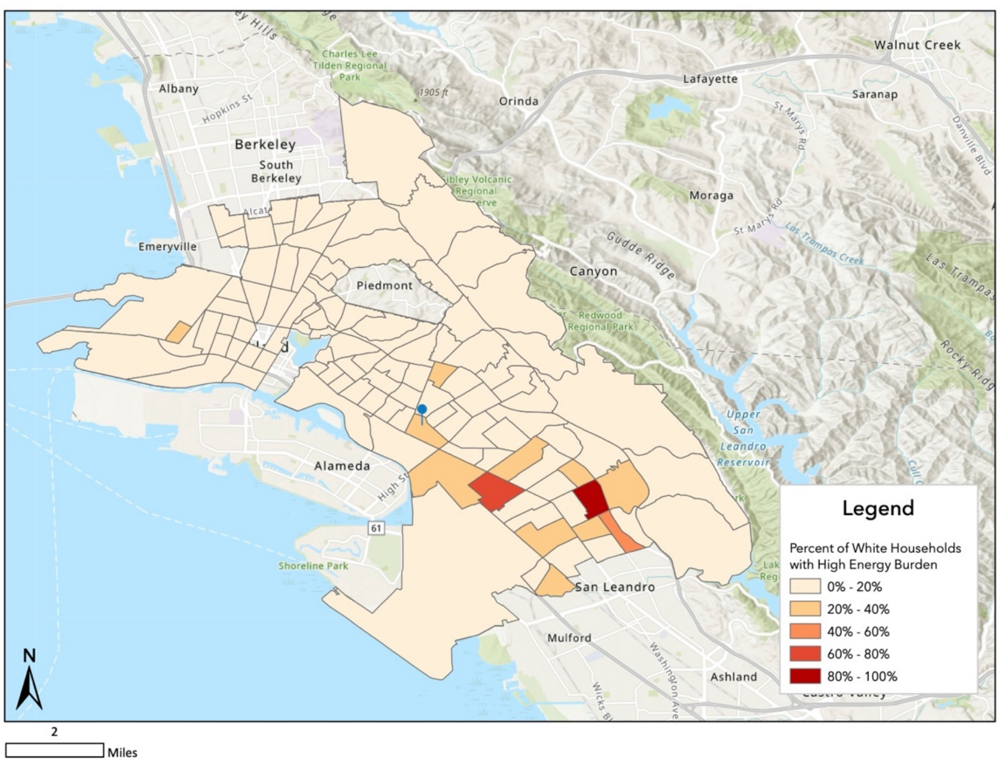

Figure 9. Map of percentage of white Oakland households with high energy burden

2018 Oakland Black Population with High Energy Burden

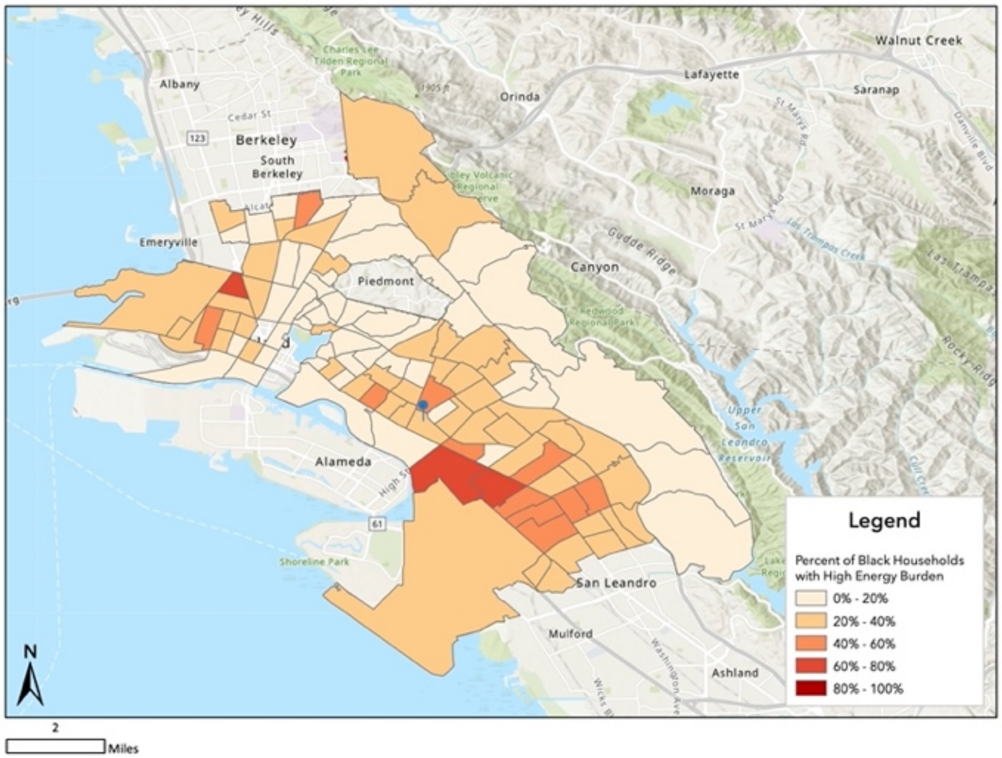

Figure 10. Map of percentage of Black or African American households with high energy burden

2018 Oakland Hispanic or Latinx Population with High Energy Burden

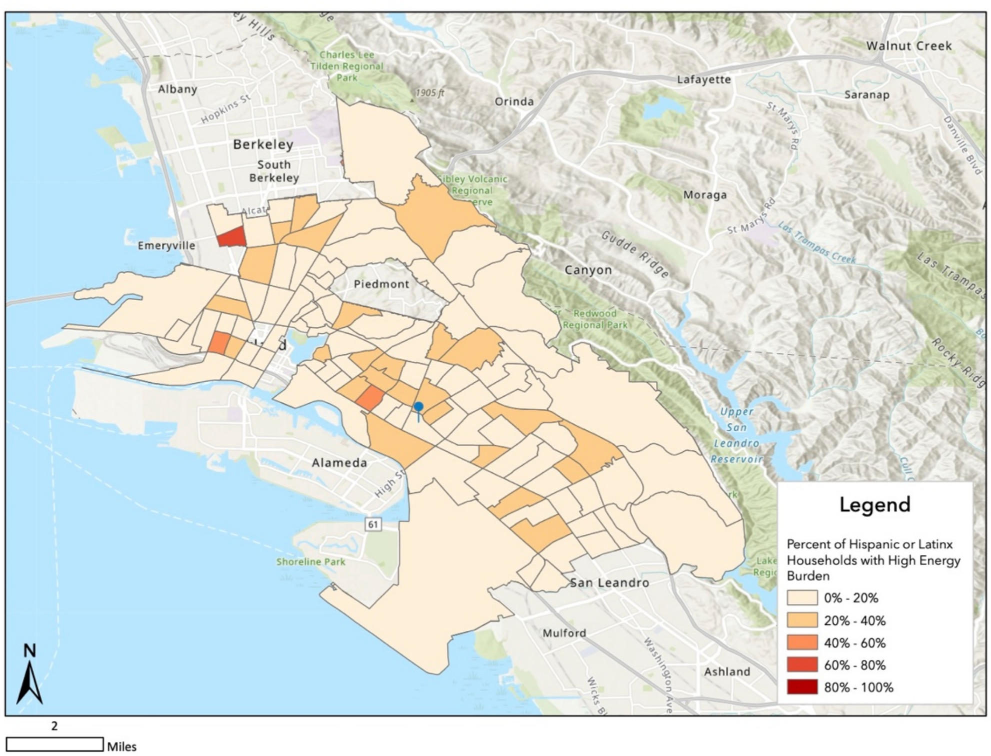

Figure 11. Map of percentage of Hispanic or Latinx households with high energy burden

Figures 6-11. Maps visualizing energy costs and racial disparities in energy burdens in Oakland, CA. A "high energy burden" is calculated as energy costs equaling 6% or more of annual income. These maps demonstrate that in Oakland, there are higher percentages of Black and Brown Households facing high energy burdens than white households. The blue pin marks the location of the Fruitvale neighborhood, where Oakland EcoBlock will be created. Energy costs data sourced from NREL (National Renewable Energy Laboratory). (2019). *Low-Income Energy Affordability Data (LEAD) Tool*. https://lead.openei.org. Census tract income data is sourced from US Census Bureau. (2018). *2018 American Community Survey*. https://data.census.gov/cedsci/.

**Since census income data was provided in set increments, calculations of percentage of households with high energy burdens are sometimes slight underestimates*

These tracts fall generally in West, North, and Central/East Oakland (Figure 6), all of which have been historically targeted through redlining practices (Schwarzer 2021). Tracts with notably low households with high energy burdens overlap with the more affluent "Hills" in Oakland (Figure 11). The Oakland EcoBlock proposes a community microgrid solution to increase renewable energy access and reduce energy costs in the Fruitvale neighborhood.

Oakland EcoBlock: Taking a holistic approach to sustainability

One of Oakland EcoBlock project's goals is to offset any cost residents must pay for the future maintenance of the system with microgrid energy savings. Since the pilot project received $5 million in funding from the California Energy Commission (CEC), residents will not pay for solar panel installation and connection to the grid, though they will be responsible for the costs of maintenance following the pilot's end in 2023. Instead, residents will receive credits for generating solar energy through net energy metering (NEM). Excess solar energy is sent back to the grid and credited to a home's utility bill. As a result, the project estimates that EcoBlock's energy consumption can reach nearly net-zero emissions.

The project plans to install solar on the rooftops of each residential unit in the EcoBlock that feed into a central solar storage battery for the community microgrid for moments when the microgrid will disconnect from the main grid. For most of the time, the EcoBlock will operate as a normal community of rooftop solar installations through NEM. However, during times of necessity such as utility power outages, the block will make use of its storage battery and protect its residents from outages.

Alongside solar installations, the project also plans to encourage electrification and efficiency in participating homes to reduce energy consumption. Firstly, the shift away from fossil fuel-consuming appliances in the home through electrification will push the project towards its goal of community decarbonization. To compensate for the resulting increase in electricity consumption, the project will ensure that participating homes consume energy efficiently by providing no-cost energy retrofits such as insulation, air sealing, and energy-efficient appliances. The project also plans to integrate other initiatives for sustainable living, including water conservation systems and charging stations for shared electric vehicles powered by the microgrid.

Although this pilot project has not yet been implemented, the implementors are currently outlining the intermediary steps necessary to achieve their goals. To settle on a residential block to participate in the pilot program, the program administrators released a call for applications from a block of 10-15 neighboring homeowners. Blocks that applied should have shown a capacity to accommodate solar panels and EV charging stations, average annual energy bills of at least $500, and a commitment to developing a cooperative model that would sustain the project past its pilot period (CITRIS and the Banatao Institute 2019). This request for applicants specifically mentioned a prioritization of applicants facing higher energy burdens. Specific information about the pilot neighborhood has not been released for privacy concerns, but according to Dr. Alexandra von Meier, the project's Principal Investigator, the chosen Fruitvale District neighborhood has a “really diverse community—not particularly high income” (CITRIS, 2022). The project conducted outreach through several community-based organizations with closer ties to local communities than the institutions administering the program (EcoBlock, 2020). This multi-level collaboration is a crucial step towards ensuring that the benefits of renewable energy programs reach energy burdened households.

Splitting ownership over the microgrid

One aspect of the EcoBlock that has garnered attention is the cooperative-like model to share ownership of and manage the solar generation and storage assets. The project grants share ownership over generation and storage technology to neighborhood residents, as opposed to a utility or a third-party organization, by developing a community member-led nonprofit association, similar to a Homeowner’s Association. The technology that distributes the generated solar, on the other hand, is owned by PG&E. In fact, the microgrid is built upon existing PG&E distribution technology so that the maintenance of energy distribution is still the utility’s responsibility. Therefore, working through existing infrastructure is a more economical and efficient route to developing the EcoBlock. However, there are some drawbacks that come with PG&E’s ownership over distribution technology in the community microgrid.

In 2021, the Oakland EcoBlock supported PG&E’s request to the California Public Utilities Commission to broaden the criteria for the utility’s Community Microgrid Enablement Program beyond communities facing high fire or power outage and shutoff risks (von Meier 2021). This program provides financial and technical support to proposed grid-connected community microgrid projects in PG&E’s service areas (PG&E n.d.). The successful broadening of qualifications allowed the EcoBlock to coordinate project development with PG&E under the utility's Community Microgrid Enablement Tariff (CMET) structure, which dictates how the EcoBlock and utility will jointly operate the microgrid. Under the CMET, however, PG&E manages the distribution of generated energy and controls the switch that connects and disconnects the microgrid from the central power grid (PG&E 2021). This stipulation takes away some of the control that community microgrid users could have over the operation of their microgrid.

Developing a scalable community microgrid model

Beyond this pilot project in the Fruitvale District, the EcoBlock team hopes to develop a scalable community microgrid model that other neighborhoods can adapt. The program hypothesizes that a neighborhood block is an ideal scale for a financially feasible community microgrid that achieves emissions reductions while fostering community. I highlight two aspects of EcoBlock's implementation strategy that contribute to its scalability: community building and accessibility of information.

Studies have shown that residents who actively engage with neighbors and community members who have adopted residential PV systems are more likely to follow the same path (Noll et al. 2014). These findings emphasize trust's role in a community's confidence in renewable energy solutions. Passive engagement, such as across different neighborhoods, with communities that participate in residential solar programs can also influence a community's likelihood of engaging with such programs (Noll et al. 2014). When large institutions such as the University of California, Berkeley and CEC, administer a community program, demonstrating that the project will center local priorities can play an especially important role in building confidence among other communities.

The accessibility of information on project developments also plays a key role in ensuring that the EcoBlock model can be applied to other regional contexts. Oakland EcoBlock has a significant online presence. The program website provides both updates on project developments and educational material on the financial, technical, social, and legal factors that go into developing a community microgrid. EcoBlock team members have also attended several webinars and panel discussions to discuss the purpose of community microgrids and the EcoBlock model in the renewable energy transition. Institutional support from UC Berkeley and state and city entities likely encourages such visibility. Sharing project goals and lessons learned throughout the development process can build confidence in the program's success and stimulate passive peer effects on other communities engaging with this material.

Education and engagement play important roles in the proliferation of energy programs. On the other hand, the project may run into financial and legal barriers to scalability. Other neighborhoods looking to adopt the EcoBlock model may not have access to the same grant funding awarded to Oakland EcoBlock. New projects must seek funding opportunities or absorb the costs of PV installation into the costs of program participation. Seeking innovative strategies to overcome a lack of financial support for residents will be crucial in maintaining the accessibility of the EcoBlock model.

Lessons learned through an energy democracy framework

The Oakland EcoBlock brings unique goals to the microgrid community: using a multi-faceted approach to fostering sustainable communities and creating a framework applicable to other regional contexts. Here, I place the steps Oakland EcoBlock has taken to achieve these goals into Cervas and Giancatarino's (2017) energy democracy framework for "Green Zones":

1) "Identifying overburdened and impacted communities,"
2) "Prioritizing identified communities for public investment,"
3) "Advancing on-the-ground models,"
4) "Providing resources and assistance to impacted communities," and
5) "Establishing community governance and democratic decision-making process."

- **Giving priority to energy burdened communities** *(in alignment with Green Zone recommendations one and two)***:** When searching for a pilot neighborhood, Oakland EcoBlock planned to prioritize applications with energy burdened households. Indeed, the piloted project is located in the Fruitvale District, an area with histories of community disinvestment and housing burdens. In scaling up the EcoBlock model, outlining engagement targets more explicitly will ensure the equitable distribution of community microgrid benefits. In developing a scalable model, the EcoBlock team could also leverage their existing connections with the City of Oakland and other state energy entities to advocate for policy to identify energy burdened communities as the primary beneficiaries of state and city microgrid programs, such as that of PG&E's CMEP.

- **Generating solar power on-site through a solar microgrid** *(aligning with Green Zone recommendation three)*: As a community microgrid project, the EcoBlock contributes to locally generated renewable energy growth. In addition, the project's larger goal of developing a scalable model can help propel the movement for decentralized energy.

- **Community ownership and governance** *(aligning with Green Zone recommendation five)*: Oakland EcoBlock places significant focus on the community aspect of community microgrids. By setting up a community association in charge of distributing the costs and benefits of running the microgrid, EcoBlock aims to provide more voice to community members in how the program runs. Neighborhood block participants also share ownership of all solar generating and storage technology. Decentralizing ownership of energy generation is a notable step toward transforming our energy system. However, the power given to residents through ownership is partly limited by PG&E's ability to control the microgrid's distribution and islanding capabilities. Continued advocacy effort to pursue community ownership over microgrid operation could seek pathways through or outside of PG&E's CMEP.

Oakland EcoBlock strives to develop an innovative model for sustainable communities through focus on renewable energy, efficient energy and water consumption, and community ownership over energy solutions. The model's envisioned features provide a glimpse into creative solutions to facilitate renewable energy transitions. Above all, the project has highlighted the value of a multi-level approach by cultivating relationships between institutions, community-based organizations, and neighborhood residents. Such approaches work to build a sense of trust and collaborative learning that is necessary for the efficacy of renewable energy programs in overburdened communities.

CHAPTER V: Cultivating relationships between solar microgrids and other solar power programs

This research study set out to explore the potential of solar microgrids beyond their dominant use for improving grid reliability. According to the US Department of Energy (DOE), in 2021 there were a total 195 solar microgrid installations across the US, 42 of which were installed in a city/community or multi-family residential context (DOE Microgrid Installation Database, 2021). Solar microgrid cases around the US differ in their structures, intended use, and intended impacts. Commonwealth Edison (ComEd)—an Illinois utility provider—is implementing the Bronzeville Community Microgrid in Chicago, a utility-operated "clustered" microgrid model (Community of the Future ComEd, n.d.). The clustered model joins an existing microgrid on the Illinois Institute of Technology (IIT) campus to new microgrid infrastructure powering over 1000 community centers, businesses, housing complexes, and critical community facilities with 750 kW of solar, 5 MW of natural gas, and battery storage (Cohn, 2022). Some of ComEd's articulated motivations for this project include reducing greenhouse gas emissions and improving "energy resilience" through a more sustainable and reliable system (Community of the Future ComEd, n.d.). In comparison to The St. Peter and Oakland EcoBlock, this project spans a significantly larger area. Another example of a community solar microgrid is Resilient Palisades' Pali Microgrid for the Pacific Palisades neighborhood in Los Angeles, CA. Resilient Palisades, a resident-founded nonprofit, aims to connect residences and businesses in the neighborhood through a solar and battery storage model. In comparison to The St. Peter and Oakland EcoBlock projects, residents finance the Pali Microgrid through a group-buy model, or a model for discounts through bulk purchases (Resilient Palisades, n.d.). Since Pacific Palisades is a predominantly white and high-income neighborhood, the choice to self-finance the project is more feasible; in 2019, the Brentwood-Pacific Palisades neighborhood community was 86.4% white and had a median household income of $186, 205 (Los Angeles Department of City Planning, 2021). Solar microgrid projects can take on different forms when backed by different motivations and regional contexts. The St. Peter Microgrid and Oakland EcoBlock projects were chosen for this study since their motives integrate a focus on socio-economic benefits into the environmental and performance benefits of solar microgrids.

Through the cases of The St. Peter Microgrid and the Oakland EcoBlock, I have attempted to demonstrate that solar microgrids can indeed be an approach to lowering energy costs. I have demonstrated that energy justice goes beyond affordable energy; these cases have grounded their approach in strengthening the communities that draw power from the solar microgrid, which is a crucial step towards bringing Baker's (2019) call for anti-resilient change to fruition. My case study analyses draw from Cervas and Giancatarino's (2017) framework for building "Green Zones" for this reason. This framework can work to both provide guidance for encouraging energy democracy through individual programs and projects, but also how these projects should fit into wider policy change to distribute energy ownership and access in a way that benefits communities historically marginalized from the energy system. In this chapter, I will synthesize the main findings from my two case studies and discuss their contribution to such a political and structural shift in our energy system.

Finding 1: Solar microgrids can lower energy costs, particularly when accompanied by reducing energy consumption.

Both the St. Peter Microgrid and Oakland EcoBlock strive to lower energy costs through on-site generation and lowering consumption through energy efficiency retrofits. First, The St. Peter Microgrid exemplifies the long-term cost benefits of renewable energy generation. Whereas the residents of Orleans Parish on average pay $2,180.08 annually in energy costs, the average resident of The St. Peter sees a statistically significantly lower annual bill of $367.52. In fact, multiple residents have even seen a $0 energy bill. The implications of these savings are significant. For the average resident of Census Tract 44.01, where The St. Peter is located, an annual energy bill of $367.52 could reduce energy burdens by around 85%. In a time such as now, when financial pressures from the COVID-19 pandemic add onto existing housing cost burdens, access to such energy cost relief holds extreme potential to ensure safety and comfort in low-to-moderate income (LMI) households.

A key companion in energy affordability to renewable energy generation is energy efficiency retrofits. Efficiency measures ease renewable energy transitions by reducing the amount of energy necessary to purchase and thereby increasing the number of housing units that can be powered by an energy system. The upfront costs of installing multiple energy efficiency measures are high, especially in older homes where installing measures may first require significant improvements in the home's structure. The St. Peter and Oakland EcoBlock's incorporation of retrofits in their microgrid projects aids LMI homeowners in overcoming this cost barrier. Together with The St. Peter's education of residents on energy-savings consumption habits and Oakland EcoBlock's integration of electric vehicle access and water conservation measures, these case studies take solar microgrid project beyond simple energy cost savings. These projects find harmonies with other energy and resource consumption measures to multiply impact on residents' well-being.

Finding 2: Community needs are well-met when community members or a community-based organization (CBO) hold decision-making power. But, equity goals should be explicit.

Both The St. Peter and Oakland EcoBlock take on a community-centered approach to implementing a solar microgrid. Many researchers have studied the value of peer effects among community members in feeling comfortable and interested in adopting new renewable technologies (Noll et al., 2014). When the local level plays an active role in decision-making, policies and programs can effectively reach target populations, work through an equity-lens, and build trust and coordination across multiple levels of governance (Mohnot et al., 2019). Setting up structures for community governance should originate from an explicit and specific designation of target population that the program will benefit. This specificity should go beyond terms such as 'vulnerable populations' by situating intentions in the context of the program solution (Greenlining Institute, 2019). Examples of phrasing for energy justice programs include 'communities facing high energy burdens' or 'households with limited upfront capital to finance renewable energy projects.'

The St. Peter's community thrives off building bonds with neighbors and program managers, which increases readiness and comfort in adopting new habits that complement the solar microgrid. As such, SBP has previously worked on the ground with communities on affordable housing initiatives and has found that their approach of providing accessible educational material on efficient consumption habits and being available for conversations with residents resonates well with The St. Peter community. The Oakland EcoBlock model, too, aims to meet community needs by providing decision-making power to the neighborhood residents themselves. Though the project has not been implemented yet, giving direct decision-making power to participants holds potential in shaping the project towards community needs. As this project unfolds, it will be important to see if these tactics are able to establish trust between the neighborhood community and the institutions implementing EcoBlock.

Finding 3: Solar microgrid projects can encourage positive change in our energy system by both decentralizing energy generation and redistributing energy ownership.

The St. Peter Microgrid and Oakland EcoBlock exemplify the possibility for community-level projects to incrementally redistribute ownership over energy generation. Decentralizing energy generation is one part to anti-resilient change to the energy system. The other part is redistributing the ownership over this generated energy to energy insecure communities. These steps work to subvert the inequities of access in our current centralized energy system. In the past, benefits for primarily higher-income households and pushback from utility companies on the feasibility of widespread energy distribution have restricted the ability for distributed energy initiatives to actively restructure the energy system (Baker, 2019). The St. Peter Microgrid and Oakland EcoBlock's efforts to redistribute decentralized energy ownership to communities facing higher energy burdens are encouraging of a future for energy democracy models to take hold in the energy system.

These case studies' findings highlight the unique position of solar microgrids in an energy democracy framework. Solar microgrids, like other forms of local renewable energy, do have the potential to lower energy costs and ease energy and housing burdens. At the same time, the findings suggest that residential solar microgrid projects are often centered around sharing. I propose that solar microgrids can lead us closer to an energy commons by encouraging social connections through energy sharing. Realizing this potential will require active consideration of several organizational, legal, and financial factors. First, as discussed in this chapter, program administrators must actively integrate community leadership and priorities into the project development process. Second, the structure and planning of Oakland EcoBlock has revealed some legal barriers to implementing community-owned solar microgrids. The California Public Utilities Code does not distinguish between models that share or sell power over property lines. The EcoBlock team has suggested that the California Public Utilities Commission's placing of community microgrid models like EcoBlock under the same regulation as public utilities, who sell power across property lines, may slow the development of future community microgrids (von Meier and Kammen, 2021). The Oakland model has been able to proceed by building around the existing PG&E-owned power distribution and placing responsibility over distribution on PG&E. However, the split ownership model means that PG&E owns the means of distribution and can thus dictate when the microgrid "islands." EcoBlock residents can expect for the microgrid to "island" during PG&E's scheduled Public Safety Power Shutoffs, in which PG&E would island the microgrid to mitigate grid-related wildfire risks (EcoBlock, n.d.b). However, PG&E in the past has had issues with not warning customers before well before shutoffs (Penn, 2019b). This legal barrier to retaining complete community ownership over microgrid functionality could be an important future focus for political advocacy in establishing community ownership.

Lastly, both The St. Peter Microgrid and Oakland EcoBlock envision a reproduction of their microgrid model to other communities. The concept of scalability prompts consideration of the financial feasibility of projects. Both case study projects received grant funding, which eased costs of implementation and allowed the projects to offer residents low to no-cost benefits such as energy efficiency retrofits. Unless future projects are awarded grant funding as well, it will be important for program administrators to explore design and implementation strategies that can maintain affordable costs for low-to-moderate income communities to the continued prioritization of energy insecure households. It will also be important to watch how EcoBlock operates beyond its pilot period to understand if the neighborhood block scale can provide a cost-effective model.

Integrating solar microgrids into solar power policies and programs

Rather than suggesting that solar microgrids are the sole solution towards equitably redistributing renewable energy benefits, this study offers insight on how solar power projects can follow the example of The St. Peter and Oakland EcoBlock to actively target communities historically marginalized from the energy system and integrate community priorities through engagement and community leadership. Community-centered solar microgrid models are growing. Maintaining visibility could be an important strategy to establishing more structured support for distributed renewable energy from policymakers and regulatory agencies. In Chapters 3 and 4, I demonstrated the alignments of The St. Peter Microgrid and Oakland EcoBlock case studies with

Cervas and Giancatarino's (2017) "Green Zones" framework at a project level. On a nationally applicable policy level, I propose that the renewable energy field should establish programmatic and political advocacy networks between solar microgrids and other decentralized renewable energy sources.

Cervas and Giancatarino intend for energy and environmental policy to apply the "Green Zones" framework to a range of environmental justice initiatives. This framework creates room for communities to implement different forms of decentralized renewable energy based on local priorities and capabilities, and even a combination of different systems. Microgrids can lower energy costs and increase independence for communities that are able to install solar on-site. However, on-site solar installation (rooftop or ground) may not be an option for homes with weak roofs, limited outdoor ground space, or for the renter population. In such contexts, programs such as community solar or community choice aggregation could offer an alternative source of decentralized renewable energy generation.

A community solar model generates solar energy off-site and is available for residents to subscribe to or purchase shares in. Customers then receive credits for the purchased solar power on their regular utility bill. Community solar does not require residents to install solar panels and are generally larger-scale projects developed on open ground. Customers who subscribe to community solar-generated energy do not own the solar panels and thus bypass the upfront costs of solar panel installation, whereas customers who purchase shares own parts of the community solar farm and often assume some of the costs of installation and maintenance (Michaud 2020). Community solar is an increasingly popular option for residents to incorporate solar power into their daily consumption mix. As of December 2020, 39 states have community solar programs and 22 have implemented policies supporting community solar (National Renewable Energy Laboratory, n.d.). Solar microgrids and community solar overlap in that customers can enjoy lower energy payments and projects can grant customers with the ability to own the system or parts of it. The two differ primarily in consumer proximity to the system. Such overlaps and differences can allow different forms of decentralized renewable energy to occupy different spheres of residential renewable energy initiatives while still contributing to a common goal of combatting energy injustice.

The Washington DC Solar for All Program is one example of how one policy program can employ several renewable energy solutions. Passed in 2016, the program mandates the distribution of locally generated solar energy to 100,000 low-income households, and at least a 50% reduction in their energy bills by 2032 (Department of Energy and Environment, 2020). In 2019, the program reported an installed 7 MW of solar that benefitted 8,600 out of 292,000 households in the city (DOEE 2020; US Census Bureau 2019). The program's implementation plan is founded upon the convergence of different local residential solar models. To achieve their target of 100,000 households, the Department of Energy and Environment (DOEE) has funded organizations providing no-cost solutions to qualifying households. These solutions include rooftop solar on low-to-moderate income residences, community solar shares, ownership through solar cooperative models, and solar renewable energy credits or other financial benefits apart from utility bill credits (DOEE 2020). This multi-layered participation structure increases the accessibility of Solar for All program. Many political actors agree that a program that diversifies its participating organizations and the projects it offers can accommodate the differing needs of consumers in a given area (Michaud 2020). In addition, selecting primarily local community organizations and solar companies for the program creates more opportunity for close community engagement. Different projects target different areas of the city and some chosen organizations, such as Groundswell and Solar United Neighbors, have history of advocacy in accessible renewable energy.

Sustainable Westchester, a non-profit coalition of municipalities in Westchester County, NY, offers another example of how microgrids can fit with other forms of decentralized renewables. The coalition aims to facilitate energy transitions by offering municipalities in the county a choice of several renewable energy programs, including community choice aggregation, community solar, energy efficiency, and in the near future, microgrids. Under the community choice aggregation program, Westchester Power, residents are placed on a fixed-rate, municipality-purchased power supply, as opposed to the regional utility, with the option to opt-out and draw from the regional utility at any time (Sustainable Westchester, 2020). Residents may opt into the organization's community solar program at the same time. Sustainable Westchester also assisted some of its interested municipalities in applying for the New York Energy Research and Development Authority's (NYSERDA) NY Prize funding opportunity for microgrid implementation. 10 municipalities under Sustainable Westchester won the first round, which funded the implementation of microgrid feasibility studies (River Journal, 2015). Though these municipalities did not proceed to NY Prize Round 2 funding (NYSERDA, 2017), Sustainable Westchester's support for its participating municipalities highlights the importance of learning and advocacy through political networks.

In the past, clean energy opponents have mobilized across national networks to weaken energy policy efficacy and rigor through coordinated efforts (Stokes, 2020). To counter opposition to renewable energy and justify placing more renewables into the hands of communities, municipalities and community-based organizations can learn and advocate through similar networks, within state and across state boundaries (Stokes, 2020). In the ways that this study has put different solar microgrid projects into conversation with one another, communication across a network of actors in decentralizing renewable energy can create learning opportunities for the successful adoption of future microgrid projects. The St. Peter Microgrid and Oakland EcoBlock shared similar goals of lowering energy costs and centering community priorities in program development. However, they faced different barriers and approached community engagement from different angles. These differences represent learning opportunities from both projects for future microgrid projects that share similar visions. The Washington DC Solar for All Program and Sustainable Westchester's abilities to find harmonies among different forms of distributed renewables further suggest that the advancement of solar microgrids and other distributed renewable energy resources are not mutually exclusive. Rather, different structures can work together to offer communities the choice to pursue paths towards shared energy that align best with their priorities.

CONCLUSIONS

The visions and successes of two solar microgrid case studies in the US, The St. Peter and Oakland EcoBlock, have upheld the idea I put forth at the beginning of this study: solar microgrids have a place in the path to energy justice and energy democracy. Traditionally, governments and organizations have installed solar microgrids to support the central grid or introduce a source of back-up power. This study suggests that solar microgrids can also further efforts to distribute the cost and social benefits of distributed solar to energy insecure communities, who have historically been left out of the implementation of renewable energy programs. This study situated these findings on a foundation of "anti-resilience" put forth by Baker (2019), which calls for renewable energy initiatives that disrupt the current US energy system's roots in exploitation and marginalization of disadvantaged communities.

The nature of microgrids presents an interesting duality. The model can both create a more distributed energy network while strengthening internal networks in a community. A microgrid's capability to function independently of the central power grid reduces community dependence on a centralized authority that governs energy provision and consumption. The combination of this transition with the energy sharing feature of residential microgrids can strengthen bonds within a community and create outlets for communities to have more voice in the consumption of the energy they generate. Both The St. Peter and Oakland EcoBlock are evidence to the fact that such a community-oriented structure results from the active integration of community priorities and leadership into program structure.

It is important to reiterate that transformative change can be incremental and progressive. For this reason, this study examined The St. Peter and Oakland EcoBlock through a lens of potential, rather than holding the cases up to the standard of an ideal future. Through this approach, I identify several successes and learning opportunities in these cases. The St. Peter demonstrates that solar microgrids can offer significant cost savings to energy insecure households. Oakland EcoBlock demonstrates that shared solar power and community governance can cultivate fruitful relationships even across property lines. Both cases highlight the need for active community engagement and advocacy for structured political and financial support to ensure that programs target underserved communities as the primary recipients of renewable energy benefits.

Lastly, this study emphasizes the importance of diverse approaches to addressing the varying needs and priorities of different communities. Environmental and energy justice policy frameworks and layered renewable energy programs reveal the value in converging several options for adopting decentralized renewables. This study supports the incorporation of solar microgrids into these pathways and argues that building learning and advocacy networks across different types of renewable programs can strengthen the visibility of decentralized models in the energy policy sphere. There is not just one right path towards justice in our energy system, but we can progressively work towards justice by identifying the synergies between different forms of energy justice programs to work towards a shared vision of power redistribution.

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Appendix A: Methods for Data Analyses

To visualize the energy burdens in Orleans Parish, LA and Oakland, CA, data analysis was conducted in Microsoft Excel and visualizations in ArcGIS Pro. The maps drew data at the census tract level from the National Renewable Energy Laboratory's Low-Income Energy Affordability Data (LEAD) tool and the US Census's American Community Survey (ACS). Energy costs data from the LEAD tool represented 5-year estimates for 2016, i.e. 2012-2016 estimates. To present energy burden calculations that encompassed some of this range while still ensuring the data can reflect more current trends, ACS income data from 5-year estimates for 2018 (2014-2018) were used to represent household income.

Households experience high energy burdens when energy costs consume 6% or more of annual income. The ACS data was presented in households income bins ranging from less than $10,000 to over $200,000. The percentage of households facing a high energy burden was calculated as the number of income bins falling within the high energy burden threshold for each census tract. One limitation of using binned income data is that the calculations may slightly underestimate the percentage of burdened households in some census tracts where the 6% burden threshold fell in the middle of an income bin. Despite this limitation, the racial disparities in energy burdens are still evident.

Energy costs data for The St. Peter residents was shared by the SBP team for the purposes of this study. This data was compared to the LEAD tool average annual energy costs of all census tracts in Orleans Parish. Data was presented without any personally identifiable information for all apartment units to maintain the privacy of the apartment residents. Microsoft Excel was used for data cleanup and RStudio 3.5.2 was used for all statistical analyses.

An exploratory data analysis was first conducted to extract summary statistics from both datasets and explore preliminary relationships between the datasets. Two conduct a t-test, random samples of size 20 were taken from each dataset. The summary statistics of each sample is presented below:

	Average Annual Energy Cost	*Minimum Annual Energy Cost*	*Maximum Annual Energy Cost*
Orleans Parish 2016 N = 20	$2,168	$1,473	$2,604
The St. Peter 2021 N = 20	$359.70	$0	$699.80
Difference in Average Annual Energy Costs		$1808.30	

A one-sided t-test was then conducted from the random samples to determine if the energy costs of The St. Peter are significantly lower than that of the whole parish. Since the equal variance assumption for t-tests was not met, the Welch's t-test for unequal variance was used for analysis. Although both datasets are located in the same census tract, the assumption of independent datasets is satisfied by the fact that the LEAD tool presents data from 2012-2016 while The St. Peter was opened in 2020, so the overall parish data does not overlap with the energy costs of The St. Peter.