

PERSPECTIVE

Participatory research in energy justice: guiding principles and practice

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# Progress in Energy



## PERSPECTIVE

# Participatory research in energy justice: guiding principles and practice

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## Abstract

This perspective explores the imperative role of participatory research (PR) in advancing energy justice. We argue that using PR methods and principles at the intersection of energy and justice offers a critical research advantage. Here, we contend that PR frameworks are integral to bridging the gap between energy justice theory and practice, emphasizing the need to move beyond decontextualized principles to address specific injustices related to race, class, gender, and coloniality. We present three energy justice case studies that used participatory approaches in diverse contexts: Amazon, Brazil; Philadelphia, Pennsylvania, USA; and Holyoke, Massachusetts, USA. These cases showcase the versatility of PR methods in understanding and addressing energy challenges within local communities. We highlight guiding principles of PR, emphasizing the importance of prioritizing community needs, respecting diverse expertise, building trust, designing for transparency and accountability, choosing appropriate methods, adapting to changing circumstances, flexible, and aiming for long-term collaboration. Lastly, our perspective suggests future directions for participatory energy justice research, including the potential for PR to inform multi-scale policy, practice, and advocacy. We underscore the importance of collaborations between researchers and community organizations through citizen science, emphasizing the need to integrate diverse disciplinary perspectives to effectively address complex energy justice challenges.

## 1. Introduction: why does energy justice need participatory research (PR)?

This perspective demonstrates how PR frameworks are integral to advancing convergence research in energy justice, including in contexts of engineering and technology practice. It is well-established that energy extraction, development, production, and consumption are embedded within systems of power that impose disparate burdens along axes of race, class, gender, and other intersections of power (Moore 2019, Konisky 2020). A core driver of inequity and harm comes from traditional energy planning and policymaking processes, reflecting decisions made by distant authorities without meaningful input from affected communities (Sovacool *et al* 2016, García *et al* 2021, Adams *et al* 2022, Roque 2023). The scholarship to advance just energy systems is dominated by decontextualized principles and frameworks rather than anchored in actual-world realities and systems. When Jenkins *et al* (2021) reviewed

literature, they found that 40% of work in this domain had no research design or methods section. They conclude that ‘energy justice remains, to some degree, conceptual and not applied’ (17). Alongside this, where a universal understanding of energy justice is assumed, it can propel interventions that reinforce rather than eliminate—conditions that perpetuate challenges to residents (Daggett 2021, Sultana 2022, Dunlap and Tornel 2023).

Energy justice scholars have identified community-engaged research as a key opportunity to advance energy equity in the quest for energy transitions (Jenkins et al 2020, Ash et al 2023). At the same time, there have been calls for research that attends to the visions of energy justice organizations and is rooted in the concerns of frontline communities (Jenkins et al 2020, de Onis 2021, Elmallah et al 2022). Within these contexts, PR frameworks and methods provide opportunities to bridge gaps between conceptual understandings of energy justice and lived experiences of those impacted by the phenomenon. Drawing from emancipatory and action traditions, PR principles recognize and center knowledge generated through reciprocal partnerships with residents, organizations, rights-holders, and stakeholders. PR can build from local experiences of energy and conceptions of justice. The guiding principles of PR offer strong foundations for research that advances energy justice goals.

PR collaborations not only create cutting-edge knowledge about energy injustices but also work to address them through capacity building within communities. In the context of energy research, PR has been used to advocate and inform beyond the lifetime of the project, providing—accurate, comprehensive data that is especially relevant for facilitating just energy transitions (de Onis 2021, 2018, Suboticki et al 2023). As such, PR is well-suited to support local collaborators in identifying policies and solutions that are most equitable within their contexts while also advancing cutting-edge knowledge of an increasingly complex problem faced nationally and internationally.

In what follows, we provide an overview of key PR frameworks and methods. We then provide case studies of participatory energy justice research in practice—Amazon, Brazil; Philadelphia, Pennsylvania (USA); Holyoke, Massachusetts (USA). Looking across these three contexts, we summarize guiding principles for establishing participatory energy justice research projects and identify the limitations of these projects. By way of conclusion, we point to future directions for participatory energy justice research, especially convergence research that integrates transdisciplinary and community knowledge to address technological, social, and policy barriers to just and sustainable energy systems.

## 2. PR frameworks and methods

PR encompasses methodologies, frameworks, and approaches that engage with research participants as co-creators of knowledge rather than as research subjects (Cornwall and Jewkes 1995, Vaughan 2020). PR aims to democratize knowledge by conducting research *in partnership with* people and communities—rather than *on* or *for* them (Bradbury 2015, Roque et al 2022). By legitimizing community knowledge and lived experiences as scientific data, PR provides rigorous means of generating local information to guide actions and decision-making (Fals-Borda and Rahman 1991). Though PR approaches are diverse in the role non-academic partners play in the overall research project and dissemination of results, their overarching commitment is translating knowledge into actions that resolve inequities and create more just societies. However, PR methods have not always been utilized for supporting community empowerment. Scholars have noted how in academia, participatory methods have been also utilized in ways that are extractive for data collection and not community empowerment (Cochrane and Corbett 2020, Lasker and Lasker 2019). As such, it is important to recognize that while these methodologies and frameworks are grounded in emancipatory and adjacent traditions, the execution of such an approach is dependent on the commitment of those involved in the research effort to utilize the methodologies for their original intention (not for extractive data collection).

There are many frameworks for PR (table 1). Central to all of them is active participation of local stakeholders (e.g. community leaders, organizations, policymakers, and residents) who are involved in the issue being studied (Wallerstein et al 2020, Roque et al 2023). In this way, PR aims to address power imbalances (Grant et al 2008, van and Boettiger 2009). Certain PR approaches, such as participatory action research (PAR) and community based participatory research (CBPR), establish partnerships where community collaborators drive the research program (Wallerstein and Duran 2010, Gubrium and Gubrium 2013). Other PR approaches, including Feminist, Decolonial, and Indigenous Research, produce knowledge that is relevant to the desires of people and communities typically excluded from dominant power (Gill et al 2012, Liboiron 2021, van Anders et al 2023).

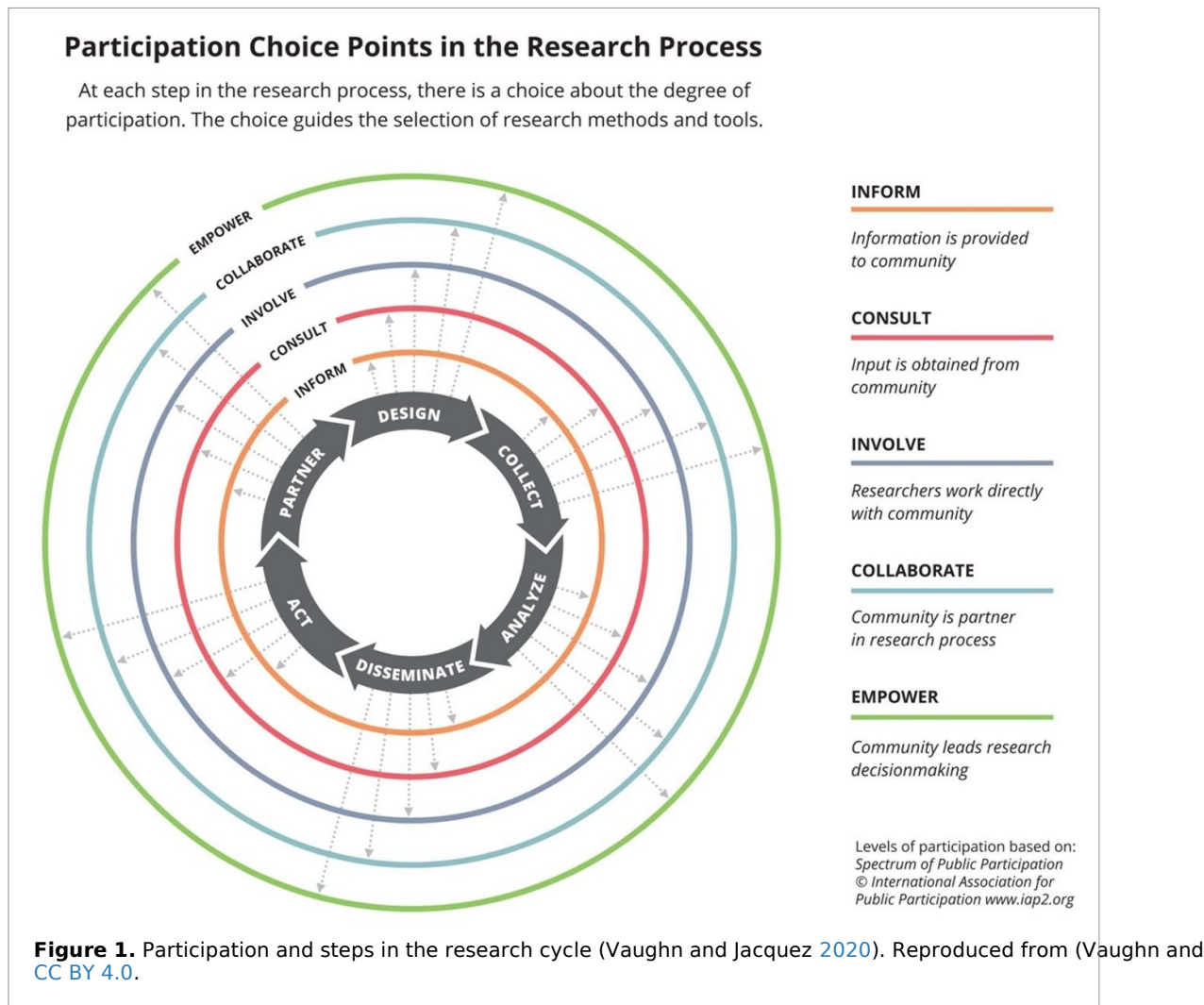
PR frameworks are not mutually exclusive. Instead, they offer a suite of approaches that can be adapted to suit particular research circumstances through dialogue between people, organizations, and university-based collaborators. Participatory energy justice research may specifically benefit from

**Table 1.** Overview of participatory research frameworks.

Research framework	Definition	Key texts
Participatory action research (PAR)	PAR involves participants and academic researchers in a collaborative, iterative research process with the goal of empowering those most affected and informing action.	Wheeler et al (1989), Baum et al (2006)
Community-engaged research (CEnR)	In CEnR, an active collaborative partnership is established between the academic researcher and community with the undertaking research with scientific and community benefits. This research relationship continues beyond the life span of one project and extends to an in-depth trust-based partnership where each partner is able to exercise agency, and their roles continually evolve along the project's life cycle.	Bradbury (2010), Sánchez et al (2021)
Community-based participatory research (CBPR)	CBPR is a type of PAR popularized by public health research that emphasizes equitable community stakeholder involvement at each stage of the research process. CBPR often involves ongoing partnerships between community organizations and academic researchers.	Israel et al (2018), Valenzuela et al (2018)
Citizen science	Citizen Science aims to bring communities into knowledge production activities. While citizen science is most often associated with projects that build community capacity for data collection, there are many stages in the research process where community members can participate, including study design, data analysis, and communication of findings. Citizen science projects intend to leverage the expertise of specific communities who have historic, embodied, or local knowledge. In many cases citizen science projects are designed to provide communities with training or information that will be of benefit.	Kimura and Kinchy (2019), Ottinger (2022)
Indigenous methodologies	Indigenous Methodologies aim to redress the violence of colonization through research advancing Indigenous people's self-determination—especially regarding land, water, air, and data. Research using this framework, including in relation to energy justice priorities, is led by Indigenous people and organizations who sometimes partner with non-Indigenous people and organizations.	Atalay (2020), Sleteth (2022)
Feminist methodologies	Feminist methodologies address the power inequities, cultural differences, and harms that get reproduced through research. While the methods used are multidisciplinary, studies that use feminist methodologies are designed to repair cultural biases and gaps in knowledge that have been created through systemic oppression. In energy justice research, for example, studies that use feminist methodologies highlight the workings of gender, age, class, race, and sexuality, their intersectionalities, and how these sociopolitical dynamics matter for policy.	Bell et al (2020), Buchler et al (2020), Basmazoglu and Holland (2002)
Participatory convergence research	The Participatory Convergence approach calls for researchers to collaborate with researchers from different disciplines and stakeholders from diverse backgrounds. This approach is based on Convergence research and Participatory Action Research, which encourages teams to create strong partnerships, have cycles of action and reflection, and co-design significant and sustainable interventions to address societal challenges, such as energy injustices.	Morales et al (2022), Roque et al (2022)
Experimental ethnography	Experimental ethnography leverages participant observation as a collaborative tool for working with communities to explore problems and imagine solutions. This often involves the use of 'experiments' broadly understood, but often involving media, new technologies, or the use of workshops for two-way or tactile learning.	Warley (2015), De la Cruz et al (2023), Canale (2017)

'participatory convergence' framework (Roque et al 2023, Moran et al 2022). Participatory convergence is a PR framework that aims to simultaneously integrate transdisciplinary knowledge with diverse community knowledge. This makes participatory convergence well-suited to energy research.

PR frameworks emphasize collaborative research design, data collection, and analysis, and community decision-making. However, as presented in figure 1, the stakeholder and local actors' engagement



fluctuate across a project (Vaughn and Jacquez 2020). This framework is reflective of diverse degrees of participation (Kelty et al 2015). The team should determine the appropriate PR framework (see table 2) for achieving the desired participation level at each stage of the research process. The process begins with building from creating partnerships with local communities toward supporting communities in taking action (see Vaughn and Jacquez 2020).

The basic level of participation is 'Inform', which involves one-way communication to local communities. The first step towards community participation. The next level is 'Consult', which involves asking community members for their opinions. The 'Involve' level requires research teams to routinely engage with community members to understand if research projects address their needs. Moving to the 'Collaborate' level, community stakeholders and university research teams mutually agree to share planning and decision-making responsibilities. Finally, the highest level, 'Empowerment', signifies a stage where community members actively participate in conducting meaningful research (Arnstein 1969, IAP2 International Federation 2020, Vaughn and Jacquez 2020).

In summary, teams conducting participatory energy justice should prioritize the project goals and select methods that align with stakeholder interests and maximize potential real-world impact. It is possible that certain tools and methods may encourage high levels of stakeholder participation in some stages, while other stages may require a more research-driven approach.

All PR is likely to involve human subjects research oversight by university institutional review boards (IRBs). University IRBs apply internationally recognized research standards of respect for persons, beneficence, and justice (Whiteford and Trotter 2008). Research involving Indigenous communities is likely to involve compliance with tribal protocols (e.g. tribal IRB and research governance) to prevent exploitative research and ensure ethical interactions between researchers and sovereign Indigenous communities (Moodie 2010). PR teams often convene community advisory boards (CABs) to identify specific needs and design research protocols that address them. Together, university and non-university research efforts exist to ensure research contributes to the well-being of people and their communities.

**Table 2.** Examples of participatory methods in energy research.

Participatory method	Description	Example in energy research
Community-Based Participant-Observation (CBPO)	Is an innovative ethnographic method, in which community residents collect information and observers participant observation (Roque <a href="#">2023</a> ).	Community-Based Participant-Observation clarified the justice implications of fossil fuel energy waste, especially adverse health and social impacts (Cannon <i>et al</i> <a href="#">2023</a> ).
Eco-calendars/seasonal calendars	Seasonal and Eco-calendars involve collaboration between community residents and researchers to design tailored strategies addressing social-ecological conditions and environmental concerns (SantoDomingo <i>et al</i> <a href="#">2016</a> ).	Adaptation longitudinal approach to rural areas demonstrated how key tools for electrification face seasonal barriers and technical challenges that impede social acceptance (Etienne and Robert <a href="#">2024</a> ).
Participant observation	Participant observation entails acquiring knowledge through direct engagement in the everyday activities of residents within their setting. It involves actively participating in routine affairs of the community to gain firsthand and immersive understanding of their experiences (Schensul <i>et al</i> <a href="#">1999</a> ).	Participant observation helped to identify the people living in low-to-moderate-income communities of color were enthusiastic about phasing out fossil fuels but skeptical that their communities would benefit from that transition (Hernández <a href="#">2016</a> , Harper <i>et al</i> <a href="#">2023</a> ).
Participatory mapping	Widely used in natural resource management, participatory mapping helps to understand allocation and control of resources and adaptation strategies. Maps may be made through sketching, marking existing maps, or using GIS (Chambers <a href="#">2006</a> , Pearson <i>et al</i> <a href="#">2017</a> , Sangaramoorthy and Kroeger <a href="#">2020</a> ).	Participatory mapping made it possible for researchers and community members to establish the uneven social-ecological effects of electric dam projects, especially inequities not registered by other methods (Castro-Diaz <i>et al</i> <a href="#">2018</a> ).
Scenario planning	Technique utilizing qualitative and/or quantitative approaches with stakeholders to generate different scenarios (present or future oriented) to inform decision making (e.g. preparedness for transitions) (Amer <i>et al</i> <a href="#">2013</a> , Iwaniec <i>et al</i> <a href="#">2020</a> ).	Participatory scenario planning bridged diverse understandings of energy systems and shared capacities among stakeholders for considering the energy system complexities and their human dimensions (Miller <i>et al</i> <a href="#">2015</a> ).
Participatory modeling	Engaged approach in which stakeholder knowledge is utilized to create computer-based models that can inform risk assessment, learning and decision making for policy action (Zellner <i>et al</i> <a href="#">2012</a> , Voinov <i>et al</i> <a href="#">2016</a> , Quimby and Beresford <a href="#">2023</a> ).	Qualitative and quantitative modeling supported long-term planning for energy transitions, especially in relation to their complex technical and social bases (Mallem and Malekpour <a href="#">2018</a> ).
Photovoice and participatory video	Photovoice and participatory video methods engage community members in documenting a specific topic or research question. The photos are used as prompts for focus group discussions. Often, researchers and community members communicate their research with multimedia displays or exhibitions (Gubrium and Harper <a href="#">2013</a> , Pink and Mackley <a href="#">2012</a> ).	In multiple contexts, participatory photo and video elicitation methods have clarified how people understand energy extraction, production, and use, as well as the implications of energy transitions (Sarrica <i>et al</i> <a href="#">2018</a> ).
Transect walks	Transect walks are a method conducted with key informants and researchers through the communities and surrounding areas to identify resource areas, and ask questions to identify problems, opportunities, and solutions (Chambers <a href="#">1994</a> , Pink <a href="#">2007</a> , Selin and Gano <a href="#">2016</a> ).	Walking landscapes with residents living in the vicinity of proposed shale gas sites surfaced competing local identifications of underground risk (Ryder <i>et al</i> <a href="#">2023</a> ).
Visioning workshops	Visioning combines systems thinking and participatory approaches to stimulate local preferences about possible future states (Winkler and Iwaniec <a href="#">2014</a> ).	Visioning workshops create community-level agendas in ways that support Indigenous-led visioning to address colonial violence through renewable energy implementation (Cain <a href="#">2024</a> ).
Informal science education	Staging hands-on science learning at community events can broaden research impact beyond the limited scope of researchers and related professionals (Synder <i>et al</i> <a href="#">2014</a> , Knutson <i>et al</i> <a href="#">2020</a> , Crowley <a href="#">2020</a> , Kenner <i>et al</i> <a href="#">2020</a> ).	Hands-on workshops supported participants in connecting global climate change processes (e.g. GHG emissions) to household systems (Kenner <i>et al</i> <a href="#">2020</a> ).

Any research method or tool can be participatory if it is chosen and used collaboratively by academic and community stakeholders. PR methods can range from qualitative (e.g. photovoice, interview, participatory mapping) to quantitative methods (e.g. surveys, modeling, assessments) (Macaulay 2022). Depending on the framework and methods chosen, the degree of participation across the research varies (Vaughn and Jacquez 2020, Quimby and Beresford 2023). Teams should determine the most appropriate research method based on the research purpose, available resources, and context (Torralba et al 2022). Table 2 provides examples of common participatory methods that may be used in energy justice research.

To summarize, PR is an ongoing process guided by local concerns. By focusing on responding to local concerns, PR projects build trust between researchers and the people and organizations with whom they work (Ducua et al 2022). This helps emphasize collaboration, builds on existing knowledge, and challenges extractivism (Cargo and Mercer 2008, Fahlberg 2023). By engaging in a ‘bottom-up’ approach, PR values and centers local knowledge and expertise to the same extent as academic knowledge generation (Feldman 2019). At the same time, PR is significant because it also aims to have relevance and applicability beyond the immediate context, supporting knowledge that can be translated into practice elsewhere (Bradbury 2010). As an iterative process, PR scaffolds collaborations between university and community researchers to create knowledge that is simultaneously relevant to local concerns and can be applied to support evidence-based action in other contexts.

### 3. Examples from the field

Below we describe three distinct cases of participatory energy justice research—hydroelectric dam impacts in the Brazilian Amazon; household energy insecurity in Philadelphia, US; and community energy justice in Holyoke, US. We highlight how each used specific participatory methods. These examples describe how PR enacts specific forms of participation (see: Kelty et al 2015) and partnership relations. They also show how PR can be designed with program development, policy change, and educational outcomes in mind.

#### 3.1. Amazon (Brazil): from large-scale hydroelectric dams to community energy systems

**Context**—The first case of study is based on long-term research conducted by Castro-Diaz (2019). This research aimed to understand the social-ecological impacts and multidimensional energy injustices for communities living downstream from large-scale hydroelectric dams (Castro-Diaz et al 2024). The study takes place in the Brazilian Amazon, a riverine community dependent on fisheries for their livelihoods, located 30 km downstream from the Belo Monte hydroelectric complex. There are two important characteristics of this community to consider: (1) there is a lack of study of downstream communities in the context of dam development (Richter et al 2010, Baird et al 2021), then the experiences of downstream communities with dams have not been widely documented. (2) Locals from this community are identified as riverine people, a group that has been historically marginalized and excluded from decision-making processes (Doria et al 2017).

Belo Monte is the fourth largest dam in the world and has an estimated installed capacity of 11.23 GW. However, due to changes in climate patterns, it is expected to produce an average of 4.46 GW (Corrêa Da Silva et al 2016). The dam is located in the Xingu River, in the State of Pará. In the 2000s, the Brazilian president approved the dam’s construction without waiting for the Environmental and Social Impact Assessment (Mayer et al 2021). It has negatively impacted local agriculture (Calvi et al 2018), employment (Bro et al 2018), and fisheries yields (Boanada 2015, Fainguelernt 2020), while resettling 22 000 people (Randell 2016). Additionally, communities downstream from the dam were not consulted, impacted or compensated (Castro-Diaz et al 2018).

**Using participatory methods**—To understand the social-ecological impacts and energy injustices for riverine people faced due to the construction of Belo Monte, Castro-Diaz conducted in-depth interviews, participatory mapping, participant observation, and fishing trips, which is a type of transect walk (see table 2) that allow researchers and community partners to explore the study area. Data were collected during the late stage of construction (2016) and early operation of Belo Monte (2017, 2019). The research found that local communities face multidimensional and multitemporal energy injustices generated by the construction of the dam (Castro-Diaz et al 2024). Castro-Diaz stayed in the community from June to July in each data collection period. This research design allowed Castro-Diaz to build trust, validate findings, and create a space for the emotional sharing of personal experiences and fears associated with the dam with the community residents. The relationship with local actors has been maintained, since the first year of data collection, local actors were aware of the aims and scope of the research, furthermore, returning to the community as well as maintaining periodic contact via WhatsApp.

**More just outcomes**—By using participatory methods and exploring the energy injustices a community is experiencing, Castro-Diaz *et al* (2024) highlighted the importance to co-design energy solutions tailored to local communities' social-ecological conditions and their needs. For instance, Moran *et al* (2022) explored energy solutions for off-the-grid Amazonian communities that are environmentally, socially, economically acceptable, just, and equitable and could be co-created with the communities. They used diverse participatory methods, such as visioning workshops, to learn how residents envision the energy system and their energy needs (Moran *et al* 2022). They have also involved residents in collecting data on the physical and hydrologic conditions of the area to determine the best spot to locate the in-stream generators and PVs, as well as how to fix and maintain the infrastructure (Moran *et al* 2022, Brown *et al* 2022).

### 3.2. Philadelphia, Pennsylvania (US): tackling household energy insecurity at Neighborhood Energy Centers (NECs)

**Context**—Our second case study focuses on The Energy Rights Project (ERP), which was part of a community-engaged research (CEnR) conducted by Kenner (2013–2023). ERP was designed based on findings from a 5 year, community-based climate education project that used informal science education and a participatory method (Kenner *et al* 2020); collaborators included staff members from frontline organizations focused on public health, social and environmental justice (Adams *et al* 2022). Eighteen workshops were held in community locations that included public libraries, senior centers, and churches; these were held in many different neighborhoods and drew more than 400 participants between 2014 and 2019. While the demographics of community participants were broad, a majority of workshop participants self-identified as African American or Black women >55 years. One of the most significant findings of the project was that unaffordable utility bills were the urban climate impact that most concerned community members. Many were already struggling to pay their bills—even when they practiced conservation, received assistance, or had made repairs and upgrades to appliances and housing stock, energy was still a burden. This led to the formation of one community partner, Energy Coordinating Agency (ECA), to design a study documenting the locally-specific conditions of household energy insecurity in Philadelphia, PA. This included assessing the availability of local, state, and federal programs designed to mitigate the harm that comes from a lack of access to affordable and reliable energy services, and the limitations and oversights of existing assistance programs. Access to energy was a key priority, in other words, for local organizations working to address energy insecurity. The study focused on what was not working and how to address gaps, whether in service or policy.

**Using participatory methods**—ERP used experimental ethnography (see table 1) to investigate household energy vulnerability in the Mid Atlantic region; the project used participatory methods from the start, including with the initial grant proposal, which was drafted with staff members from ECA and community leaders from ECA's network of NECs. Using experimental ethnography, ERP researchers used participatory observation to support the process of building educational programming with ECA's energy conservation and community programs staff, which incorporated informal science education. Focus groups and interviews were used alongside educational programming to investigate dynamics, barriers, and opportunities to address energy insecurity.

To design and plan the work, Kenner organized meetings and asynchronous communication with project partners and community stakeholders to decide together how to structure data collection activities, surveys, interview questions, and data management protocols. In all cases, Kenner provided drafts of materials in advance, which were discussed and revised in collaborative settings; over the duration of the project, meetings typically involved somewhere between 2 and 10 staff members from community organizations. ERP researchers also worked with a community educator to design energy conservation workshops (Kenner *et al* 2022), which provided hands-on or visual descriptions of new energy technologies—from heat pumps—and hints of energy transition policies that might impact consumers (like the Inflation Reduction Act). Fifteen co-designed workshops were held, many in neighborhoods with an existing energy justice focus. As was the case in the climate education project, a majority of participants were Black women over 55 years old. In addition to collaborative project design, Kenner assembled two advisory committees, one of community members and one of urban ethnographers who use CBPR. As the project progressed, updates were shared regularly at monthly meetings convened by ECA, this allowed for input on the location and timing of activities, connections to project partners, and specific issues to look for or mention in community outreach. In 2022, ERP researchers presented initial findings and solicited feedback ahead of scholarly presentations at two separate meetings. These meetings were conducted over Zoom and the resulting feedback was constructive and supportive. Most recently, study findings were shared at a city-wide conference attended by over 100 energy professionals, which resulted in a Q&A discussion about the value of ethnography in energy justice work.

**More just outcomes**—There are three ‘more just’ outcomes from ERP: education; relations and documentation. One dimension of participation identified by Kelty *et al* (2015) are the educational dividends that individuals gain from engaging in research, community, or political process. ERP is committed to publishing findings in formats that can be used to further engage community members in conversation and action. ERP publications include tri-fold pamphlets, one-page info sheets, and newsletters, as well as digital publications provided through the project website and social media. Supplemental files and Energy Rights Project (2024). Printed copies of pamphlets, info sheets, and newsletters are distributed at community events to engage attendees in conversations about energy justice in their neighborhoods—deferred maintenance, asthma, and energy insecurity itself. In November 2023, for example, ERP co-tabled at three community events with project partners; hand-outs on deferred maintenance, medical vulnerability, and weatherization were used as a jumping off point to engage community members in conversation about electrification and residential energy policy that is being developed in the wake of IRA.

Working side by side with community organizations on outreach and education activities, at neighborhood events or otherwise, helps build relationships with project partners and local community members. Relationship building is always a first step of EJ research and the development of action mechanisms that foster and sustain relationships should be seen as an important outcome itself.

### 3.3. Holyoke, Massachusetts (US): Holyoke Community Energy Project (HCEP)

**Context**—Our third case study focuses on the HCEP, an ongoing effort to integrate participatory research, convergence and citizen science through CBPR. Two co-authors contribute to directing the project (Harper and Nwadiaru) and a third is a participating researcher (Nwadiaru). HCEP developed out of community food justice research and public art collaborations between university-based faculty and community organizations (Harper *et al* 2023; Krupczynski 2011). Holyoke, Massachusetts is a majority-Latino city with 37 000 people in the Connecticut River valley. City residents contend with simultaneous challenges of deindustrialization and environmental injustice, especially the intersections of concentrated poverty, substandard housing, and poor air quality. At the same time, Holyoke residents and organizations have actively mobilized to preserve Latino cultural heritage and for environmental justice, including the closure of a coal power plant. This context led co-authors Caverly and Harper, and other university-based collaborators to partner with Neighbor to Neighbor Holyoke (N2N) to develop a program that explores how household electrification could best support the material interests of long-term Holyoke residents, especially low-to-moderate-income people. One key priority for N2N was developing evidence-based research and organizing frameworks to ensure electrification and energy transitions improve housing quality for low-to-moderate income Holyokers without displacing them from their homes.

**Using participatory methods**—HCEP uses participatory methods to ensure research goals, research designs, and outputs align with community desires. It is guided by a campus-community compact (Campus Community Compact 2009). For example, before submitting proposals for external funding, university-based researchers collaborated with N2N staff and member organizers to use scenario planning to understand community priorities for household energy, including in relation to fossil gas (Harper *et al* 2023). Subsequent federal grant proposals were drafted in collaboration with N2N staff and member organizers, as well as with the support of a CAB of staff from Holyoke-based housing, arts, and health agencies. Grant proposals included subawards for N2N so that funded grants provided organizational resources, especially staff time, necessary for them to collaborate with university-based researchers.

The core of HCEP is an Energy Justice Leaders (EJLs) curriculum that uses participatory methods to support cohorts of Holyoke residents in shared learning about energy in their homes and communities. Priorities for the curriculum were identified in focus groups with city residents. Through Photovoice and storytelling methods, the program centers EJL participants’ understandings of their energy systems. Walks and participatory mapping support EJL participants in developing energy and environmental justice tours that situate energy challenges within successful struggles for environmental justice in Holyoke. Participatory modeling provides a framework for participants to identify energy system challenges (e.g. energy costs, split incentives problems, indoor air quality). EJL participants collaborate with university-based researchers to survey members of their communities to understand their perspectives on possible solutions to addressing those challenges (e.g. local ordinances, weatherization subsidies, gas-to-induction conversion, etc). After completing the EJL program, participants can elect to continue participating as community researchers. In this role, they collaborate with university-based researchers to conduct community-based research and experimental ethnography to refine technical interventions, policy proposals, and advocacy strategies to facilitate household electrification without displacement.

**More just outcomes**—Through community-university research collaborations in Holyoke, HCEP has met the desires that LMI people, especially LMI renters, have for their energy systems. This has meant

priorities of city residents and justice-focused community partner organizations at the forefront which avenues of research to pursue first (Caverly et al 2023). Early priorities include: local ordinance subsidize electrification of space and water heating in rental apartments while also preventing gentrification; addressing substandard housing conditions through energy efficiency upgrades; a solar-powered refrigerator to store and distribute produce to food insecure households from a garden. In this way, participatory frameworks and methods have been essential to building energy research that forms the basis of evidence-based energy transition design, governance, and advocacy.

## 4. Guiding principles of PR and energy justice

Participation from stakeholders and those directly impacted by energy injustices is critical to address the urgent challenges of our time (Hendricks 2020). As the world faces the dual imperatives of reducing emissions and ensuring a reliable and sustainable energy supply, research plays a vital role as a driver of innovation and progress. PR around energy justice issues fosters a deeper understanding of how systems work, as well as their environmental, economic, and societal impacts. Feeding grounded understandings of energy into technological innovation and social change can ultimately pave the way for a more sustainable and equitable energy future. Actually, doing so depends on PR projects ensuring research is accountable to the residents, organizations, and stakeholders who make it possible. In the cases presented above, we highlight key principles for PR in the field of energy justice.

### 4.1. Prioritize local needs

By working in partnership with people and organizations, participatory energy justice research addresses complex local needs. From the Brazilian Amazon to urban centers like Philadelphia and small cities like Holyoke, the importance of understanding the local context is evident. PR can surface how people experience energy challenges that are acutely shaped by its geographical, cultural, and socio-economic context. By acknowledging and addressing these specificities, participatory methods become more effective in addressing energy injustices. Importantly, PR does this without oversimplifying 'community'. For example, in the Philadelphia case study documented how household experiences of energy insecurity varied across the same city and neighborhoods.

### 4.2. Respect diverse expertise

The case studies, as well as the PR literature, highlight how respect towards all participants is critical (Caverly et al 2018). Respect towards community members is important but also to practitioners and researchers from varied disciplines. Embracing PR emphasizes the intrinsic value of experiential knowledge. It is important to recognize the agency of those marginalized or adversely affected by existing social structures through transformational initiatives. In doing so, PR acknowledges all participants' diverse backgrounds and perspectives, which helps create a safe and respectful environment. This is especially relevant for energy justice research to create mutually beneficial collaborations between university and community organizations as well as partner organizations.

### 4.3. Build trust

The establishment of trust-based relationships is fundamental. It requires consistent effort towards creating an environment of mutual trust and collaboration among all stakeholders. In all our case studies, we demonstrated how researchers engaged in conversations and activities with community partner organizations and stakeholders right from the start of the projects. To establish trust, it is crucial to be transparent, listen, and be achievable and commit to a long-term relationship (Cornwall and Jewkes 1995). In Holyoke, researchers built trust by working with partner organizations to address community desires around food justice and public art before shifting into energy research.

### 4.4. Act and reflect

Aligned with PR principles, the process involves a dynamic interplay of action and reflection, generating knowledge explicitly geared towards informed and purposeful interventions (Reason and Bradbury 2010). To illustrate, in Philadelphia, ERP was designed as a response to findings from Ready Philly that community organizers and researchers had arrived at together; as a result, ERP focused on documenting a less visible issue (energy insecurity) that was of greater immediate impact and relevance to workshop participants.

### 4.5. Design for transparency and accountability

Transparency and accountability hinge on clear communication of research expectations and avoiding over-promising (Cornwall and Jewkes 1995). This principle ensures that the research process remains

trustworthy and accountable to all involved parties and that knowledge generated is shared in an accessible form with stakeholders. In the Amazon, Castro-Diaz took care to present the results of participatory mapping about the impacts of hydroelectric dams to local residents for feedback and to move forward with publications. This allowed opportunities for community revision and for research partners to shape what became of the data they created.

#### 4.6. Choose appropriate methods

Choosing the right methods and tools tailored to the context, research goals, and participants' needs is crucial. Participatory methods should be selected once the objectives of the process are clearly defined, an appropriate level of engagement is identified, and relevant stakeholders are chosen for inclusion in the process. Furthermore, teams should consider available funding and staff capacity when selecting methods (Cornish et al 2023). Across all three case studies, particular methods were chosen in dialogue with participants as part of iterative processes in which partner organizations, residents, and stakeholders actively shape the research process.

#### 4.7. Adapt and be flexible

A range of methods have been used in these cases (e.g. participatory mapping, visioning workshops, focus groups, surveys etc). They reflect the need for adaptable approaches, as academic researchers often shift topics and methods in response to community partners' goals and ethical considerations. In the three case studies, researchers adapted their aims based on feedback from partner organizations and community participants.

#### 4.8. Aim for long-term collaboration

Building enduring partnerships is a cornerstone of effective PR for energy justice. All three case studies highlight the significance of long-term collaborations between university-based researchers and local community organizations. Such collaborations creatively leverage university-based resources to support durable relationships with grassroots organizations that are essential to ongoing research and design beyond the scope of a single project. The HCEP is an instance of team-based research involving researchers across all stages of their careers. The ERP and Brazilian cases reflect long-term collaborations begun by a midcareer and a junior scholar, respectively.

#### 4.9. Acknowledge complex systems

Recognizing the intersections of environmental, racial, and economic justice is crucial. In Brazil, the impacts of hydroelectric dams was embedded within disparate impacts at the intersections of race, ethnicity, and gender. The Holyoke case exemplifies the integration of just and sustainable local energy systems into a broader framework of addressing deindustrialization and environmental injustice. The ERP addresses energy insecurity within the complexities of social welfare and climate justice. Understanding and addressing these interconnected challenges requires holistic approaches that acknowledge the multifaceted nature of energy justice concerns.

In summary, these guiding principles encapsulate the essence of participatory energy justice research. Such work emphasizes respect, trust, community needs, reflective action, transparent accountability, methodological appropriateness, as the linchpins of a robust and ethically grounded research framework to understand and address energy injustices.

## 5. Limitations

When organized around energy justice issues, PR provides rich insights into the role of the energy system in people's lived experience, the barriers communities face in accessing energy, and creative solutions for equitably expanding access to energy. However, PR is also labor-intensive. Significant resources are required to build and maintain partnerships between scientific teams and community partners. Training in participatory methods and approaches, including understanding their tradition and usage, is also essential to move beyond these approaches as extractive methods but rather lift their original intentions of supporting positive change with non-academic partners. University researchers who engage in PR commit much of their time to developing strong relationships, communication, and trust, which may not be recognized by traditional academic reward systems. Higher education organizations such as Campus Compact and The Faculty Senate University Civic Engagement Network (TRUCEN) advocate for community engagement to be recognized in tenure and promotion policies. Community organizations, for their part, may find that working with academic scientific teams puts a strain on staff time, detracting from core activities. PR teams should adapt

limitations by budgeting grants in such a way that partner organizations derive benefits, not just working on knowledge production.

Participatory energy justice research will require university researchers to share control of research questions, methods, and outputs with community-based stakeholders (e.g. participants, organizations). As emphasized by scholars such as Cornwall and Jewkes (1995), PR must navigate the complex interplay of power and privilege to ensure equitable partnerships between researchers and communities. This involves acknowledging and addressing existing power imbalances, fostering meaningful dialogue, and supporting the agency and self-determination of marginalized groups. At times, university researchers will need to adjust projects to account for community partners' priorities and goals or to pivot away from projects that are not interesting or possibly damaging to communities. This often presents additional ethical dilemmas, such as conflicting with priorities of the funding source and predefined research objectives. In such instances, a need for reflexivity and responsiveness on the part of researchers arises. Researchers must engage in transparent and respectful dialogue with communities, recognizing their right to shape the research process and outcomes. Ethical issues related to diverging priorities can hinder progress toward long-term goals, undermining collaboration, trust, and stakeholder buy-in. Without sustained funding support, research initiatives may struggle to achieve meaningful impact or bring about lasting change in communities affected by energy injustices. We hesitate to frame this as a limitation. Rather, it reflects how PR can create space for ethical research and democratic decision making that respects community expertise alongside academic knowledge.

## 6. Future directions for participatory energy justice research

PR is crucial to energy justice research because it offers frameworks and methods that place the needs and concerns of marginalized communities at the center of research and policy decision-making. To achieve equitable and sustainable energy systems, it is crucial to directly engage with communities most affected by energy-related injustices, such as unequal access to clean energy resources or exposure to environmental hazards. Involving these communities in the research process—especially in identifying problems and developing solutions—provides an essential understanding of unique challenges and aspirations for energy justice. Through participatory methods and frameworks, researchers can bridge the gap between research and practice, ultimately contributing to more informed, inclusive, effective, and just energy policies and interventions that align with sustainability and social equity principles.

PR frameworks and methods can offer a foundation for energy justice research to move beyond decontextualized concepts to inform multiscalar policy, practice, and advocacy adapted to be effective in their local contexts. The implementation of PR frameworks can guide the identification of energy justice metrics which is relevant for just bulkpower systems planning with relevance at different scales. Some of the metrics identified transcend community borders. For example, the tools detailed above can be used to shift beyond the simple electrification of personal vehicles and assess regional accessibility and equity needs. PR could provide policy guidance to address equity implications in public transit investment, vehicle incentive structures, and charging infrastructure deployment. By engaging end-users, community members, and stakeholders in the research process, researchers can gather real-world insights, identify barriers, and co-create solutions that address concerns of specific groups such as the elderly, people with disabilities, low-income riders, and rural populations. This collaborative approach leads to more relevant and effective policy recommendations, technologies, promoting greater access to and engagement in the transition to sustainable transportation.

Another PR opportunity involves collaborations between university researchers and community-based organizations through citizen science. This approach could help visualize local energy system burdens, including cumulative exposures from smaller, dispersed sources. These cumulative impact profiles and hyperlocal air quality insights are not available in existing regulatory data and can inform more targeted assessment tools. Such tools will be essential to incentivizing transitions from fossil-fuel sources to clean, zero-emission infrastructure. A continuous and ongoing engagement allows community priorities to inform grassroots leadership to shape regulatory procedures and policy recommendations.

Finally, it is crucial to emphasize the significance of collaborating with stakeholders and researchers from diverse disciplines. Energy researchers are typically based in environmental and computational science, engineering, and related fields. PR experts are typically based in the social sciences, arts, human geography, community health education, and related fields. PR offers an opportunity for ground-truthing models used by energy systems modelers and co-creating objectives and values for such models with the community. Collaborating with and sharing knowledge across these domains will provide a diverse range of perspectives and insights, ultimately enabling research teams to tackle complex challenges more effectively. A strong methodological commitment to participatory energy research will help advance knowledge and address energy justice challenges and possible methods for addressing them.

## Data availability statement

The data cannot be made publicly available upon publication because no suitable repository exist for hosting data in this field of study. The data that support the findings of this study are available upon reasonable request from the authors.

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