Identifying Barriers That Impede Cost-Effective, Holistic, and Equitable Building Performance and Zero Carbon Goals in Low-Income and Disadvantaged Communities

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ABSTRACT

This report aims to holistically understand the barriers, needs, and challenges faced while decarbonizing residential and commercial buildings in disadvantaged communities. By engaging local and national organizations that work with low-income and disadvantaged communities (LIDAC), the authors place the voices of community experts at the center to listen, hear, and understand—from a new perspective—what impediments exist to local building decarbonization.

The first part of the paper outlines the methodology, including the process for identifying organizations; the second part presents findings from the case study discussions, including organizational successes, barriers to missions, needs, and potential solutions; and the final section presents conclusions and takeaways from this work. The primary intended audience for this work includes, but is not limited to, 1) energy program managers tasked with identifying needs and opportunities to decarbonize buildings and 2) decision-makers interested in understanding where additional funding might be needed to achieve deep and scalable decarbonization for the building energy sector in the United States.

Introduction

Because people in the United States spend around 90% of their time indoors and/or someone is at home during the weekdays (75%), we can think of buildings (and the built environment) not as a backdrop but as an influential and dynamic part of our lives (U.S. EPA 1989.; U.S. EPA 2023.; Institute of Medicine 2011). Residential buildings shelter people where they live; commercial buildings are hubs for local employment, neighborhood engagement, community identity, and wealth generation (Theodos and González 2019).

Despite their importance to communities, many residential and commercial buildings across the United States are in a state of deferred maintenance. Historically, energy efficiency, energy equity, and decarbonization efforts have been focused on single-family residential units and high-performing commercial buildings, e.g., buildings larger than 50,000 square feet with a

building automation system to control HVAC systems such as hospitals, offices, and warehouses (Karvonen 2013; While and Eadson 2019; Wilson et al. 2019; York et al. 2022; Trenbath et al. 2022). Single-family residential and large commercial buildings are critical to addressing inequities, but current U.S. building stock decarbonization analysis often misses the unique considerations of decarbonizing commercial buildings in LIDAC communities.

The owners of small, minority-owned businesses in disadvantaged communities tend to have limited labor mobility and less access to capital (Clarke et al. 2023). These barriers are one of many challenges to keeping buildings compliant with new codes or building performance standards.

Federal efforts are underway to accelerate building decarbonization efforts in disadvantaged communities (Executive Office of the President 2021; The White House 2023). Characterizing historical renovation activity from the Commercial Buildings Energy Consumption Survey (CBECS) demonstrates the lack of building upgrades and the need for accelerated efforts. Of the 77% of U.S. small commercial building stock (e.g., buildings between 1,000 and 5,000 square feet) built before 2000, 64% have not been renovated since 2000 (U.S. EIA 2022). Previous research identified several barriers to explain the scale of disinvestment and deferred maintenance in small building stock (Langner et al. 2013). Challenges toward decarbonization efforts of small buildings include:

- Limited capital
- Higher transaction costs relative to energy cost savings
- Lack of time to research and implement energy efficiency (EE) solutions
- Split incentive challenges between owners and tenants
- Lack of available sector-specific resources and technologies.

As such, efforts to decarbonize the buildings sector must consider decarbonization within broader infrastructural, socio-demographic, economic, and socio-cultural realities.[1]

Methodology

This research centered the expertise of local community-based organizations to identify barriers and needs impeding the adoption of energy-efficient building technologies in LIDAC communities. To achieve this, we partnered with local community-based organizations, nonprofits, and national organizations serving the needs or physically located in LIDAC communities.

It is worth noting that the authors of this paper recognized that underserved communities and our participating local community-based organizations/nonprofits do not resonate with being identified as or serving disadvantaged communities, despite the recent federal designation under the Justice40 Initiative. We use the term “low-income and disadvantaged communities or LIDAC communities” in line with the current guidance from federal government; however, we reserve the right of members of these communities and participating organizations and nonprofits to self-identify.

For this report, we refer to these local community-based organizations and nonprofits anonymously as our participating “local organizations.” Responses from our national organizations will be called out separately where appropriate. If responses are not denoted, then readers

[1] In the United States, commercial and residential buildings account for 70% of electricity use, 40% of primary energy consumption, and 30% of greenhouse gas (GHG) emissions (NREL 2022).

can assume results are from our local organizations. All local organizations had aspects of building decarbonization included in their mission areas, yet had not widely adopted commercial building energy technologies, deeming them the perfect partner for this research to identify the "real" barriers impeding systematic adoption of building energy technologies in LIDAC communities.

Table 1 lists the 13 participating local and 3 national organizations and their geographic location (spanning across 23 states ranging from Florida to Oregon), mission, and approach. This work used a multi-pronged approach to identify and engage with LIDAC communities across the United States, which included:

1. **In-depth identification of organizations:** This first step identified potential local organizations to be included in outreach. We identified organizations that conducted one or multiple activities (e.g., search engine keywords used) related to low-income, underserved, marginalized, frontline, and environmental justice communities; clean energy adoption; building decarbonization; and equity, energy justice, and environmental injustices using desktop-based research. We also leveraged research networks gathered from other national laboratories. The structured keyword and network-based search identified 143 organizations for potential outreach.
2. **Initial classification of organizations:** Each of the 143 organizations was classified by location (city, state, and/or national), focus area, and activities. Based on a high-level review of each organization's mission and overview of activities, we prioritized local and national organizations based in or serving LIDAC communities with efforts focused on residential and/or commercial building decarbonization for deeper analysis. This filtering resulted in a short list of 50 organizations.
3. **Organization scoring:** Each down-selected organization was scored (on a scale of 1–5) based on its mission within the building sector and its connection to and focus on work with LIDAC communities. Some organizations did not have publicly available contact information, preventing direct outreach to their teams. We created this arbitrary scoring criteria to narrow the list of local and national organizations to ones most relevant to the project's scope of work and identify those we wish to pursue to partner with. The score and availability of contact information resulted in a final outreach list of 25 organizations.
4. **Staggered outreach to organizations:** Between November 2022 and June 2023, the project team reached out to these organizations and others based on follow-up recommendations. Communication included at least one email providing an overview of the project and a request for a one-hour call to learn more about their organization and discuss questions related to building decarbonization.
5. **Data collection:** Our staggered outreach led to one-on-one meetings with 13 local organizations and nonprofits and 3 national organizations across 23 states that promote building improvements and EE measures in LIDAC communities. Rather than developing a representative sample for the entire United States, we aimed to capture local conditions related to barriers and successes for at least one local area in each state. The focus was on local and national organizations whose approach and current success are shaped by community needs and priorities. There were two subsequent roundtable discussions, each involving up to five organizations.
6. **Process for capturing each local and national organization's expertise:**

- We provided an overview of the National Renewable Energy Laboratory's (NREL) mission as well as the purpose of the project and the role their local and national organization played in the research project.
- We asked each local and national organization's representative to do the following during our one-on-one meetings:
    - Describe their organization's mission and how it serves or benefits underserved, marginalized, and/or disadvantaged communities
    - Explain the needs and burdens of the local communities their local or national organization serves
    - Describe any barriers that impede their local or national organization from achieving their mission
    - Brainstorm mechanisms in which NREL can provide support in the future to achieve their local organization's mission.
- We logged keywords and concepts that each local and national organization identified and pooled key takeaways into a Mural Board to visualize similar needs, barriers, and success stories. Figure 1 demonstrates an example word cloud visualization depicting how the 16 participating organizations' missions involve building decarbonization.
- Local and national organizations identified barriers and needs, and we leveraged this expertise to identify common hurdles toward implementing commercial building energy-efficient technologies in disadvantaged communities.
- The project team held brainstorming sessions to discuss potential pathways for how NREL can assist with identified barriers and needs based on desired success story outcomes.
- The team worked with local and national organizations to narrow down the next steps to identify mechanisms to reduce barriers by brainstorming tailored solutions tied to the needs of LIDAC communities and local organizations' mission areas.

Table 1. Overview of local and national organizations

Participating Organization	Location	Vision, Mission, and Approach
Alliance to Save Energy	National	A nation that uses energy more productively to achieve economic growth, a cleaner environment, and greater energy security, affordability, and reliability.
Catalyst Miami	Miami, Florida	A just and equitable society in which all communities thrive. Identify and collectively solve issues adversely affecting low-wealth communities throughout Miami-Dade County.
Center for Environmental Transformation	Camden, New Jersey	Engages, educates, and inspires people to practice a more environmentally responsible way of living on the planet.
Coalition of Communities of Color	Oregon	Advancing racial justice through cross-cultural collective action.

Participating Organization	Location	Vision, Mission, and Approach
Community Power Minnesota	Minnesota	Educating and activating the residents of Minnesota cities and towns to create clean, local, equitable, affordable, and reliable energy systems.
Environmental Transformation Movement of Flint	Flint, Michigan	Growing diverse environmental justice leaders and just relationships to secure a healthy, sustainable future by and for Flint residents.
GRID Alternatives Colorado	Denver, Colorado	Increasing access to solar and clean mobility through solar deployment projects and workforce development activities.
Miami Workers Center	Miami, Florida	Building power with working-class tenants, workers, women, and families in Miami-Dade County. Through leadership development and grassroots campaigns, we seek to transform our workplaces and neighborhoods to win the respect, rights, and resources we all deserve.
Mountain Association	Eastern Kentucky	Promoting energy democracy by lifting community voices to the table.
Solar Stewards	National	Systemic change for more equitable and renewable energy systems.
Southeast Energy Alliance Solar Stewards	Southeastern U.S. (serves 11 states)	Regional energy efficiency organization that promotes energy efficiency as a catalyst for economic growth, workforce development, and energy security.
Spark Northwest	Seattle, Washington	Partners with communities to build an equitable clean energy future in pursuit of a Northwest region 100% powered by clean energy that shifts power and wealth to marginalized communities.
Texas Energy Poverty Research Institute	Austin, Texas	Inspiring lasting energy solutions by linking community voices with science, data, and innovative partnerships and delivering best available information to decision-makers.
The Minneapolis Foundation (REAMP)	Illinois, Iowa, Michigan, Minnesota, North and South Dakota, Ohio, Wisconsin	Set collective strategy and enable collaboration on climate solutions in the Midwest by connecting diverse perspectives, harnessing unique expertise in spaces for intentional strategy setting, and building the capacity for excellent implementation.

Participating Organization	Location	Vision, Mission, and Approach
Union of Concerned Scientists	National	UCS puts rigorous, independent science into action, developing solutions and advocating for a healthy, safe, and just future. Today, UCS is a group of nearly 250 scientists, analysts, policy experts, organizers, and communicators dedicated to that purpose.
VERDE Builds	Oregon	Building environmental wealth by investing in climate resilience through our profound belief that frontline communities are the most important voices in the climate movement.

Findings

Organizational Mission, Vision, and Successes

Several of the participating organizations have, for years, advocated for their community members' energy, environmental, and financial needs. Of the participating local organizations for this research project, 81% of all the organizations' missions focus on local needs, especially LIDAC communities. Furthermore, 88% of our participating local organizations reside in multicultural communities, many of which have experienced historical disinvestment in building energy decar-

Figure 1. Word cloud analysis depicting how different local organizations' missions relate to building energy decarbonization.

bonization efforts.

Table 2 depicts the versatility of how different local organizations' successes at the community level in LIDAC communities correlate to building decarbonization. We gathered such expertise from one-on-one meetings and roundtable discussions with our participating local organizations.

Table 2. Organizational successes

Focus Area	Successes
Clean energy policy advocacy	Successfully advocating for the passage of multiple ballot measures (e.g., Portland Clean Energy Benefit Initiative) and policies to further equitable clean energy deployment in their communities, and at the local, regional, and national level.
Clean energy deployment, including building decarbonization	• Leveraging existing clean energy funds and pilot grants to deploy energy-efficient solutions and technologies, such as weatherization, solar, and heat pumps, in communities. • Coupling deployment with innovative community-owned financing options to reduce impacts of gentrification and displacement.
Housing rights	Advocating for community members' rights and supporting them through legal filings, inclusive financing options for energy efficiency investments, and piloting solar installation on modular homes as a solution to their local housing crisis.

Comprehensive community engagement	• Developing a transparent and culturally responsive community engagement and communication strategy, including:
	  ○ Communicating tangible and meaningful benefits (such as savings that will allow families to spend money on other needs) during outreach efforts (e.g., making energy savings meaningful).
	  ○ Communicating the impact of energy and climate decisions on everyday facets of life (e.g., schooling, building safety during hurricanes and floods).
	• Conducting intentional outreach to community members based on unique community needs—for example, distrust in utilities may mean greater community interest in distributed energy resources and other decentralized solutions.
	• Actively listening to community partners to thoroughly understand their needs and ensure these are appropriately communicated.
	• Investing the time and effort to develop meaningful and trusted relationships with community members—for example, by being honest about available opportunities and services, and clearly stating when you can or cannot address their needs.
	• Prioritizing regular and helpful communication products, including multi-language outreach and communication as appropriate.
	• Prioritizing knowledge co-production throughout the research process and engaging community partners as equals rather than subjects in research activities.

Clean energy programming	Co-designing and providing input on the implementation of new, targeted utility programs.

The one-on-one meetings with these organizations provided insights into their successes as well as existing barriers, challenges, and needs. The roundtable discussions provided multiple organizations an avenue to brainstorm potential solutions, including those that might be provided by the U.S. Department of Energy and national laboratories, such as NREL. Subsequent sections in this report summarize these insights.

Barriers

Although this work focused on commercial buildings, it is worth noting that discussions with our local organizations revealed a central takeaway: Most local organizations in LIDAC communi-

ties focus on decarbonizing and electrifying *residential* buildings. The local organizations mentioned that this oversight of commercial buildings is not due to the lack of interest or desire from residents, tenants, and community-based organizations. In fact, many local organizations noted growing community conversations and enthusiasm for future commercial decarbonization efforts to improve public health and climate change outcomes. Instead, this imbalance may exist for several reasons,

Table 3 reports high-level barriers impeding local organizations from adopting building energy-efficient technologies in LIDAC communities.

Table 3. Barriers facing local organizations

Systemic	Legacies of discriminatory practices and policies persist today; examples include historical policies such as redlining, restrictive racial covenants, the Federal Highway Act, and the siting of commercial and industrial pollution sources. These practices and policies underpin the current state of building infrastructure in LIDAC communities. Moreover, an insufficient tax base hinders commercial building upgrade efforts.		
Policy	• Building codes typically focus on new buildings, yet residents of most communities, especially LIDAC communities, live and work in older buildings (built before the 1980s). This policy gap stalls efforts to universalize building upgrade efforts in existing building stock. • Existing energy efficiency programs typically operate independently, making applying for and obtaining federal and state funding to support building upgrades a time-consuming undertaking. • Health and safety standards tied to qualification for weatherization assistance discourage many people from applying or getting accepted.	• The complexity of existing permitting processes can significantly delay project development. • There can be misalignment with housing authority priorities that stalls upgrades in affordable housing buildings. • Navigating funding opportunities may be a barrier for communities without dedicated grant writing staff. Current programs designed for the lowest income households and communities exclude communities and businesses that are not necessarily in the lowest income percentile but still require weatherization support.	• Some cities and states have neither policy environments conducive to solar adoption nor utility programs that incentivize building upgrades. Investor-owned utilities support solar energy expansion only to the extent mandated in their legislation while actively blocking solar energy production from entities outside of the utility's control. • Split incentives between landlords and tenants create barriers for small businesses and commercial entities that do not own their buildings. • Engaging tenants of housing authority buildings is challenging when housing authorities become the primary decision-makers regarding whether solar and energy efficiency measures are incorporated for housing authority buildings.

			There is a high rate of deferrals from utility assistance programs, which leaves the building owner unsupported financially to opt into building energy efficiency.
Infrastructural	• Deferred maintenance exacerbated by insufficient operating funds (caused in part by historic disinvestment) contributes to the poor pre-weatherization condition of buildings. • Pre-weatherization conditions of buildings may prolong and complicate upgrades.		
Financial	Upfront capital is required for upgrades, and this hurdle is even higher for buildings requiring additional work before weatherization.	• For residents of LIDAC communities, building upgrades are a low priority compared to immediate needs, such as food, clothing, energy bills, or debt. • A state of financial precariousness holds back those operating in commercial buildings from investing in building energy efficiency technologies over basic business necessities.	Not found during this research project.
Capacity and Workforce	• Insufficient labor and funding capacity within local organizations prevents scaling and replicating building upgrades. • Lack of expertise and knowledge among key stakeholders (e.g., building managers, facility managers, and contractors) when making certain building upgrades, such as heat pump installation. • Skepticism among community members and some building contractors about the benefits of energy efficiency and renewable energy.		Not found during this research project.
Climate and Health	Buildings, communities, and utilities may be vulnerable to extreme weather events, but the building infrastructure may not be resilient during these events.		
Other	A lack of comprehensive and accessible data on energy vulnerabilities (e.g., energy burdens experienced by homeowners and commercial building owners or tenants such as small business owners) and utility bill vulnerabilities (e.g., utility debt of residential and commercial building owners and tenants).		

Local organizations serving LIDAC communities lack the resources, expertise, capacity, and funding to tackle the complexity of decarbonizing commercial buildings.

Residential building types and technologies have more easily characterizable needs and usage patterns representing their occupants, so household types are often directly mapped to their occupants (e.g., single-family homes, mobile homes). In contrast, commercial building types are more problematic to characterize because they can have a variety of occupants and be mixed-use,

energy intensive, have high utility bills, and deal with split incentive issues compounded by high occupant turnover.

These organizations face systemic and infrastructural barriers with origins in community disinvestment. Previous evidence shows that those living in redlined communities have higher exposure to air pollution and older electrical distribution equipment (e.g., utility redlining) (Fears 2022; We The People Michigan 2022). One-on-one meetings with local organizations revealed an additional barrier: disinvestment in less affluent neighborhoods poses an even greater challenge to cities and communities, especially those with relatively low taxation, to support infrastructure development. This disinvestment contributes to a vicious cycle where neglected buildings and infrastructure lead to fewer workforce and economic development opportunities, resulting in limited means to support investment in infrastructure, such as residential and commercial building upgrades.

Similarly, policy barriers can limit or constrain building upgrade efforts. A specific example from one local organization was how a lack of decarbonization priorities in the housing sector (such as regulations from affordable housing authorities) reduces the desire for building managers to pursue incentives and implement energy efficiency measures. On the other hand, even where policies exist, they may be disjointed and, at times, overwhelming. They can require separate funding applications to multiple programs to acquire adequate funding that facilitates combining funding from different sources to finance building upgrade efforts. Additionally, over 70% of local organizations mentioned that the design and eligibility criteria of some policies may hinder energy efficiency measures by not creating sufficient pathways for all to qualify. For example, those applicants deferred from receiving weatherization assistance support due to health and safety concerns such as mold or asbestos. Owners of buildings in poor condition sometimes only qualify for weatherization assistance after bringing buildings to meet the minimum code, yet the cost to do so often exceeds the owner's financial capacity. For example, an applicant may be deferred from a weatherization program because of a hole in the roof.

Identified Needs Facing Local Organizations

Discussions with local organizations about their mission areas and barriers faced were followed by conversations on needs pertaining to the following categories: 1) policy, 2) infrastructural, 3) financial, 4) capacity building and workforce, 5) climate and health, and 6) analysis and support (

Table *4*). All local organizations mentioned that additional funding and support were needed to implement various decarbonization measures, including funding for the pre-weatherization of buildings in LIDAC communities and equipping a range of building stakeholders with the expertise and knowledge to undertake building upgrades.

Table 4. Near-and long-term needs identified by local organizations

	Building and Community-Level	Utility-Level
Infrastructural	Identification of contractors, preferably minority-owned, in the region.	
Financial	Dedicated funding for local organizations to serve as a bridge between community members and building contractors, funding opportunities, and utilities.	
	Additional federal funding to support building upgrades; tools to identify and access federal funding (e.g., Inflation Reduction Act, Technical Assistance funds).	Easily accessible and adequate funding for pre-weatherization of buildings in LIDAC communities.
Capacity Building and Workforce	Training and equipping local organizations to engage meaningfully with utilities, especially regarding available programs and complex rate structures.	
Climate and Health	Support for proactive communication for building upgrade concerns to federal agencies (not only in the aftermath of extreme weather events).	

Resources	• Fact sheets created for local organizations to communicate the benefits of energy efficiency and specific technology solutions, such as heat pumps, (particularly from neutral third-party organizations) to community members and politicians.
	• Decision-support tools to:
	  o Understand and demonstrate energy affordability metrics (e.g., State and Local Planning for Energy [SLOPE], Low-income Energy Affordability Data [LEAD]) tailored to the needs and burdens of LIDAC communities.
	  o Develop highly localized regional map of energy insecurity and racial injustice across all regions to accurately benchmark a variety of buildings based on the deferred maintenance state.
	  o Locate or create Geographic Information Systems (GIS) data for building ownership data to disentangle the building's and owner's location.
	• Decision-support analysis on:
	  o Benchmarking
	  o Rate design that incorporates energy justice: Local organizations are being asked to provide input on efforts to incorporate energy justice into utility rate design, but they lack the technical know-how to provide informed input.
	  o Electricity rates can be higher than paying for gas for heating and cooking.
	  o Electrification can also result in losing fuel assistance subsidies.
	• Support with communicating building upgrade concerns to federal agencies (beyond communications in the aftermath of extreme weather events).
		Not found during this research project.

Potential Solutions to Address Identified Barriers and Needs

The project team conducted additional research where possible to offer a more expansive breakdown of potential solutions to address barriers and needs faced by LIDAC communities. The proposed solutions from all participating local organizations are presented in a high-level manner below via subsections.

Immediate Policy Priorities

As an immediate priority, several local organizations suggested that policies governing federal and state funding opportunities must be informed by fixing issues in current buildings based on community needs (e.g., reinsulating buildings, solving health and standard concerns like asbestos and mold, changing doors and windows, repairing roofs, and installing heat pumps). There remains a need to assess the potential gentrification effects of such upgrades, as well as measures to ensure building occupants are not priced out of their neighborhoods after residential and commercial building improvements are conducted. Some participants noted that the Inflation Reduction Act (IRA) and Bipartisan Infrastructure Law (BIL) funding could counteract gentrification by enabling a shift to more community-owned energy assets.

Not addressing this priority quickly could cause those who could benefit the most from the IRA and BIL funding to be left behind. In parallel, local governments can utilize public buildings such as city hall, the fire department, or the public library to demonstrate decarbonization opportunities and clean energy solutions (e.g., solar on the roof, heat pumps) to familiarize local communities with the technologies used for building upgrades beyond code compliance. Compensating attendees for their time is also highly valuable. This familiarity would help accelerate adoption once the current building stock is ready (e.g., pre-weatherization concerns have been addressed). Specific policy suggestions included:

- Prioritize federal and state funding to LIDAC communities for building upgrades, especially in low tax base areas.
- Redesign weatherization and utility programs to allow for automatic sign-up for qualifying buildings in LIDAC communities rather than having individual applicants apply.
- Use community mapping in modeling tools to verify prequalification/income criteria rather than doing so at the census tract or census block level.
- Invest in upgrading cornerstone buildings in communities (e.g., churches/faith-based organizations, recreational spaces, public libraries, city halls, fire departments, small businesses, and schools).
- Develop inclusive federal, state, and utility investments that finance improvements across various building types, owners, and occupants.
- State-level public service commissions and legislatures must end caps on renewable energy production in states such as Michigan.
- Ensure the IRA supports community-ownership of clean energy assets to promote wealth generation and prevent gentrification and displacement.

Finance Holistic Building Upgrades using Utility Investments Tailored to Community's Needs

Organizations identified a need to prioritize federal and state funding to LIDAC communities, especially those with low tax bases. This solution would begin with estimating the costs to get buildings weatherization-ready, that is, to bring them up to conditions suitable for building

upgrades. Cities and local governments need to partner with other stakeholders, such as local organizations, contractors, building experts, developers, utilities, and community members, to estimate the associated building upgrade costs while identifying potential financial and cultural barriers to decarbonization. Funding for these upgrades could then be directed to the relevant entities to begin the identified upgrades. In this way, these cities and local government stakeholders could extend current federal and local building upgrade programs to account for the needs and barriers faced by LIDAC communities.

On the utility side, several local organizations suggested targeted utility investments focused on building-related upgrades. The goal would be to finance upgrades for those who do not qualify for free assistance yet cannot afford to upgrade residential and commercial buildings independently. The innovation here is to have utilities invest in upgrading buildings, akin to investments in power plants, but with a positive impact on the future growth of communities. To ensure utility financed energy efficiency investments are equitable, implementers should have caution and review location-specific regulations and legislations that govern each utility's policies and programs. Similarly, intervening funds could connect qualifying community members, business and building owners, and households to available funding opportunities. Participating organizations noted that there are often many utility programs that LIDAC communities are unaware of for which they qualify. As such, a network of local organizations must be supported in connecting community members and businesses to programs supporting increased building upgrades. Utility investments paired with pre-weatherization support can also be leveraged in LIDAC communities to:

- Provide local and minority-owned businesses with funding and training to conduct building upgrades.
- Create prioritized lists of building retrofits, including upgrades of insulation, windows, doors, and heating systems.
- Conduct solar-plus-storage readiness assessments to support solar deployment (in communities with interest).
- Ensure broad dissemination of funding opportunities, such as Low-Income Home Energy Assistance Program (LIHEAP) funding roof replacement despite the status of health and safety standards.
- Conduct in-depth analysis and create proactive and tailored solutions to support and understand the cost and effects of upgrades on neighborhood wealth and potential gentrification and displacement.

Create a Pool of Intervening Funds for Bridge Support of Implementation of Energy Programs

Local organizations noted an interest in federal and state funding that supplements utility investments by paying local organizations to support the implementation of programs. These organizations are the boots on the ground and provide an important bridge to connect community members and businesses to funding opportunities, especially those in LIDAC communities. This intervening fund would allow local organizations to hire additional staff members to play this critical role of bridge support while addressing the need for more staff and/or time to develop competitive proposals. Additionally, this intervening fund could equip local organizations and LIDAC communities to respond to state and federal funding opportunities for building energy efficiency efforts. Similar potential solutions include:

- Utilities could invest in and partner with state and local organizations to conduct building upgrades.
- Connect and equip local organizations to respond to federal funding opportunities.
- Support training and capacity building focused on energy managers, that is, the individuals who can assess energy use and support affordable and useful retrofit work for businesses in LIDAC communities.
- Connect local organization staff to technical assistance offerings (such as the Clean Energy to Communities [C2C] Program).
- Develop year-round energy justice leadership institutes to equip and train community advocates.
- Facilitate robust, data-driven decision-making in communities, as this economic opportunity could lead to exploitation by businesses.
- Many organizations noted the value of communities working with researchers that reflect the demographics of their communities to ensure personable and real representation. They specifically noted that young women and researchers of color at NREL and other laboratories should conduct strong outreach and direct community engagement (especially when interacting with children and younger adults).

Conclusions and Takeaways

This report presents findings from discussions with local organizations on their building decarbonization efforts in LIDAC communities. Using a qualitative analysis approach, we engaged with the organizations to understand the building decarbonization landscape at the local level. Findings from the case study discussions and subsequent roundtable discussions highlighted organizational successes, barriers to missions, needs, and potential solutions. While this work engaged several organizations, its findings are not comprehensive. They are meant to be the start of a larger conversation that looks to local organizations to bridge the gap between efforts at the community scale and state and federal tools and policies. Takeaways from this study include the need for pre-weatherization funding in LIDAC communities and a desire for increased resilience (preparing for disasters instead of only responding to them).

During conversations with local organizations, authors of this report became increasingly aware of warnings that differences between anonymized, modeled data and actual conditions are significant enough to disadvantage those at the geographic and economic margins. Ensuring all data accurately represent communities (at scales finer than a census tract) becomes a matter of social justice. Efforts to include more "lived experience" in modeling tools should be continued. Qualitative data provided by community members or local organizations—including carefully presented qualitative data—can be a valuable addition to quantitative datasets. Future work at NREL could pursue an increased understanding of how modeling can include more broadly representative data within national datasets without violating privacy laws or making modeling tools too cumbersome.

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References

Clarke, A., M. Deru, E. Lockhart, L. Beshilas, G. Paranjothi, N. Wiltse, S. Belding, R. Jackson, N. Radhakrishnan, M. Egea-Casalduc, K. Grimes, and B. Engelman. 2023. " Centering Energy and Environmental Justice in the Buildings Energy Sector." *NREL/TP-5500-83173.* http://doi.org/10.2172/2005548.

Executive Office of the President. 2021. "Interim Implementation Guidance for the Justice40 Initiative." https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-28.pdf.

Fears, D. 2022. "Redlining means 45 million Americans are breathing dirtier air, 50 years after it ended." *The Washington Post*. www.washingtonpost.com/climate-environment/2022/03/09/redlining-pollution-environmental-justice/.

Institute of Medicine. 2011. *Climate Change, the Indoor Environment, and Health.* Washington, D.C.: National Academies Press. http://doi.org/10.17226/13115.

Karvonen, A. 2013. "Towards Systemic Domestic Retrofit: A Social Practices Approach." *Building Research & Information* 41 (5): 563–74. http://doi.org/10.1080/09613218.2013.805298.

Langner, R., B. Hendron, S. Pless, M. Huppert, and R. Cochrane. 2013. "Industry Research and Recommendations for Small Buildings and Small Portfolios." *NREL/TP-5500-57776,* 1260323. http://doi.org/10.1080/09613218.2013.805298.

NREL (National Renewable Energy Laboratory). 2022. "Greenhouse Gas Emissions Accounting in Buildings." www.nrel.gov/docs/fy22osti/81671.pdf.

The White House. 2023. "FACT SHEET: President Biden Signs Executive Order to Revitalize Our Nation's Commitment to Environmental Justice for All." The United States Government. https://www.whitehouse.gov/briefing-room/statements-releases/2023/04/21/fact-sheet-president-biden-signs-executive-order-to-revitalize-our-nations-commitment-to-environmental-justice-for-all/.

Theodos, B., and J. González. 2019. "Building Community and Wealth in Disadvantaged Commercial Corridors: Chicago's Neighborhood Opportunity Fund." Washington, DC: Urban Institute.

Trenbath, K., R. Meyer, K. Woldekidan, K. Maisha, and M. Harris. 2022. *Commercial Building Advanced HVAC Controls Deployment—Barriers, Drivers, and Costs.* NREL/TP-6A50-82117. https://www.nrel.gov/docs/fy22osti/82117.pdf.

U.S. EPA (Environmental Protection Agency). 1989. "Report to Congress on indoor air quality. Volume 2. Assessment and control of indoor air pollution. Final report" United States. https://www.osti.gov/biblio/6958939.

U.S. EIA (Energy Information Administration). 2022. "2018 Commercial Energy Consumption Survey Final Results." Table B8: Year constructed, number of buildings. https://www.eia.gov/consumption/commercial/data/2018/bc/pdf/b8.pdf.

U.S. EIA (Energy Information Administration). 2023. "2020 Residential Energy Consumption Survey Final Results." Table HC9.9 Household demographics of U.S. homes, by home size, 2020." https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%209.9.pdf.

We The People Michigan. 2022. "Utility Redlining: Inequitable Electric Distribution in the DTE Service Area." wethepeoplemi.org/wp-content/uploads/2022/08/DTE-Utility-Redlining-V3_20220822-FINAL.pdf.

While, A., and W. Eadson. 2019. "Households in Place: Socio-Spatial (Dis)Advantage in Energy-Carbon Restructuring." *European Planning Studies* 27 (8): 1626–45. http://doi.org/10.1080/09654313.2019.1595533.

Wilson, E.J.H., C.B. Harris, J.J. Robertson, and J. Agan. 2019. "Evaluating Energy Efficiency Potential in Low-Income Households: A Flexible and Granular Approach." *Energy Policy* 129 (June): 710–37. http://doi.org/10.1016/j.enpol.2019.01.054.

York, D., C. Cohn, D. Morales, and C. Tolentino. 2022. "Building Decarbonization Solutions for the Affordable Housing Sector." American Council for an Energy-Efficient Economy. https://www.aceee.org/sites/default/files/pdfs/u2204.pdf.