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# The geographies, typologies, and trends of community-based organizations for solar energy in the United States

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ABSTRACT

Community-based organizations (CBOs)[1] play an important role in developing solar energy in low- and moderate-income (LMI) communities. This article shares the perspectives of CBO leaders in LMI communities, identifies and addresses solar information gaps, and provides recommendations State Energy Agencies and other government leaders can use to better involve CBOs in solar program initiatives. Using semi-structured interviews and focus groups with CBOs from across the United States (US) we develop typologies of CBO structure and function, and determine the primary motivations, challenges, opportunities, and communication barriers CBOs face. We explore the correlation between key typologies such as tenure, staff capacity, population served, organizational structure, and region with the organizational activities performed by solar-related CBOs. CBOs operate in disparate regional political and economic ecologies. Our findings suggest strategies for states to support their engagement in solar-related endeavors, particularly with respect to the dissemination of the Bipartisan Infrastructure Law, Inflation Reduction Act, and the EPA Greenhouse Gas Reduction Fund: Solar for All. Developing policies that encourage CBOs to enter the solar training and installation domains, alongside targeted grants and capacity-building initiatives can help maximize community benefits. States can additionally contribute to the positive trajectory and collaboration between state agencies and CBOs in advancing solar energy adoption by fostering a supportive environment.

## 1. Introduction

Frontline[2] community-based organizations (CBOs)[3] play an important role in disseminating knowledge and information, providing critical legal, consulting and financial support, and facilitating solar project development that is needed for solar to be developed efficiently, equitably, and cost-effectively in low- and moderate-income (LMI) communities [1–7]. Our research seeks to create opportunities for state energy agencies (SEAs) to better understand the perspectives of CBO leaders in LMI communities, to identify and address solar information gaps, and to provide recommendations for how states can involve CBOs in solar program initiatives. Using semi-structured interviews of 41 CBOs from across the US and conducting focus groups of 35 CBOs and SEA representatives, the article provides recommendations of how state and federal government agencies can support CBOs to play an effective role in their communities.

For solar advocacy and dissemination to adequately address issues of access, equity, and inclusion, it is essential to understand the role of, and potential for information exchange by CBOs [5,8]. In particular, examining the actual and potential interactions of CBOs can shed light on the

*Abbreviations:* LMI, low and middle income communities; CBO, community-based organization; SEA, state energy agency; EJ, environmental justice; CESA, Clean Energy States Alliance; BIPOC, Black, Indigenous and people of color.

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[1] There is no single definition of or universally accepted characteristics of a CBO. We define a CBO as "formal or informal organizations or citizen groups engaged in activities explicitly designed to encourage the adoption of solar." This definition is similar to what Noll et al. (2014) use in the solar PV context.

[2] We define frontline communities here as communities that have been disproportionately harmed by environmental degradation, socio-political disenfranchisement, and economic disinvestment, in alignment with Enterprise Community Partners [9].

[3] There is no single definition of or universally accepted characteristics of a CBO. We define a CBO as "formal or informal organizations or citizen groups engaged in activities explicitly designed to encourage the adoption of solar." This definition is similar to what Noll et al. [10] use in the solar PV context.

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efficacy of state energy programs that seek to promote solar development in LMI communities. This paper provides findings on how CBOs and communities absorb new information about solar energy and what types of connections and resources are most valuable to decision makers. Policymakers, the solar industry, CBOs, and other stakeholders have become increasingly interested in ensuring that LMI residents can access and benefit from solar. This reflects a growing awareness of environmental justice (EJ) and equity issues, and a concern that solar energy could lose public support if it is perceived as benefiting only the affluent [3,11–13]. Our results can help these policy makers understand the context in which CBOs are operating, the challenges they face, and how policies can better support CBOs who are advocating, educating, training and deploying solar energy in their communities.

In particular, CBOs can be beneficial for supporting successful LMI solar development since they are trusted in the local community and know how best to engage with local residents. Involving CBOs can also help overcome some of the distrust that many residents of communities feel towards utilities, energy companies, and the solar industry because of bad experiences with competitive electricity suppliers and other marketers [14–17]. It takes time and resources for states and other players in the solar market to work in partnership with CBOs, but this type of partnership can achieve greater efficiency and reduce solar project failures [4]. Partnerships involving CBOs can help avoid "one size fits all" approaches that thwart place-specific solutions, while community supports and involvement can be beneficial both for onsite solar installations, as well as for larger shared solar projects [3,5,16]. By working with CBOs, SEAs and other stakeholders can better design programs that are responsive to the needs of LMI communities.

There have been promising efforts to increase the role of CBOs in solar development, such as in solar education and project development [2,18]. A few SEAs and quasi-state agencies (i.e., organizations with some regulatory authority akin to state agencies), as exemplified by Energy Trust of Oregon, have partnered with CBOs to advance LMI solar. Despite these encouraging signs, there has not been a systematic study to understand and analyze the solar knowledge, roles, perspectives, and needs of CBOs. Not all CBOs are alike in their level of solar knowledge, relationship to the local community, desired roles in the solar economy, attitudes towards working with state agencies or the solar industry, or necessary resources to play an effective role in advancing solar. Our work undertakes systematic research to understand the roles of CBOs and to foster their engagement with state solar programs in order to achieve faster, cost efficient, and equitable solar development in LMI communities.

We use the interview data as well as documentary evidence collected about CBOs, their organizational structures, and their organizational goals to develop a preliminary typology of these organizations as seen in Section 4. The resulting explanatory model of organizational dynamics facilitates a better understanding of the CBOs (what they are and how they fit into the information channel between the state and the LMI communities). CBOs are relevant stakeholders influencing the information flow in terms of both how and what kind of information reaches LMI communities. Understanding the nature of communication flows, the challenges CBOs face as well as the kinds of resources that enhance their work can lead to more successful policies that support CBOs in promoting solar energy in the LMI communities.

## 2. Literature review

CBOs play an increasingly critical role in local clean energy transitions, and can be transformative in accelerating the urban adoption of renewable energy systems by catalyzing market transformations for solar adoption [5,8,18–21]. CBOs are particularly crucial to ensuring solar programs and policies serve low- and moderate-income (LMI), systematically excluded, or otherwise vulnerable communities, given the energy insecurity that already affects millions of Americans and that has been exacerbated by the COVID-19 pandemic [1,2,19]. Studies on CBO innovations around community shared solar reveal the various strategic ways in which CBOs substitute for or complement top-down, government-led energy policies and standard normative energy -transition goals. Their work on energy transitions simultaneously also contribute several non-energy, societal and organizational benefits [18]. A national study by Carley, Engle and Koniskey notes that nonprofits and front-line community organizations, rather than government agencies, administer most U.S. energy justice programs (including training, advocacy, and weatherization initiatives) [2].

NYSERDA's *New York State Disadvantaged Communities Barriers and Opportunities Report* [12] identifies four categories of barriers hindering clean energy access for LMI communities: Physical and Economic Structures and Conditions (e.g., high building upgrade costs, limited access to services and infrastructure), Financial and Knowledge Resources and Capacity (e.g., limited income and credit access, lack of information and training opportunities), Perspectives and Information (e.g., limited understanding of clean energy benefits and climate change risks, historical mistrust of government and utilities), and Programmatic Design and Implementation (e.g., misaligned program offerings, insufficient resources and coordination).

Shittu and Weigelt [22] additionally point out that LMI communities' access to solar is significantly influenced not just by income but also by available community ownership models and local regulatory frameworks. Hoicka and MacArthur [23] similarly demonstrate that community energy is affected by diverse political economic contexts, but that community projects can enhance engagement across a wide segment of society and open ownership models. CBOs promote distributional, recognitional, and procedural energy justice by empowering LMI neighborhoods, to ensure that solar development is led *by* community members rather than by developers from outside the community [3], and by driving collaborative partnerships to support environmental protection, social equity, and economic growth during clean energy transitions even when government actors do not support transition policy [5,19]. Moreover, community-based organizations and grassroots organizations play a significant role in promoting environmental changes by giving importance to the political aspects of energy rather than treating it as a neutral and non-political resource [24]. Studies demonstrate that given the socio-cultural and geographic challenges of energy transitions, and the widely diverging perceptions of and motivations for solar energy adoption across communities, energy projects that are community-led and place based – that is, targeting the local context and engaging local people actively in development and implementation – are critical for promoting energy justice and for bringing the benefits of solar energy to disadvantaged communities[4] [6,7,18,25–27].

However, CBOs achieve sustainability and clean energy goals at variable rates due to gaps in funding, support, and communication across sectors and regulatory scales [21,28,29]. Wright and Reames [21] identify lack of community engagement, human resource capacity, government funding, revenue diversification, and federal or county/regional government collaboration as the five factors most often impeding CBOs' achievement of clean energy and sustainability goals. In addition, since energy is primarily regulated at a state or local level, each state or even municipality effectively functions as a separate energy

[4] Defined here in accordance with the New York Climate Leadership and Community Protection Act [36] which cites disadvantaged communities are:

1. Areas burdened by cumulative environmental pollution and other hazards that can lead to negative public health effects.
2. Areas with concentrations of people that are of low income, high unemployment, high rent burden, low levels of home ownership, low levels of educational attainment, or members of groups that have historically experienced discrimination based on race or ethnicity.
3. Areas vulnerable to the impacts of climate change such as flooding, storm surges, and urban heat island effect.

market, so that the absence of federal and in some cases state standards [20,30,31], and the inconsistency of regulations at the local, state, and national levels, significantly impede community clean energy transitions [32–34]. Policy differences across federal, state, and local jurisdictions– and in particular conflicting regulations across those jurisdictions–create divergent "policy corridors" and amplify local controversy and uncertainty regarding solar adoption, especially within transitioning coal communities [31,34,35]. Moreover, utilities will often not seek to support community solar project accessibility for LMI households unless compelled by external regulatory requirements or retail choice markets, and without state policy intervention the solar adoption gap between environmental justice and other communities is likely to increase, reinforcing the importance of consistent and coordinated state and federal policies [13,22,37]. Since clean energy action at the local level is often dependent on state fiscal support, accessibility to solar for LMI households can be shaped by policy, and clean energy policy adoption occurs more frequently in states with supportive state and federal governance. Financial incentives alone are not sufficient to address clean energy transition gaps; coordinated multilevel governance is critical for promoting stable local clean energy transitions [12,38–42].

Moreover, to support a just energy transition that safeguards socio-economic, environmental, and health benefits for disadvantaged communities, solar adoption incentives (both ongoing and in up-front subsidies, per O'Shaughnessy et al. [43]) must be combined with community education about solar, earlier engagement by local agencies and developers with residents, effective communication of solar benefits (including non-environmental benefits) and efficacy, capacity-building[5] for local groups to support solar development and implementation, solar project coordination support from public agencies, and standardization of community solar program policies [12,17,43–47]. With respect to solar education, capacity building, and coordination, studies demonstrate a key barrier to community adoption of shared solar is the distrust of non-local sources of information such as utilities and state agencies, while trusted of "peers and near-peers"— that is, people within trusted social networks and other groups within the community–are the most influential information source when it comes to the understanding of solar benefits and, as a result, the diffusion of new solar technologies or practices, such that local community referrals are the highest source of solar leads for LMI households [14–17,48,49].

To address solar adoption barriers in disadvantaged and LMI communities and to increase access to and ownership of clean energy programs, NYSERDA [12] makes several in-depth recommendations, including: co-designing programs and projects alongside communities; providing clearer opportunities for public input and participation in governance processes and clean energy programs; lowering program barriers to entry by offering direct community education and expanded eligibility; coordinating programs and policies across state agencies; emphasizing the state's role as connector between federal and local programs; targeting services and resources to disadvantaged communities' needs; and mobilizing community-based networks and action; many of these suggestions are reinforced by the U.S. Department of Energy's report *Affordable and Accessible Solar for All* [11]. Studies also reinforce that solar information dissemination and opportunities for public input and participation must be tailored to address accessibility limitations in LMI households (e.g., lack of internet access or limited English proficiency), and that incentive programs and funding streams targeted towards disadvantaged and LMI communities are critical for solar growth in environmental justice neighborhoods [13,50].

CESA [3] similarly recommends that partnerships with trusted community organizations, strong consumer protection, solar education, training, and workforce development (i.e. capacity building), and increased availability of financing are all crucial for successful solar development in LMI communities. The CESA Solar with Justice project [3] seeks to advance these types of solutions by actively encouraging SEAs to collaborate with CBOs in frontline communities and by working with CBOs directly to educate community members and build community capacity for leading on solar development. As a result, they are facilitating pathways for local stakeholder involvement in program development and ownership and enabling better knowledge sharing between SEAs and CBOs to advance more efficient, equitable, and affordable solar development in LMI communities. This study examines the critical role that CBOs play, the divergent conditions that CBOs of different types and in different communities face, and strategies that can help improve CBO's success in solar development respective to divergent CBO conditions and types.

## 3. Methodology and data

Our research goal is to understand the views, experiences, and beliefs that different CBO stakeholders face regarding challenges, opportunities, communication barriers, and motivations in the implementation of solar projects in LMI neighborhoods. As such, we relied on semi-structured in-depth interviews [51,52] with CBOs to learn about their work on solar and particularly focused on the nature of their relationships with state and local governments. In the next section, we provide details of our data collection strategy and empirical approach.

### 3.1. Data collection

We surveyed existing research studies and reports on solar CBOs, multi-dimensional barriers to solar energy adoption by LMI communities, solar energy equity, and strategies for engaging CBOs and LMI communities in solar. Based on the initial review of journal articles, policy documents, and professional reports, we identified key issue areas around solar experiences of CBOs and LMI communities (as described in the literature review above). This allowed us to capture the baseline views on the opportunities and challenges for LMI communities as well as the role of CBOs in assisting and working with LMI communities to participate in equitable solar energy development.

To help create a database of state-wide CBOs working in the solar space and to initiate the engagement with them, the research team organized a Solar with Justice National Workshop 2021 (July 12–14th). The workshop invited more than 35 CBOs across 15 states. During the three-day workshop, we organized three focus groups to hear directly from the participants on their perspectives on solar development and the ways in which CBOs can better assist and work with LMI communities. The focus groups enabled us to identify the key questions in communication, opportunities, challenges, relationships, and effective strategies in advancing solar development in LMI communities. These results from the workshop served as a basis for designing our interview instrument. In focus groups, we could learn about the broad range of experiences as different CBOs shared their knowledge and perspectives on specific issues [53–55]. We could also get data on group dynamics by observing the conversations between CBOs and state energy agency representatives.

We then built a qualitative database with data from interviews, online research on the interview participants, and organizational and media documents. Using the workshop database, we deployed a two-pronged purposive sampling strategy [56] to choose information-rich CBOs that could provide us with sufficient heterogeneity in data on the legal status of organizations, their tenure, structure, and staff size. In addition, we also ensured the representativeness of the states in selecting CBOs (Fig. 1). First, we contacted CBOs who were already included

[5] "Capacity building" here is defined in alignment with the United Nations as "the process of developing and strengthening the skills, instincts, abilities, processes and resources that organizations and communities need to survive, adapt, and thrive" (United Nations, n.d.). In the context of facilitating a clean energy transition, capacity building refers to building or enhancing the resources and abilities a CBO has to deliver and implement clean energy projects and services in/for LMI communities [45].

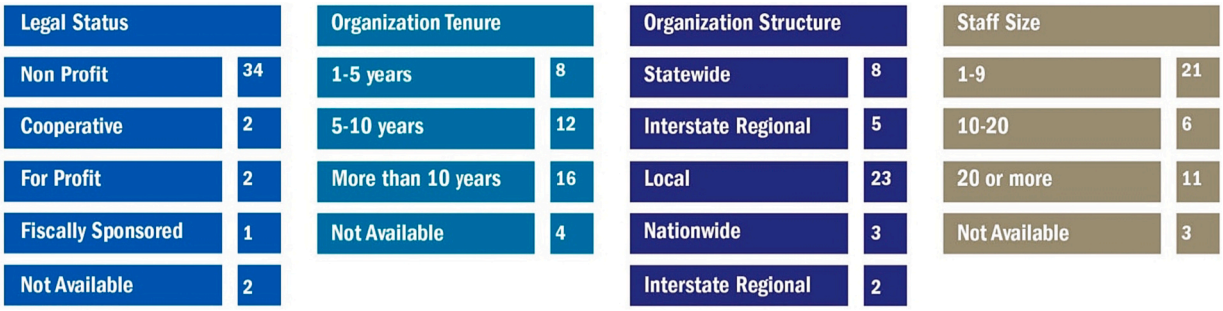


**Fig. 1.** Key typology descriptors by number of interviewee organizations.

in the CBO list that CESA had pre-developed. Second, we reached out to CBOs that participated in the Solar with Justice National Workshop and encouraged their continued participation in the research. Over 200 CBO directors, managers, and staff of CBOs were contacted and 41 CBO representatives were interviewed to gather insights on their respective organizations, including various descriptors that shape our CBO typology. To increase participation, we provided $50 gift cards and drew extensively on CESA's connections with CBOs. Using this incentive strategy, we could elicit a good interview response rate of (~20 %).

The interviews focused on several questions that underpin the research including: What are the attitudes of CBOs and communities they work with on opportunities for solar development? What resources do CBOs and the communities they support need? What are the barriers CBOs face in disseminating knowledge about solar or supporting solar project development? How do knowledge and support flow between state and city agencies, CBOs, and communities? How can solar dissemination be made more successful by working with CBOs of different types? The interview questions were designed to capture and identify the phenomena and narratives around the key challenges, opportunities, and relationships in LMI solar energy development. The interviews followed Internal Review Board protocol and were conducted virtually using a video conferencing tool for transcribing purposes. Each interview took about approximately 60 min to complete. In several cases, we reached out to the interviewees for clarifications and to access relevant documents about the work of their organizations.

Fig. 1 presents the distribution of CBOs interviewed based on four key parameters: legal status, organization tenure, organization structure, and staff size. Fig. 2 shows the geographic representation of the interviewed organizations, utilizing the DOE Regional Specialist Regions. For Appalachia, we used the Appalachian Regional Commission's designation of Appalachia down to the county level as the official designation is across state lines.

### 3.2. Data analysis

With the structures in place, the interview transcripts were coded in three steps using the software NVivo [57]. The coding aimed to generate insights on the relationship between technocratic norms and politics in climate policy, as well as to identify attributes of market-based governance in each area. The second approach, following Eisenhardt and Graebner [58], involved analyzing the transcripts to gain insights into how CBOs operate across types and regions. The coding process progressed from initial codes to analytical categories. First, the transcripts were open coded to identify, categorize and describe the phenomena of CBO typology, key concepts, and place-based connotations. Second, axial coding was performed to relate the open codes to one another and to identify relationships. The axial codes were subsequently coded into analytical categories to map key concepts and networks among CBOs and to present a typology model. The findings presented in this article are primarily based on axial and analytical coding methods identifying the predominant characteristics and relationships among bi-directional nodes and establishing analytical categories.

The axial coding resulted in the identification of core organizational types which are presented in the data tables in Section 4.. These typologies represent key themes and patterns found in the interview data. The analysis of the typologies was conducted across regions, allowing for a comparison of responses and the identification of any significant differences.

The third approach, following Gioia [59], treated the interviewees as 'knowledgeable agents'. This perspective recognized the interviewees as individuals who possess valuable insights into their own experiences, thoughts, intentions, and actions. By adopting this approach, the study aimed to ground its findings in the informants' own accounts and experiences. This approach provided additional insights into the opportunities challenges faced by organizations, the ecological context in which they operate, and their responses to the existing policy environment in which they are situated. The coding of the interviews in Nvivo facilitated a systematic analysis of the data, allowing for the identification of key themes, patterns, and variations in responses, which was used to develop the case typologies.

## 4. Results and discussion

### 4.1. CBO typology and core concepts

Our analysis of case typologies revolved around two categories: organizational functions and organizational characteristics, as seen in Fig. 3 below.

#### 4.1.1. CBO organizational typology

The characteristics outlined in yellow represent predominant characteristics for each parameter, i.e. the characteristics with the most references for each parameter when coded. In our sample, the predominant organizational characteristics are identified to be 'nonprofits', that have been functional for more than 5 years and are headquartered in cities. In addition, organizations that are either a part of collaborations or coalitions are predominantly referenced. For organization tenure, organizations that have been in operation for less than 9 years or more than 20 years are predominant.

Additionally, organizations are categorized as either 'solar directed', meaning that solar work is a primary objective for their organization, or 'solar adjacent', meaning that solar work is supportive of or ancillary to the organizations core mission and goals. As seen in the figure above, in terms of organizational solar involvement, the predominant characteristics are administering solar related programs and projects and facilitating solar installation. Furthermore, the predominant type of solar installation for the organizations we interviewed is community solar. In relation to focuses of solar adjacent organizations, the predominant characteristics are energy efficiency and workforce development. Identifying the broader focuses of solar adjacent organizations through NVivo analysis was helpful to understand the relationships between intersecting issues as well as the types of CBOs interested in doing solar

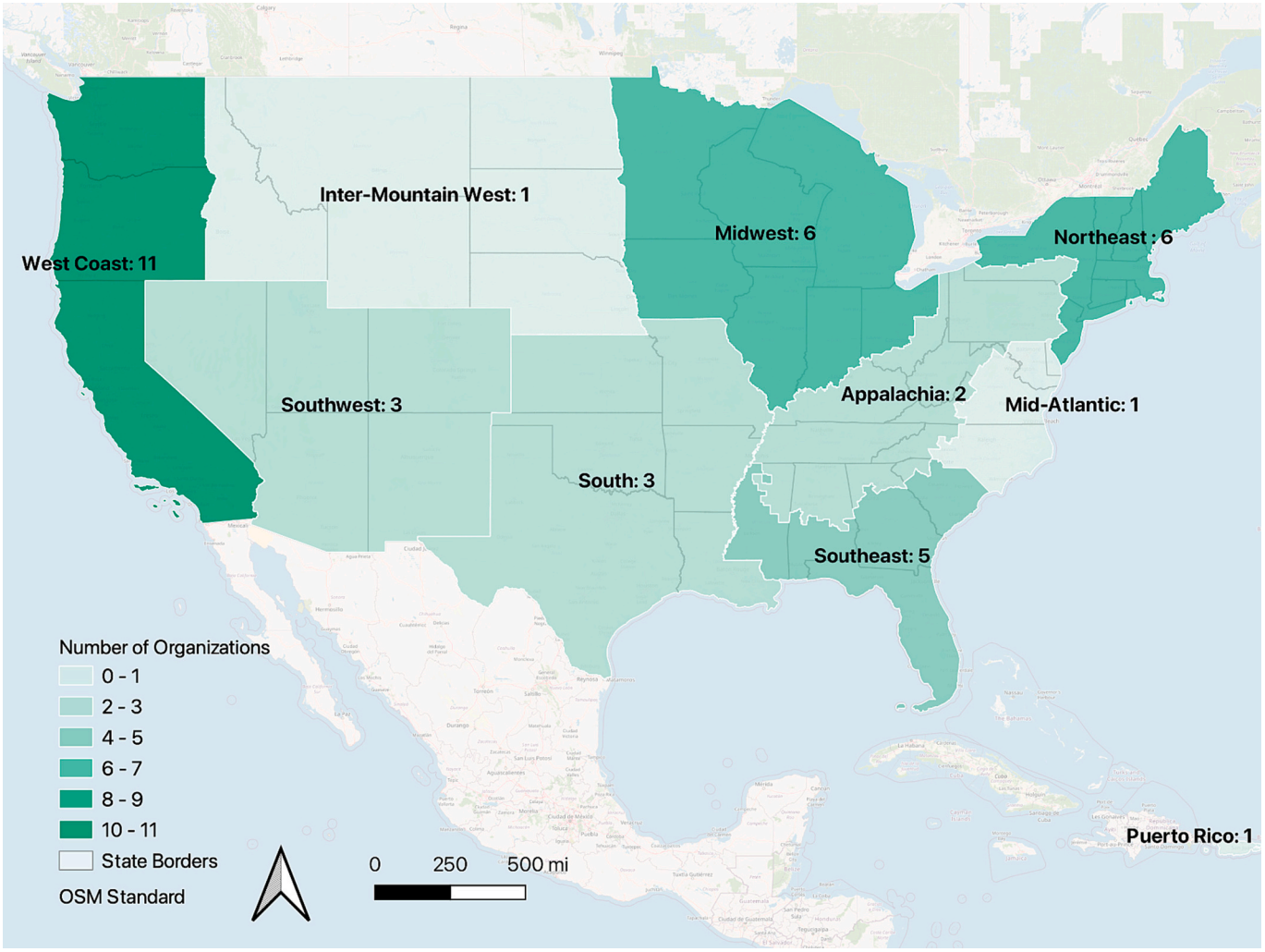


**Fig. 2.** Organizations interviewed by region.

work.

*4.1.2. Core concepts typology*

The figures described below, Figs. 4–6, represent the core concepts determined through a multistep analysis of our interviews, as described in the research analysis section. Specifically, the concepts outlined in yellow represent the predominant characteristics, or the concepts that have the most references to them within each category. Core concepts with a similar number of references were taken into account and are highlighted in yellow.

In terms of opportunities for solar work implementation, many of the references from interviews focus on capacity building and partnership building. Community empowerment,[6] specifically through direct cost savings and/or youth empowerment (e.g., through education, engagement, or employment readiness related to solar development), is one of the major motivations for solar involvement for interviewed organizations as can be seen by the number of references. The other major motivation identified from the data is energy and environmental justice, which is related to seeking independence from existing energy systems as well as achieving energy resilience and recovery in the face of climate events or other energy disruptions.

With regard to relevant policies, more than 37 % of our sample report the relevance of state level policies in their work. Examples of these policies include net metering ordinances, the Oregon Community Solar Program, and the New York Climate Leadership and Community Protection Act bill passed in 2019 which is a commitment to 100 % zero-emission electricity by 2040.

The challenges that interviewed organizations face are several-fold and are presented in Fig. 5 below. Gaining community trust and public understanding is identified as the most pressing concern in our sample, especially for an emerging technology like solar, and particularly for LMI communities. Resource (i.e. funding) availability is a predominant challenge that is dependent on various factors including grant writing capabilities, availability of funding sources, and sufficient funding necessary to build organizational capacity for solar development and implementation. This is particularly challenging given that a number of CBOs have a small staff that is often fulfilled on a voluntary basis. Organizations are often impeded by limited staff and technical expertise. With respect to external challenges, there are also many references to challenges in working with electric utilities and in dealing with governmental bureaucracy. CBOs working in deploying solar directive activities are concerned that utilities can make site interconnections difficult and can advocate against net metering.

The four major relationships that this paper explores are relationships with local government, state agencies, other CBOs, and with the

[6] Community empowerment here is related to, as Coy et al. [60] cite, "individual or collective 'power to' cultivate transformation," defined per Slocum et al. [61]: "a process through which individuals, as well as local groups and communities, identify and shape their lives and the kind of society in which they live" [60].

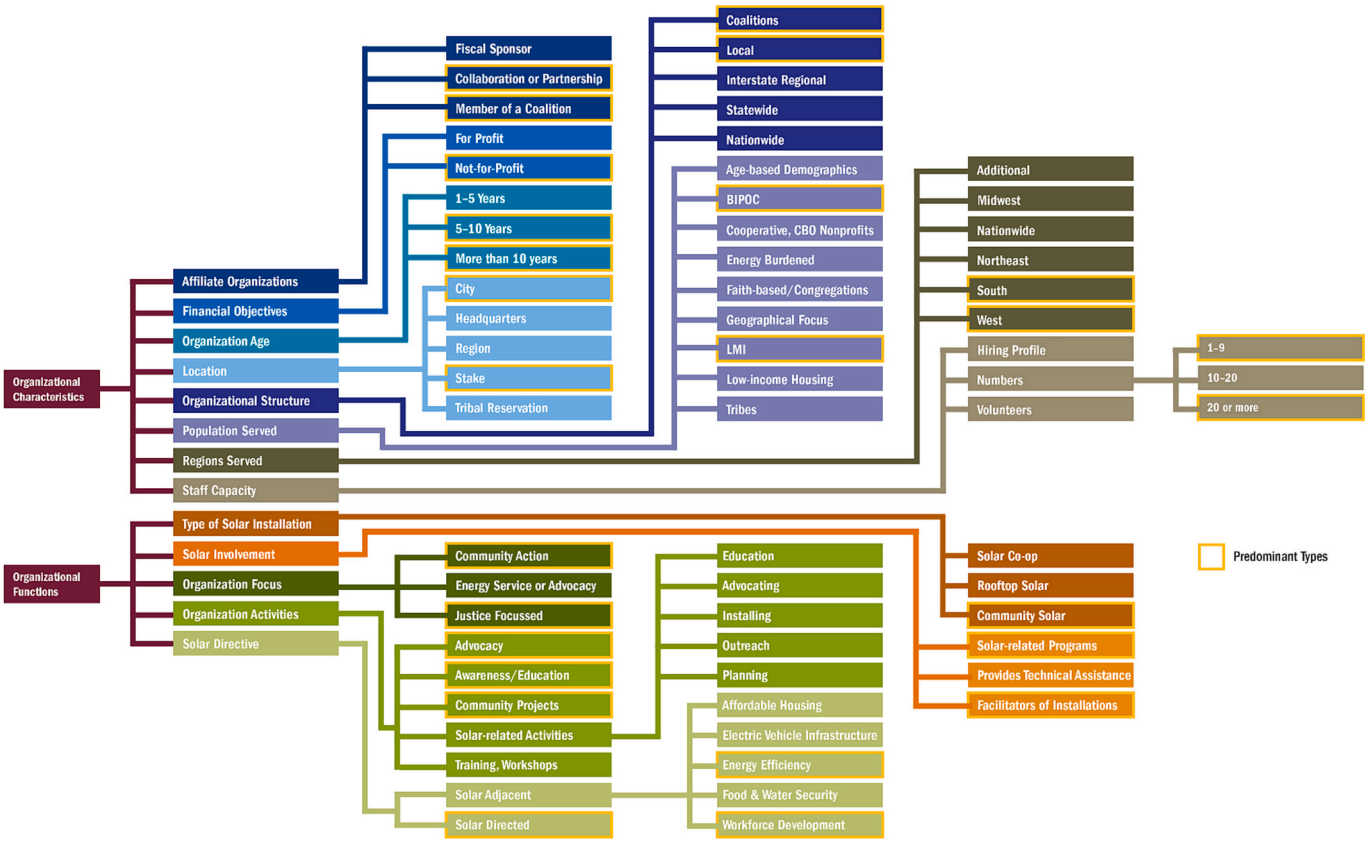


**Fig. 3.** Organizational typology overview diagram. The tabs highlighted in yellow are the predominant types in a category based on the number of coded references.

community that the interviewed organizations are serving. The core concepts within the nature of relationships are identified in Fig. 6. Of relationships with local governments, there seem to be an equal number of opportunities and challenges, with opportunities revolving around the proximity and accessibility of local officials, and challenges focusing on the reach of authority and access to resources. For relationships with other CBOs, there is a demonstrated predominance towards coalition building among CBOs, and a recognition that CBO partnerships can enhance the scope and scale of work that CBOs can successfully undertake. There seem to be substantial challenges in working with state agencies as a result of bureaucracy, staff capacity, and difficult processes of coordination. Sixty-five percent of our sample raised concerns about public utility providers and energy companies. These concerns revolved around actions that block overall solar development such as advocating against net metering. With respect to community relationships, a number of CBOs suggested that effective methods of working with communities include initiating several community meetings and setting up key points of communication within LMI communities.

### *4.2. Comparative analysis: interpretation of key relationships using CBO organizational typology features*

This section highlights the synthesized findings from comparing several core concepts, such as challenges of resource availability, with a CBO typology feature such as tenure or staff capacity. The results and potential takeaways are detailed below, and these interpretations will be further explored and validated through subsequent surveys. Supplementary Table 12 in the Appendix summarizes the key findings discussed in this section.

#### *4.2.1. Core conceptions and tenure*

Compared with organizations that have been operating for less than 10 years, organizations that have been operational for more than 10 years reveal more references to opportunities for development and implementation of community-led distributed solar energy systems. The areas where CBOs suggested they experience opportunities such as community empowerment and resilience and energy and environmental justice are equally distributed in terms of the number of references identified between organizational tenure for more than 10 years and less than 10 years. For organizations with a tenure of 10+ years, 71 % of references for challenges are made up of Poverty and Energy Burden, Public Understanding and Concern, and Funding Challenges; For 5–10 years, 66 % of references for challenges are made up of Challenges of Outreach and Coalition Building, Resistance from Utilities, and Political Challenges; For 1–5 years, 69 % of references for challenges are made up of Challenges of Outreach and Coalition Building, Funding Challenges, and Political Challenges. The data suggest that CBOs that have been in operation for different lengths of time face unique challenges. Specifically, we find that funding and resource challenges are predominant for younger (1–5 years) organizations, whereas for organizations established within 5–10 years, major challenges revolve around relationships with other organizations. For organizations operating more than 10 years, addressing direct community challenges like reducing poverty and energy burden predominate. These findings will be tested with a national survey, but could suggest that policies can be better tailored to suit the needs of organizations operating at different phases of their life cycle.

#### *4.2.2. Volunteer involvement and population served*

Non-profit organization interviewees in our sample more frequently express solar related opportunities when compared with for-profit organization interviewees. This suggests that over time, nonprofits develop networks, funding streams, and policy advocacy capabilities that enhance their work and approach. Similarly, our results show that

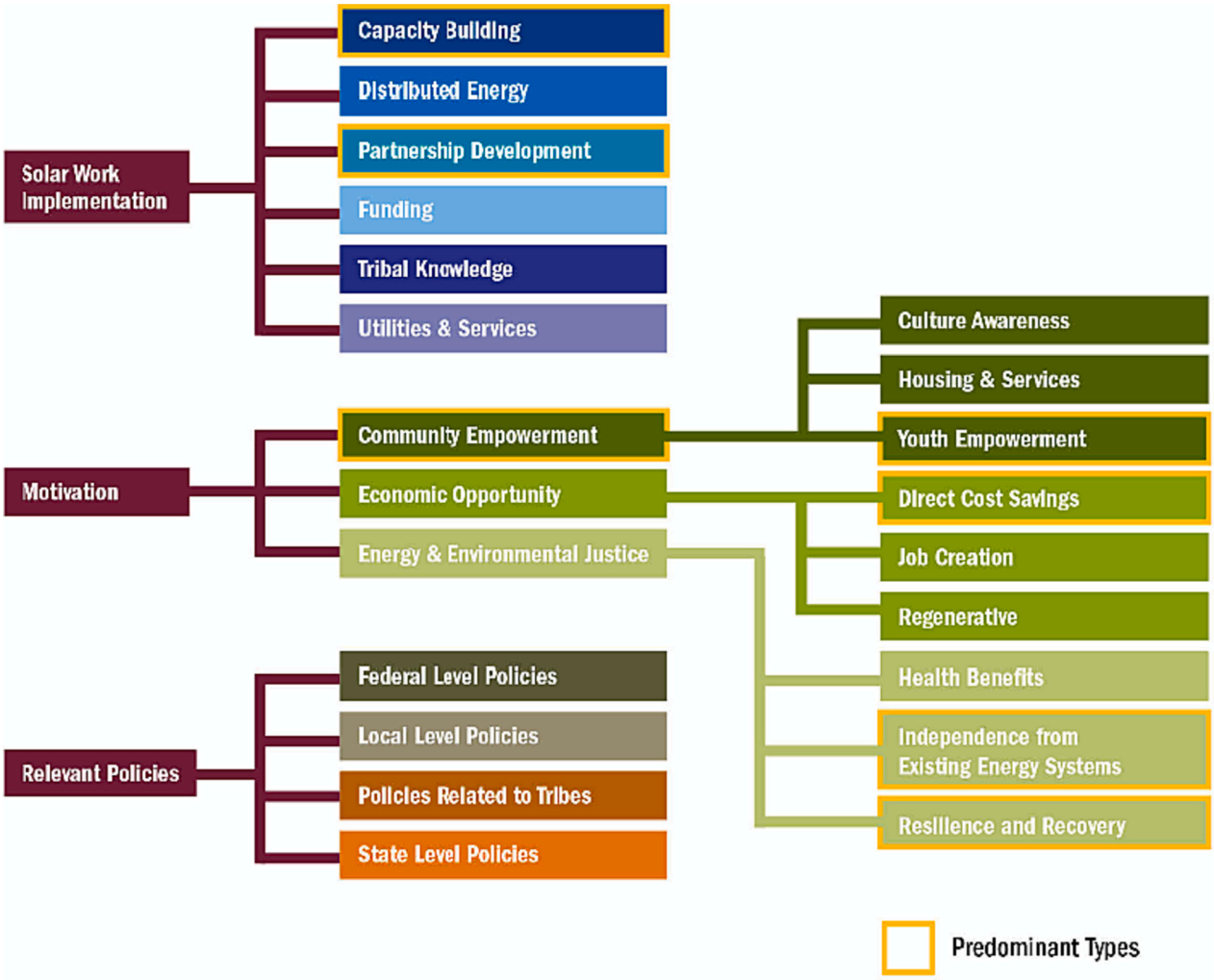


**Fig. 4.** Typology of opportunities and relevant policies.

organizations with no volunteer participation generally expressed more opportunities for growth and more areas of work in which their organizations can expand. The data suggest that nonprofits with volunteers have greater success establishing themselves and are working well with both the communities they serve and the regulatory agencies on which they rely. CBOs with no volunteer participation tend to express greater concerns for gaining community trust in solar and for navigating the challenges of outreach and coalition building to promote solar development. Due to this correlation, we plan to explore the role of volunteers in gaining community approval of community solar in certain contexts through a larger national survey of CBOs.

Among organizational focus types, the organizations who suggest they work on community action, service, and or resilience predominantly express more optimism towards distributed solar energy. We also find that organizations that are primarily serving cooperatives and Black, Indigenous, and people of color (BIPOC) communities express greater interest in distributed solar energy systems than organizations serving other populations. Our interview data indicate that organizations that are primarily serving LMI, energy-burdened (that is, low-income households spending a higher percentage of household income on energy costs) communities as well as tenants of low-income housing are primarily concerned about community empowerment and enhancing community resilience,[7] which are goals distributed solar energy systems may be better able to accomplish.

#### 4.2.3. *Core concepts and regional analysis*

There is variation in the nature of challenges that CBOs face across different regions. The CBOs we interviewed in the Northeast express concern for gaining community trust on solar more predominantly than other regions. CBOs we interviewed in the Southwest predominantly raise concerns about addressing poverty and energy burden compared to other regions. CBOs in the Midwest that express more frequent concerns over the political challenges they face. Not surprisingly, our observations reveal that CBOs that are primarily serving the BIPOC and LMI

[7] Community resilience per the U.S. Department of Energy is "defined by a community's ability to use available resources to respond to, withstand, and recover from adverse situations." In the context of this study, "community resilience" specifically refers to community energy resilience - that is, how distributed solar energy systems can protect the economic well-being and public health of communities in the face of energy disruptions, especially for LMI communities who are typically more affected by disruptions and have to wait longer for reconnection after outages [62].

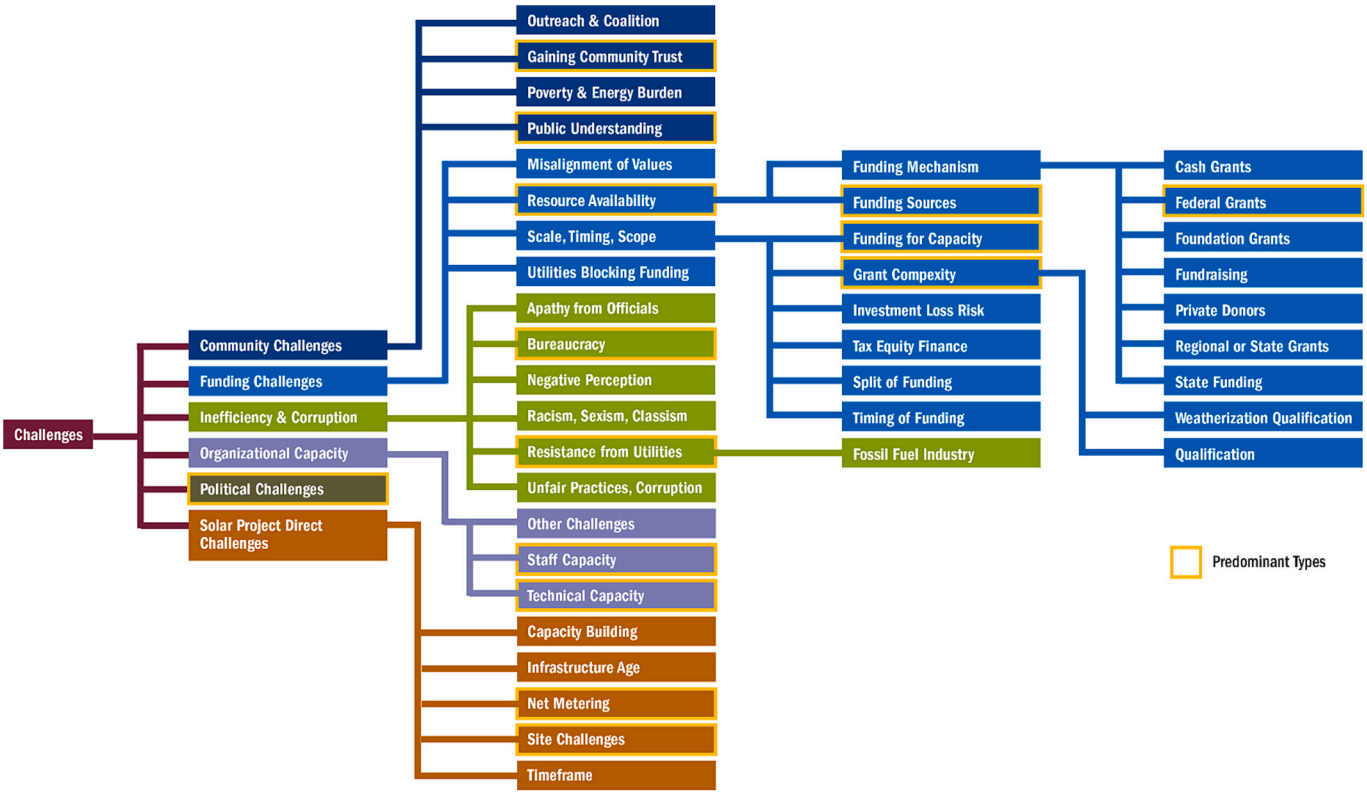


**Fig. 5.** Typology of core challenges.

communities raise more frequent concerns about funding and gaining community trust for solar. In most regions, over 50 % of the organizations we interviewed primarily serve BIPOC communities.

In terms of regional challenges related to relationships, out of the total references to challenges with relationships with state governments, 53 % come from organizations in the South, showing that some state governments in the South may be obstructing instead of supporting solar development. Organizations in California and Oregon, Virginia, Alabama, and Colorado mentioned challenges with utilities blocking funding. Despite the different political environments these states have, CBOs identify utilities blocking funding as a common challenge.

The three overarching motivations commonly presented among CBOs are community empowerment and resilience, economic opportunity, and energy and environmental justice. As seen below in Fig. 7, the organizations we interviewed in the West Coast and Southeast focus on community empowerment and resilience, the organizations we interviewed in the Midwest and Northeast focus on energy and environmental justice, and the organizations we interviewed in Appalachia have the highest proportion of organizations motivated by economic opportunity (i.e., the potential for economic growth in the community as a result of solar development). In recent years, there have been a number of investments by states in the Appalachian region to encourage solar development, which corroborates our findings [63].

#### 4.2.4. Core concepts and staff capacity

A key challenge of CBOs is the high degree of correlation between organizations that face both staff capacity-related challenges and challenges – referring to the number of staff, hours staff can work, and the capabilities and resources of staff related to actions like fundraising, outreach, and solar development – around lack of technical knowledge. In our analysis, 82 % of organizations that have technical knowledge challenges have staff capacity challenges and 67 % of organizations that have staff capacity challenges have technical knowledge challenges. This provides evidence that CBOs would be greatly served by increased technical assistance through State Energy Agencies. When comparing organizations of different sizes (1–9, 10–20, and 20 or more employees), 53 % of references to funding challenges come from organizations with 1–9 staff members, which may show that funding challenges are exacerbated through low staff capacity.

In addition, 60.7 % of references to challenges related to relationships with state governments came from organizations with 1–9 staff members. In terms of relationships with state governments, 68 % (13 of 19) organizations with relationships to other CBOs have challenges forming relationships with state governments. This suggests that while most organizations have the capacity to form relationships with other CBOs, they still have challenges forming relationships with state agencies. This may mean organizations, especially those with smaller staff, are prioritizing their staff capacity to form relationships with other CBOs or it may simply be challenging to form relationships with state government agencies. Some of the challenges mentioned include lack of access, political and policy challenges. This finding suggests that state government agencies should take a more proactive role in reaching out to CBOs. Working through their relationships with CBOs, state agencies might be able to provide support to communities they would not otherwise be able to reach.

#### 4.2.5. Core concepts and solar directed or solar adjacent

Fig. 8 illustrates the organizations' primary focus on solar development and implementation, categorizing them as either solar directed or solar adjacent. Approximately half of the interviewed organizations are solar directed, while around one-third engage in solar adjacent work related to energy efficiency, weatherization, energy bill assistance, and reducing energy burden. Funding challenges are a common concern for both solar directed and solar adjacent organizations, with an equal distribution of references to funding challenges. Among organizations involved in solar-related programs and projects, they accounted for 67 % of references to relationships with other community-based organizations (CBOs), suggesting increased collaboration. Additionally, our analysis

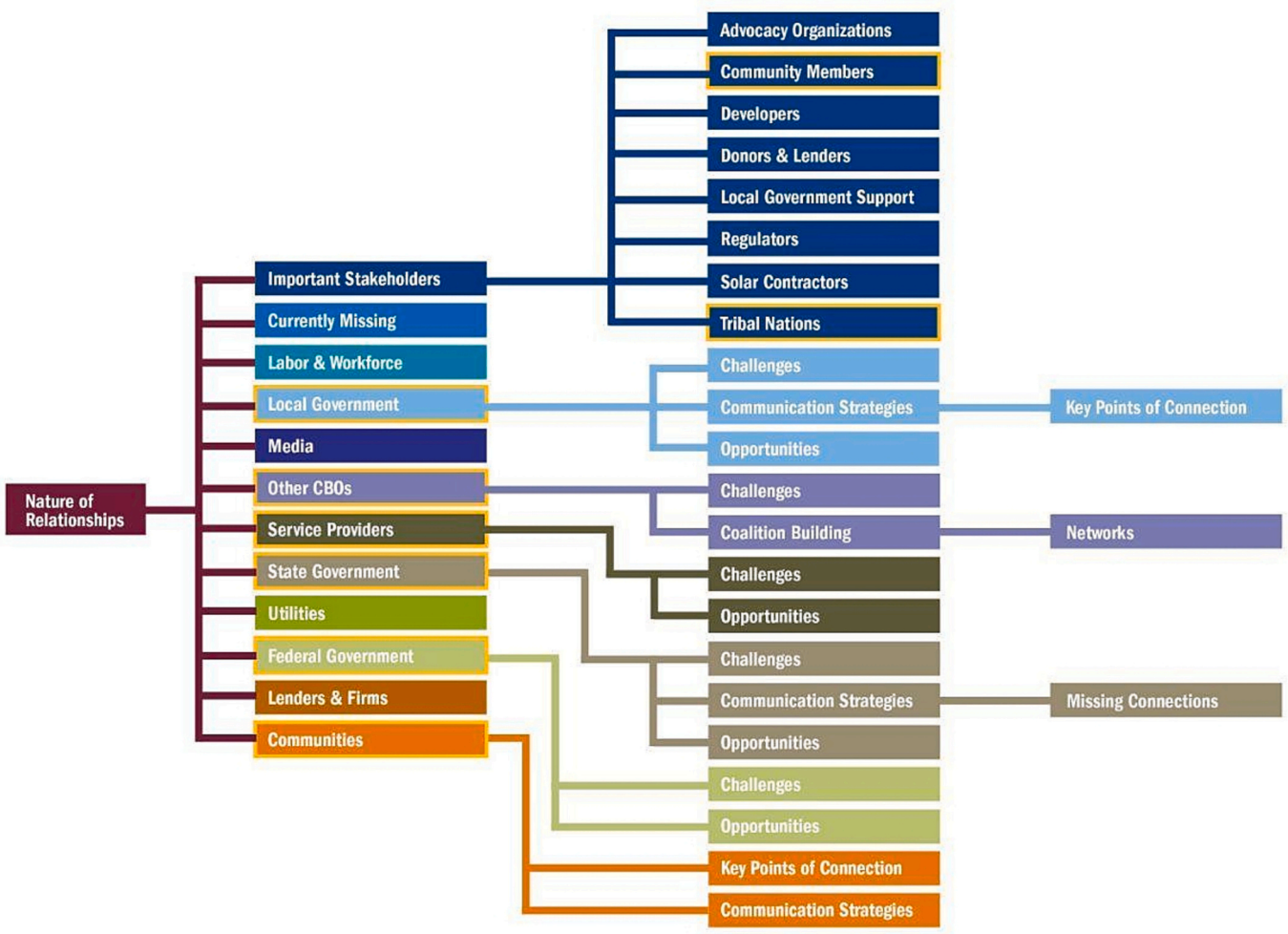


**Fig. 6.** Typology of nature of relationships.

indicates that newer organizations and those directly involved in solar project installation face greater political challenges compared to other types of CBOs. These interpretations will be further validated and corroborated through a national-scale survey.

### 4.3. Predominant characteristics

This section highlights the predominant characteristics of organizations aggregated by region, as well as solar directed organizations, and solar adjacent organizations considered across activities to suggest preliminary typologies of CBOs that can be further tested and explored. These are not definitive typologies as they are illustrative of our sample and therefore cannot be easily generalized. They can be useful as a prototype which will be explored further through a national CBO survey reaching a large sample size.

#### 4.3.1. Regional analysis

This section provides an overview of the predominant characteristics observed across different regions. To classify the regions within the United States, we utilized the Department of Energy's Regional Specialist designations, supplemented by the Appalachian Regional Commission (ARC) designation for Appalachia. Additionally, Puerto Rico was considered as a separate region. Fig. 9 displays the number of organizations interviewed in each region, with darker colors indicating a higher number of organizations interviewed. For each region, our focus was to identify the predominant characteristics within the typologies present in our sample.[8] We analyzed parameters such as affiliate organizations, tenure, legal status, staff capacity, organizational activities and services, population served, solar-directed initiatives, and solar involvement. By analyzing the number of references coded for specific characteristics within each typology, we aimed to identify prevailing trends.

Fig. 9 illustrates the predominant characteristics for each typology in the regions defined by the DOE Regional Specialist designation. In the West, organizations interviewed primarily focused on installing solar in low and moderate-income (LMI) communities, with a majority being nonprofit entities. The Southwest region exhibited predominant characteristics related to solar adjacent activities, such as energy efficiency, weatherization, and reducing energy burden, along with awareness raising and education initiatives. In the South, organizations in our sample predominantly engaged in solar advocacy, were smaller in size, nonprofit in legal status, and had a tenure of over 10 years.

In the Midwest, organizations were characterized by smaller size, nonprofit status, and a focus on awareness raising, education, and

[8] It is important to note that this analysis was conducted to enhance our understanding of the sample and should not be interpreted as representative of common characteristics across regions.

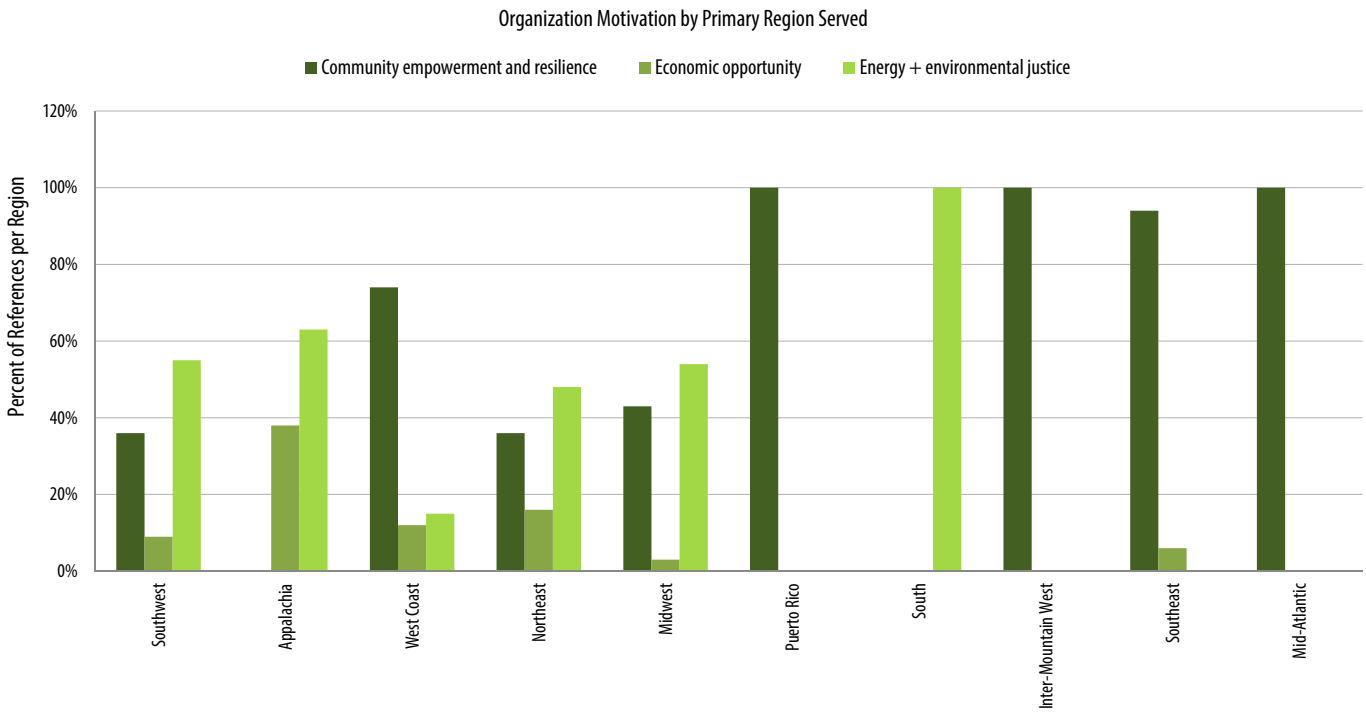


**Fig. 7.** Predominance of organization motivation by region.

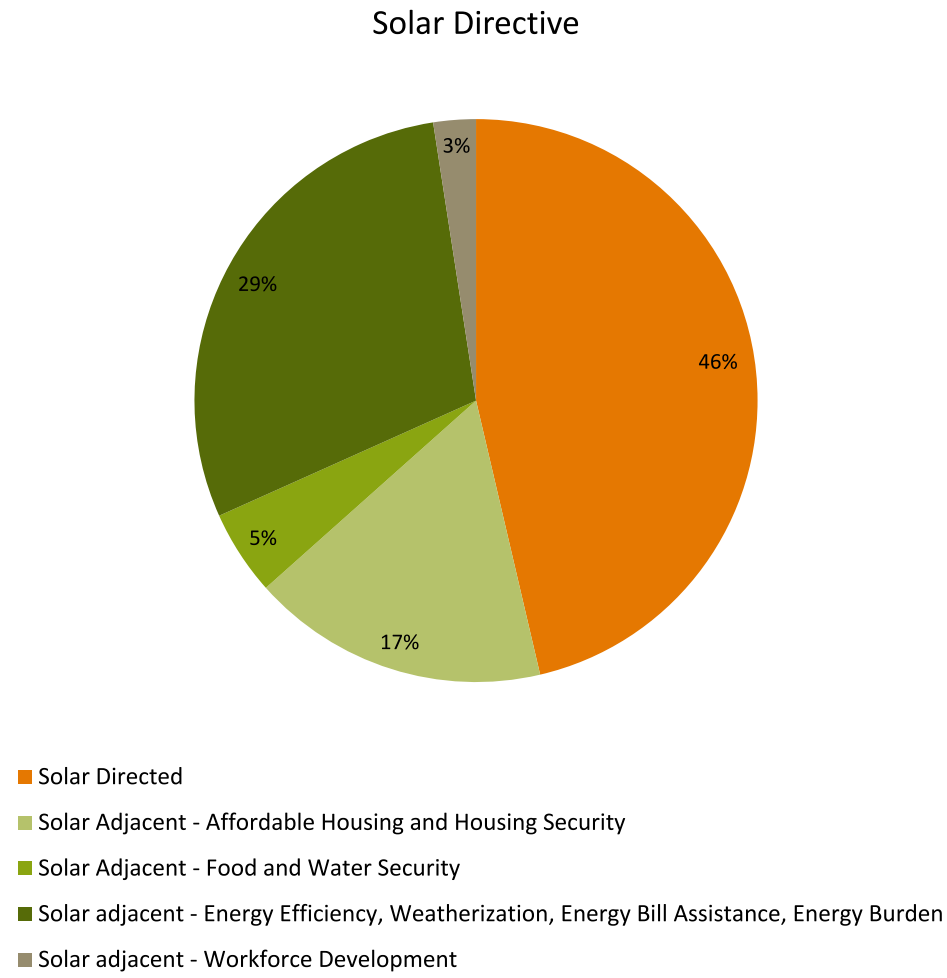


**Fig. 8.** Solar directive by percent of organizations.

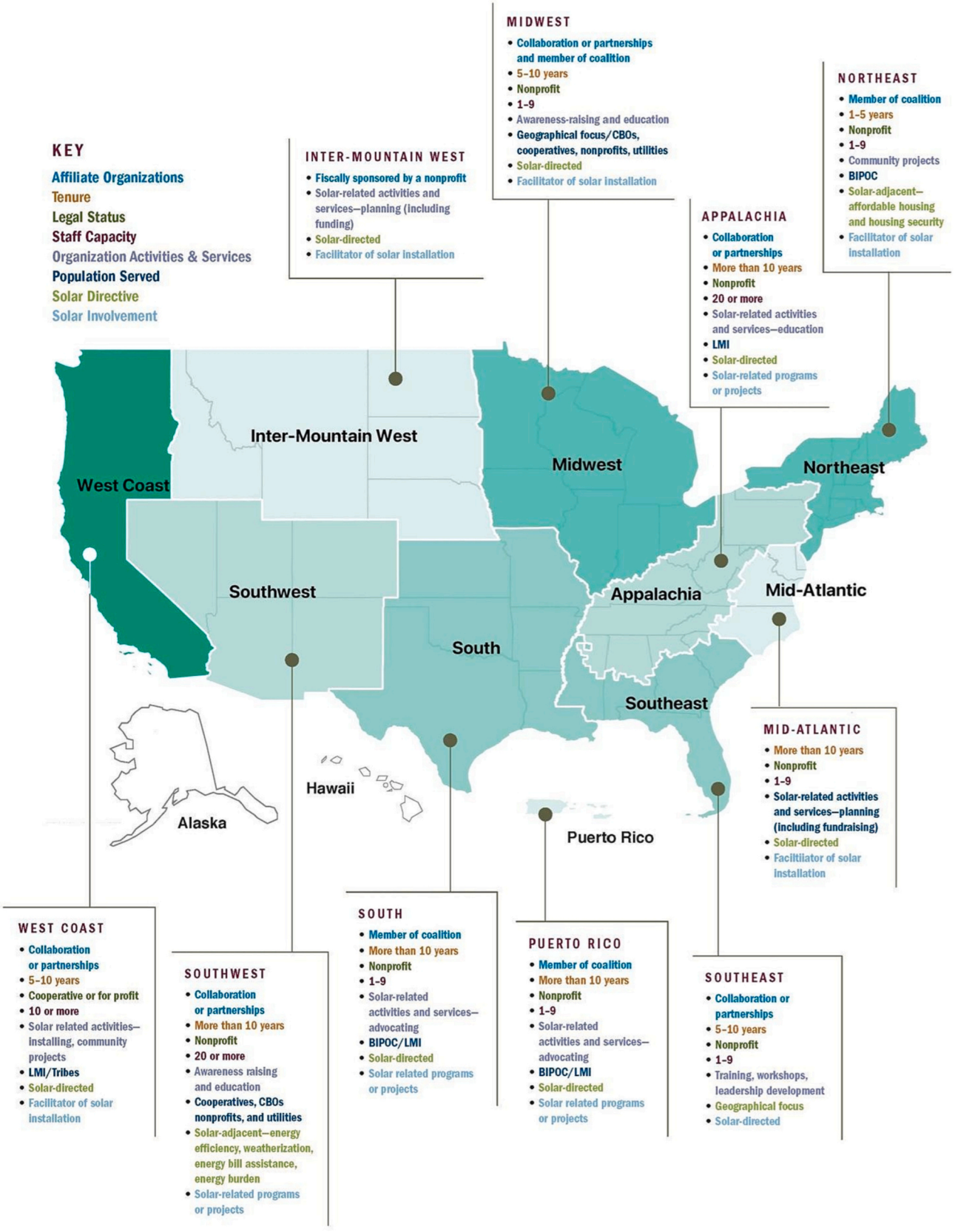


**Fig. 9.** Regional distribution of CBO predominant types and focus. The characteristics listed for each region represent the predominant type for each characteristic based on the number of references coded.

facilitating solar installation. Appalachia was predominantly represented by large nonprofit organizations with longer tenures, primarily conducting solar-related education for LMI residents. The Southeast region featured organizations with characteristics of large size, nonprofit status, long tenure, and advocacy activities, including solar adjacent initiatives focused on energy efficiency, weatherization, and reducing energy burden. In contrast, in the Northeast, organizations exhibited predominant characteristics of smaller size, shorter tenure, community project activities, and solar adjacent initiatives related to affordable housing and housing security. Limited data was available for the Mid-Atlantic and Puerto Rico, as we only interviewed one organization in each region. The organization in the Mid-Atlantic was a smaller nonprofit focused on solar planning and funding, while the organization in Puerto Rico was a small, newer nonprofit conducting training workshops and leadership development in the solar field.

#### 4.3.2. Solar directed organization activities and types

We interviewed 19 solar directed and 22 solar adjacent community-based organizations, identifying five main activities: advocacy, education, installation, planning, and outreach. Predominant characteristics were determined based on parameters such as affiliate organizations, financial objectives, tenure, location, structure, population served, staff capacity, and focus. We identified the predominant characteristic within each typology based on the number of references coded in our analysis. See Fig. 10 for details.

This analysis explored how specific typology characteristics of organizations correlate with their focus on different forms of solar work, such as advocacy or installation. Predominant characteristics were identified for each type: advocacy-focused organizations collaborated as nonprofits, serving BIPOC/LMI populations with smaller staff capacities, multiple regions, and a tenure of over 10 years; education-focused organizations collaborated as nonprofits in cities, prioritizing justice and serving local LMI communities; solar planning organizations emphasized community action and resilience, serving local LMI populations through collaborations, partnerships, and a tenure of over 10 years; outreach-focused solar directed organizations collaborated nationwide, focusing on community action, resilience, and serving LMI populations, with a small staff capacity and tenure of over 10 years. In contrast, organizations focusing on solar installations pursued for-profit objectives, collaborated, had a tenure of over 10 years, served LMI populations with small staff capacities, and prioritized energy services or advocacy.

These results suggest that community-based organizations operate within distinct regional ecologies influenced by political and economic factors, which correlate with their organizational structures, focus, and predominant types of work. A detailed understanding of these regional ecologies can facilitate collaborative shifts in work domains, such as transitioning from outreach to installation. However, it is important to note that these findings are preliminary and will be further examined through a national survey of CBOs.

#### 4.3.3. Solar adjacent organization activities and types

Solar adjacent organizations leverage solar as a means to further their broader missions, encompassing activities like weatherization, energy efficiency, reducing energy burden, affordable housing, water and food security, electric vehicle infrastructure, and workforce development. Policymakers and state energy agencies would benefit from considering these additional co-benefits when designing grants, subsidies, and programs. Our analysis revealed four main activities undertaken by solar adjacent organizations, distinct from direct solar-related work: advocacy, awareness raising and education, community projects, and training, workshops, summits, and leadership development. While these organizations may engage in multiple activities, we classified them based on their primary focus for the purpose of analysis. Although implementing solar projects may not be their immediate objective, solar programs often form part of their larger missions.

Applying a similar methodology used in studying solar directed activities, we identified the predominant types for each activity (Fig. 11). In the case of advocacy, the predominant characteristics involved coalition membership, nonprofit status, tenure of over 10 years, state-level service, a staff size of 10–20 employees, affiliation with nationwide organizations, emphasis on energy service provision and advocacy, and targeting energy burdened and low-to-moderate-income (LMI) communities. This indicates that organizations primarily engaged in advocacy tend to be well-established with a relatively large staff. For awareness raising and education, the predominant characteristics varied more, including partnerships and collaborations, nonprofit status, tenure of over 5 years, service across multiple regions, a staff size of 1–9 or more than 20 employees, affiliation with statewide organizations, emphasis on energy service provision and advocacy, and serving other cooperatives, community-based organizations (CBOs), or nonprofits. This suggests a diverse range of organizations are involved in awareness raising and education activities.

In the realm of training, workshops, summits, and leadership development, the predominant characteristics encompassed coalition participation, nonprofit financial incentives, tenure of 5–10 years, local population service, a staff size of 20 or more employees, coalition-based structure, justice-focused approaches, and serving LMI and geographically specific populations. These organizations tend to be more locally-


**Fig. 10.** Solar directed community-based organizations. Note: The characteristics listed for each solar directed activity or service represent the predominant type for each characteristic based on data saturation.


**Fig. 11.** Typology of solar-adjacent organizations.

led and relatively newer compared to advocacy organizations, often with a larger staff. For community projects, the predominant characteristics included coalition membership, tenure of 5–10 years, service at the city scale, a staff size of 1–9 employees, primary focus on community action, service, and resilience, and serving Black, Indigenous, and People of Color (BIPOC) residents. This indicates that organizations engaged in community projects primarily aim to strengthen energy resilience within their local communities.

## 5. Conclusion and policy implications

The results of this study identify potential characteristics that may determine trends that can be explored further in a national survey of solar related community-based organizations. In particular, our findings and key typologies suggest that attributes such as tenure, staff capacity, population served, organizational structure, and region, likely correlate with the organizational activities performed by solar related community-based organizations. A survey study could be used to test whether these typologies indeed can be used as a guide to predict an organization's core mission: whether it's advocacy, education, outreach, planning, or installation. Then it might be possible to predict what their critical needs are. For example, our interviews show that organizations conducting installation are more likely to have a longer tenure and medium staff capacity, but additional data are needed from a national survey to determine statistical conclusions for each of these organizational activities. In addition, these functions are not necessarily mutually exclusive, and many organizations can have multiple organizational activity focuses.

Other trends that deserve further research include the typologies that allow organizations to form coalitions. We find that among the CBOs we interviewed, larger organizations (20 or more employees) are better able to participate in coalitions. Compared to CBOs directly involved in solar installation, CBOs that are involved in solar associated projects or programs (which could include solar related outreach, advocacy, and other functions) are more likely to band with other CBOs. In the follow-on study, a survey study would be appropriate to understand how regional dynamics determine the types of activities conducted by CBOs, particularly in face of vastly different policy environments across the U. S.

Our interview findings suggest that utilities sometimes present obstacles to CBOs and adversely affect their ability to conduct advocacy work, particularly related to community-driven or community-led solar development. These challenges include interconnection and net-metering policies all of which vary widely across regions and by state. Building from this work it is important to understand which CBOs in which regions are most affected by this dynamic. We also find that out of the activities and services of CBOs not related to solar, the organizations engaged in broader advocacy face the most significant political challenge, suggesting that CBOs may restrict their work to advocacy because they face barriers in extending this work to other domains. This finding will be further explored to understand how political challenges determine the activities and services provided by CBOs, between advocacy, community projects, training and workshops, and broader awareness raising and education.

With the passage of the Inflation Reduction Act, the Infrastructure Investment and Jobs Act, and the release of the EPAs Greenhouse Gas Reduction Fund: Solar for All, there is opportunity to ensure funds are equitably deployed to CBOs, as CBOs are critical in ensuring funds meet community needs in LMI and BIPOC frontline communities. In terms of the focus on clean energy infrastructure in historically underserved and disadvantaged communities, the Inflation Reduction Act created the Clean Energy and Sustainability Accelerator, which will seed state and local funding for financing of clean energy projects over 50 % of which will be in disadvantaged communities [64]. As these programs are being developed, a focus on investment in the needs of CBOs could be prioritized. The Infrastructure Investment and Jobs Act provisions, such as advancing clean energy, from a $750 million grant for developing advanced energy manufacturing in coal communities to $3.5 billion in weatherization programs, although not specifically addressing solar, are opportunities for providing further support for community-based organizations [65].

Our research findings highlight the existence of two main types of community-based organizations (CBOs): solar directed and solar adjacent. Solar directed organizations focus primarily on solar development, while solar adjacent organizations utilize solar to support related objectives such as energy burden reduction, housing quality improvement, and food security. These categorizations provide insights into the characteristics of the organizations in our sample, although they do not serve as definitive typologies based on activities and services provided.

States aiming to support community solar development should consider several factors. Offering grants and programs at different scales targeted towards CBO staff capacity building can be beneficial. Our interviews reveal diverse perspectives on funding for CBOs. Some organizations with limited staff capacity prefer smaller-scale grants, while others require larger investments. It is worth noting that many CBOs, particularly those operating in low-income and BIPOC communities,

face challenges in accessing resources and developing technical capacity. Programs that support staff capacity, including technical assistance and volunteer recruitment, can help address these challenges.

CBOs play an essential role as platforms for communities to voice their concerns and facilitate connections between regulators, officials, and communities. In our interviews, some CBOs expressed the need for reevaluating net metering policies in different states particularly from the standpoint of low-income communities. Sometimes net metering policies in certain states are structured in a way that might only benefit middle to upper income people. For example, the credits certain rooftop owners earn to offset the energy they use from the grid remain valid for a relatively short period of time. Similarly, virtual net metering is not available in all US states making it difficult for certain groups of people. To overcome these challenges, states should reconsider their priorities concerning net-metering and other related policy conditions. CBOs could offer diverse perspectives on existing net metering schemes particularly from the low-income perspective and further improve these policies. Enhancing opportunities for CBOs to connect with other organizations, policymakers, and regulators at different levels can foster stronger relationships and collaborative projects.

This work further highlights the significance of peer-to-peer partnerships and coalitional behavior in empowering CBOs. Providing network-wide support can facilitate the transition of CBOs from solar-adjacent to solar-directed activities. Additionally, policymakers should consider supporting co-benefits, such as providing energy storage or net-metering programs, alongside direct solar grants and subsidies. By acknowledging and promoting the broader benefits of solar, such as weatherization, housing, education, and food security, states can maximize the positive impact of CBOs. It is important to note that our research is based on a relatively limited sample of 41 organizations interviewed, which imposes limitations on the analysis and conclusions drawn. However, our findings suggest regional and political factors may influence the direction taken by organizations. Regions with favorable policies and economic opportunities tend to have more CBOs involved in physical projects alongside advocacy efforts. Future studies using focus groups and surveys can validate and expand upon the typologies established in this research.

In summary, our findings provide insights into the typologies of CBOs and suggest strategies for states to support their engagement in solar-related endeavors. Developing policies that encourage CBOs to enter the solar training and installation domains, alongside targeted grants and capacity-building initiatives, can help maximize community benefits. By fostering a supportive environment, states can contribute to the positive trajectory and collaboration between state agencies and CBOs in advancing solar energy adoption, particularly with an eye towards the dissemination of Bipartisan Infrastructure Law and Inflation Reduction Act.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.erss.2023.103311.

## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Janelle Knox-Hayes reports financial support was provided by U.S. Department of Energy.

## Data statement

Due to the sensitive nature of the questions asked in this study, survey respondents were assured raw data would remain confidential and would not be shared. Data not available/The data that has been used is confidential.

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