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Transforming ENERGY

A GUIDE TO ENGAGING UNDERSERVED COMMUNITIES IN COMMERCIAL ENERGY EFFICIENCY FIELD VALIDATIONS

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Cover photo: Teams representing local communities from across the country collaborate at a working session of the Solar Energy Innovation Network in November 2022. The program brings together underserved communities to explore new approaches to the equitable adoption of solar energy.

Photo by Harrison Dreves, NREL

NOTICE

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INTRODUCTION

Crown Heights, in the New York City borough of Brooklyn, is a rapidly changing neighborhood of attractive older buildings and a diverse population. As the area gentrifies, however, affordable housing becomes harder to find, pushing out many low-to-moderate income residents and people of color.

Photo from BlocPower

The White House's Justice40 initiative requires that 40% of the benefits of specific federal investments be directed to disadvantaged and underserved communities.[1] Clean energy and energy efficiency are two such investment categories, so the U.S. Department of Energy developed policy priorities to guide implementation of the Justice40 initiative, including addressing **energy burden**s, ensuring equity in access to clean energy technology, and improving energy resiliency.[2] Research, development, validation, and deployment are essential stages of technology development in the energy sector, and new technologies can advance the Justice40 initiative and U.S. Department of Energy's policy priorities. This guide examines the validation stage of new **commercial building** technologies.[3]

Commercial building field validations involve implementing a new technology in an operating building and assessing the technology's performance, often over a year or more. Sometimes the **building owner** must purchase the equipment, other times a manufacturer supplies the technology.

According to researchers consulted for this guide, validations often occur in new, large, technologically upgraded buildings. Fewer validations occur in buildings in underserved areas or in older, smaller buildings. Meeting the White House's climate goals—reducing U.S. greenhouse gas emissions 50%–52% below 2005 levels by 2030, reaching 100% carbon pollution-free electricity by 2035, and achieving a net-zero emissions economy by 2050[4]—as well as its Justice40 goals, will require validating and deploying energy efficiency technologies and renewable energy across the country, including in underserved communities. In concert with other simultaneous efforts, **field validation**s expand the reach of new technologies and afford researchers opportunities to ensure the technologies they're validating perform as expected in diverse buildings and communities. Researchers can also learn to modify new technologies so that they function properly in buildings with different technology levels and maintenance histories.

1 https://www.whitehouse.gov/environmentaljustice/justice40/
2 https://www.energy.gov/diversity/justice40-initiative#:~:text=Increase%20parity%20in%20clean%20energy,training%20for%20individuals%20from%20DACs
3 A comprehensive version of this work is included in the proceedings of the 54th Annual Conference of the Environmental Design Research Association. https://www.edra.org/page/Proceedings_TOC
4 https://www.whitehouse.gov/climate/

Limiting **field validation**s to **building owner**s and building types in more affluent areas can lead to gaps in research knowledge; a lack of awareness of beneficial technologies for thousands of **building owner**s, tenants, and occupants; and diminished opportunities for energy and cost savings among **energy burden**ed groups.[5,6] Deployment of new energy technologies is increasing and it is crucial to make energy efficiency upgrades more equitable and the benefits of new technologies more accessible to the underserved populations most impacted by high energy costs.[7,8] Conducting **field validation**s in underserved communities is one way to expose **building owner**s and occupants to these new technologies, and, with effective networking and outreach, that exposure can extend to the larger community.

Terminology

The U.S. Department of Energy describes disadvantaged communities as experiencing a combination and accumulation of **energy burden**, socioeconomic vulnerabilities, environmental and climate hazards, and dependence on fossil fuels.[9] This guide uses the U.S. Department of Energy description and adds groups historically underrepresented in **field validation**s—community-serving organizations, for example—to more inclusively describe the communities this work is intended to reach. We use the term "underserved" in lieu of "disadvantaged" here, because conversations with experts revealed "underserved" more accurately represents the societal positioning of the community. This term is also supported by other works[10] and is referenced in the White House's description of disadvantaged—"disadvantaged communities that are marginalized, *underserved*, and overburdened."[11]

Although the terms field "validation" and "demonstration" seem similar, this guide uses field "validation" to describe the installation and evaluation of a new technology in the field. The technology will be demonstrated and explained to the **building owner**, tenant, and occupants,

5 https://www.aceee.org/research-report/u1713
6 https://doi.org/10.1080/09505431.2013.786989
7 https://doi.org/10.1016/j.ref.2022.02.002
8 https://www.aceee.org/sites/default/files/publications/researchreports/ie1502.pdf
9 https://www.energy.gov/diversity/justice40-initiative#:~:text=Increase%20parity%20in%20clean%20energy,training%20for%20individuals%20from%20DACs
10 https://publications.anl.gov/anlpubs/2022/05/175535.pdf
11 https://www.whitehouse.gov/environmentaljustice/justice40/

but it will first and foremost be validated according to technical guidelines.

"Commercial" buildings contain businesses selling goods and services, as well as nonprofits, community centers, schools, daycares, and nursing homes. Broadly speaking, a building not used for single-family housing purposes is categorized as a **commercial building**, although this category usually does not include industrial buildings.

Working in underserved communities may require researchers to engage with a wide variety of stakeholders. For example, according to the experts interviewed for this work, buildings in these communities are often older and smaller than those in more affluent communities and may be maintained by a small staff or even a single individual. That person can be the **building owner**, but there are also instances in which the **building owner** makes high-level equipment and research participation decisions and an **on-site contact** such as a property manager is responsible for maintenance, repairs, and tenant relations, among other things. Although the **building owner** and **on-site contact** can be the same person, the **on-site contact** is often the party in regular communication with researchers. Some **building owner**s do not live locally and may not engage with researchers beyond higher level discussions.

Context

Although conducting **field validation**s in underserved communities is relatively new, best practices for engaging underserved communities are well documented. Engaging **building owner**s for **field validation**s is somewhat different than engaging communities in that researchers often seek a single contact—a **building owner**—and focus on work specific to that contact. More general community engagement guidance is still relevant, and greater community engagement can come into play when sharing results and technology information with a neighborhood, business association, or other local group.

Researchers may have experience developing new technology based on prior research and gaps in the market without much engagement with a diverse set of stakeholders. But when community members—**building owner**s in the case of validation projects—are involved, solutions can be more tailored and creative, decisions and adoption can occur more quickly, there is space for community members to learn and contribute, and resources can be engaged more easily.[12] Thoughtful community inclusion can also boost community support for renewable energy development.[13] Excluding stakeholder input can lead to incomplete solutions that cause future issues; engagement needs to become standard practice to halt this cycle.[14]

Discrimination and lack of resources have greatly reduced underserved communities' trust in institutions, and it is important to understand past unsuccessful interactions and their impacts.[15,16] Policies and procedures need to be updated to embed equity and justice into systems and hold project organizers and participants accountable.[17] Understanding the community, its trials, and its physical space is an early step in successful collaboration.[18,19]

Both historic and current demographic and geographic data are also key in community-engaged evaluation and decisions,[20] but existing data do not always completely or correctly represent life in communities.[21] In addition to learning more about historic discrimination and underinvestment, researchers can use social media and other localized media to understand the lived experience in an area.[22] Together with direct stakeholder engagement, these approaches help researchers become familiar with a community.

Communities can develop positive visions for their energy futures, both collective and individual, beyond what data reveal. Idealized futures could be imagined as safe and secure and include universal amenities like reliable utilities and affordable energy bills. Shared ideas can lead to

12 *https://smartnet.niua.org/sites/default/files/resources/Public%20Participation%20Handbook.pdf, https://www.planning.org/publications/report/9165143/*
13 *https://doi.org/10.1016/j.egycc.2020.100013, https://doi.org/10.1016/j.ref.2022.02.00*
14 *https://doi.org/10.1016/j.egycc.2020.100013*
15 *https://www.planning.org/publications/report/9165143/*
16 *https://planning.org/publications/document/9186035/*
17 *https://climateaccess.org/sites/default/files/usdn_equity%20Sustainability.pdf*
18 *https://cacm.acm.org/magazines/2017/10/221317-research-for-practice-technology-for-underserved-communities-personal-fabrication/abstract*
19 *https://www.planning.org/publications/report/9165143/*
20 *https://climateaccess.org/sites/default/files/usdn_equity%20Sustainability.pdf*
21 *https://planning.org/publications/document/9186035/*
22 *https://www.planning.org/publications/report/9165143/*

a sense of belonging[23] and can exist within a neighborhood, block, or group of building occupants. Community members need to have the opportunity to contribute and analyze information to develop solutions and visions for their future.[24] Involvement in validation projects is one way to support community visions of the future.

Social livelihood needs such as safe neighborhoods, technological needs like updated infrastructure, and the equitable integration of both are important in communities.[25] Technology, however, can lead to hierarchies and marginalization of less powerful groups.[26] Social and technological elements need to be woven together so they benefit all users.[27] Collaboration between groups such as **building owner**s and researchers is important for developing strong bonds and impactful research, and combating hierarchical structures. It can be challenging to ensure equitable outcomes, and it is important to track progress and adjust methods as needed.[28]

Engaging a community can be more art than science and can be challenging for the inexperienced.[29] Connecting with staff at trusted organizations, businesses, and institutions and working with these contacts to foster and support relationships with other community members can help build trust, and the resulting relationships with local leaders as well as community members should be cultivated and maintained.[30,31,32] Engagement will be ongoing, and conversations should focus on community assets and building on those assets rather than on area deficits.[33] This approach will help community members feel and recognize that their input is valuable.[34]

> *Engaging a community can be more art than science.*

When the building's boiler failed, an affordable multifamily property in Crown Heights, Brooklyn, replaced it with clean, energy-efficient mini split heat pumps.

Photo from BlocPower

Building upon initial conversations between **building owner**s and researchers, it is important for researchers to help **building owner**s understand how their input can positively influence the work, and how their input will be included in the collaboration.[35] **Building owner**s' lack of experience with **field validation** can be a barrier to participation,[36] and researchers need to explain processes and highlight contribution opportunities. Agreed-upon evaluation metrics should be openly discussed to indicate progress,[37] and there should be single, clear points of contact for both the **building owner** and the researchers to simplify communication.[38] The technologies must function in low-resource contexts, and researchers should recognize and clearly communicate their limitations. Challenges solved by technology alone are more typical in affluent, higher-resourced communities.[39]

Current literature speaks to the stages and aspects of engaging underserved communities. There does not yet appear to be much information about the "how" of underserved community engagement specific to commercial technology validations. This guide helps fill this gap.

23 https://doi.org/10.1016/j.erss.2021.102205
24 https://cacm.acm.org/magazines/2017/10/221317-research-for-practice-technology-for-underserved-communities-personal-fabrication/abstract
25 https://doi.org/10.1016/j.erss.2021.102205
26 https://doi.org/10.1016/j.erss.2021.102205
27 https://ifis.asu.edu/sites/default/files/general/miller_et_al_2018_asu-ae4h_poverty_eradication_through_energy_innovation.pdf
28 https://planning.org/publications/document/9186035/
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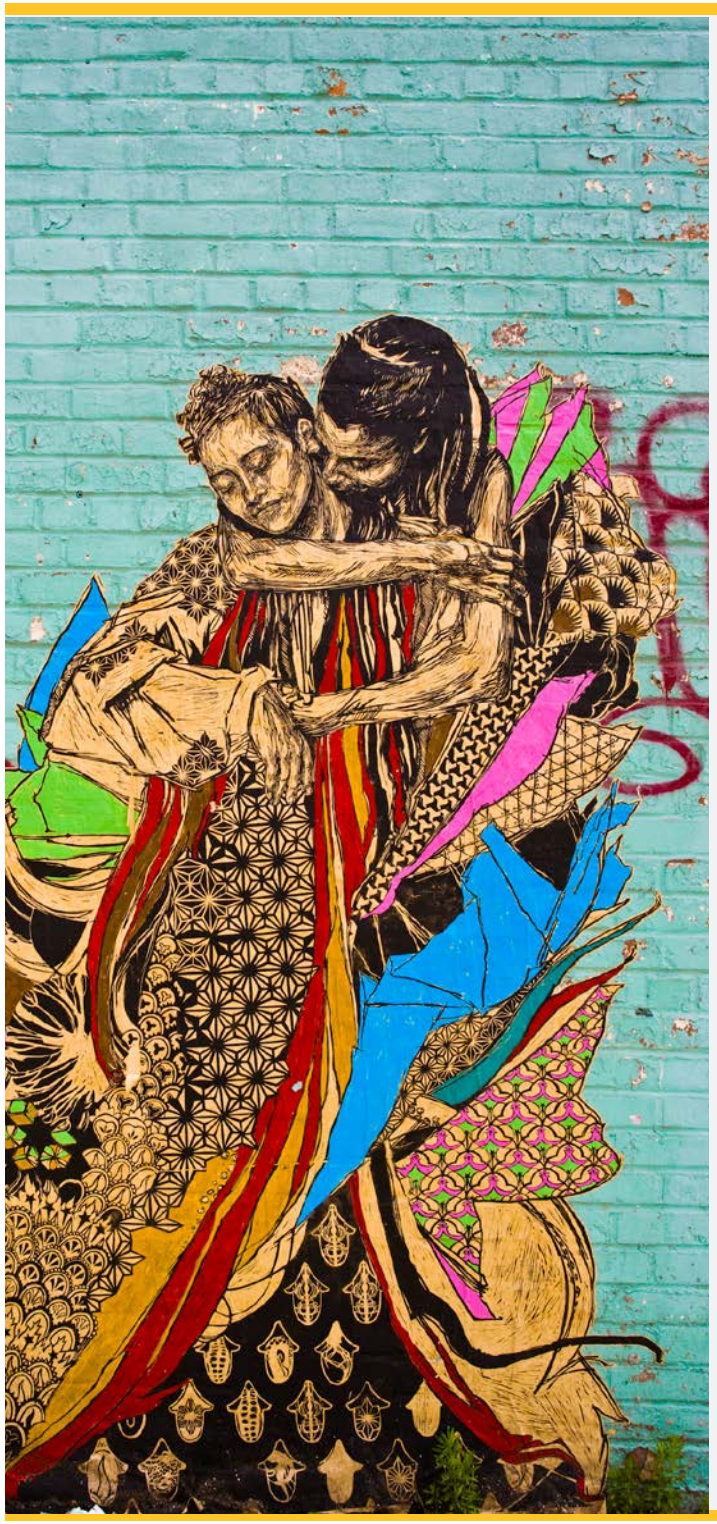
36 https://www.planning.org/publications/report/9165143/
37 https://climateaccess.org/sites/default/files/usdn_equity%20Sustainability.pdf
38 https://www.aceee.org/research-report/u1713
39 https://cacm.acm.org/magazines/2017/10/221317-research-for-practice-technology-for-underserved-communities-personal-fabrication/abstract



Improving building energy efficiency is one of the most cost-effective strategies for investing in underserved communities. Like many disadvantaged communities, Brownsville, in the New York City borough of Brooklyn, is a study in contrasts. Often cited as one of the most dangerous areas of the city, it is also home to stunning street art like this painting by swoon.

Photo from Nicholas Noyes, *http://flickr.com/photo.gne?id=2709833449, https://creativecommons.org/licenses/by-nc-sa/2.0/*

Energy Efficiency Co-Benefits

According to ENERGY STAR®, a program promoting energy efficiency and run by the U.S. Environmental Protection Agency and the U.S. Department of Energy, the average **commercial building** wastes 30% of the energy it consumes.[40] For **building owners** and tenants in underserved communities, where maintenance is often deferred because of limited resources, improving building energy efficiency can yield immediate and significant energy and cost savings.

For many **building owners** in underserved communities, however, benefits other than energy efficiency are a higher priority. These include, but are not limited to:[41,42,43]

- At the building level, improvements in
  - Thermal comfort
  - Health and well-being of occupants
  - Indoor air quality
  - Resilience during power interruptions
  - Workforce productivity
  - Operations and maintenance costs
  - Tenant retention
  - Tenant energy burden
  - Property value.
- At the community level, improvements in
  - Job creation
  - Local air and water quality
  - Tenants' **energy burden**
  - Resilience during power interruptions (energy-efficient buildings can be used as shelters)
  - Grid resilience (resulting in fewer power interruptions).

40 *https://www.energystar.gov/buildings/resources_audience/small_medium_offices*
41 *https://www.betterbuildingsbc.ca/faqs/what-are-the-benefits-of-energy-efficient-buildings/*
42 *https://www.energy.gov/eere/energy-efficiency*
43 *https://energyefficiencyimpact.org/co-benefits-with-energy-savings/*

THE RESEARCH

NREL researcher Matt Hogan works in the Optical Characterization and Thermal Systems lab in the Energy Systems Integration Facility, testing equipment. New energy efficiency technology is lab tested before field validation begins.

Photo by Dennis Schroeder, NREL

This guide presents information to help researchers engage with **building owner**s traditionally excluded from **field validation**s of commercial energy efficiency technology. This guidance is applicable to researchers conducting **field validation**s as well as researchers and other organizations seeking to expand participation in energy efficiency programs. We sought to present this guidance along two main lines—analyzing characteristics of buildings where technologies could be validated, and developing local partnerships for successful validations. The strategies can apply to building selection and collaboration with its owner.

Methods

We identified common required and desired **field validation** building characteristics by analyzing seven **field validation** reports on a range of new or updated technologies. These reports used traditional field validation sites not located in underserved communities. We also identified key stages and major themes of underserved community engagement by speaking with 29 validation, equity, justice, and energy program subject matter experts (**Figure 1**).

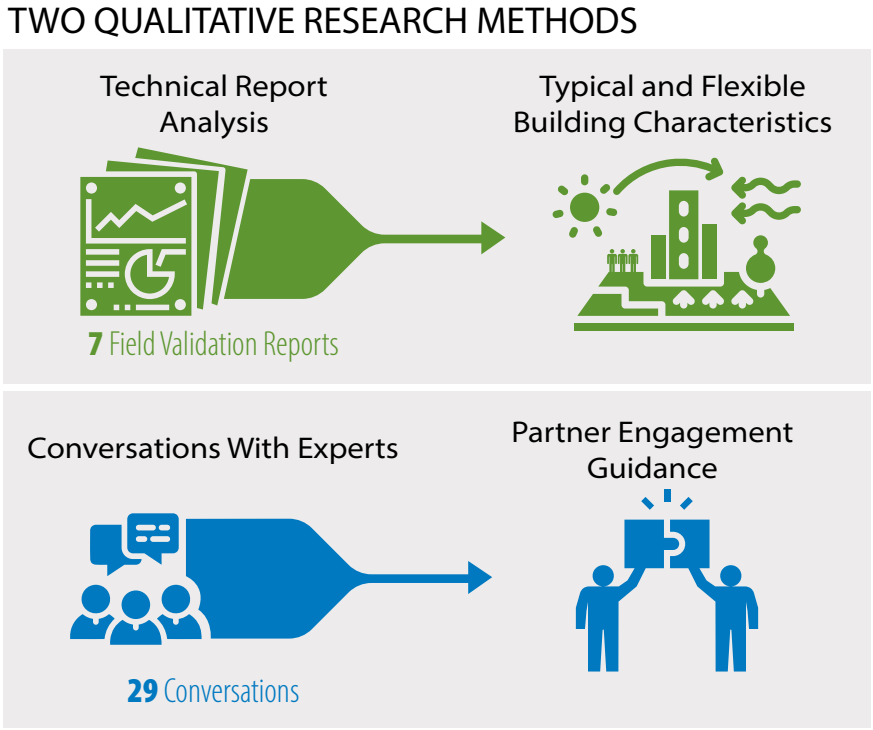


Figure 1. Selected methods and applicable results

Credit: Marjorie Schott and Project Noun, NREL

Technical Report Content Analysis

We reviewed the field validation reports and captured building characteristics described as required or desired. We then categorized these characteristics into broader themes, determined which building characteristics were less likely to be found in the older or smaller buildings common in underserved communities, and recommended strategies that could be tailored to the selected building. The reports covered plug load management, condenser fan motors, air cleaning, cooling tower water treatment, and electrical submetering.

Semi-Structured Expert Conversations

During the semi-structured conversations, we asked a range of experts standard open-ended questions with variable follow-up questions. They provided guidance on **field validation** engagement as well as equity, justice, energy management programs, and research logistics. To achieve a broad perspective on this topic, we prioritized speaking with individuals with specialized expertise from different types of organizations (**Figure 2**). A chronological depiction of the stages and themes resulting from these conversations is also summarized in **Figure 3**.

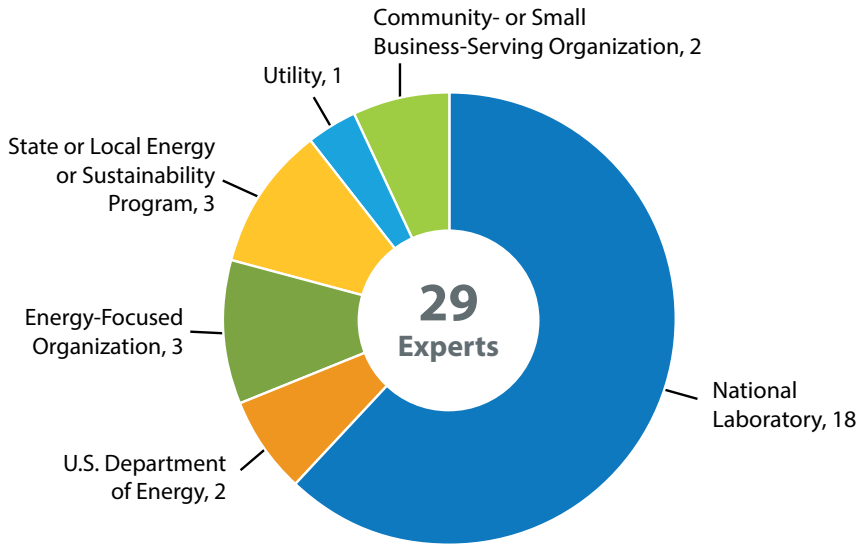
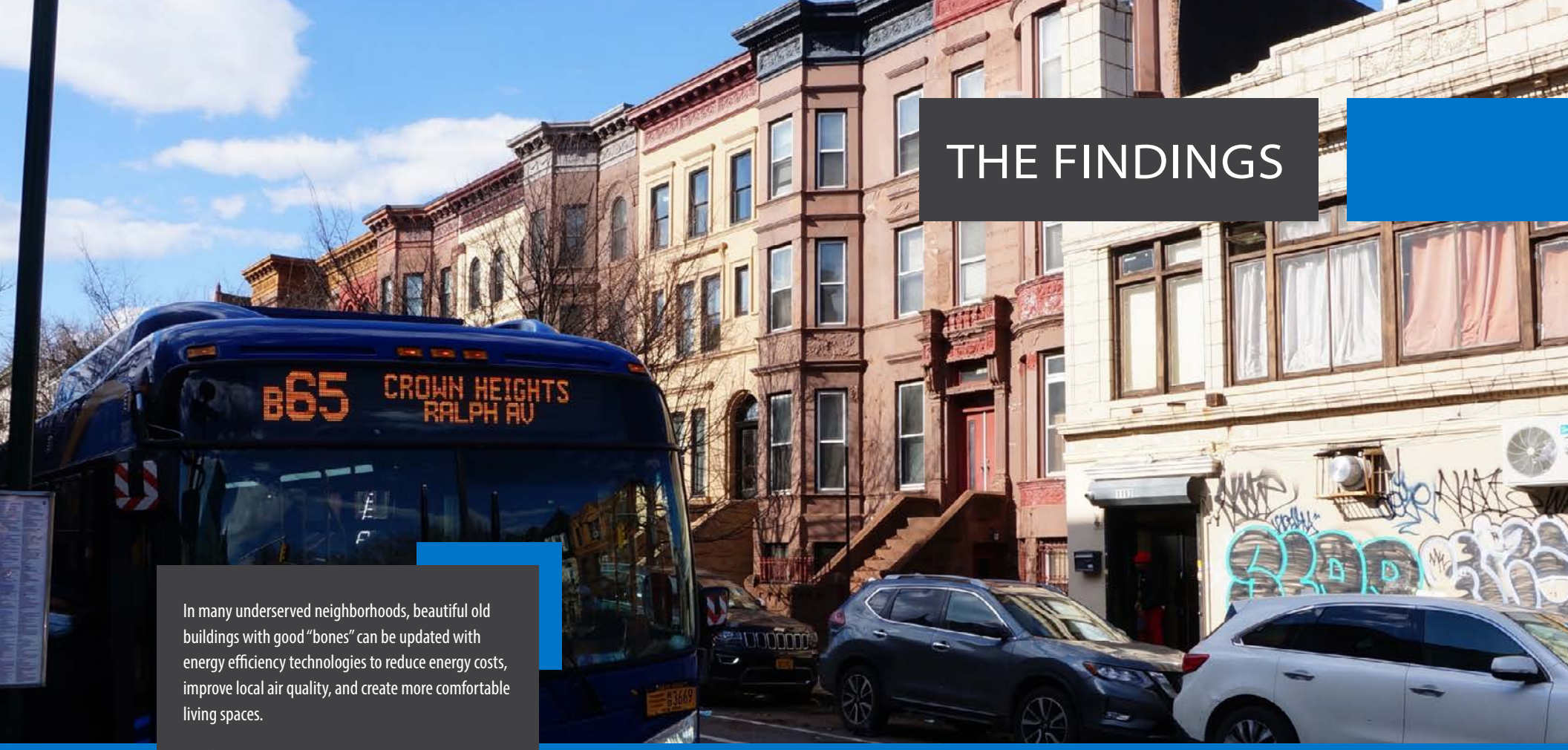


Figure 2. Counts of experts and their fields

Credit: Marjorie Schott, NREL

The sample is not representative of all experts in each field, but rather consists of experts with firsthand, relevant experience.

THE FINDINGS



In many underserved neighborhoods, beautiful old buildings with good "bones" can be updated with energy efficiency technologies to reduce energy costs, improve local air quality, and create more comfortable living spaces.

Photo from BlocPower

Our review of the technical reports contributed to increased understanding of typical building requirements; helped us determine how validation project requirements match building characteristics in underserved communities; and identified which, if any, requirements can be waived or modified (**Table 1**). Our conversations with the experts provided guidance on site selection, project planning, partnership building, respectfully conducting validations, and maintaining relationships (**Figure 3**).

Building Characteristic Analysis

Our technical report analysis resulted in twelve categories of required or desired validation building characteristics, and each category includes between one and five more specific characteristics. The categories and characteristics are detailed in **Table 1**, which also includes a brief discussion of each category. What is required or desired for one study may be irrelevant to another, and building characteristics are both objective (**commercial building** required) and subjective ("good" internet connection required). Researchers can use these results to assess the building characteristics essential to their research effort as well as characteristics that can be more flexible.

Table 1. Common Characteristics of Buildings Hosting Validations Based on Report Analysis

Categories	Characteristics	Discussion	Recommendations for Researchers
 Building Type	1. Commercial 2. Represent target market 3. Multi-tenant 4. Small (~15,000 square feet) 5. High-efficiency, all-electric, well-operated	The first four characteristics are common to many small buildings; the fifth indicates a more advanced building less likely to be found in an underserved community.	Work with manufacturers to develop strong business cases for new products that can be easily implemented in buildings in underserved communities.
 Existing System Capabilities	1. Ability to synchronize new and legacy equipment 2. Technology or equipment utilized or affected by the technology being evaluated 3. Remote monitoring capability 4. Remote control capability 5. Building automation system	The first three characteristics are typically available or achievable with simple equipment like cellular modems. The final two may be challenging in older, under-resourced buildings.	Ensure the technology is a good fit for the building, and remember that the building must be representative and the technology's performance should be replicable. If the barriers are too great, address them in future research.
 Electrical Infrastructure	1. Clearly mapped electrical infrastructure 2. Requirements around risers, panels, circuits, and capacities	Information about the existing infrastructure is helpful to both the building owner and the researcher.	If infrastructure information is unavailable, assist with cataloging to determine whether the existing infrastructure is appropriate for this study.
 Loads	Measurable loads in the technology-affected area, such as plug or ventilation loads	Building owners may not understand the different types of loads in their buildings.	Assist building owners with this assessment.
 Internet/ Wi-Fi	Good to excellent wireless service	In older buildings, rural areas, and locales with less internet infrastructure, reliable service can be a challenge. Fast, reliable wireless service is helpful, but many studies can proceed without it or with limited service.	Improve internet functionality by using cellular modems during the study. Clearly communicate whether wireless service improvements end when the study ends. Wireless service challenges can also alert the technology company to the need for alternative solutions.
 Spatial Needs	1. In the electrical room 2. Inside panels 3. In other technology-specific locations 4. Ability to maintain, monitor, account for, and possibly manipulate environments around technology	Finding space in older or smaller buildings, or beyond their original function to satisfy businesses' needs (for example, a church building that is now a restaurant) may be challenging.	Together with the technology company, consider new and alternative methods of working within space constraints, which would be beneficial to both the technology company and future customers.

Categories	Characteristics	Discussion	Recommendations for Researchers
 Existing Building Information	1. Up-to-date building drawings 2. Ventilation and commissioning 3. Functionality of existing equipment 4. Access to available reports, such as testing, adjusting, and balancing [TAB] reports 5. Other logs and building system records, like maintenance records and past building uses 6. Someone familiar with the building's systems	Especially in smaller buildings, information about challenges with and the functionality of current equipment may be available, but—depending on the building's tracking and monitoring capabilities—it may be difficult to get detailed information.	Determine whether the information is necessary for the validation, and, if it is, explore alternative strategies such as installing logging equipment before the study begins, conducting a detailed site visit, or getting an energy audit, possibly at no cost through the utility.
 Study Length	Buildings need to be available for the duration of the study, including a baseline data collection period, whether it is multimonth or multiphase.	This requirement is common in all field validations, and the monitoring period may vary based on technology.	Plan the study to minimize study length and disruptions, and explain expectations to building owners and on-site contacts.
 Point of Contact	1. On-site manager and staff representative to act as liaisons 2. Building owner willing and able to be involved 3. An on-site contact—who may or may not be the owner—for regular monitoring	Responsive points of contact and clear communication between on-site contacts and researchers are critical to a successful project.	Take care to build a strong relationship with the partner and develop an understanding of their goals and existing challenges. To minimize the burden on the partner, develop the most direct line of communication and engage the minimum number of building staff required. Also, build support for the project by educating the building owner about the technology, validation, risks, and research plan and providing a single, specific point of contact with the research team. In addition, develop a transition plan in case points of contact change to ensure smooth communication and continuity in data gathering. Review the **Engagement and Research Project Guidance** section for more detailed information on working with a partner.
 Building Owner	1. Open to new technology 2. Willing and able to participate, engage, and provide feedback 3. Comfortable with the study length 4. Understands system operations or closely coordinates with the system operator	Building owner and tenant operations should be prioritized over the field validation.	Acknowledge that business operations trump validation concerns. Prior to the study, educate the owner about the co-benefits of the technology and explain how these benefits could improve their operations or their customers' experiences. During the study, help building owners develop knowledge about building equipment and operations that will prove useful going forward, and clarify the owner's role versus that of an on-site contact who is regularly present at the site.
 Occupants	1. Willing and able to participate in the study as needed 2. Comfortable with study length 3. Able to regularly interact with the technology as required 4. Aware of the technology functionality 5. Aware of the point of contact 6. Equally informed—all shifts have the necessary information	Occupant engagement will vary from study to study, but occupants may play a larger role moving forward given the increased awareness of energy equity and energy justice.	Coordinate with the owner or on-site contact to ensure new staff are familiar with the study, and be prepared for occupant engagement if it is a component of the research. As appropriate, provide materials detailing the co-benefits of the technology and instructions for interacting with any new equipment.
 Coordination	Depending on the building management structure and the size of the validation study, participants may include: 1. Building and equipment owner 2. Technology company and data acquisition manager 3. Legacy/existing system data acquisition manager 4. Project leader and data analyst 5. Building occupants	Building owners and on-site contacts in underserved communities typically wear many hats and have many demands on their time.	Make coordination clear and simple to avoid burdening building owners and on-site contacts.

FIELD VALIDATION STAGES

STAGES	THEMES FROM EXPERT DISCUSSIONS		RECOMMENDATIONS FOR RESEARCHERS
1 Field Validation Considerations in Underserved Communities	• Address energy use, emissions, and climate change • Prioritize energy equity and energy justice • Take advantage of opportunities to improve technology development	• Increase energy efficiency technology adoption • Be respectful and do no harm • Simplify communication	• Ensure the technology is fully ready for field validation, has a high likelihood of success, and is the right fit for the building and the community • Recognize the benefits of working with an underserved community
2 Research Design and Project Planning	• Focus on research design flexibility, including evaluation of possible risks • Integrate other applicable metrics along with technology evaluation metrics	• Build flexibility into project timeline and budget • Plan to compensate organizations and building contacts	• Understand that validations in underserved communities take more time and resources • Allow time to build connections, ensure mutual benefits, and evaluate building conditions and potential risks, including a contingency plan in case the technology fails during the validation • Build extra time, budget, and research design flexibility into the project, including the additional time and budget required to uninstall the technology in the event that the owner decides not to keep it
3 Find a Building Partner	• Evaluate and consult online tools • Understand underserved areas, especially the chosen research area • Work with a bridging organization to find a partner • Select a building • Analyze technical and interior building characteristics	• Pitch the project • Work with owner to solve problems beyond saving energy • Consider the unique concerns of building owners • Communicate transparently and honestly • Consider the unique concerns of building tenants	• Use resources such as online tools and groups such as bridging organizations to find a building partner • Establish and nurture relationships with building owners, bridging organizations, and tenants • Prioritize equity and justice in the validation process and approach traditionally excluded communities respectfully
4 Work With the Building Owner or On-Site Contact	• Develop clear, straightforward agreements • Identify points of contact • Plan for disruptions	• Monitor, evaluate, and maintain the equipment and systems during validation • Consider impacts on building owner at the end of the study	• Work closely and effectively with the building owner or on-site contact • Show respect, support, and follow-through during the project • Focus on collaborating with communities and building owners or on-site contacts while improving building function and enhancing researcher-partner connections
5 After the Research	• Maintain existing relationships and continue to build connections • Offer ongoing technical support and resources	• Share results and findings with building owner, bridging organization, and other appropriate parties	• Treat the validation process as the beginning of a relationship • Nurture partnerships established during the project to foster adoption and understanding of energy efficiency technologies • Communicate results and newly identified research and development needs to researchers, manufacturers, utilities, and policymakers
Additional Feedback	• Develop requirements for requests for proposal	• Expand community engagement beyond the building partner	• Seek expert input from multiple fields and practices when developing proposals for field validations in underserved communities • Expect the engagement process to involve scientific and interpersonal nuances and proficiency and to take extra time

Figure 3. Field validation stages in approximate chronological order. Note that each project is unique, the actual order may vary, and the building partner should be engaged as early as possible.

Engagement and Research Project Guidance

The results of the expert conversations are presented in stages comprising themes that roughly follow the chronological order of preparing for and conducting validations, as shown in **Figure 3**. Researchers can use these results to understand the benefits of working with underserved communities, plan research projects, find partners, and build valuable relationships.

Stage 1—Field Validation Considerations in Underserved Communities

Several experts emphasized the need to be thoughtful about which technologies are evaluated in buildings in underserved communities. Technologies designed to function with cutting-edge building upgrades or meant for larger buildings, for example, may not be suitable. Likewise, low-maintenance technology with shorter returns on investment can be good fits for partners new to validations. Stage 1 details high-level considerations for working with underserved communities.

Address Energy Use, Emissions, and Climate Change

Underserved communities may house suitable host sites for technologies that address energy use, emissions, and climate change. Buildings in underserved communities can have deferred maintenance as a result of being under-resourced, and the condition of the buildings and their typical fuel sources may contribute to increased energy usage. Validating new technologies in underserved buildings can therefore result in greater greenhouse gas emissions savings than in buildings that are already relatively energy-efficient.

Experts also cited the disproportionate impact of climate change on underserved communities. New technologies can help **building owners** and **on-site contacts** moderate rising energy bills resulting from extreme temperatures and can help make buildings more comfortable and resilient as the climate changes.

> *Energy efficiency improvements can free up capital that would otherwise go to energy costs.*

Prioritize Equity and Justice

Many conversations emphasized prioritizing equity because of the systematic dearth of investment in underserved communities and the subsequent lack of opportunities. Experts cited historical redlining and limited access to loans and other sources of capital to finance improvements as examples of obstacles to upward mobility.

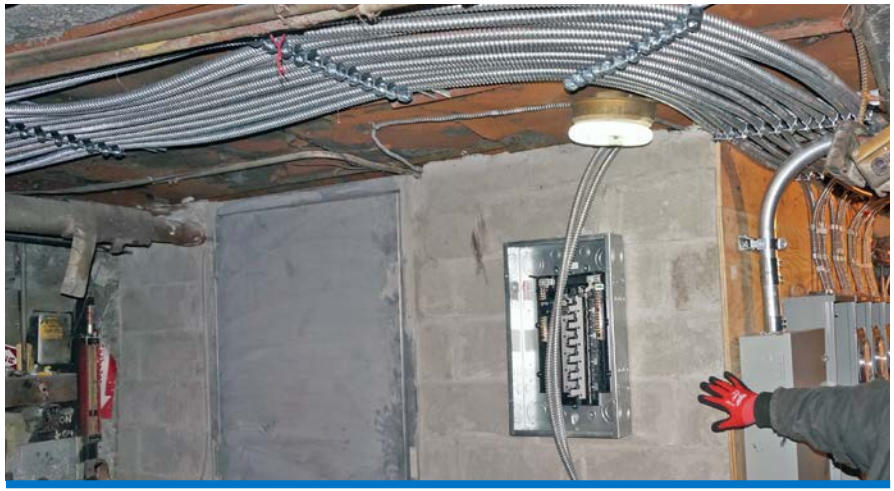
There were also multiple mentions of the sentiment, "lifting up the most underserved lifts up all," echoing the idea that bridging the efficiency gap in buildings in underserved communities could have a greater impact on overall building efficiency than making improvements to more energy-efficient buildings. Validation projects were described as one way to boost investment in a local building and expand opportunities for the **building owner** or tenants because energy efficiency improvements can free up capital that would otherwise go to energy costs.

Improve Technology Development

There were multiple mentions of the improved technology development that could result from rethinking traditional validation buildings. Several researchers mentioned that data from more diverse buildings and conditions could help support technology development and highlight strengths or gaps in a technology's design. Other experts explained that solutions only designed for more upgraded buildings may not interest owners of older buildings in underserved areas because the owners' unique needs were not considered during technology development.

Increase Adoption

According to community engagement experts, informing underserved communities about new, effective technology can help build awareness of **Energy Efficiency Co-Benefits**, including cost savings, improved occupant comfort, and healthier indoor environments, and can help increase adoption. Business and **building owner**s are often handling multiple duties and do not have the time to research new technologies or building improvement options. Researchers should explain how the technology will improve the building owner's bottom line or address other metrics they value so they can make an informed business decision. Inclusion in a **field validation** provides an opportunity to learn about the technology firsthand; become comfortable with it and aware of its capabilities; and share experiences with building occupants, colleagues, and others.



An affordable multifamily property in Crown Heights, Brooklyn, replaced a failed boiler with a heat pump system, which required upgrading the electrical service. The new system also improved indoor air quality and reduced the energy required for heating and cooling.

Photo from BlocPower

Do No Harm

Several experts warned that engaging underserved communities in **field validation**s should not be done to "check the box" of including a previously excluded group. It is important and valuable to include a diversity of **building partner**s in validation opportunities, but this inclusion needs to be thoughtful, respectful, and treated as a long-term partnership investment rather than a requirement to satisfy and move on. The harms that should be avoided include wasting partners' time and resources, damaging the participating building or increasing its operating costs, and creating distrust by poorly managing the relationship. To ensure positive relationships, researchers must accept the realities community members and building owners are facing and manage expectations. For example, buildings may require long-deferred maintenance or other upgrades before the validation can proceed.

There were also several firm reminders that technology is not to be "tested on" underserved communities. The technology to be validated must be at a readiness level that is presumed to be functional and beneficial; underserved communities should not be test subjects for underprepared researchers or projects. Experts also emphasized considering the right location for the technology. For example, would this technology be a good fit in this context, even in a perfectly updated building? Could the building actually benefit more from air sealing and insulation (more traditional building improvements) than from the latest technology? Researchers need to identify appropriate opportunities to engage underserved communities and avoid any possibility of causing harm to vulnerable populations.

Simplify Communication

Owners juggling multiple roles and responsibilities likely do not have the resources to support a large staff. Using smaller buildings for **field validation**s can, however, have the silver lining of a single point of contact rather than multiple layers of management, and that can improve communication efficiency and partnership opportunities. Several experts suggested resources on small buildings and small portfolios that could help build understanding of the unique constraints and conditions of those settings.[44,45]

44 *https://www.nrel.gov/docs/fy14osti/57776.pdf*
45 *https://www.nrel.gov/buildings/small-businesses.html*

Stage 2—Research Design and Project Planning

After deciding to choose a building located in or serving an underserved community, researchers may need to adjust their typical research design and project management approach. **Field validation** researchers explained that successful research design often includes two components—understanding the information needed from the technology validation and understanding occupants and their behaviors.

Focus on Research Design Flexibility

When designing research in buildings in underserved communities, researchers should set realistic expectations and build in flexibility. Older, smaller buildings with more deferred maintenance may require more of the research team's resources and time. When possible, several experts suggested involving the **building owner**, tenants, and occupants in the development of the proposal and project plan so the research becomes a productive partnership rather than an inconvenience. A few researchers also suggested thinking about ways to integrate lab and field evaluations to ensure the success of **field validation**s. Greater integration of these stages may allow researchers to work out more technology issues prior to field deployment, which could increase confidence in a technology's success in the field.

Integrate Applicable Metrics

Several researchers suggested integrating more **energy equity** and **energy justice** research metrics in addition to the evaluation metrics appropriate to the technology, and one expert suggested a specific study to review.[46]

Other researchers and experts explained that the commercial (rather than residential) setting of the validations may make certain metrics more or less applicable, depending on the technology being validated. For example, metrics related to occupied hours will be different in commercial settings than they are in residential settings. Several experts suggested including metrics that are of interest to the **building owner**, **on-site contact**, or broader community. These metrics could include energy efficiency, energy costs, financial benefits, social equity and justice, and/or occupant well-being. Findings should be shared with **building owner**s and **on-site contact**s, and, if appropriate, with the wider community, including neighborhood groups, business development organizations, or other local residents or businesses that could benefit from the results.

Givey Kochanowski (right), the Alaska Program Manager for the U.S. Department of Energy's (DOE's) Office of Indian Energy, works with participants during the 2018 Energy Planning and Development Workshop in Kodiak, Alaska. Among other things, DOE programs help local tribes offset diesel use with clean energy technologies.

Photo by Harrison Dreves, NREL

46 *https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-32179.pdf*

Build Flexibility Into Project Timeline and Budget

A practical project timeline and budget flexibility need to be built into the validation effort. Researchers and outreach experts alike noted that preparing for and conducting work in underserved communities will take more time and resources as researchers work to develop new partnerships. This increase in resources should be accounted for in the budget, communicated to the funder, and explained to all involved parties. A few researchers emphasized the importance and significant time investment of bringing five key parties together—researchers, the technology company, the utility, the funder, and the **building owner**—all of whom are involved in the validation itself. The local utility and community-based organizations can also be important partners before and after the validation.

There is increased interest in engaging building occupants so they can learn about the technology's impacts, and including human subjects in research requires institutional review board guidance. Researchers should speak with their respective institutional review board[47] subject matter expert or liaison as early as possible to understand the trainings, approvals, and other processes involved.

Compensate Organizations and Building Contacts

Compensation was a common theme in nearly all conversations. Experts were in agreement that organizations connecting researchers to **building owner**s should be compensated for time spent on the project, or could even be employed as subcontractors to provide structure to the compensation. **Building owner**s or **on-site contact**s should be employed this way as well. Experts also agree the technology should be gifted to the **building owner** and the installation costs should be covered by the validation project. The **building owner** should not pay for the technology and installation or participate in a cost share arrangement. Several experts also suggested planning a budget line item to replace the building's equipment if the technology fails.

47 *https://www.apa.org/advocacy/research/defending-research/review-boards*

Stage 3—Find a **Building Partner**

After deciding to work with a **building partner** in an underserved community and making project plan adjustments, researchers will select the geographic area and validation building.

Evaluate Online Tools

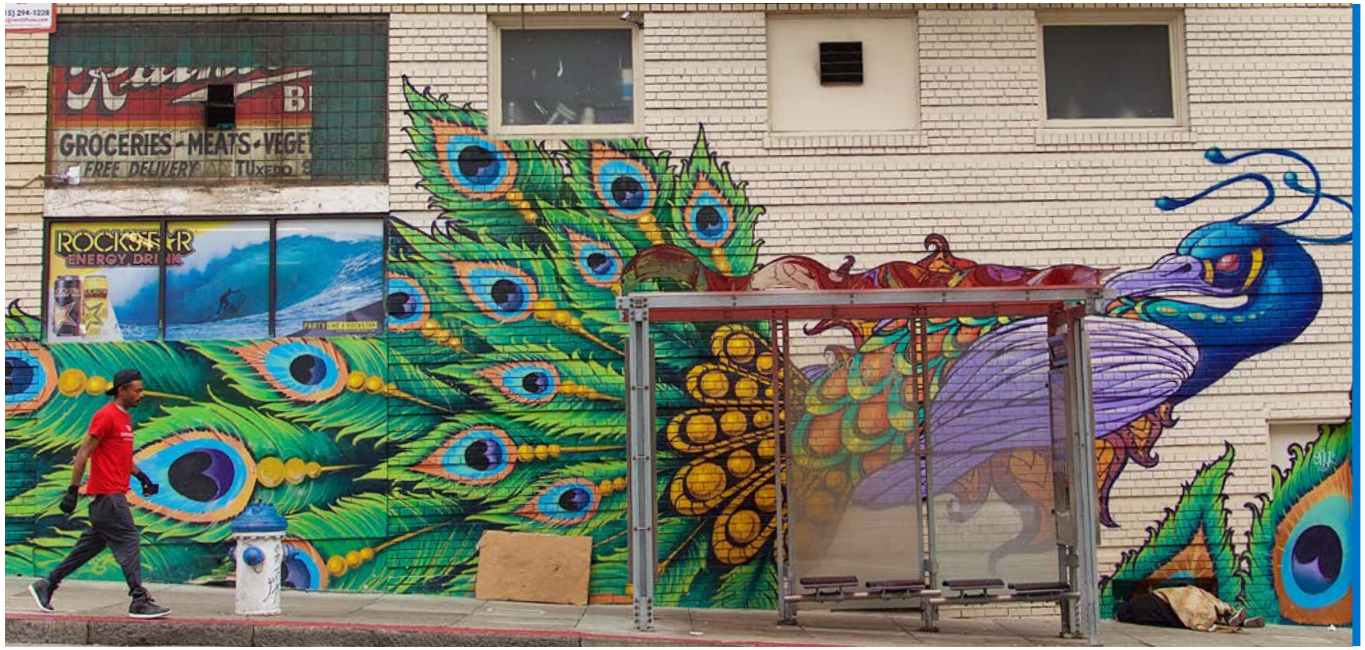
There are several online tools that use different methodologies for identifying underserved communities, including the Energy Justice Mapping Tool—Disadvantaged Communities Reporter,[48] the Environmental Justice Screening and Mapping Tool (EJScreen),[49] the Climate and Economic Justice Screening Tool (CEJST),[50] and the Low-Income Energy Affordability Data (LEAD) Tool.[51] To optimize the value of these tools, experts recommended considering the technology to be validated and its climatic requirements. For example, does the technology specifically require a humid or dry environment and how much seasonal variation, if any, does it need?

Experts then recommended beginning a regional search with those parameters, and suggested that researchers use the tool(s) to identify areas near existing contacts, if relevant. If the technology does not have a climatic requirement, researchers could begin by thinking about where their existing contacts are located, and then using the tool to identify more specific areas of interest. There are multiple stages at which a mapping tool can help identify an underserved community.

Understand Underserved Areas

Several engagement and equity experts emphasized the need to understand underserved areas, especially the chosen research area, including both the history and current circumstances of the neighborhood, city, and region. Researchers should investigate histories of redlining and other forms of systematic disinvestment and disenfran-

48 *https://energyjustice.egs.anl.gov*
49 *https://ejscreen.epa.gov/mapper/*
50 *https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5*
51 *https://www.energy.gov/eere/slsc/maps/lead-tool*



Building relationships with local partners who can foster understanding of life in an underserved community will aid researchers during the technology field validation and can pay dividends beyond the scope and duration of the project. This vibrant mural on Leavenworth Street between Geary and O'Farrell adjacent to a person sleeping on the sidewalk speaks to the contrasts in the diverse and gritty Tenderloin district of downtown San Francisco.

Photo from Ed Yourdon, *http://flickr.com/photo.gne?id=23058597764, https://creativecommons.org/licenses/by-nc-sa/2.0/*

chisement to better understand the barriers and challenges faced by community members and the reasons they may be hesitant to enter into a partnership with a large institution. Engaging directly with community members and stakeholders is an effective way to learn more about the area.

Researchers can attend community events and set up a table with information and friendly representatives to create familiarity between the research organization and community members in a casual, approachable environment. There were also recommendations concerning the future of the building, especially if the area is gentrifying and current residents are being displaced due to rising housing costs. Having broad knowledge of the area builds important understanding and context for the validation's impact over time.

> *Researchers should investigate local histories of disinvestment and disenfranchisement to better understand community challenges and barriers.*

A few engagement experts suggested finding key partners who could become champions and examples of positive partnership. This is possible if the relationship is successful and the partner is interested. If the experience is handled well—even if the new technology has glitches or does not perform properly—the partnership can act as a catalyst for future collaboration and serve as an example for **building owner**s who may be hesitant to participate.

Work With a **Bridging Organization**

Many experts emphasized the benefits of working with a **bridging organization**—an established organization or existing connection in the area—to help researchers find **building owner**s. These organizations should be local and have trusting relationships with **building owner**s, who are often their constituents. Regional (multistate) organizations were seen as too far removed from the **building owner** level, although these organizations may have relationships that could connect researchers and **building owner**s. A common theme was the importance of researchers building a trusting, cooperative, and mutually beneficial relationship with the **bridging organization**.

Researchers need to be clear about how they introduce themselves and their work, and how this project fits into a larger organization, whether that is a federal department or another entity. This introduction should describe the relationship between the **building owner** and researcher and note that the **building owner** will be compensated for time spent on the project. The **bridging organization** could even be hired as a subcontractor. Experts also suggested nonmonetary forms of compensation and recognition, such as the inclusion of the **bridging organization**'s and **building partner**'s logos and names in reporting, as appropriate and with permission, to give them recognition for the role they played in the research. It may also be helpful and of interest to tour the researchers' lab or other buildings hosting validations.

Researchers need to be clear and transparent with the **bridging organization** about the proposed research and what is needed from **building owner**s. The **bridging organization**'s name and reputation is tied to their recommendation to work with the researcher, and they want to remain a trusted resource for their community. Researchers should make it easy for **bridging organization**s to reach out to their constituents by providing plain language descriptions of the technology, the project, the risks, and the benefits. These descriptions should include translated materials if necessary as well as the contact information of a reliable and responsive project contact. These descriptions may be inserted into organizational newsletters and other updates.

Researchers should be prepared to attend meetings—in person or virtually—to pitch the project to the **bridging organization**'s members. Finally, **bridging organization**s and **building partner**s may have other needs or challenges researchers can assist with, such as finding and applying for funding for energy saving building upgrades and learning where to look for reports and other resources. A list of possible **bridging organization**s is shown in **Figure 4**.

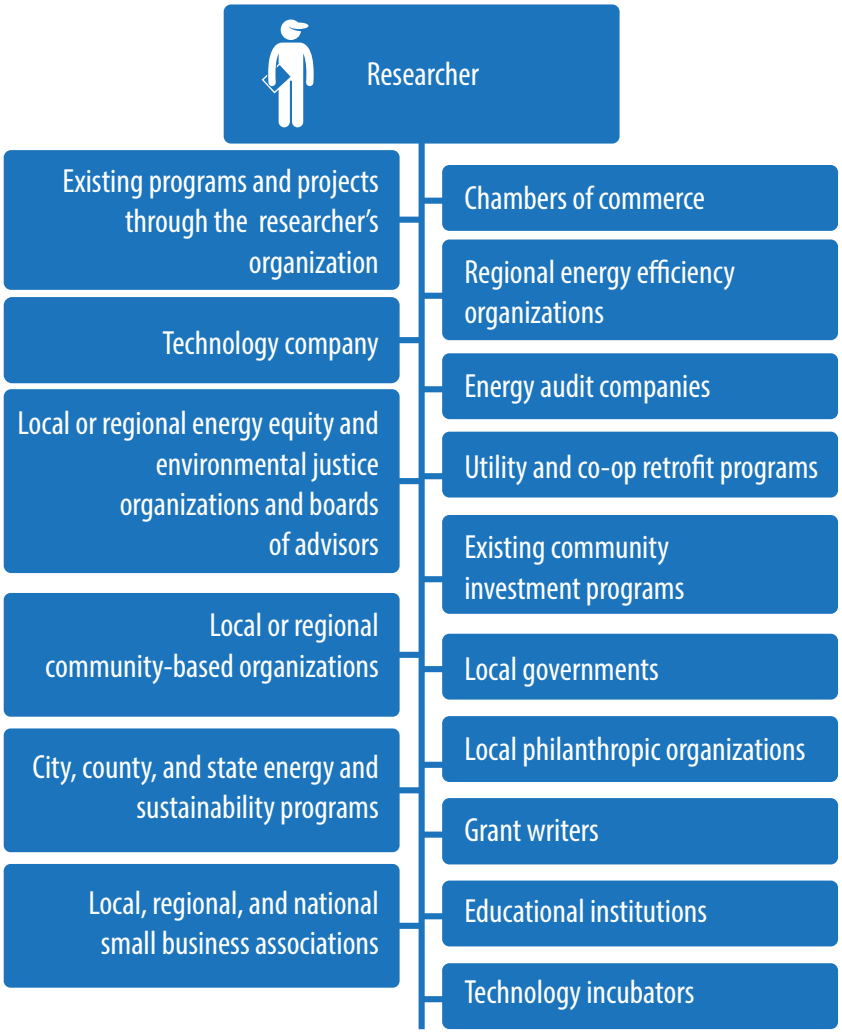


Figure 4. Bridging organizations and connections

Credit: Marjorie Schott, NREL

Select a Building

Any building other than a single-family residential, low-rise multifamily, or industrial building is a **commercial building**. This includes businesses, nonprofits, community centers, schools, daycares, nursing homes, and mid- and high-rise multifamily buildings.

In underserved communities, **commercial building**s tend to be older, smaller, and mixed-use. These buildings often house both multifamily housing and small businesses.

Beyond the building characteristics appropriate for the validated technology, several experts suggested selecting a building that houses a community-serving organization. These organizations often have limited budgets and could benefit from reduced energy bills and access to new technologies that would otherwise be financially out of reach. There may also be opportunities to engage the organization's clients and provide educational opportunities while partnering on the validation.

Examples of community-serving organizations are places of worship, community centers, and nonprofits. Experts also suggested engaging small businesses for several of the same reasons—limited budgets, opportunities, and bandwidth to explore new technologies. Further, researchers are encouraged to reach out to minority- and women-owned businesses to work toward eliminating support gaps. Most broadly, experts suggested inviting parties such as **building owner**s, tenants, occupants, and clients—who are connected to the building but not typically included in traditional validation projects—to participate in some way.

Analyze Building Characteristics

Results from the **Building Characteristic Analysis** indicate a variety of technical and interior building characteristics necessary for most validations. In addition, several researchers stated that site visits are critical before all **field validation**s, but especially when the buildings

In underserved communities, commercial buildings tend to be older, smaller, and mixed-use. These buildings can include both multifamily housing and small businesses.

Photo from Jeff, *http://flickr.com/photo.gne?id=4503480497, https://creativecommons.org/licenses/by-sa/2.0/*

may have deferred maintenance or unique characteristics. It is important the building be in a condition to introduce the technology.

For example, there may be building upgrades related to energy efficiency, deferred maintenance, or code compliance that need to be completed first. Engagement and equity experts emphasized that the **field validation** project should pay for as many required upgrades as possible in preparation for technology installation or recognize where these upgrades are needed before installing the new technology. One expert mentioned the importance of the **building owner** reviewing their insurance policy to be clear what building equipment it does and does not cover. The physical security of the equipment should also be considered because theft, damage, or tampering may occur, and the space constraints in older and smaller buildings may necessitate unconventional installations.

The researchers also emphasized that the building should be representative rather than an outlier. Does it fall within a subset of **commercial building**s—a religious building used regularly for that purpose, for example? Or would its unique characteristics make study results inapplicable to other **commercial building**s as in the case of a religious building that has been retrofitted for use as a restaurant? Experts agreed on the importance of finding ways to be more flexible and investigate new installation methods to uncover opportunities for implementing the technology in a wider variety of buildings.

Another important consideration is access to qualified contractors. It is not uncommon to have hiccups with a new technology and providing good service to the **building owner** or **on-site contact** is important for a positive relationship and successful validation. Finally, one researcher emphasized that the technology under study can scale with building size, and smaller technology—residential technology, for example—could be validated in smaller buildings.

Pitch the Project

It is important to keep **bridging organizations**' and **building owner**s' perspectives in mind when pitching the project. The technology is cutting edge, but researchers should understand that **building owner**s may not immediately see its value. It is important to communicate the technical value of the project but to also explain it in terms of issues it addresses beyond improving energy efficiency, also known as **co-benefits**. A few recommendations included the term "code switching," referring to a strategy researchers can use to "switch" to language and topics that are clear and matter to **building owner**s rather than focusing only on the scientific value of the project. Experts advised that researchers explain each step of the process very clearly, clarify what **building owner**s and **on-site contact**s can expect, and give them the tools to succeed. They also need to help the **building owner** determine whether this technology offers enough value to be worth their time.

Experts noted the importance of being thoughtful about how the different parties—researcher, funder, technology company, etc.—are integrated into conversations. Not only can the relationships between these groups be confusing, but **building owner**s and **on-site contact**s may have had negative past experiences with researchers or other entities uninterested in community concerns and focused on narrow goals.

In November 2022, local communities from across the country sent representatives to a collaborative working session of the Solar Energy Innovation Network (SEIN) held on the NREL campus in Golden, Colorado. This session was part of SEIN Round 3, which focused on solar in underserved communities.

Photo by Harrison Dreves, NREL

One engagement and equity specialist cautioned researchers to be careful with terminology, including words that may seem common in the energy field. A concept like "net zero," for example, could be perceived as only relevant to "rich" and affluent communities, which may be inconsistent with how local contacts identify themselves and their neighborhoods. Terminology could also be unfamiliar to the potential partner, which could be isolating and off-putting.

Emphasizing common values can be more successful—discussing saving money, for example, rather than a topic that may seem political, such as climate change. The messaging needs to be very clear, and one expert suggested something as simple as "this is what we are investigating, this is how to apply and participate, and this is what we will need from the building and owner."

> *Solving problems beyond saving energy and identifying* ***co-benefits*** *of interest to the building owner were common themes.*

Solve Non-Energy Problems

A very common theme in expert conversations was the need to solve problems beyond saving energy, and to identify the specific **co-benefits** that are of interest to the **building owner**. Several experts emphasized that although **building owner**s do care about reducing energy use, they often have larger or more pressing business or building concerns. If the new technology can address these concerns, **building owner**s can put resources elsewhere, such as toward enhanced services or business operations. Suggested areas included safety and security, health and wellness, business and building operations, time and cost of maintenance, water usage, foot traffic, and occupant comfort and experience.

Experts emphasized, however, that it is important to learn about the **building owner**'s specific challenges. For example, some local jurisdictions have "clean," "green," or "sustainable" building ordinances, and **building owner**s may be interested in learning how the technology can help them satisfy those requirements. HVAC consistency also came up, and some **building owner**s expressed interest in having more granular control over spaces such as conference rooms.

Consider **Building Owner**s

Building owners and **on-site contact**s are essential to the success of **field validation**s, and **building owner**s in underserved communities have specific concerns and needs. Logistically, large, corporately run buildings often have many layers of management and coordination, and smaller buildings in underserved communities may only have one or two layers of management, which can mean fewer players and simpler communication. However, because the **building owner** or **on-site contact** is managing many aspects of operations, they may be pressed for time and should be compensated for time spent on the project.

It is also important to consider **split incentive**s—situations in which the **building owner** may purchase the equipment (up-front cost), but the tenant may pay the energy bills (operating cost)—and how that affects the parties' willingness to participate.

Communicate Clearly

Transparency in communication, risk explanation and mitigation, and expectation management are critical to the process of finding a **building partner** and developing a successful relationship. Trust and clarity need to be built first with the **bridging organization**. To achieve this, researchers need to acknowledge and explain the technology's risks, what the technology can and cannot do, and who is responsible for rectifying issues. These considerations need to be clearly explained and captured in an agreement that includes the technology company and its role.

Researchers need to explain that the new technology may not operate exactly as the prior technology did, and they should be prepared with examples of other buildings participating in the validation; **building owner**s may be more comfortable knowing they are not the only participants. In addition, researchers must explain why this technology can be trusted even though it is new, and the technology itself must be

Built in 1928 by architect John Eberson, the restoration of the Capitol Theater in Flint, Michigan, was completed in 2018. Lovingly restored older buildings in underserved communities often become gathering places.

Photo by Kelsea Dombrovski, NREL

safe. One expert suggested compiling a journey map of the **building owner**'s participation in the research to help the researchers understand where burdens will arise and the **building owner** understand when disruptions will occur.

> *Transparency in communication, risk explanation and mitigation, and expectation management are critical to the process of finding a **building partner** and developing a successful relationship.*

Energy cost savings—or lack thereof—will also need to be explained up front. Although the new technology may reduce energy use, savings may not materialize if there is a rate change or electricity is more expensive than gas. Although experts encouraged gifting the technology and compensating the owner or **on-site contact** for their time, the tenant or owner will still be responsible for the energy bills and they need to be prepared for cost changes. Sustaining savings can be challenging, so researchers should be sure the technology is delivering benefits beyond initial adjustments to their bills or operations.

Finally, transparency around upfront costs is important. Similar buildings in the area may be interested in purchasing the technology, and will need to know the upfront and maintenance costs as well as whether any local contractors are familiar with the technology. Setting expectations for the **building owner**, **bridging organization**, and other building managers who might be interested in the technology will be important, and the accessibility of the technology needs to be understood by all. It may be that the technology performs well with great benefits but peer buildings could not adopt it, in which case researchers and the technology company would need to consider appropriate messaging around, and perhaps analysis of, the product cost.

Consider Building Tenants

Many experts emphasized the need to consider building tenants—not just the **building owner** or **on-site contact**—from the beginning of the search process. Tenants may need to participate in the research or may be affected in other ways, including during installation, maintenance, equipment malfunctions, or disruptions to the building environment such as changes in temperature, lighting, or indoor air quality. Because of this, tenants need to be considered and included in discussions of agreements, disruptions, and other aspects of the validation. One expert suggested setting two meetings—one with the **building owner** and one with tenants—to understand the perspective of each. In terms of agreements, several experts explained that tenants should be signatories to participation agreements alongside **building owner**s, and that there should be protections in place so **building owner**s will not increase rents or remove tenants if the building upgrades increase the property's value. Experts recognized, though, that it is beyond the researchers' role to try to influence legal contract processes.

> *One expert suggested setting two meetings—one with the **building owner** and one with tenants—to understand the perspective of each.*

Stage 4—Work With the **Building Owner** or **On-Site Contact**

After finding a **building partner**, researchers must cultivate the relationship thoughtfully and institute safeguards to reduce negative impacts.

Develop Agreements

Several experts emphasized the need for agreements to be clear and straightforward, with any technical or legal language explained. **Building owner**s and **on-site contact**s need to understand their responsibilities over the duration of the validation and tenants should also be considered and included in agreements. In addition, if the technology does not work as expected, the agreement should describe the process of purchasing and installing replacement equipment. All agreements should be translated into the **building owner** or **on-site contact**'s preferred language and should include references to code violations or other health and safety challenges that could affect the building and the validation project.

Identify Points of Contact

Experts explained that clear points of contact on both the building and research side are essential. **Building owner**s and **on-site contact**s need to know who to get in touch with about questions and equipment issues, and researchers need to know who to contact with questions or updates about equipment inside the building. All parties should collaborate on a plan to ensure reasonable access to each other, and researchers should emphasize the importance of identifying a new building point of contact promptly in the event of staffing changes.

Plan for Disruptions

Researchers need to plan for disruptions the new technology and the validation process might cause. Experts advised that if researchers need information about the building ahead of time, they should develop easy ways for the **building owner** to convey it. For example, taking photos of existing equipment would be a lighter lift than copying down and sending unit information, although this still requires owner approval. In the event of a disruption, researchers need to communicate its likely effects as well as the steps to be taken to mitigate the impact. They could, for example, install replacement components when the building is closed. It is also important that researchers or hired contractors handle the safe disposal of any equipment that may be removed.

Monitor, Evaluate, and Maintain the Installation

Equipment approachability was mentioned by several experts. Following installation, the technology should be convenient to use if it requires regular interaction from the **building owner**, **on-site contact**, tenants, occupants, maintenance staff, or contractors. The project plan should include an educational and training component appropriate for the owner, **on-site contact**, tenants, and maintenance personnel, and researchers should leave clear instructions specific to each of these participants and groups. Researchers should establish a point of contact the **building owner** or **on-site contact** can call on when issues arise during monitoring, evaluation, and maintenance, as well as identify local contractors who can assist. Researchers and contractors should discuss the technology with the **building owner** or **on-site contact** and answer their questions over the course of regularly scheduled check-ins during the monitoring and evaluation period. Open communication about the maintenance tasks and costs may influence the building owner's interest in keeping the equipment.

Complete the Study

At the end of the study, many experts suggested gifting the technology to the building if it is functioning and the **building owner** wants to keep it. Gifting technology could come at a considerable cost, and this should be addressed in early discussions. Researchers should consider the cradle-to-grave impact of the technology for the **building owner**. If the new technology will not remain in the building, the initial agreement should identify the replacement equipment and the party responsible for the replacement. Several experts suggested the research team should absorb the cost.

Stage 5—After the Research

Researchers have important roles to play, even after the study has concluded.

Maintain and Build Connections

Engagement and equity experts explained that it is essential to maintain and continue to build connections with the **building owner** and the **bridging organization** following the study. Both groups may have future questions, ideas, and feedback researchers can assist with, and researchers may need input or have future partnership opportunities. Many underserved communities have experience with research that did not benefit community members and have been taken advantage of in other ways. Technology validations must not continue this cycle, and researchers must follow through on all established agreements.

Offer Technical Support and Resources

Once a research partnership has ended, **building owner**s may have additional questions related to energy efficiency or building operations. Researchers should assist with these inquiries and share other resources as necessary and possible. If additional opportunities for research or funding come up, researchers should make a point of sharing this information with partners. In other words, researchers should proactively continue the relationship(s).

Share Results and Findings

Engagement and equity experts emphasized the importance of sharing results and findings with the **building owner**, **on-site contact**, **bridging organization**, and community and research groups who have an interest in the results. When data are processed, thoughtfully distributing the results can have a big impact on understanding the technology and future adoption. Although energy savings are important, they may not be a priority to the **building owner**. Reduced costs or improvements elsewhere in the building—in indoor air quality, for example—may be essential information for the **building owner** and

Connecting with established neighborhood groups during the process of finding a building for the field validation project helps build and nurture relationships with local residents. In 1992, Abu Talib and a group of neighborhood residents founded the Taqwa (Arabic for "the Peace") Community Farm in the Highbridge neighborhood of the Bronx in New York City. The half-acre lot at 164th Street and Ogden Avenue, once emblematic of urban decay, is now a lush garden tended by volunteers from nearly100 families.

Photo from Preston Keres, USDA/FPAC, *http://flickr.com/photo.gne?id=52195822641*, *https://creativecommons.org/licenses/by-sa/2.0/*

others curious about the technology. Several experts mentioned that sharing results should be built into the budget. This could take the form of printed information and a site visit to share the results at a community or organizational meeting, with meals and childcare provided for attendees.

Thoughtfully sharing results can also provide data the community can use to apply for grants for additional building improvements, further reducing energy consumption and saving money. In addition to a report and a meeting, results can also be shared on the websites of the research organization, building and/or business, and **bridging organization** as well as through tangible products such as informational posters that could be displayed in public locations in the neighborhood. It is also important to communicate results and newly identified research and development needs to researchers, manufacturers, utilities, and policymakers.

Additional Feedback

Many experts offered additional advice and suggestions, which fell loosely into two themes.

Expand Community Engagement

Experts shared ideas about how to expand technology validations beyond **building owner**s and **bridging organization**s. Several supported the idea of having local trade school instructors and students participate in installations to learn about the technology, and there were suggestions to seek out minority-owned contracting businesses to do the installation and maintenance. This additional engagement with organizations in these spaces can expand the reach of these opportunities.

Develop Requirements for Requests for Proposal

Several experts advised against including a request for proposal requirement that all **field validation**s be conducted in small to medium buildings in underserved communities. Some technology will not be relevant and will not address pressing issues faced by buildings in these communities.

Another suggestion was that request for proposal descriptions require applicants to seriously consider demonstrating their technology in an underserved community and then justify why it would or would not be a good fit. There were also a few suggestions to build partnerships prior to responding to a request for proposal to involve the **building owner** or **on-site contact** from the beginning and provide a clearer description of the research design as part of the proposal. Several experts suggested requests for proposal include evaluation metrics beyond cost and energy savings. For example, including metrics assessing **energy justice**, such as the effect on **energy burden**, or metrics of interest to the **building owner**, such as the effect on occupant comfort, would be valuable additions to studies.

CONCLUSIONS

Public art, like this mural in Grand Rapids, Michigan, can help create neighborhood identity, a sense of place, and strong community connections.

Photo by Kelsea Dombrovski, NREL

The information in this guide can help achieve the goals of increasing the deployment of energy efficiency technologies and providing clean energy benefits to underserved communities.

Key Takeaways

- ✔ Rethink field validation approaches and thoughtfully consider the fit between a technology and an underserved community
- ✔ Adjust project planning to account for increased time and budget, especially during the stages that include finding a partner, evaluating the building, and sharing results
- ✔ Develop flexibility and creativity around building requirements
- ✔ Engage meaningfully when looking for a **building partner** from the earliest stages of project development
- ✔ Recognize the community's and **building owner**'s goals
- ✔ Solve problems beyond reducing energy use
- ✔ Consider impacts to building tenants
- ✔ Respectfully engage with building occupants during the validation
- ✔ Share results with **building owners**, occupants, and the larger community
- ✔ Maintain ongoing relationships with **bridging organization**s and **building partner**s

Future research should confirm this guidance by applying it to a validation in an underserved community. This guidance can and should evolve as validations are conducted in a greater diversity of buildings and locations to increase instances of equitable decarbonization, technology adoption, and positive partnership. Field validation procedures should continue to evolve to develop greater focus on underserved communities and disinvested buildings as important field validation research locations.

Researchers can think creatively about which building features are needed and which they can work around to increase validation participation opportunities. The evaluation of past **field validation** reports provides an understanding of commonly required and desired validation building characteristics. Although building needs will vary by study, researchers may find that gathering additional and different types of data and providing tailored technical assistance and opportunities to **building partner**s are a better fit for underserved communities.

In some cases, a building in an underserved community may not be the right fit. Although there are many reasons to include underserved communities in **field validation**s when the validation is the right fit for the building and the community, additional considerations may work against choosing this type of building. For example, these buildings will require more time and resources than working with traditional **field validation** partners because of the need to build connections, evaluate building conditions, and ensure mutual benefits. On the other hand, the additional resources can lead to expanded benefits, as these partnerships will present opportunities to gather unique findings and build long-term relationships. Building in a longer timeline, bigger budget, and more flexible research design will support project success while expanding the validation's impact and data collection opportunities.

Engaging with the community to find a building partner is perhaps the most important aspect of conducting field validations in underserved communities. Respectful relationships with **building owner**s, **bridging organization**s, and tenants are crucial to a successful validation and ensure valuable data collection by prioritizing equity and justice in the process.

Working effectively with the **building owner** or **on-site contact** is important in all technology validations, but it is especially important when working with underserved communities. These groups have not historically been shown the respect, support, and follow-through they deserve, and have had fewer opportunities to improve the buildings in their area. Researchers have the chance to collaborate with communities and **building owner**s or **on-site contact**s while improving building function.

Although the validation may be the initial impetus for connecting with the bridging organization and building owner, it could be the beginning of a relationship that leads to ongoing collaboration. Continued partnership is key for successfully growing adoption and understanding of, as well as helping users feel comfortable with, the new energy efficiency technologies. Consider looking to the community for skilled and talented technicians willing to install and maintain the equipment and/or be trained in the technology.

Conducting **field validation**s with underserved communities will involve scientific and interpersonal nuances and proficiency, and should not be expected to be fast and simple. The required relationship building will take time, but will ultimately strengthen the research, foster ongoing relationships among participants, and enhance the knowledge and future opportunities of the community partner.

Small businesses like the Bridge Coffee Shop in Brooklyn in New York City are often the backbone of underserved communities and are frequently found in mixed-used buildings with dwellings on the floors above the storefront.

Photo from dumbonyc, *http://flickr.com/photo.gne?id=2677655522, https://creativecommons.org/licenses/by-sa/2.0/*

GLOSSARY

bridging organization. A local organization or existing connection grounded in the community that has trusting relationships with building owners.

building owner. Party that owns the building and makes equipment and participation decisions.

building partner. Includes the owner, on-site contact, and other building points of contact.

co-benefits. Benefits beyond reducing greenhouse gas emissions or energy use or sequestering carbon, which can include, but are not limited to, cost savings, job creation, reduced air pollution, and improved grid reliability and resilience.

commercial building. A building other than a residential building, including any building developed for or public purposes.[52] Commercial buildings can contain businesses selling goods and services as well as daycares, nursing homes, and mid- and high-rise multifamily buildings. Broadly speaking, any building not used for single family housing purposes is a commercial building.

energy burden. The percentage of gross household income spent on energy. The national average energy burden for low-income households is 8.6%, compared with an average of 3% for other households. About 50 million U.S. households (44%) are defined as low income.[53]

energy equity. A situation in which the economic, health, and social benefits of energy use extend to all levels of society, regardless of ability, race, socioeconomic status, or existing energy systems.[54]

energy justice. Social and economic energy equity that aims to correct the historic social, economic, and health injustices disproportionately inflicted on underserved communities by the energy system.[55]

field validation. The installation and evaluation of a new technology in the field.

on-site contact. Party responsible for maintenance, repairs, tenant relations, etc., who is likely to be in regular communication with researchers. Sometimes the building owner is the on-site contact, but it can also be a property manager, building superintendent, or other employee.

split incentive. Scenario in which a building owner pays the upfront cost of energy efficiency upgrades and tenants pay the energy bills.

52 *https://www.govinfo.gov/content/pkg/USCODE-2021-title42/pdf/USCODE-2021-title42-chap81-subchapII-sec6832.pdf*
53 *https://www.energy.gov/eere/slsc/low-income-community-energy-solutions*
54 *https://www.pnnl.gov/projects/energy-equity*
55 *https://iejusa.org*

Small, mixed-use buildings like this one in rural Michigan serve multiple purposes in underserved communities.

Photo by Kelsea Dombrovski, NREL

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