Title

Leveraging the Power of Communities to Decarbonize Buildings

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ABSTRACT

Local actions are increasingly seen as essential for buildings to transition off fossil fuels, led by local governments who have enacted ambitious climate action plans. A complementary approach described in this paper leverages existing connections and institutions within a local area to implement programs led by members of the local community.

This paper presents findings from the Oakland EcoBlock pilot project, which has built on existing relationships among neighbors on a block in Oakland to decarbonize a cohort of residential buildings. We focus on lessons learned about social dynamics and individual behavior that can be used to improve local programs in the future. These lessons include factors such as the need for strong local champions who can serve as "connectors" within a community, the importance of neighbor-to-neighbor marketing of the program, the need for objective educational materials to build trust within the community, and the effectiveness of starting with relatively easy community activities initially (such as tree planting) to build working relationships. This package of social/behavioral activities helped the EcoBlock increase retrofit program participation within the target population from the 5-10% rate typical of low-income programs to approximately two-thirds of the residents.

Introduction

California's existing building stock is responsible for about one quarter of the state's greenhouse gas emissions, largely from on-site combustion of natural gas (CARB 2026). To meet the state's ambitious climate goals that call for net-zero emissions by 2045, these existing buildings must be upgraded and electrified to eliminate CO_2 emissions (Howlett et al. 2025). Many local governments around the state have their own ambitious climate targets; building retrofits are a key action to meet these targets. As we weatherize, make energy efficient, and electrify buildings, we must supply power from carbon-free sources, and preferably, to avoid costly upgrades to the transmission and distribution system, source from distributed generation located near the buildings that are consuming the power. Several factors hinder the adoption of these clean-energy technologies, including: 1) high transaction costs inherent in the one-house-at-a-time deployment model, 2) lack of awareness of the benefits of these technologies, particularly in hard-to-reach market segments, and 3) limited access to capital to finance the large capital investments required when coupling energy retrofits with distribution generation systems.

To address these challenges, the EcoBlock concept has been developed over the last decade at UC Berkeley, as a new model for urban transformation to reduce carbon emissions while helping communities adapt to climate change impacts. By coupling efficiency improvements and electrification with community solar energy at the block scale, this approach unlocks social and environmental benefits such as improved indoor air quality by transitioning away from natural gas and providing equitable access to clean technologies. To transform housing stock at the pace required by climate goals, however, we must leverage economies of scale. By aggregating the required design, permitting, financing, and construction work across a block of homes, the EcoBlock concept aims to reduce transaction costs, overcome information barriers, and allow access to lower-cost financing mechanisms that are not available to individual building owners. Aggregating homes at the block level with smart control systems can also allow them to coordinate their power demand and reduce the impact of electrified buildings on the grid. By combining technical measures with limited public financing and helping neighbors self-organize, the EcoBlock approach brings the daunting challenge of a complete energy makeover within reach for low- and middle-income people who need it the most.

To test the EcoBlock concept, the authors are part of a research team, led by the California Institute for Energy and Environment (CIEE), that is demonstrating the EcoBlock's energy upgrades, stormwater mitigation, and shared transportation systems sited at a residential neighborhood in Oakland, California. The project has piloted the detailed design, permitting, community engagement, and governance processes needed to successfully deploy these systems for a residential block. The technologies used in EcoBlock are all commercially available but are integrated at the unique scale of a residential urban block and delivered through a unique process that is designed to be replicable and scalable in similar communities. The pilot deployment has several goals: reduce greenhouse gases, leverage economies of scale, activate and strengthen the community, improve sustainability, and develop a path to scale.

The pilot project has completed the participant recruitment, design and construction phases, and is starting the monitoring phase to assess the performance of the upgrades. The energy upgrades address the building envelope (insulation and air sealing), electrification of natural gas end-uses (space conditioning and water heating, cooking, and clothes drying), electrical service upgrades, and rooftop solar arrays. All the participating homes received these upgrades. The project also developed a detailed design for, but did not implement, a block-level microgrid with central battery and a curbside EV charger with shared EV. The capital costs for the energy upgrades to the homes were entirely covered by research grants from the California Energy Commission and a philanthropic donor.

This paper focuses specifically on the social and community aspects of the Oakland EcoBlock pilot: the factors considered in selecting a block, the recruitment of participating households, and the activities undertaken to educate the block residents and build community.

Block Selection

A block with the right mix of social, technical, and demographic characteristics was essential for ensuring the success of the pilot project. We released an opportunity notice inviting blocks to self-organize and nominate themselves. The recruitment process was intended to be bottom-up: by reaching out to key partners, such as community organizers, associations, City council members, and others to find potential existing communities that were likely to be interested and could most benefit by hosting an EcoBlock. The team ultimately received 12 applications. We used the following process to select and enroll a host block for the research project:

1. Define eligibility and selection criteria.
2. Release Opportunity Notice for block self-nomination.
3. Conduct outreach through a hired community liaison.
4. Neighborhoods self-organize and apply.

5. Use selection criteria to identify top four blocks.
6. Interview block leads and selected residents.
7. Review energy consumption and bill data.
8. Select block.
9. Interested residents sign Letter of Intent.

The Opportunity Notice highlighted several important criteria, as listed below, to help blocks decide if they wish to apply.

1. Show enthusiasm for co-creating the first EcoBlock and collaborating in this project.
2. Show capability of co-creating a Cooperative with neighbors for ongoing operation after the project ends.
3. Have some unshaded roof area for solar panels on each house.
4. Have an average annual energy bill (gas and electric) per household of at least ~$500 per year (to ensure a minimum level of bill savings).
5. Be willing to have 3-6 curbside parking spaces be converted to EV charging parking.
6. Consist of ten or more interested homeowners of single or small multi-family residences that are next to each other (contiguous) (maximum 30 housing units total) in the City of Oakland, CA.

Tables 1 and 2 list the full set of criteria used to evaluate the candidate blocks, along with the weights assigned to each criterion to develop a composite score. The relative weights among the factors were a consensus among the research team about how strongly that factor would affect the success of the pilot project, based on experience working with an initial block in Oakland during an earlier planning phase (Barr et al 2019). Each factor was scored on a sliding scale, according to how well the application met that criterion.

The most successful block applications were driven by a small number of champions on the block who were committed to the idea of neighbors working together and were “connectors” with strong existing social relationships. In some cases, the opportunity to participate in the EcoBlock program was a catalyst for neighbors to work together on activities.

While the process described here was effective in recruiting a very hospitable block for implementing our pilot project, we recognize that scaling this concept will require working with blocks that are more challenging. The recruitment methods described here should be seen as a way to find the early adopters in a city or region, and the methods would evolve as the program became established and evolved to serve a broader cross-section of the population.

Table 1: Block Selection Criteria – Social/Community

Factor	Points	Data Source	Basis for Score
Residents have existing community organization	5	Application Form	Informal or formal block or neighborhood association
Block social cohesion	5	Application Form	Self-report of block social activities (parties, night-out events, produce swaps)
Energy burden	5	Map Analysis (Census)	Aggregate energy burden by neighborhood

Participants have demonstrated strong environmental values	5	Application Form	Current participation in related activities
Disadvantaged community	10	Map Analysis (CalEnviroScreen)	Block is within 0.5 miles of disadvantaged community
Presence of multi-family housing units interested	5	Map Analysis	At least 1-2 multifamily buildings on the block, for diversity
Building ownership distribution	5	Application Form	No single entity owns a disproportionate number of housing units on the block
Total	40		

Table 2: Block Selection Criteria – Technical

Factor	Points	Data Source	Basis for Score
Responsiveness to Opportunity Notice	3	Application Form	Timeliness, completeness, and quality of application responses
Proximity and contiguity of parcels expressing interest	13	Application Form (map of interested parcels)	Total number of housing units willing to participate (min. 10)
Suitable aggregated roof area for solar	5	Map Analysis	Suitable roof area for avg. of >5kW solar per housing unit
Suitable location for shared energy equipment	6	Map Analysis	Vacant lot on block, or adequate open space or outbuilding for battery and transformer
Sufficient energy usage to justify investment	10	Application Form	Average annual energy bill per household of at least ~$500 per year
Distribution feeder capacity	5	Utility Distribution Capacity Map	Distribution Feeder Close to Capacity
Repaving scheduled	3	Map Analysis (City data)	Street Scheduled for Repaving during microgrid construction
Sidewalk repair requested	3	Map Analysis (City data)	Potential indication of committed neighbors
Presence of alley behind the houses	2	Map Analysis	Alleyway for service access and building of infrastructure
EV parking	5	Map Analysis	Enough space on the street for EV parking space
EV charging	5	Map Analysis	Enough space on the street or sidewalk for EV charging Station
Total	60		

Block Engagement and Education

After initial screening, meeting with the top four blocks, and with input from PG&E, the City of Oakland, and the research team, we selected the block: a cul-de-sac with 25 properties of 1-4 unit older homes, with a mixture of homeowners and renters (Figure 1).

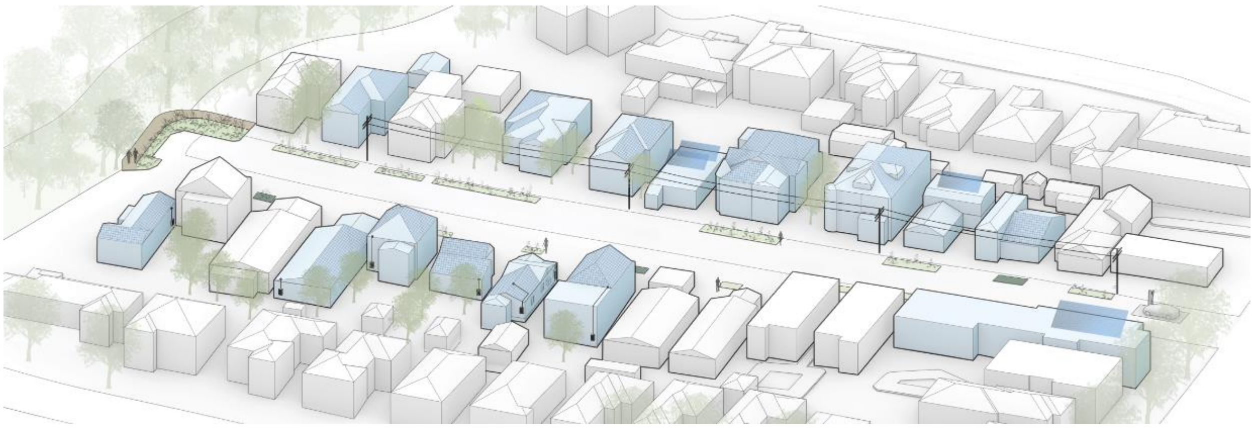

Figure 1: Schematic of participating homes (in blue) on the EcoBlock. *Source*: EcoBlock project.

Once the block was selected for the pilot program, we contacted all the building owners on the block to solicit their participation and began a dialog with the block residents to understand what concerns they had with their living situation, identify possible solutions, and educate them about potential energy upgrades available through the program. These conversations were open to all block residents, including renters, and a majority participated in at least one of the sessions. In talking with our pilot block, we identified several issues that affected their quality of life, as well as some possible solutions, summarized in Table 3.

Table 3: Community Concerns and Possible Solutions for Pilot Block

Concern	Possible Solution
Security (abandoned vehicles, drug deals)	Connect neighbors to local police beat officer
Trash dumped	Connect neighbors to bulky trash pickup; work together in picking up litter
Not enough parking	Connect neighbors to parking enforcement; reduce vehicles with shared EV
Old inefficient, leaky homes	More comfort with efficiency upgrades
Poor indoor air quality	Electrify to avoid gas combustion products for better air quality
High energy bills	Reduce bills with efficiency and solar
Susceptible to heat events	Heat pumps and building envelope retrofits provide efficient cooling
Power outages	Microgrid or backup batteries
Can’t afford upgrades	Lower upgrade costs and financing through EcoBlock program

Don’t know where to start on home energy upgrades	Work with neighbors and program resources to develop upgrade plan

This process of listening to the block residents and responding to their expressed needs was important to building trust that the research team was acting in their best interest. The pilot EcoBlock was intentionally selected as a very diverse community–in terms of age, race, household makeup (seniors, young families, couples), ethnicity, primary language, and income, and it was important to engage with the residents in ways that they felt were culturally appropriate. For instance, the research team was represented as much as possible by women and people of color, particularly the community liaison, who is a woman of color and a well-connected community organizer in Oakland. We also tried as much as possible to meet with the residents in small group discussions whenever soliciting input from them, so that people felt less inhibited in offering their opinions. Figure 2 shows an example of a community meeting in which we used small breakout groups to solicit input on EV parking options. In critical interactions with the residents, the research team provided Spanish and Mandarin translation, and neighbors helped with translation for non-native residents who spoke other languages. We also arranged food and music (provided by one of the neighbors who is a musician) at the larger meetings, in order to foster a stronger sense of community.

Figure 2: Small group meetings were used to solicit input from block residents. *Source*: EcoBlock project.

To further build trust as we recruited residents to formally participate in the EcoBlock project, we found it was helpful to start with small actions that build collaboration and camaraderie among the neighbors on the block while delivering tangible benefits to the entire community. For instance, early in the project the research team organized a greywater laundry-to-landscape[1] workshop hosted in a block resident's backyard and invited all the block neighbors to help install the system. About eleven people participated and reported that they enjoyed and learned from the experience and got to better know their neighbors. During the course of the project, as shown in Figure 3, the research team also removed 1000 square feet of concrete in the sidewalk planting strips, and helped the neighbors plant six street trees, mulch the sidewalk strips, and plant a new stormwater bioretention basin that was constructed at the end of the block as part of the research project (funded through a U.S. EPA grant).

Figure 3: Block sustainability activities. Source: EcoBlock project.

Another aspect of the project that helped connect neighbors to each other was a series of educational meetings hosted by the research team to get feedback on elements of the project and teach the residents about various upgrade options for the energy and water systems in their homes and the block. These meetings included infographics and posters; we also produced a monthly newsletter emailed from the research team that further explained the concepts and kept participants apprised of the project status (Figure 4). The team developed a private webpage for the block residents to access all these materials. We heard anecdotally that these educational materials helped foster neighborhood interaction in cases where a resident missed one of the meetings or didn't understand some of the content and would ask a neighbor for a summary in their own words.

[1] Laundry-to-landscape is a water conservation measure that diverts wastewater from a clothes washer for use in landscape irrigation, through a network of subsurface pipes and water emitters, thus reducing the amount of potable water used for irrigation.

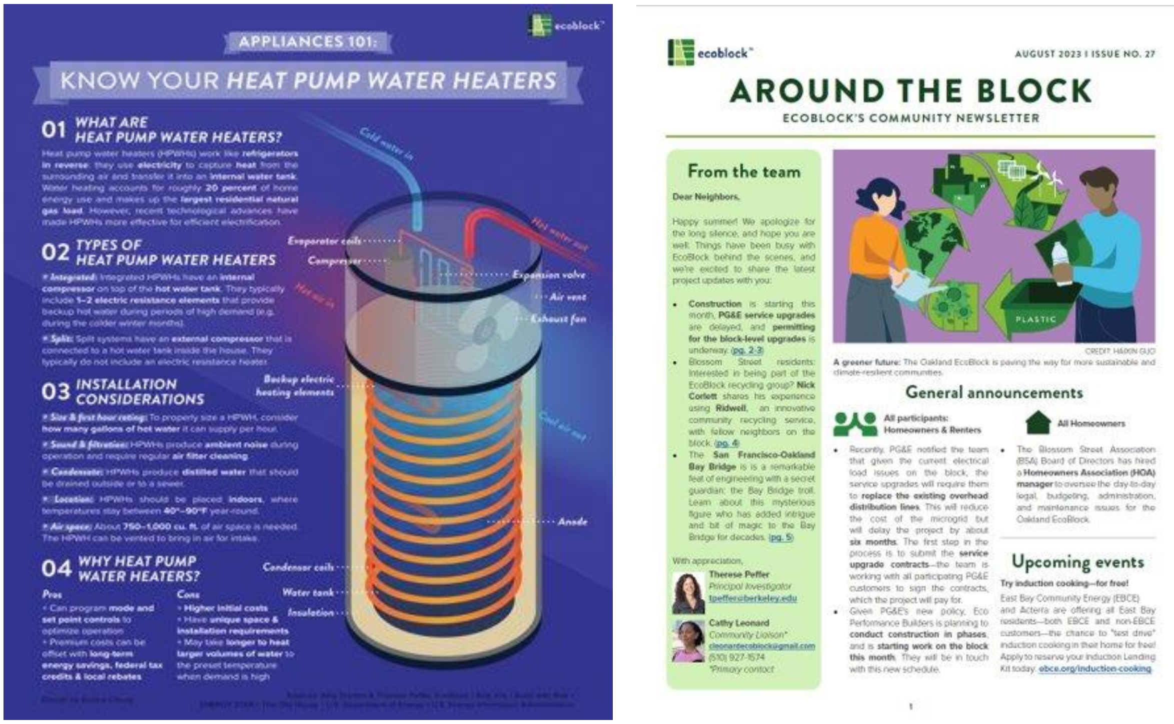

Figure 3: Example infographic and newsletter used for resident education. Source: EcoBlock project.

Another way that the research project fostered community was by bringing the neighbors together to form a cooperative association for shared ownership of the rooftop solar arrays installed as part of the project. Some roofs are more shaded than others, or have more complicated structure, or are easier to install panels. This concept of shared ownership of energy assets is a key aspect of EcoBlock, allowing all participants to equitably share in the benefits of bill savings from rooftop solar (and the reliable power of a microgrid, if that were included in the project). To implement this ownership model, five project participants volunteered as block leaders to participate in the discussions, and the research team hired an attorney who specializes in cooperative law to help this leadership team decide on various aspects such as the legal structure and the process for residents to join in the ownership. The leadership team operated using a consensus decision-making process: everyone voices an opinion and either votes for an option, or voices an objection. The group talks through the objection and ranks the choices until one is selected that has no objections. (We used this same technique in a couple of surveys of block residents: to select a spot for the curbside EV charger and to select the design for the bioswale). Legalese was also an issue; one homeowner volunteered to write the documents in a way that was easy to understand by non-lawyers. This process resulted in the formation of a cooperative block association with a board, bylaws, and a membership agreement (similar to a homeowner's association, or HOA), that all the neighbors were invited to join. The overall process is shown in Figure 5.

Ultimately, the five-member volunteer board who helped create the bylaws and membership agreement talked to their neighbor homeowners and convinced them to join the association. This was quite effective: about two-thirds of the households on the block signed the membership agreement. The association will support the ongoing expenses for operation and maintenance of the communally-owned solar arrays through a modest fee proportional to the utility bill savings each member receives from the solar array on their roof. The association bylaws include a provision for new members to enter the organization and for members to exit the organization (e.g., if they sell their home) by purchasing their rooftop solar array at its depreciated value.

Figure 5: Process for forming a block association for shared asset ownership.
Source: EcoBlock project.

Challenges

We had to overcome several challenges in engaging and organizing the community while implementing the Oakland EcoBlock pilot project, including the potential for utility bill increases, concerns about interacting with local government agencies, tenant/landlord split incentives, and language and technology barriers.

Utility Bill Increases

One of the most significant barriers to electrification retrofits in many states is the relative price of electricity and natural gas. For a home that replaces its HVAC, water heating and appliances with electric models, without any home performance or solar upgrades, the total utility bill (electric and gas) may increase (Christopher and Lazo 2026). One of the key principles of the EcoBlock approach is that by bundling electrification with efficiency improvements and solar, these bill increases can be avoided.

Although this bundled approach can usually avoid bill increases, some residents needed more information about the benefits of this approach, including non-energy benefits such as improved indoor air quality and thermal comfort. In practice, the EcoBlock bundled strategy worked well for most of the homes, but we found a few specific instances where bills still increased. These included situations where the house could not be sealed nor fully insulated due to its configuration (e.g., attic too small), or where the occupant was not educated about proper thermostat operation for a variable-speed heat pump. In other cases, participants didn’t understand that they needed to call the utility to switch to an all-electric rate plan after an electrification retrofit, in order to take advantage of a larger amount of baseline energy use on the electric rate plan. This experience points to the need for ongoing education and follow-up after the retrofits, to ensure that the residents get the best energy performance possible from their homes.

Local Government Interactions

In asking residents to undertake whole-home retrofits, one area of resistance we encountered was from property owners whose buildings had existing unpermitted work or unpermitted rental units, due to concerns about city building inspectors discovering the work and requiring expensive remediation to bring the building into compliance with current codes and rental laws. The research team had several discussions with the relevant departments in the City of Oakland and helped clarify that building inspectors are generally only focused on the work covered by the current permit for which they are inspecting the house, and typically only identify other issues if they are a significant health or safety concern. The city is also not interested in taking rental units off the market given the current housing shortage in Oakland and California more generally. As a result of the experience in this pilot program, Oakland city staff are developing an amnesty program to accept unpermitted work or rental units after mitigating any significant health and safety issues. Some other cities around the country have ordinances for this purpose, which serve as a helpful model.

Another concern expressed by potential participants was increased property taxes from reassessment due to building improvements.[2] This was mainly addressed by educating the residents that rooftop solar projects are exempt from property tax reassessment in California, as are like-for-like replacements of building equipment and systems. Nevertheless, some homeowners expressed concern after receiving reassessment notices from the county assessor's office (triggered by building permits) after the retrofit construction was done, which required submitting paperwork to explain the actual scope of work for the retrofit. This is an issue that will need to be addressed more comprehensively for a scaled-up retrofit program, including possibly providing a template for participants to use for their appeal and providing advisors who can help participants navigate these types of issues.

Renter-Occupied Buildings

A common experience for home retrofit programs is that retrofitting renter-occupied buildings can be challenging, due to both the tenant-landlord split incentive problem, as well as renters' concerns about displacement (eviction) before the retrofit or rent increases after the retrofit work is completed. The EcoBlock pilot project had several multifamily buildings participate, although these were mostly small (2-3 unit) buildings where the owner occupied one of the units, so the split incentive impact was much smaller because the landlord directly benefitted from the retrofit. For renters, the City of Oakland has a strong rent control program that limits rent increases and evictions, so these concerns have mostly been addressed through city (and state) renter protection policies. This would still be a concern in other jurisdictions that do not have strong renter protections and could possibly be addressed through project

[2] In California, annual property tax reassessments are limited to a low percentage rate to account for inflation, but significant reassessments can occur after home improvements to account for the increased value of the improvements.

agreements with landlords to limit rent increases, or possibly through innovative financial tools such as on bill financing or Metered Energy Efficiency Transaction Structures (MEETS) that eliminate the split incentive by moving the capital costs of energy retrofits off the landlord's balance sheet (MEETS Coalition 2026).

Language and Technology Access Barriers

As mentioned earlier, the block selected for the EcoBlock pilot was very diverse, including a wide range of income levels and up to six different native languages spoken on the block. One resident was illiterate; some did not have WiFi or a phone. The limited or lack of access to computers or email made it difficult to review and sign legal forms. In these cases, it was helpful to have a trusted neighbor nearby (also a participant in the EcoBlock project) who could contact the resident and facilitate an in-person visit to review and sign forms. For interacting with non-English speakers, the research team translated important legal materials into Spanish and Mandarin, and worked through fluent neighbors on the block (or relatives) to conduct interpretation for the other languages. One significant barrier we ran into is that the Net Energy Metering (NEM) interconnection documents from the local utility are only available in English and must be signed online. For these situations, we paid for interpreters or asked a bilingual neighbor to verbally translate and explain the document to the account owner. In addition, these forms clearly have the word "contract" on them, and caused concern for a number of residents about what exactly they were being asked to sign.

Lessons Learned and Conclusions

The Oakland EcoBlock pilot project taught us several lessons that can be used to improve future efforts to provide energy upgrades and electrification in low- and moderate-income urban neighborhoods.

First, by engaging a contiguous block of neighbors it is possible to leverage the existing network of social relationships to increase program participation and transform an energy program into something that delivers wider community benefits. The key is building a trusted relationship between the program implementer and the community; as Stephen Covey says, "Change moves at the speed of trust" (Covey and Merrill 2008). Trust is something that is built through two-way dialog and builds progressively as a community experiences both their neighbors and the program implementer as being trustworthy. For this reason, we have come to view the EcoBlock approach not as a one-time "bulk retrofit" of a city block, but rather an ongoing process with many possible variations. In this approach neighbors learn to work together toward common goals and progressively take on more ambitious activities. This can be visualized along the continuum shown in Figure 6. We found that the simple, yet tangible, activities to the left of the figure are an important step in building trust and confidence in working together, while education and data collection is simultaneously happening to lay the groundwork for more ambitious activities (such as bulk appliance purchases or whole-home retrofits) to be implemented as the community gains information and confidence. By providing opportunities for block residents to volunteer and lead their neighbors, it provides greater buy-in to the program.

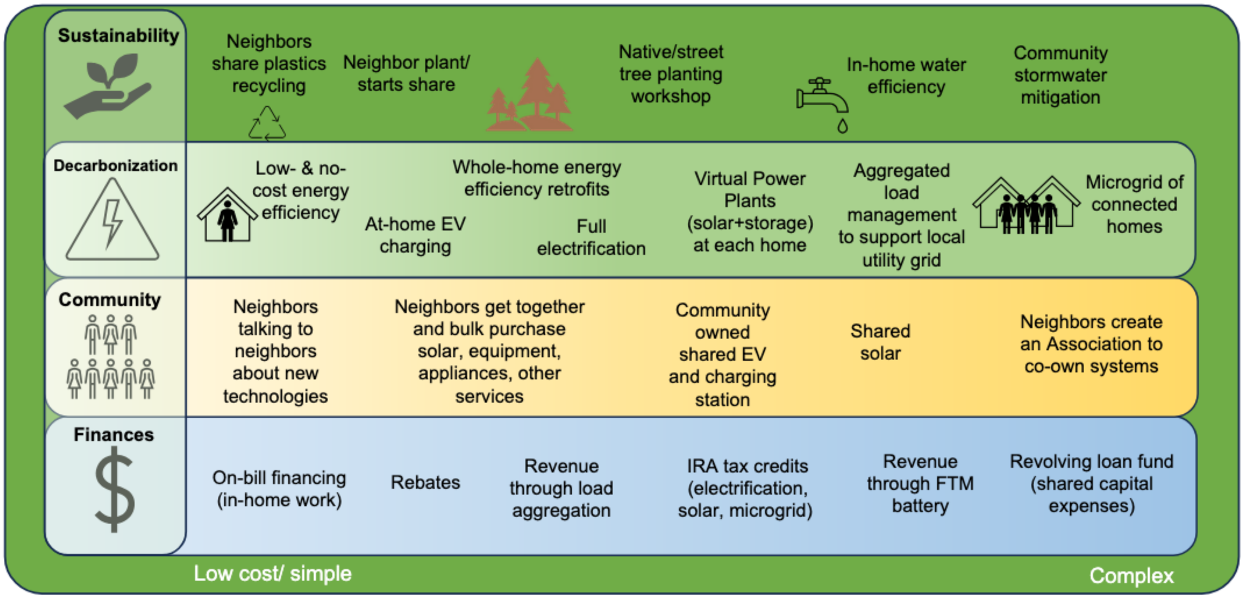

Figure 6: The portfolio of EcoBlock activities, viewed as a journey that a block can take, progressing from simple and low-cost actions on the left to more ambitious community activities to the right. The rows are the four pillars of the EcoBlock approach. Source: EcoBlock project.

Second, by leveraging the peer-to-peer neighbor effect (Min 2025), we realized a relatively high participation rate. For the Oakland pilot, approximately two-thirds of the households on the block ultimately participated in the full retrofits. This high rate is at least partly due to the cost of the upgrades being completely offset by grant funds from the research project, but at the same time some of the retrofits were extensive and required a lot of construction on each home, and were drawn out over an extended time because of the nature of a research project.[3] This participation rate compares favorably with typical no-cost low-income programs, such as the Weatherization Assistance Program, which average about 5% participation of the target population (Fowlie et al. 2018, Morales and Nadel 2022).

Finally, we learned that a successful "treatment" of an entire block requires a flexible set of offerings to address the varying needs of each household on the block. This includes factors such as income (different financing approaches are needed for middle vs. low-income residents), life stage (some residents may have health or other issues that prevent them from engaging in a project at the outset), building lifecycle (e.g., some homes may have just replaced their furnace, water heater or completed a major remodel and not want to take on new construction work for a while), and social/cultural factors (including different languages and understanding and perceptions of new technologies (Langevin et al, 2023). Despite these differences, the EcoBlock pilot showed that a diverse set of neighbors can work together to achieve common goals and improve the quality of life for everyone on the block.

The EcoBlock project team is working now to build on these findings from the pilot deployment to develop a program model that can be implemented across a bigger group of blocks in Oakland. The foundation of this program will leverage the pilot learnings: engaging individual blocks of residents, employing community-based organizations for outreach to recruit

[3] The final project deliverable, the EcoBlock Guidebook, will provide a range of costs per home. ecoblock.berkeley.edu.

groups of homes, and applying energy upgrades in quantity. To support this block-level engagement, we are designing a set of municipal (or possibly regional) program resources that could include things like educational materials, contractor qualification standards, financing packages (including loans and access to incentives from other energy programs), and the administrative infrastructure to manage a program like this. We believe this program model is transferrable to other areas of California and the US, with some adaptation to accommodate local climates, housing stocks, utility tariffs and programs, and home contractor markets. Nevertheless, the basic concept of engaging program participants as neighbors, rather than disconnected residents across a broad geographic area, is a powerful approach that should prove effective in most communities.

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AI-Assisted Tools Disclosure

No AIs were harmed in the writing of this paper.