Centro de Estudios®
Espinosa Yglesias
PROMOVEMOS LA IGUALDAD DE OPORTUNIDADES

Just energy transition, structural inequities, and social mobility: the case of Mexico

Autores:

Danae Hernandez-Cortes
Arizona State University

Alejandro Lopez-Feldman
University of Gothenburg y Universidad Iberoamericana

Rafael Pineda Albarrán
Mariana Ramos Flores
Roberto Vélez Grajales
Centro de Estudios Espinosa Yglesias

Documento de trabajo núm.

01/2026

Centro auspiciado por: ESRU Fundación Espinosa Rugarcía

Just energy transition, structural inequities, and social mobility: the case of Mexico

Danae Hernandez-Cortes[1] Alejandro Lopez-Feldman[2] Rafael Pineda Albarrán[3]
Mariana Ramos Flores[4] Roberto Velez Grajales[5]

June 2025

Mexico's energy transition unfolds in a context of deep structural inequalities and persistently low social mobility. While most households have electricity, large disparities remain in affordability, reliability, and the capacity of energy access to expand capabilities and opportunities. This paper develops a framework linking energy justice to social mobility, combining empirical evidence on energy poverty with the social and solidarity economy (SSE) perspective. Using household survey data, we document inequities in access to energy services and show how low-income households face disproportionate burdens that constrain educational and occupational mobility. We then explore how SSE-based models, particularly energy cooperatives, can improve affordability, reliability, and community participation in energy governance. A case study of a fishing cooperative in Yucatán illustrates how renewable energy projects may both alleviate deprivation and foster upward mobility. We argue that embedding distributive and procedural justice into Mexico's energy transition is essential for inclusive and sustainable development.
Keywords: just energy transition, energy justice, energy poverty, social and solidarity economy, social mobility, energy cooperatives, Mexico
JEL Classification: Q42, Q48, O13, I32, J62, D63, O35

[1] Arizona State University. Danae.Hernandez-Cortes@asu.edu
[2] University of Gothenburg and Universidad Iberoamericana. alejandro.lopez.feldman@efd.gu.se
[3] Espinosa Yglesias Research Centre. rafael.pineda@ceey.org.mx
[4] Espinosa Yglesias Research Centre. mariana.ramos@ceey.org.mx
[5] Espinosa Yglesias Research Centre. rvelezg@ceey.org.mx

1. Introduction

The global energy system is undergoing significant changes towards reducing energy generation from fossil fuels and increasing the use of renewable energy, such as wind and solar. For instance, according to the International Energy Agency, the share of renewable energy in 2030 is expected to be nearly 20 %, up from 13 % in 2023 (IEA, 2024). While these increases in renewable energy have the potential to decrease pollution from fossil fuel generation (Hollingsworth & Rudik, 2019) and potentially increase access to energy among communities that have been historically marginalized (Sovacool & Drupady, 2016), understanding existing disparities in energy access in low- and middle-income countries is important, especially under the context of structural inequities that these countries face. Similarly, improvements in energy access under the energy transition could also contribute to reshaping inequities in the future.

The objectives of this project are twofold. The first objective is to understand the relationship between structural inequities, social mobility, and the just energy transition with a special focus on Mexico. The second objective is to establish criteria for identifying and selecting energy transition projects based on the perspectives of social mobility and the social and solidarity economy framework. Mexico has high levels of inequality and low social mobility rates (Velez-Grajales et al., 2018). At the same time, low-income households face significant barriers to energy access. According to some studies, Mexican households experience challenges due to a lack of energy access or affordability (Soriano-Hernandez et al., 2022) and energy poverty (Garcia-Ochoa & Graizbord, 2016b; SENER, 2022). Understanding the role of the energy transition in decreasing or increasing these disparities will allow us to inform existing policies that aim to develop renewable energy projects in historically marginalized communities. It is important to note that the energy transition aims to restructure the systems of energy production and ownership more broadly, and energy justice is only one aspect of this objective. However, energy justice is often one of the main points in discussions about the energy transition in Mexico (Presidencia de la República, 2025).

The structure of this paper proceeds as follows. The first section explains the relationship between energy justice and social mobility. The second section uses household survey data to diagnose energy poverty and inequities in Mexico empirically. The third section provides an overview of social mobility and the social and solidarity economy framework, emphasizing energy cooperatives. The fourth section develops a framework to understand the potential to achieve social mobility in the context of energy transition. The fifth section develops criteria for identifying, selecting, and prioritizing future energy projects, focusing on the energy transition.

2. Energy transition, capabilities, and social mobility

This section aims to understand the relationship between energy access and social mobility, emphasizing how the capabilities approach provides a framework to understand how the energy transition could impact structural inequities. The central idea of the *functionings and capabilities approach* (Sen, 2000) is that people's well-being derives from their freedom, i.e., from expanding their available choice space. In this sense, the more options for combining functionings, the greater the capabilities of people, and therefore, the more freedom individuals have to choose what they want to be and do in their lives. When Sen (1980) asks, "Equality of what?" he refers precisely to capabilities. If we achieve such equality, regardless of the level of capabilities, all people will have the same diversity in choice options.

If there is equality of basic capabilities, we can expect differences in people's achievements to be determined more by differences in effort. In other words, people's achievements will be less influenced by socioeconomic status or place of origin. In such a way, a society with equality of basic capabilities will be closer to one with equal opportunities for all. One of the implications of the above is that a society with such characteristics will have higher rates of social mobility: with equal opportunities, effort, and not people's circumstances (factors beyond their control) determining their achievements. In other words, there will be a greater exchange of socioeconomic positions on the social ladder. Therefore, as granted access to public services such as health and energy reduces inequality in capabilities, the social mobility rate will increase.

Energy access can play an important role in equalizing basic capabilities. Considering that energy access broadens the range of people's functionings, capabilities also broaden. If such access reaches the entire population, specific groups do not face restrictions for more functionings. Thus, society is closer to equality of capabilities. If this happens, the space of opportunities expands for all people and more for those with previous existing restrictions. As a result, social mobility increases. Besides access, the previous mechanism can also be extended to energy availability and reliability. Therefore, the energy transition could increase capabilities, equalize opportunities, and improve social mobility.

Energy use is an important determinant of the individual's election space. As a result, it has implications for a household's economic well-being through several factors such as fuel expenditures, access to heating or air conditioning, and performance of daily activities such as studying, working, and domestic activities. These factors can potentially impact households' well-being (Day et al., 2016) and their social mobility. Lack of access to energy and its potential benefits can be considered as energy deprivation, and households that cannot meet their energy needs given their current socioeconomic circumstances are "energy poor." Energy poverty (fuel poverty) is often measured as a function of a household's income. For instance, the UK defines households as "fuel poor" when their income is lower than average, and fuel costs are higher than average.[1] However, income might not be the only barrier to access to energy or the primary determinant of energy deprivation, and efforts have been made to consider different dimensions of energy use and access to understand when a household might be energy deprived.

For example, Sovacool and Dworkin (2015) defined energy justice to denote the circumstances where an "energy system fairly disseminates both the benefits and costs of energy services, and that provides an impartial energy decision making." The authors define different principles for a just energy system: availability, affordability, due process, good governance, sustainability, intragenerational equity, intergenerational equity, and responsibility. This definition allows for a more comprehensive understanding of what aspects are important to achieve energy justice. Furthermore, it directly connects to the social mobility literature: a just energy system could increase capabilities, increasing social mobility. Another important aspect related to energy justice is the notion of procedural justice. Procedural justice denotes the equality of participation in the decision-making

[1] While the US does not have a formal definition of energy poverty, different energy assistance programs to address high energy costs are based on income levels such as the Low Income Energy Assistance Program, that provides financial support to low income households to cover energy expenditures or the Weatherization Assistance Program, that provides financial assistance to perform energy upgrades that could reduce energy expenditures in the future (Bednar and Reames, 2020).

process. In the context of energy justice, procedural justice refers to the involvement of individuals in the design, implementation, and evaluation of energy policies.

The discussion of energy justice in the context of low- and middle-income countries is relevant since many of these countries often lack access to high-quality energy resources, or high shares of their population cannot afford access to energy. According to some studies, in the case of Mexico, households can be classified as "energy poor" due to a lack of accessibility or affordability of modern energy services and fuel (Soriano-Hernandez et al., 2022). This context provides an opportunity to understand which factors contribute to households experiencing energy poverty and how this might affect their social mobility. Garcia-Ochoa and Graizord (2016a) identify different dimensions that affect energy poverty in Mexico, such as access to water heating, food cooking and refrigeration, lighting, ventilation, and entertainment. Measuring energy poverty based on access to services allows us to understand how households' economic conditions and access to public services impact energy deprivation. However, this might not be the only way populations are energy-deprived. Access to reliable energy services is another critical component, especially in low- and middle-income countries. Access to reliable energy sources can affect households' well-being due to its impact on energy use (Fowlie & Meeks, 2021), energy efficiency (Berkouwer & Dean, 2022), household work allocation (Pakhtigian et al., 2024), and health outcomes (Berkouwer & Dean, 2023), which can affect households' social mobility.

This paper argues that access to reliable energy services is a fundamental component of energy justice and considers how notions of access and economic conditions due to unequal opportunities impact households' likelihood of increasing social mobility. Similarly, section 4 explains how the economic framework of the social and solidarity economy might allow Mexican communities to achieve reliable energy access.

3. Energy poverty indicators and current energy inequities in Mexico

Understanding existing access to energy services in the current population is important to emphasize the importance of energy deprivation as a driver of current socioeconomic inequities. This section aims to provide an overview of current energy inequities in Mexico. To do so, we leverage publicly available data from Mexican household surveys to measure energy inequities across households' income distribution. Understanding current inequities will allow us to understand which households are likely to face energy poverty and which dimensions are critical to consider while measuring disparities in energy access.

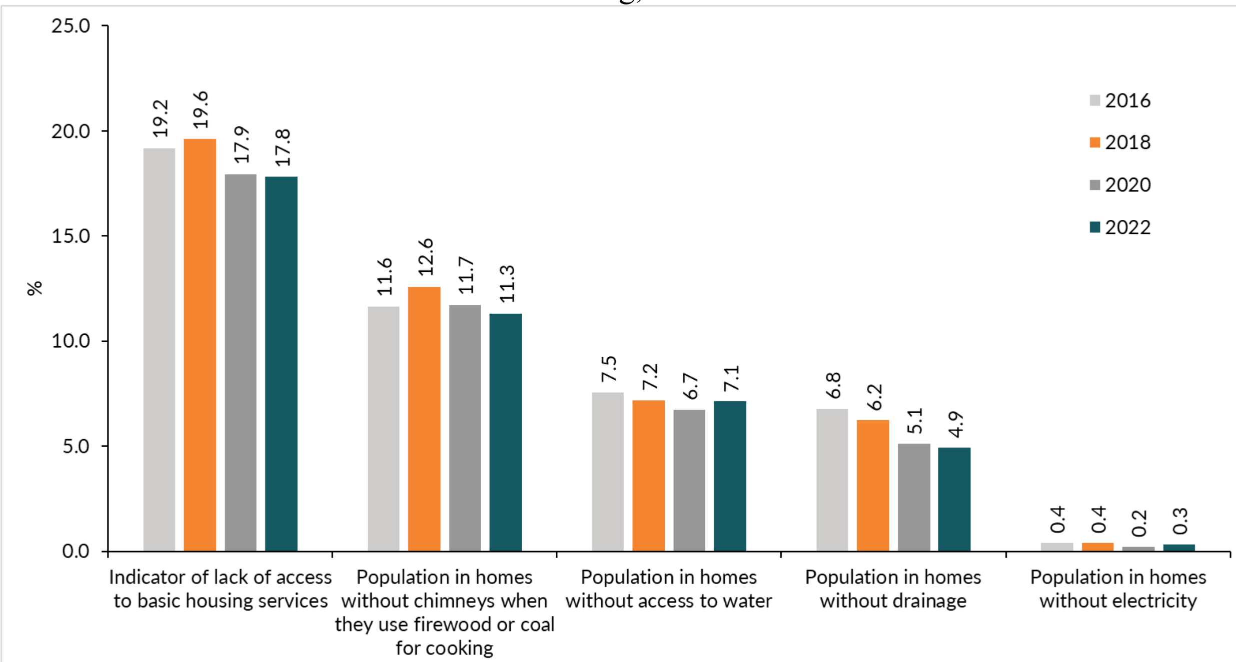
The official poverty measurement developed by the Consejo Nacional de Evaluación de la Política de Desarrollo Social (CONEVAL) offers a first approximation of the current state of energy poverty and its interaction with inequality. Given that it is a multidimensional measurement, emphasis is placed on achieving economic well-being and fulfilling social rights. Access to basic services at home is an important measure related to energy access and consumption. For a person to be declared deprived in this area, they must live in homes that have at least one of the following subdimensions: 1) water is obtained from a well, river, lake, stream, pipe; or if their piped water is obtained by hauling from another home or the public tap, 2) the household does not have drainage or the drain leads to a river, sea, ravine or crevice, 3) the household does not have electricity[2] and 4) if the household uses firewood or coal without a chimney as fuel for cooking (CONEVAL, 2019).

[2] This could be due to technical (lack of infrastructure) or economic reasons. However, data on the specific reason why households lack electricity is not available.

Figure 1 shows the percentage of the population in a situation of deprivation of access to services in the home, as well as its four subcomponents (use of firewood or charcoal, water availability, drainage availability, and electricity availability), for the latest available data. By 2022, 17.8 % of the population lived in homes without access to basic housing services. About the subcomponents of the indicator, 11.3 % lived in homes without chimneys when they used firewood or charcoal for cooking, 7.1 % did not have access to water services, 4.9 % did not have access to drainage services, and 0.3 % of the population lived in homes without electricity.[3] The share of households living in homes without electricity is low, suggesting that some of the drivers of energy poverty mentioned in the previous section could be affordability and energy reliability issues.

[3] In the case of access to electricity services, the criterion considers the source of electricity: the household will have access whenever it reports access to electricity through the public service, a private plant, a solar panel, or another source; the household will be classified as lacking electricity whenever it reports not having electricity.

Figure 1. Percentage of people in the components of deprivation due to access to basic services in housing, 2016-2022

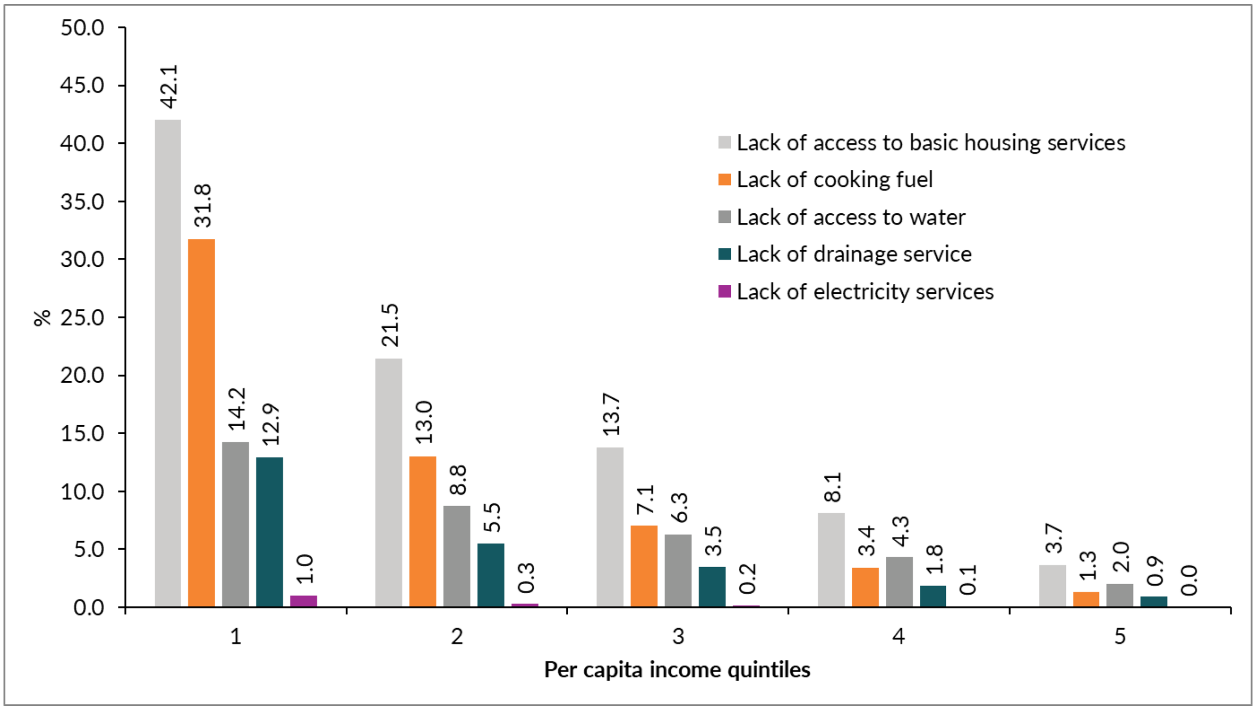


Source: Own elaboration using data from the National Household Income and Expenditure Survey (ENIGH 2022), following the multidimensional poverty measurement methodology of CONEVAL (2019).

Using the same data ordered by quintiles of total current per capita income[4] from the poorest to the wealthiest (Figure 2), we find that 42.1 % of the population in quintile 1 (the lowest income) has limited access to basic housing services (that is, more than double the national average). Conversely, only 3.7 % of the population in quintile 5 has limited access to housing services. Figure 2 also presents the data for the four subcomponents of the indicator. Appendix I Figures A1, A2, A3, A4, and A5 show the share of households by per capita income quintile lacking access to these indicators from 2016 to 2022. Overall, these indicators remain unchanged over this period.

[4] This form of income is used by CONEVAL for the official measurement of poverty in Mexico. It considers both current monetary income (salaries for subordinate work, income from independent work, income from property rental, other income from work, and transfers) and current non-monetary income (payment in kind and transfers in kind like gifts in kind excluding one-time transfers). For detailed information revise the annex A of CONEVAL (2019).

Figure 2. Distribution of the indicator of lack of access to basic housing services, 2022

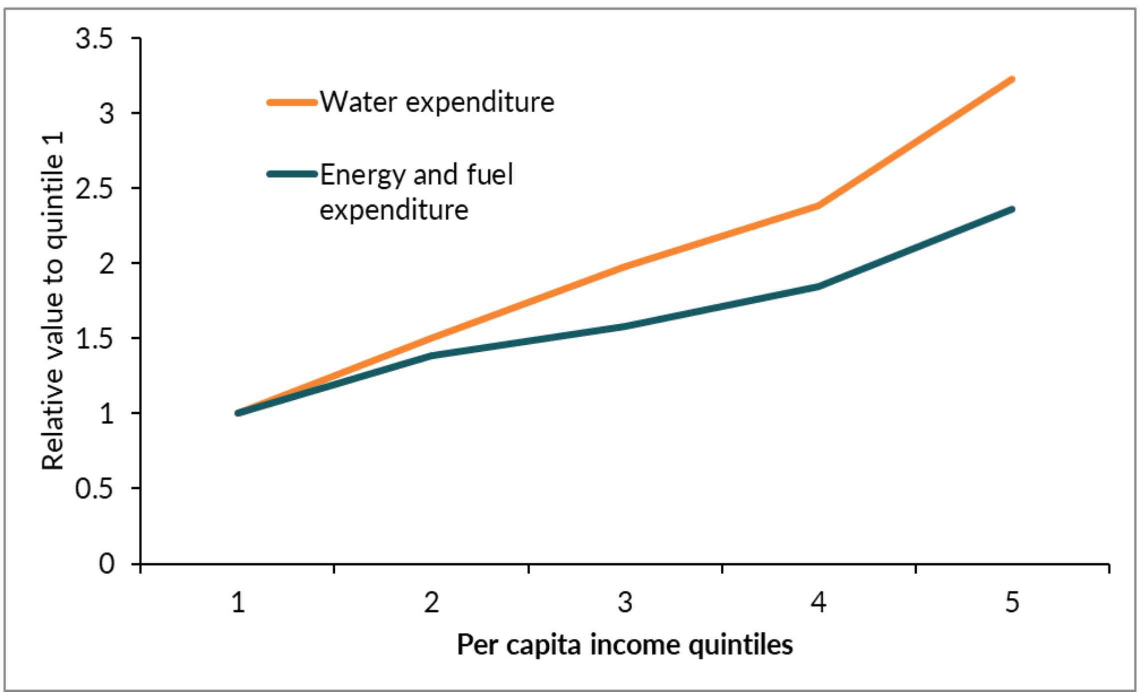


Source: Own elaboration using data from the National Household Income and Expenditure Survey (ENIGH 2022), following the multidimensional poverty measurement methodology of CONEVAL (2019).
Note: Quintile 1 has an average household size of 4.4 members, quintile 2 of 4.2, quintile 3 of 4.0, quintile 4 of 3.7, and quintile 5 of 3.1 members.

On the other hand, using the most recent edition of the National Household Income and Expenditure Survey (ENIGH 2022, by its acronym in Spanish), it is possible to identify the average amount of household expenditure on water, energy, and fuel. We obtained the average expenditure in these areas by quintiles of total current per capita income with respect to the value of the first quintile. Figure 3 shows that the fifth quintile expenditure is 3.2 and 2.3 times higher for water and energy consumption than the first. This result is consistent with the findings of Borenstein et al. (2022) in the United States. It is important to note that the first quintile uses 16 % of their total income to pay for energy and fuel services.

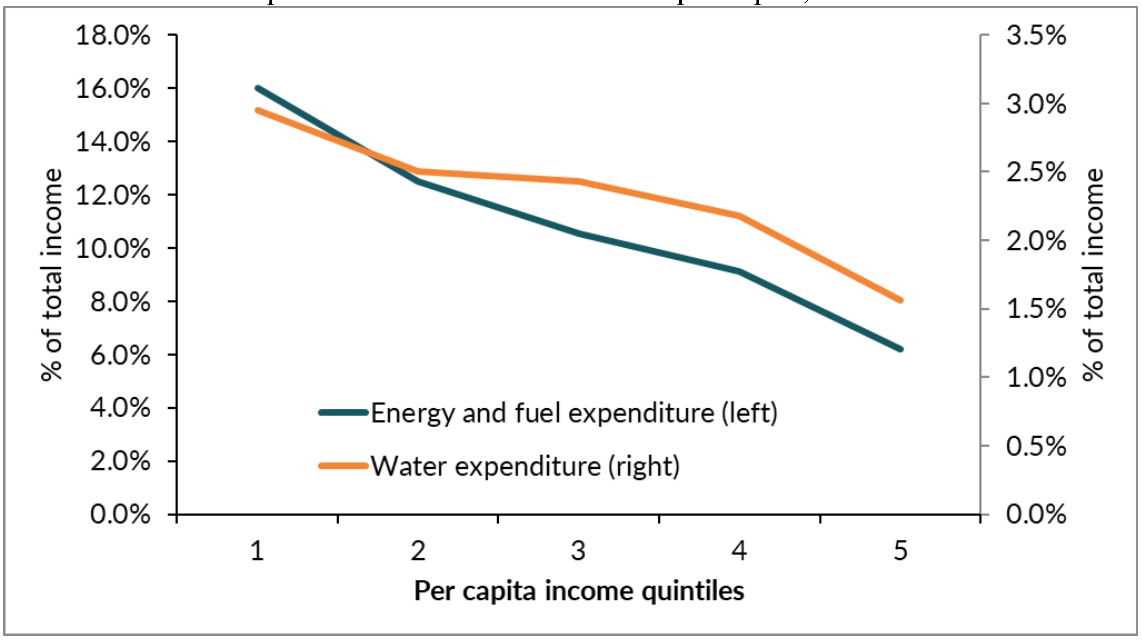
Meanwhile, the fifth quintile only uses 6.2 % of their total income to pay for energy and fuel services (Figure 4). This result implies that low-income households spend a significantly higher share of their income on energy consumption than high-income households, even if their energy consumption might be lower due to differences in consumption patterns and housing characteristics. These results have not changed significantly in recent years: if we repeat the same exercise for 2016, we find that the first quintile spent 16.9 % of its total income on energy and fuel, while the fifth quintile spent only 5.1 % of its total income (Appendix I Figure A6).

Figure 3. Average expenditure on water and energy by income quintile, relative value to the first quintile, 2022



Source: Own elaboration using data from the National Household Income and Expenditure Survey (ENIGH 2022), following the multidimensional poverty measurement methodology of CONEVAL (2019).

Figure 4. Average expenditure on water and energy as % of total current income, by quintiles of total current income per capita, 2022



Source: Own elaboration using data from the National Household Income and Expenditure Survey (ENIGH 2022), following the multidimensional poverty measurement methodology of CONEVAL (2019).

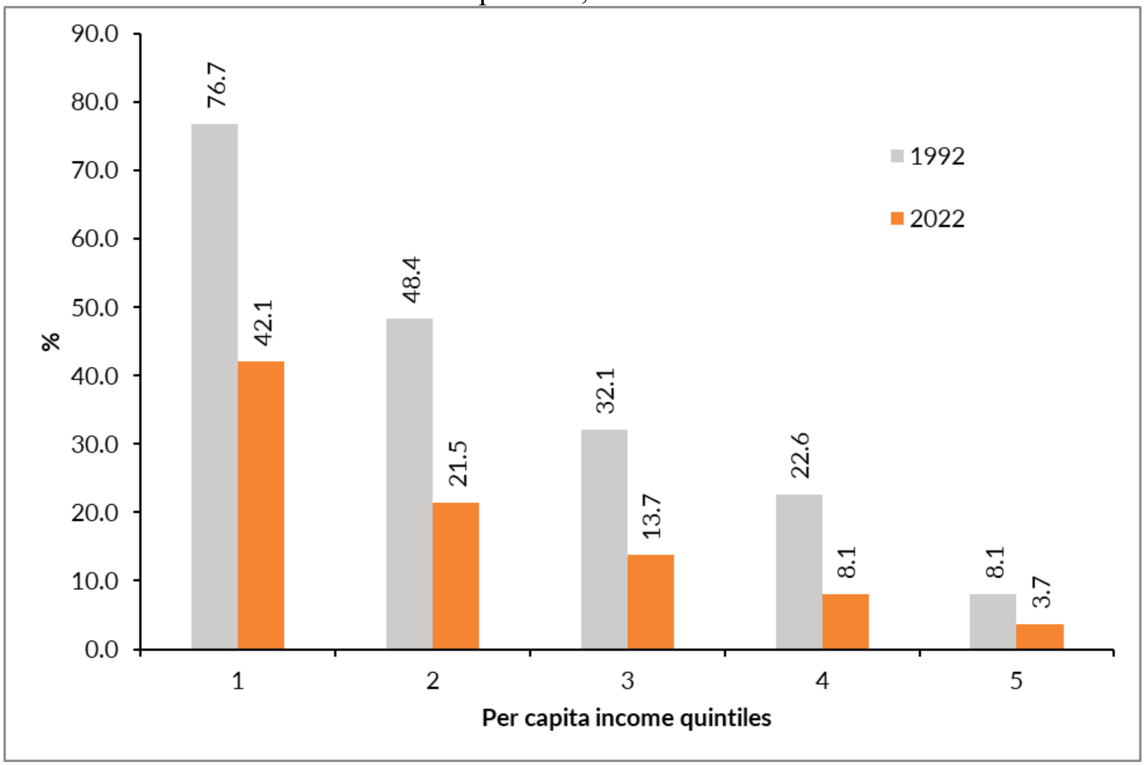
One way to understand intergenerational social mobility with the same sources of information is to measure the lack of access to basic housing services at two points in time, which allows us to examine two different generations over time. Unfortunately, the official multidimensional poverty measurement in the first data period is 2008. Espinosa (2013) obtains the evolution of multidimensional poverty from 1992 to 2008, using the ENIGH as a source of information and different estimation techniques for those indicators that are more difficult to replicate. We follow this approach to explore how different generations experience access to basic services, which allows us to evaluate intergenerational social mobility on energy access.

In the case of the indicator of lack of access to basic housing services, it is possible to recover the complete construction of the indicator, since the information on its four subcomponents (fuel, water, drainage, and electricity) is also found in all ENIGH surveys since 1992. Therefore, it is possible to distribute the indicator by per capita income quintiles in 1992 and compare it with the distribution in 2022. In such a way, the difference of 30 years represents an approximation of the change between two generations. It is important to note that the only change between the definitions of the indicator is found in the subcomponent of access to water services. Since 2016, rainwater collectors have been included to prevent this shortage.[5] Figure 5 shows the percentage of people lacking access to basic services in two different periods: 1992 and 2022.

Notably, in 1992, three-quarters of the population in the lowest quintile lacked access to basic housing services. By 2022, this decreased to 42.1 %. This progress reflects an increase in absolute social mobility for such a quintile, i.e., the current generation is better off than the previous one. However, it is important to note that such improvement is lower for the lowest quintile than for the top one (45 % vs. 55 %). In other words, the gap between the extremes of the social ladder did not decrease. It suggests that the rate of relative social mobility (i.e., positions' exchange in the social ladder) is not increasing.

[5] According to CONEVAL, "Starting in 2016, the ownership of rainwater collectors are also considered as an element to avoid presenting said sub deficiency. As of 2016, it is considered that the inhabitants of a home do not have a deficiency in the water sub-indicator if they have a rainwater collector – formally called the Rainwater Harvesting System (SCALL) – that complies with the regulations established by the National Water Commission (CONAGUA), the governing body in matters of water in Mexico" (CONEVAL, 2019, p. 56).

Figure 5. Percentage of people lacking access to basic services in the home, by per capita income quintiles, 1992 vs. 2022



Source: Own elaboration using data from Espinosa (2013), following the multidimensional poverty measurement methodology of CONEVAL (2019).

4. Social and solidarity economy and the energy sector

The social and solidarity economy framework (SSE) can be used to understand the role of energy cooperatives in reducing existing disparities while promoting social mobility. SSE is an umbrella concept encompassing two alternative approaches to the mainstream economic model: the social economy and the solidarity economy. The social economy acknowledges the "rules of the game" dictated by the capitalist system and its institutions. However, it seeks to meaningfully integrate people-centered enterprises into the economic landscape (Utting, 2015). In contrast, the solidarity economy aims for profound social and systemic transformations, challenging existing structures and addressing fundamental issues to overcome inequalities (RIPESS, 2015; Utting, 2015). This approach prioritizes empowering women and other marginalized groups while emphasizing anti-poverty and social inclusion efforts (RIPESS, 2015). At its core, SSE is about reclaiming social control over the economy, prioritizing social and environmental objectives over profit maximization (Utting, 2015).

SSE comprises various organizations and enterprises, including cooperatives, mutual associations, non-governmental organizations (NGOs), associations of informal economy workers, and sharing schemes associated with the collaborative economy (Utting, 2015). A defining feature of SSE is the active participation of individuals in shaping the economic, social, cultural, political, and environmental spheres. Central to this approach are self-management and collective ownership in the workplace and the community (RIPESS, 2015). SSE increasingly refers to forms of economic activity in which producers, workers, consumers, and citizens act collectively and in solidarity (Utting, 2015). Furthermore, SSE emphasizes the importance of a harmonious relationship between humans and nature, advocating for ecosystem preservation and sustainable ecosystem use (RIPESS, 2015). In energy transitions, SSE includes increased inclusion and democratic processes in developing and implementing energy policies, for example, including marginalized groups in decision-making processes and alternative governance and economic systems in energy production (Sareen et al., 2023).

It is important to note that, although the SSE in general, and energy cooperatives in particular, hold significant potential to contribute to sustainable, inclusive, and rights-based development, this potential is not guaranteed. Its realization depends on several factors, including institutional settings, the relationships between SSE organizations and external actors, trade-offs among competing objectives, and the internal dynamics within SSE organizations (Utting, 2015). Evidence from socially owned renewable energy projects shows that the quality of the relationships among stakeholders significantly affects their success (Cherry et al., 2023).

This perspective is critical in the context of Mexico. In May 2012, with the enactment of the *Ley de la Economía Social y Solidaria* (Law on Social and Solidarity Economy), the Mexican government recognized the social sector (ejidos,[6] communities, cooperatives, and similar organizations) as a key contributor to the country's economic and social development. This law institutionalized and promoted this sector by establishing the legal foundations and mechanisms necessary to foster the development of economic activities within the social sector. It also supported the creation of the Instituto Nacional de la Economía Social (INAES), a decentralized body of the Ministry of Welfare tasked with designing and implementing public policies to strengthen the sector. Specifically, Article 36 of the law defines the responsibilities of INAES, including support for social sector organizations in developing productive projects that contribute to community development (Congreso de la Unión, 2012), including energy transition projects. Appendix II explains the context of distributed energy generation in Mexico and articulates technical issues related to decentralized energy distribution and generation, emphasizing the role of INAES in Mexico's energy system.

[6] According to Mexico's Agrarian Law, *ejidos* are legally recognized population units with their own juridical personality and assets, holding ownership of land either granted by the state or acquired through other means. Members of the *ejido*, known as *ejidatarios*, possess rights to individually assigned parcels as well as to communal lands. The governance structure of the *ejido* is organized through collective institutions, notably the *Asamblea Ejidal* and the *Comisariado Ejidal* (Congreso de la Unión, 2024; Articles 9, 10, 21–23, 43–44).

4.1. SSE and energy cooperatives

In line with the principles of SSE, cooperatives and community-based projects offer an alternative model for energy generation and distribution. Unlike large, often multinational companies, these collaboratives are democratically organized enterprises that operate autonomously, granting members the freedom to join or leave. Their profit distribution is independent of capital contributions, and their economic interactions are guided by fairness, cooperation, reciprocity, and mutual support (Morandeira-Arca et al., 2024). Moreover, these cooperatives typically empower members to actively participate in decision-making processes regarding the cooperative's projects, principles, and future direction. In addition to owning renewable energy production facilities and supplying energy to their members and other individuals, they frequently leverage their role as energy providers to encourage and promote energy-saving behaviors among their members (Coenen et al., 2017).

Energy cooperatives and community-based renewable energy initiatives have been shown to correlate with outcomes such as community empowerment, social capital, energy democracy, and energy justice (Bielig et al., 2022). Cooperatives arguably foster the creation and dissemination of social capital (Saz-Gil et al., 2021) and help build a political base to advocate for new energy policies, which, in turn, can contribute to the transformation of the energy sector (Fairchild & Weinrub, 2017). These mechanisms offer potential explanations for some of the reported correlations. Nevertheless, more substantial evidence is required to confirm these relationships, particularly through quantitative methods, experimental designs, and longitudinal studies (Bielig et al., 2022). Furthermore, most existing evidence is for high-income countries. This is partially due to the limited implementation of socially-owned renewable energy projects in the Global South (Cherry et al., 2023).

Energy cooperatives can either sell all their generated energy externally or be energy *prosumers*, that is, they can both consume and produce energy. Although prosumer is not a new term —it originated in the late 1970s— its use in connection with the energy sector has become increasingly popular recently, driven by the growing affordability and availability of distributed renewable energy (Parra-Dominguez et al., 2023). Many argue that a sustainable energy transition requires increased involvement of actors that are both energy producers and self-consumers, i.e., prosumers (Brown et al., 2020). A more comprehensive definition of energy prosumers describes them as those producing and self-consuming renewable energy, with the potential to participate in energy markets (Campos & Marin-Gonzalez, 2020). Although individuals, families, and firms can be considered prosumers, this report focuses on community-based or community-organized prosumers, particularly cooperatives.

Community-based energy prosumer projects have grown substantially recently, especially in Northern Europe (Brown et al., 2020). Expectations surrounding the role of these types of prosumers are significant. They are anticipated to influence the trajectory of the energy transition toward a more decentralized, democratic, inclusive, fair, and sustainable energy model, while also helping to eliminate energy poverty and reduce disparities in access (Campos & Marin-Gonzalez, 2020). This is partly due to the assumption that prosumers will drive increased adoption of distributed energy systems, resulting in locally produced energy that reduces greenhouse gas emissions while creating local value. (Brown et al., 2020).

Prosumers have the potential to transition from passive consumers to active energy providers, supplementing or even competing with traditional utilities (Parag & Sovacool, 2016). In community-based models, local groups, such as neighborhoods, could collectively manage their energy needs, particularly within smart city environments incorporating technologies like smart homes. In principle, these localized energy markets could enable communities to meet their energy demands and generate revenue for community benefit. By encouraging end-user participation through locally driven efforts, prosumer markets might promote energy independence and sustainable management (Parag & Sovacool, 2016). Nonetheless, no documented evidence exists that energy prosumer cooperatives consistently receive monetary benefits from selling surplus energy.

4.2. Energy cooperatives, affordability, and access to reliable energy

Energy cooperatives have the potential to enhance access to reliable energy services, particularly in rural and underserved regions. Their community-based, member-driven nature allows them to address specific local challenges more effectively than traditional models. This approach enables cooperatives to overcome barriers such as insufficient investment and inadequate service provision by utility companies, especially in remote areas where grid extension is not always viable. By fostering local ownership and control, cooperatives can ensure that energy systems are responsive to communities' needs, promoting the productive use of energy and contributing to economic growth and poverty alleviation (ILO, 2013; Madriz-Vargas et al., 2018). This could lead to equality of opportunity and eventually increase social mobility. However, this relationship has not been studied.

Empirical evidence shows that cooperatives are particularly effective at providing affordable and reliable energy. They mitigate social barriers to the acceptance and integration of renewable energy technologies while also building local capacity for maintenance and facilitating user education on the productive uses of energy (Madriz-Vargas et al., 2018). Additionally, decentralized prosumers play a key role in enhancing flexibility within the system. By optimizing the timing of their electricity production and consumption and investing in decentralized storage solutions such as batteries or flexible heating systems, prosumers balance local energy demand and supply (Kubli et al., 2018). This ability to engage communities and tailor energy solutions to local needs has been successful in various contexts, helping small businesses, agricultural operations, and households leverage electricity for income-generating activities (ILO, 2013; Madriz-Vargas et al., 2018).

Moreover, by leveraging renewable energy technologies, particularly solar energy, cooperatives can reduce the impacts of climate change while addressing energy insecurity in vulnerable communities (Golumbeanu et al., 2023). One of the critical applications of renewable energy in these settings is cooling systems, which play a vital role in food preservation, reducing spoilage, and maintaining productivity in hot climates (Khosla et al., 2021; Golumbeanu et al., 2023). Solar-powered refrigeration, for example, is essential in sectors like agriculture and healthcare, ensuring safe food storage and access to critical services. Additionally, cooling infrastructure helps protect households from extreme heat and supports local economies by enabling continuous productivity during heat waves (Khosla et al., 2021).

Integrating renewable energy-driven cooling solutions within energy cooperatives can create a virtuous cycle of environmental and economic benefits. Efficient cooling, such as solar-powered cold storage, significantly reduces food waste by supporting cold chains for perishable goods like fruits, vegetables, dairy, and fish, which enhances food security and increases incomes for rural producers (Khosla et al., 2021; Golumbeanu et al., 2023). Access to adequate cooling infrastructure is crucial for sectors like agriculture and fisheries, where maintaining product quality is vital for sustaining economic activities in regions where higher temperatures threaten food security and livelihoods (Khosla et al., 2021).

The socioeconomic benefits of cooperative energy models extend beyond the mere provision of electricity or adaptation to climate change. By ensuring reliable access to electricity, cooperatives can stimulate local job creation and support the creation of micro-enterprises, which are essential for promoting economic growth in rural areas. Evidence for the Global South indicates that electrification can lead to employment increases of approximately 25 %, with women benefiting even more (Jimenez, 2017). Moreover, access to energy can significantly enhance agricultural productivity through electric-powered technologies such as irrigation systems, contributing to income growth and poverty reduction (Golumbeanu et al., 2023; Madriz-Vargas et al., 2018). At the same time, the cooperative model often focuses on renewable energy, aligns with broader environmental sustainability goals, helps to build resilience in rural communities, and supports the transition to clean energy (ILO, 2013; Madriz-Vargas et al., 2018). To our knowledge, there is no evidence on how cooperative energy models affect the local economy among Mexican communities. As these cooperative energy models develop, research on their potential impacts is needed, especially in the case of Mexico.

Although energy cooperatives are promising, they also face significant challenges. The high upfront costs of renewable energy technologies, such as solar panels and energy storage systems, often exceed the pooled resources of cooperative members. Additionally, fluctuating energy prices and evolving subsidy policies create financial uncertainty (Morris & Jungjohann, 2016; Schleicher-Tappeser, 2012). The technical complexity of integrating decentralized systems into national grids further exacerbates these challenges, as synchronization, grid stability, and regulatory compliance require costly infrastructure upgrades, including smart grids and advanced metering. Furthermore, without adequate storage capacity, cooperatives struggle to manage the intermittent nature of renewable energy sources (Kubli et al., 2018; Hewitt et al., 2019).

Effective governance is critical to the success of energy cooperatives, yet it often poses significant challenges. Critics of community energy models argue that individuals with more significant social, cultural, or economic capital are more likely to participate, potentially exacerbating socio-economic and spatial inequalities. The distribution of benefits from value creation depends heavily on the cooperative's specific institutional arrangements and business models (Brown et al., 2020). Moreover, the current structure of energy markets tends to favor large-scale providers, limiting opportunities for small-scale producers and delaying the development of peer-to-peer energy trading mechanisms. These structural and market-based constraints further hinder the potential of energy cooperatives (Lennon et al., 2019).

Although the literature provides substantial analysis of energy cooperatives in the Global North, mainly in Europe, limited attention has been given to their potential role in improving the accessibility, reliability, and affordability of electricity in the Global South. For instance, while Cherry et al. (2023) examine a series of case studies to understand the factors that enable the viability of socially-owned renewable energy projects in the region, they do not assess the impacts of such initiatives on accessibility, reliability, or affordability. Nor do they explore the role of these projects in reducing local inequalities or promoting social mobility. These gaps underscore the need for further research to evaluate how cooperatives might address persistent energy challenges in underserved regions.

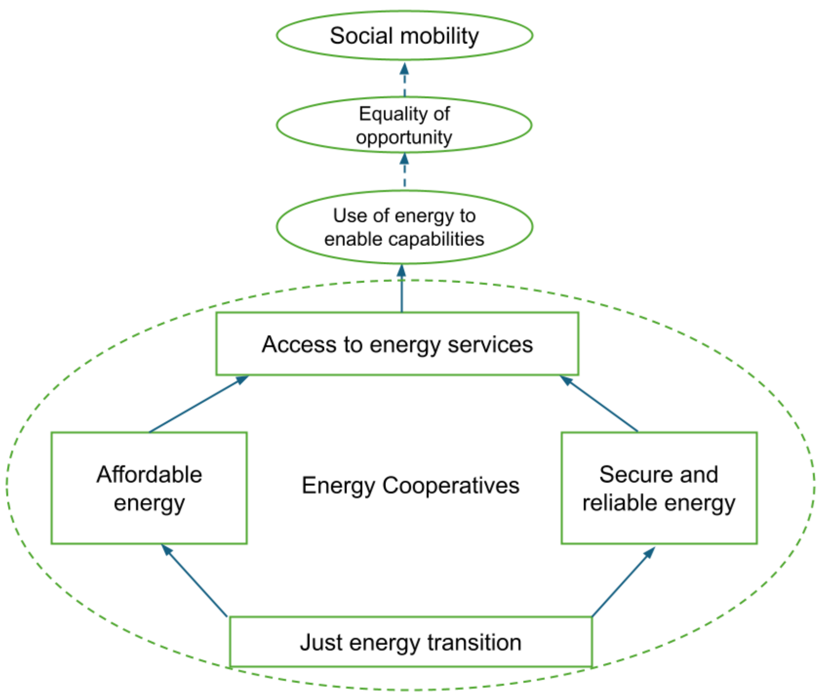
5. Framework for energy transition accounting for ESS and structural inequalities

Renewable energy generation has increased in the last few decades, accounting for almost 30 % of total electricity generated in 2024 (International Renewable Energy Agency, 2024). It is projected to continue increasing in the next few years. This transition to renewable energy sources can improve access to affordable, secure, and reliable energy in areas that have historically had low electricity access. Renewable energy generation can create labor opportunities in areas where renewable energy projects occur (Hernandez-Cortes & Mathes, 2025). It can also increase energy access for households in low—and middle-income countries (Fowlie & Meeks, 2021) and decrease wholesale energy prices (Maciejowska, 2020), which can have positive economic impacts in the long run.

However, given existing inequities in access to participation in developing energy policies that sustain the transition, alternative governance and economic structures are important to guarantee equitable access to energy services. These governance structures can be energy cooperatives or community-driven projects that allow community members to access energy services that might be missing in their communities. For instance, small-scale solar power systems that generate electricity for local use can increase energy reliability in areas with poor energy infrastructure or remote areas without access to electricity (Sharma et al., 2020). Given the high installation costs of these systems, energy cooperatives can pool resources among community members for easier adoption of these energy systems. While it is not guaranteed, this can increase energy reliability and affordability in the community, increasing access to energy services that community members can enjoy. As mentioned in Section 1, access to energy services allows households to use energy to enable capabilities, equalize opportunities, and increase social mobility.

Figure 6 summarizes these driving forces and mechanisms: a just energy transition, focusing on promoting energy cooperatives, facilitates the development of clean, reliable, and affordable energy. This, in turn, improves access to energy services, allowing households to utilize energy to enable their capabilities. Given the equality of opportunity, using energy to enable capabilities can improve household members' social mobility.

Figure 6. A framework for energy access in the context of the energy transition



Source: Own elaboration.

This framework allows us to understand the mechanisms behind the energy transition and how it can increase access to energy services that enable capabilities and can ultimately achieve social mobility. The following section explains the criteria and how they can be used to identify, select, and prioritize projects that support the energy transition.

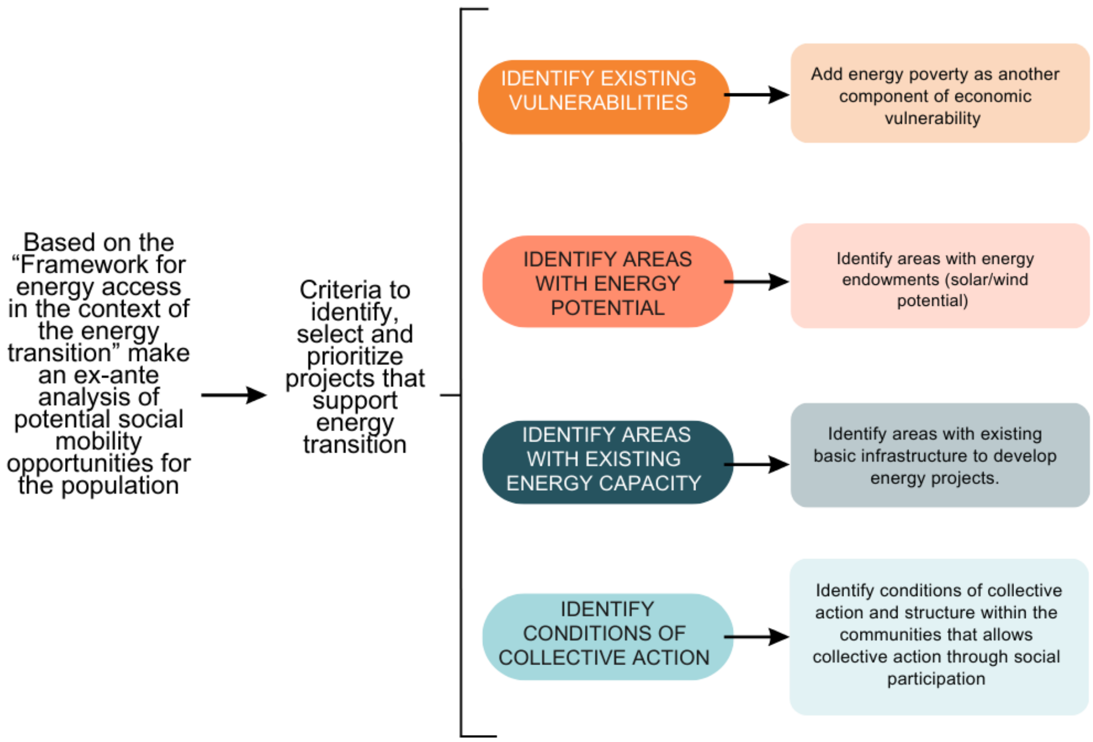
6. Criteria to identify, select, and prioritize projects that support energy transition

Given the potential of a just energy transition to increase social mobility by promoting energy cooperatives, which foster equitable, affordable, and reliable energy, it is essential to evaluate, ex-ante, the potential effectiveness of different community energy projects. This section proposes criteria for identifying and selecting projects prioritizing populations with the lowest potential for social mobility, given the "no losers" requirement in the just transition. Figure 7 illustrates the criteria to identify, select, and prioritize projects supporting the energy transition. Important to mention that these criteria are designed to evaluate potential impacts among community members. Designing methodologies for ex-post evaluation is important, and tools from the policy evaluation literature could be used to assess these impacts in the future.

As Figure 7 highlights, the first step in identifying projects is to evaluate existing energy inequities or vulnerabilities in the communities where these projects can take place. This allows for understanding current community challenges and selecting projects that could improve energy access while considering their challenges. Examples of these challenges include energy deprivation or lack of access to energy services at the community level, which is an important indicator of the total potential beneficiaries of energy projects. Second, it is important to consider geographical factors affecting the effectiveness of different energy projects. Given the importance of local factors for the success of renewable energy projects, technical analysis of energy resources and potential is paramount for developing successful projects. For example, understanding wind or solar energy potential at the community level allows the development of energy projects that the community can reliably use. Third, identifying existing material infrastructure to develop energy projects allows us to understand which complementary material investments (e.g., transmission lines) are needed to develop successful energy projects. Finally, identifying social infrastructure, such as conditions of collective action or existing governance structure, will ensure that the projects are relevant for the community and allow for community participation, which is an important aspect to enable a just energy transition.

Evaluating these criteria ex-ante can inform potential social mobility in these communities, informing which projects are more likely to increase social mobility, considering existing inequities. Appendix III summarizes two of the energy projects INAES supported in Mexico. Section 6 describes one of these projects and how the criteria in Figure 7 could be applied to this context.

Figure 7. Criteria to identify, select, and prioritize projects that support the energy transition



Source: Own elaboration.

7. Example: Fishing cooperative Manuel Cepeda

To develop a practical case study to assess the relevance of the proposed framework on just energy transition, fieldwork was conducted in the community of Río Lagartos, Yucatán. This involved qualitative research through focus groups with members of a local fishing cooperative: Manuel Cepeda (referred hereafter as "the cooperative"). This cooperative was selected because it is in the process of acquiring a solar-powered ice machine. In this regard, it actively participates in the energy transition by adopting a critical input in several phases of its fishing process.

The cooperative was founded in 1970 and currently includes 155 working members referred to as *socios* (partners) and 12 individuals who serve as the cooperative's *directivos* (managers). The distinction between *socios* and *directivos* lies in their roles: *socios* are engaged in fishing activities, and *directivos* are responsible for logistics and securing support for the cooperative's members. Decision-making occurs through assemblies, where decisions are put to a vote among both *socios* and *directivos*. The working structure of the cooperative involves the *socios* fishing in the early morning hours while the *directivos* supply ice needed to preserve the catch upon return. Subsequently, the *directivos* collaborate to distribute the fish to prearranged buyers. Ice is an essential resource for the cooperative, yet its scarcity has become a significant barrier to fishing operations. A solar-powered ice machine would allow the cooperative to preserve the catch while decreasing the costs of acquiring ice.

Given this context, two focus groups were conducted: one with the 10 *directivos* and another with seven *socios*. The objective of each focus group was to conduct an exploratory study on the cooperative's functions, the roles of its members, and the expectations surrounding the new solar-powered ice initiative. During the fieldwork, the research team gained insight into the cooperative's integration within the community, its benefits, its role in social mobility, and its potential contribution to a just energy transition. Furthermore, the team identified key demographic and economic characteristics of both the cooperative and its members, which helped confirm the relevance of the selection criteria outlined in the framework.

7.1. Methodology

The focus group discussions were structured into four main sections. A detailed summary of the questions, as well as the field instrument, is provided in Appendix IV. The first section of the focus group obtained information about the cooperative and its relationship with the community, as well as information on the main challenges incorporating renewable energy into the production process of the cooperative. The second section focused on understanding the cooperative's social organization and details of the cooperative governance and management. The third section inquired about community members' perceptions of renewable energy and government support to facilitate adopting renewable energy projects. Finally, the fourth section gathers information on perceived social mobility among the cooperative members. At the end of the focus group discussion, a questionnaire was collected to obtain the cooperative members' general demographic and socioeconomic information.

7.2. Main results

Each section of the focus group discussed different themes. The first section describes how the cooperative is managed and organized. The cooperative is organized through assemblies and has a board of directors formed by the fishermen, who are responsible for organizing meetings. The second section explains how the cooperative monitors and protects themselves. For instance, the cooperative provides a protection scheme to safeguard their fishing activities in case of contingencies and secures a market for distributing the fish products. The third section discusses how the new solar-powered ice machine could influence their production, as ice is essential for preserving the catch. The focus group participants explained that the cooperative has challenges accessing electricity from traditional sources and, therefore, a shortage of ice. It is also important to note that participants noted the current reduced catch due to climate change conditions. However, the expansion of the fishing market has allowed the cooperative to improve its economic situation despite these decreases in fishing products. Additional details are described below.

7.3. First Focus Group (Managers)

1. First section: General information about the cooperative and its relationship with the community
   - The cooperative's managers are responsible for delivering the ice to the fishermen and organizing the distribution of the fish.
   - "To become a member (worker-fisherman), you have a three-year probationary period, depending on the quality and quantity of your production."
2. Second section: Social organization within the cooperative
   - The cooperative makes collective decisions: meetings are organized by the cooperative's directors.
   - The cooperative was founded because it provides many benefits to fishermen. It provides them with backing, support, resources, and insurance.
3. Third section: Use of renewable energies
   - Renewable energy could potentially increase energy access for the cooperative production.
   - "Ice is essential for the cooperative; we need it for the fishermen, to preserve the fish for sale."

- “We have daily power interruptions, and the quality of access is poor.”

4. Fourth section: Perceived social mobility

    - Despite decrease in catch, participants have a sense of better access to markets compared to previous generations.

    - “The times we live in are better. According to previous generations, about 50 years ago, there were plenty of fish, which are gone now. However, there was no market to distribute this product. Now there is good demand; we are better off, even though there is a shortage of fish.”

7.4. Second Focus Group (Partners)

1. First section: General information about the cooperative and its relationship with the community

    - “As a cooperative, we have obtained fishing permits not granted to private individuals.”

2. Second section: Social organization within the cooperative

    - “We only work for the cooperative; we do not do independent work. Because we are organized, we set an example for other cooperatives: establishing and monitoring the closed seasons.”

    - “We begin the closed season in January, not February, because it is better for the species. We always ask the government for support to ensure closed season compliance.”

3. Third section: Use of renewable energies

- "The cost of ice is too high; we believe that we could lower the cost with solar energy."
- "The ice machines are not enough; many fishermen work in this area."
- "We know that once we have solar energy, we can consume and sell it."[7]

4. Fourth section: Perceived social mobility benefits
    - "The driving force behind us is ensuring our children can study, even though our cooperative continues to bear fruit. We have children who are doctors, engineers, nurses, etc."
    - "If we respect the closed season, we can ensure that other generations can dedicate themselves to fishing."

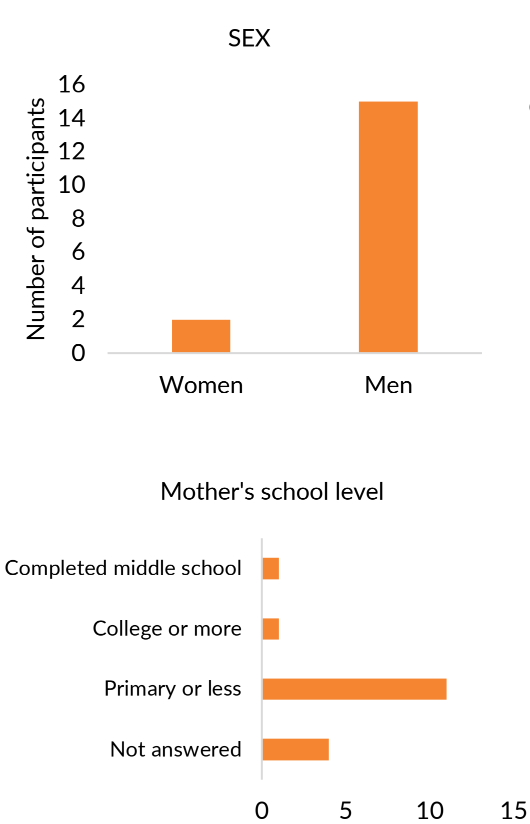
7.5. Results of the sociodemographic questionnaire

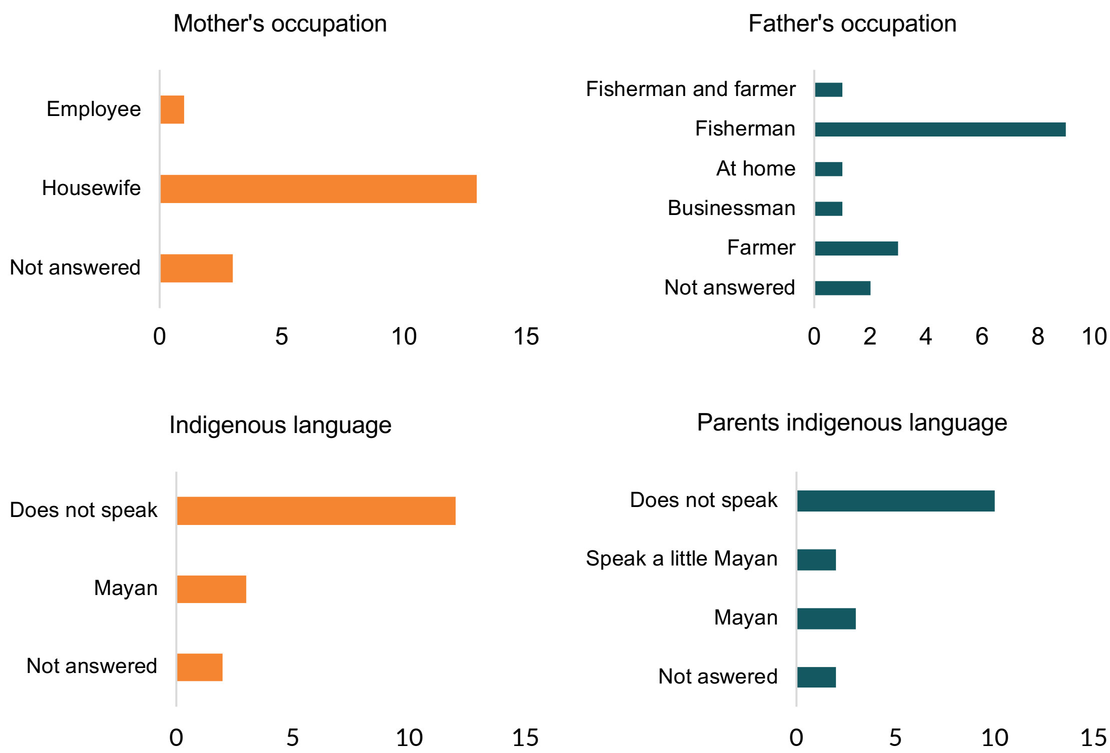
Figure 8 summarizes the socioeconomic and demographic characteristics of the focus group participants. The results of the sociodemographic questionnaire show that most of the cooperative's members are male and have little or, in some cases, no indigenous language heritage. Similarly, the results indicate that, in general, cooperative members have low levels of formal education. However, there is evidence of upward social mobility compared to their parents' educational attainment, as most parents only have primary school or less. In contrast, most of the cooperative members have completed middle school.

[7] During the focus group, the cooperative members mentioned that they are aware of a woman living in Río Lagartos who uses a solar panel to power her business. According to her, she receives a discount on her energy bill because of the solar panel. As a result, the cooperative members believe they could also receive a similar discount and, if they have any surplus energy, they could potentially sell it. Additionally, during the focus group, they shared that if they have excess ice, they also consider selling it.

Interestingly, many cooperative members have inherited their father's profession (i.e., fishing), suggesting a persistent pattern in this dimension of social mobility. These results are important considering that the cooperative members explained the importance of their children studying for a better future. During the focus group, cooperative members mentioned that even if they consider fishing a profitable occupation, education is a way to have a better future and an opportunity to have another occupation. This suggests that while cooperative members have low levels of education, they express a clear desire for their children to have greater possibilities and the freedom to pursue different occupations through education.

Figure 8. Sociodemographic characteristics of the focus group participants





Source: Own elaboration.

Finally, considering the criteria for identifying, selecting, and prioritizing projects that support the energy transition, as shown in Figure 7, it is important to note that the Solar Ice Project meets the criteria. Specifically, this project will support a community experiencing energy shortages from traditional sources, which makes them particularly vulnerable since ice is a crucial part of their productive activities. INAES, GIZ, and the IER-UNAM (Renewable Energy Institute of the UNAM)'s evaluation has confirmed that the cooperative has the necessary energy infrastructure to manage the Solar Ice Project. Finally, the last criterion related to opportunities for collective action through social participation is also evident in this cooperative. Although not explicitly stated, there are two ways in which they benefit the community: by trying to respect the closed season and providing a rescue guarantee for fishermen who encounter difficulties at sea.[8]

8. Conclusions

Mexico's evolving energy landscape presents both a challenge and an opportunity: without deliberate attention to distributive justice and social mobility, the energy transition could reinforce existing inequalities. While only a small fraction of households lack grid access, significant gaps in affordability and reliability persist, among households in the poorest quintile, who spend a disproportionate share of their income on energy and endure frequent service interruptions. These conditions restrict basic capabilities such as education, health, and productive work, ultimately limiting social mobility. A successful transition must therefore be assessed by its environmental outcomes and capacity to expand opportunities and reduce structural inequalities.

Several policy areas deserve attention to move in that direction. Promoting decentralized, community-owned renewable energy projects—especially in solar, wind, and small-scale hydro—can help reduce energy costs, improve resilience, and retain value locally. Support for these initiatives should include targeted incentives, such as capital subsidies and affordable access to credit, particularly for cooperatives and low-income households. Better coordination across sectors is also needed. Establishing mechanisms for joint planning among energy, social development, and fiscal agencies, with subnational governments and civil society, could align energy policy with broader development goals.

[8] The cooperative has stricter dates for the closed season and is trying to come up with strategies to ensure that all fishermen comply with them.

Embedding social mobility objectives into project design and implementation, sharing funding responsibilities, and ensuring citizen participation are key steps in that direction. Finally, combining public support with community and private investment, blended financing approaches can increase scale while ensuring local ownership.

The SSE model explored in this paper reflects these priorities. By identifying local energy vulnerabilities, assessing technical feasibility, and evaluating social readiness for participatory governance, projects like the Manuel Cepeda cooperative's solar-powered ice plant show how renewable energy can build capabilities, lower household burdens, and promote upward mobility. If Mexico embraces these strategies, the energy transition can become a foundation for a more just, inclusive, and sustainable future.

However, it is important to recognize that collective action and social participation—key enablers of successful community-driven energy projects—are not guaranteed. In many parts of Mexico, rising violence, insecurity, and forced migration are undermining the social fabric of communities, weakening trust, and disrupting the networks necessary for collaboration. These dynamics can erode the foundations upon which the SSE model depends, making it harder to mobilize community engagement or sustain participatory governance. As such, the criteria proposed to identify and prioritize energy projects must also assess the risks posed by these external stressors. Even well-designed initiatives may fail to achieve inclusive and sustainable outcomes without addressing these challenges.

References

Alanne, K., & Saari, A. (2006). Distributed energy generation and sustainable development. *Renewable and Sustainable Energy Reviews, 10*(6), 539–558. https://doi.org/10.1016/j.rser.2004.11.004

Bednar, D. J., & Reames, T. G. (2020). Recognition of and response to energy poverty in the United States. *Nature Energy*, *5*, 432–439. https://doi.org/10.1038/s41560-020-0582-0

Berkouwer, S. & Dean, J. (2022). Credit, Attention, and Externalities in the Adoption of Energy Efficient Technologies by Low-Income Households. *American Economic Review, 112* (10): 3291–3330.

Berkouwer, S. B., & Dean, J. T. (2023). *Private Actions in the Presence of Externalities: The Health Impacts of Reducing Air Pollution Peaks but not Ambient Exposure* (31614; NBER WORKING PAPER SERIES). http://www.nber.org/data-appendix/w31614

Bielig, M., Kacperski, C., Kutzner, F., & Klingert, S. (2022). Evidence behind the narrative: Critically reviewing the social impact of energy communities in Europe. *Energy Research and Social Science*, *94*. https://doi.org/10.1016/j.erss.2022.102859

Borenstein, S., Fowlie, M., & Sallee, J. (2022). *Paying for Electricity in California: How Residential Rate Design Impacts Equity and Electrification*. Energy Institute at Haas, University of California.

Brown, D., Hall, S., & Davis, M. E. (2020). What is prosumerism for? Exploring the normative dimensions of decentralised energy transitions. *Energy Research and Social Science*, *66*. https://doi.org/10.1016/j.erss.2020.101475

Campos, I., & Marín-González, E. (2020). People in transitions: Energy citizenship, prosumerism and social movements in Europe. *Energy Research and Social Science*, *69*. https://doi.org/10.1016/j.erss.2020.101718

Cherry, J. et al. (2023). Social ownership models in the energy transition: Report for the Presidential Climate Commission. Gqeberha: Nelson Mandela University.

Coenen, F., Hoppe, T., Chalkiadakis, G., Akasiadis, C., & Tsoutsos, T. (2017). Exploring energy saving policy measures by renewable energy supplying cooperatives (REScoops). In *Proceedings of ECEEE 2017 Summer Study on energy efficiency: Consumption, efficiency and limits* (pp. 1-12)

Comisión Reguladora de Energía. (2017, February). *La CRE aprueba instrumentos regulatorios aplicables a centrales eléctricas de generación distribuida – paneles solares*. Gob.Mx. https://www.gob.mx/cre/prensa/la-cre-aprueba-instrumentos-regulatorios-aplicables-a-centrales-electricas-de-generacion-distribuida-paneles-solares

CONEVAL (2019). Metodología para la medición multidimensional de la pobreza en México. Tercera Edición. *Consejo Nacional de la Evaluación de la Política de Desarrollo Social*.

Congreso de la Unión. (2024, April 1). *Agrarian Law* [Ley Agraria]. *Diario Oficial de la Federación*. https://www.diputados.gob.mx/LeyesBiblio/pdf/LAgra.pdf

Congreso de la Unión. (2012, May 23). *Law on Social and Solidarity Economy* [Ley de la Economía Social y Solidaria]. *Diario Oficial de la Federación*. https://www.diputados.gob.mx/LeyesBiblio/pdf/LESS.pdf

Day, R., Walker, G., & Simcock, N. (2016). Conceptualising energy use and energy poverty using a capabilities framework. *Energy Policy*, *93*(93), 255–264. https://doi.org/10.1016/j.enpol.2016.03.019

Espinosa, R. (2023). *Medición de la pobreza multidimensional en México, 1992-2008* [Tesis de licenciatura]. Universidad Nacional Autónoma de México.

Fairchild, D., Weinrub, A. (2017). Energy Democracy. In: Lerch, D. (eds) *The Community Resilience Reader.* Island Press, Washington, DC. https://doi.org/10.5822/978-1-61091-861-9_12

Fowlie, M., & Meeks, R. (2021). The economics of energy efficiency in developing countries. *Review of Environmental Economics and Policy*, *15*(2), 238–260. https://doi.org/10.1086/715606

García Ochoa, R., & Graizbord Ed, B. (2016). Privation of energy services in Mexican households: An alternative measure of energy poverty. *Energy Research & Social Science*, *18*, 36–49.

García-Ochoa, R., & Graizbord, B. (2016). Caracterización espacial de la pobreza energética en México. Un análisis a escala subnacional. Economía, sociedad y territorio, 16(51), 289-337.

Gobierno de México. (2013). *Reforma Energética*. https://www.gob.mx/cms/uploads/attachment/file/164370/Resumen_de_la_explicacion_de_la_Reforma_Energetica11_1_.pdf

Golumbeanu, R., Besnard, J., Koo, B., Hinrichs, F., Finucane, J., Purcell, C., & Barnes, D. (2023). *Accelerating the Productive Use of Electricity : Enabling Energy Access to Power Rural Economic Growth*. World Bank Group.

http://documents.worldbank.org/curated/en/099092023192023389/P1751521d3f58f6f1307c1499619e141b8baef6de8dd

Hernandez-Cortes, D., & Mathes, S. (2023). The Effects of Renewable Energy Projects on Employment: Evidence from Brazil. Forthcoming *Journal of the Association of Environmental and Resource Economists*.

Hewitt, R. J., Bradley, N., Compagnucci, A. B., Barlagne, C., Ceglarz, A., Cremades, R., McKeen, M., Otto, I. M., & Slee, B. (2019). Social innovation in community energy in Europe: A review of the evidence. *Frontiers in Energy Research*, *7*(31). https://doi.org/10.3389/fenrg.2019.00031

Hollingsworth, A., & Rudik, I. (2019). External impacts of local energy policy: The case of renewable portfolio standards. Journal of the Association of Environmental and Resource *Economists, 6*(1), 187-213.

INEGI. (2020). *Censo de Población y Vivienda 2020*. Inegi.Org.Mx. https://www.inegi.org.mx/programas/ccpv/2020/

Instituto Nacional de la Economía Social. (2023, January). *Nodos de Impulso a la Economía Social y Solidaria NODESS*. Gob.Mx. https://www.gob.mx/inaes/acciones-y-programas/nodos-de-impulso-a-la-economia-social-y-solidaria-nodess-233732#:~:text=NODESS-,Los%20Nodos%20de%20Impulso%20a%20la%20Econom%C3%ADa%20Social%20y%20Solidaria,menos%20tres%20actores%20diferentes%3A%20instituciones

International Energy Agency (IEA). (2024). *Renewables 2024. Analysis and forecast to 2030*. www.iea.org

International Labour Office (ILO). (2013). *Providing clean energy and energy access through cooperatives*.

www.ilo.org/sites/default/files/wcmsp5/groups/public/@ed_emp/@emp_ent/documents/publication/wcms_233199.pdf

International Renewable Energy Agency (IEA). (2024). *Renewable energy highlights*. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Jul/Renewable_energy_highlights_FINAL_July_2024.pdf

Jimenez, R. (2017). *Development Effects of Rural Electrification.* Inter-American Development Bank, Policy Brief IDB-PB-261.

Khosla, R., Miranda, N. D., Trotter, P. A., Mazzone, A., Renaldi, R., McElroy, C., Cohen, F., Jani, A., Perera-Salazar, R., & McCulloch, M. (2021). Cooling for sustainable development. *Nature Sustainability, 4*(3), 201–208. https://doi.org/10.1038/s41893-020-00627-w

Kubli, M., Loock, M., & Wüstenhagen, R. (2018). The flexible prosumer: Measuring the willingness to co-create distributed flexibility. *Energy Policy*, *114*, 540–548. https://doi.org/10.1016/j.enpol.2017.12.044

Lennon, B., Dunphy, N. P., & Sanvicente, E. (2019). Community acceptability and the energy transition: a citizens' perspective. *Energy, Sustainability and Society, 9*(1), 35. DOI: 10.1186/s13705-019-0218-z

Maciejowska, K. (2020). Assessing the impact of renewable energy sources on the electricity price level and variability–A quantile regression approach. *Energy Economics, 85,* 104532.

Madriz-Vargas, R., Bruce, A., & Watt, M. (2018). The future of Community Renewable Energy for electricity access in rural Central America. *Energy Research and Social Science*, *35*, 118–131. https://doi.org/10.1016/j.erss.2017.10.015

Mehigan, L., Deane, J. P., Gallachóir, B. P. Ó., & Bertsch, V. (2018). A review of the role of distributed generation (DG) in future electricity systems. *Energy, 163*, 822–836. https://doi.org/10.1016/j.energy.2018.08.022

Morandeira-Arca, J., Etxezarreta-Etxarri, E., Azurza-Zubizarreta, O., & Izagirre-Olaizola, J. (2024). Social innovation for a new energy model, from theory to action: contributions from the social and solidarity economy in the Basque Country. *Innovation: The European Journal of Social Science Research*, *37*(1), 33–59. https://doi.org/10.1080/13511610.2021.1890549

Morris, C., & Jungjohann, A. (2016). *Energy Democracy: Germany's Energiewende to Renewables*. Palgrave Macmillan. DOI: 10.1007/978-3-319-31891-2. SPRINGER LINK

Pakhtigian, E. L., Jeuland, M., Pattanayak, S. K., & Phillips, J. (2024). Estimating Lost Dividends from Incomplete Energy Access Transitions. *Journal of Benefit-Cost Analysis*, 1–33. https://doi.org/10.1017/bca.2024.14

Parag, Y., & Sovacool, B. K. (2016). Electricity market design for the prosumer era. *Nature Energy*, *16035*. https://doi.org/10.1038/NENERGY.2016.32

Parra-Domínguez, J., Sánchez, E., & Ordóñez, Á. (2023). The Prosumer: A Systematic Review of the New Paradigm in Energy and Sustainable Development. *Sustainability*, *15*. https://doi.org/10.3390/su151310552

Paudel, A., Chaudhari, K., Long, C., & Gooi, H. B. (2018). Peer-to-peer energy trading in a prosumer-based community microgrid: A game-theoretic model. *IEEE Transactions on Industrial Electronics, 66*(8), 1–10. https://doi.org/10.1109/TIE.2018.2874578

Presidencia de la República (2025). CFE y PEMEX vuelven a ser del pueblo de México: Presidenta firma leyes secundarias que revierte reforma energética de 2013.

https://www.gob.mx/presidencia/prensa/cfe-y-pemex-vuelven-a-ser-del-pueblo-de-mexico-presidenta-firma-leyes-secundarias-que-revierten-reforma-energetica-de-2013?idiom=en

RIPESS (Intercontinental Network for the Promotion of Social Solidarity Economy). (2015, February). *Global Vision for a Social Solidarity Economy: Convergences and Differences in Concepts, Definitions and Frameworks*. Recuperado de www.ripess.org

Sareen, S., Girard, B., Lindkvist, M., Sveinsdóttir, A., Kristiansen, S., Laterza, V., Aguilar-Støen, M., & Langhelle, O. (2023). Enabling a just energy transition through solidarity in research. *Energy Research and Social Science*, *101*. https://doi.org/10.1016/j.erss.2023.103143

Saz-Gil, I., Bretos, I., & Díaz-Foncea, M. (2021). Cooperatives and social capital: A narrative literature review and directions for future research. *Sustainability*, *13*(2), 1–18. https://doi.org/10.3390/su13020534

Schleicher-Tappeser, R. (2012). How renewables will change electricity markets in the next five years. *Energy Policy, 48*, 64–75. DOI: 10.1016/j.enpol.2012.04.042

Sen, A. K. (1980). Equality of What? In S. M. McMurrin (Ed.), *Tanner Lectures on Human Values* (Vol. 1). Cambridge University Press.

Sen, A. (2000). *Development as Freedom*. Anchor.

SENER. (2022). *Servicios energéticos, pobreza energética y eficiencia energética: Una perspectiva desde México*. Prepared by Odón de Buen, Norma Morales, and Juan Ignacio Navarrete. *CONUEE Papers* (No. 8).

Sharma, A., Agrawal, S., & Urpelainen, J. (2020). The adoption and use of solar mini-grids in grid-electrified Indian villages. *Energy for Sustainable Development, 55*, 139–150. https://doi.org/https://doi.org/10.1016/j.esd.2020.01.005

Soriano-Hernández, P., Mejía-Montero, A., & van der Horst, D. (2022). Characterisation of energy poverty in Mexico using energy justice and econophysics. *Energy for Sustainable Development*, *71*, 200–211. https://doi.org/10.1016/j.esd.2022.09.005

Sovacool, B. K., & Dworkin, M. H. (2015). Energy justice: Conceptual insights and practical applications. *Applied Energy*, *142*, 435–444.

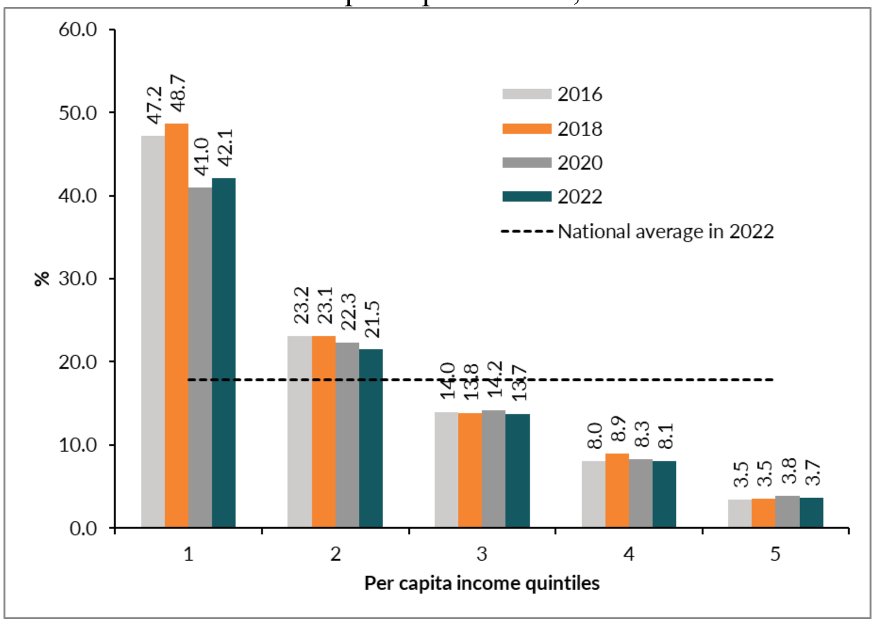
Sovacool, B. K., & Drupady, I. M. (2016). *Energy access, poverty, and development: the governance of small-scale renewable energy in developing Asia*. Routledge.

Utting, P. (2015). Introduction: The challenge of scaling up social and solidarity economý. In *Social and Solidarity Economy: Beyond the Fringe* (pp. 1–37). Zed Books.

Vélez-Grajales, R., Monroy-Gómez-Franco, L., & Yalonetzky, G. (2018). *Inequality of Opportunity in Mexico* (01/2018).

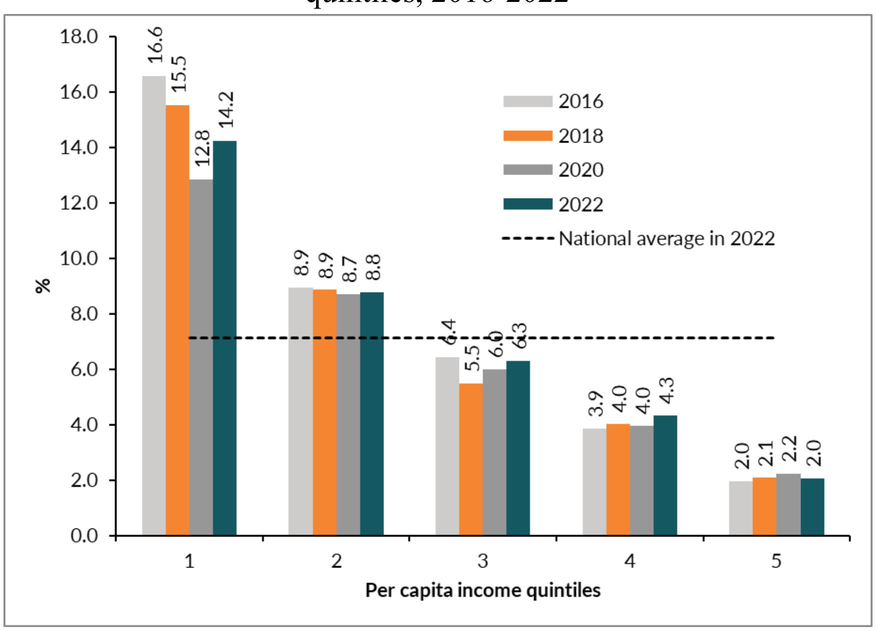
Appendix I. Additional Figures

Figure A1. Percentage of people lacking access to basic services in the home, by quintiles of total current per capita income, 2016-2022



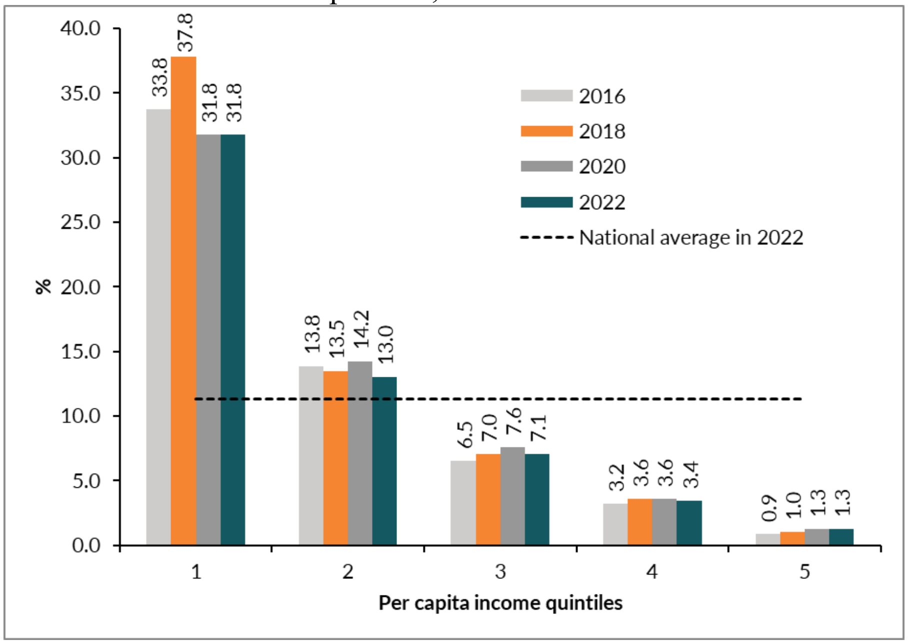
Source: Own elaboration using data from the National Household Income and Expenditure Survey (ENIGH 2022), following the multidimensional poverty measurement methodology of CONEVAL (2019).

Figure A2. Percentage of people lacking access to water by total current per capita income quintiles, 2016-2022



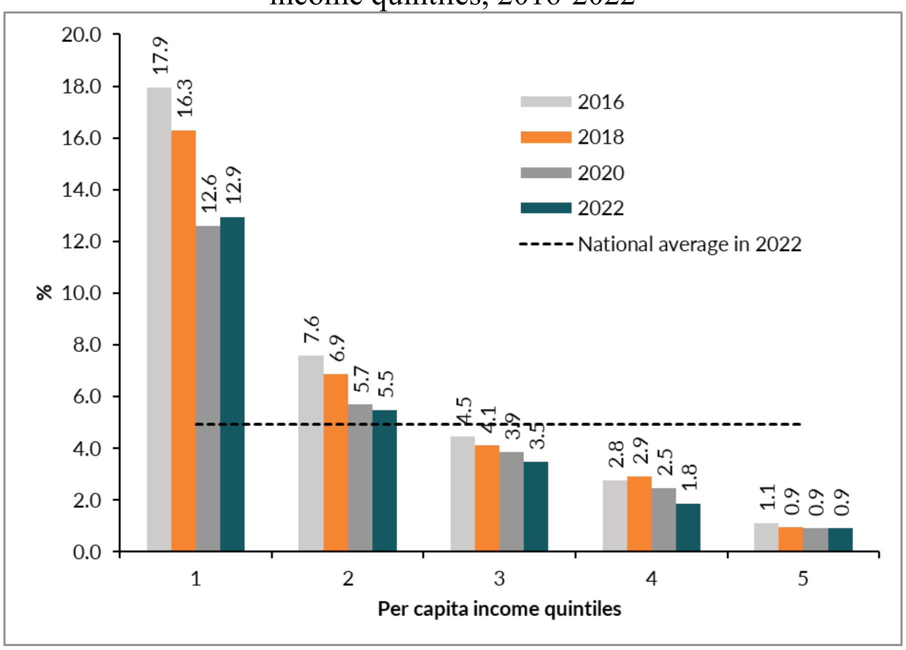
Source: Own elaboration using data from the National Household Income and Expenditure Survey (ENIGH 2022), following the multidimensional poverty measurement methodology of CONEVAL (2019).

Figure A3. Percentage of people lacking access to fuel by total current per capita income quintiles, 2016-2022



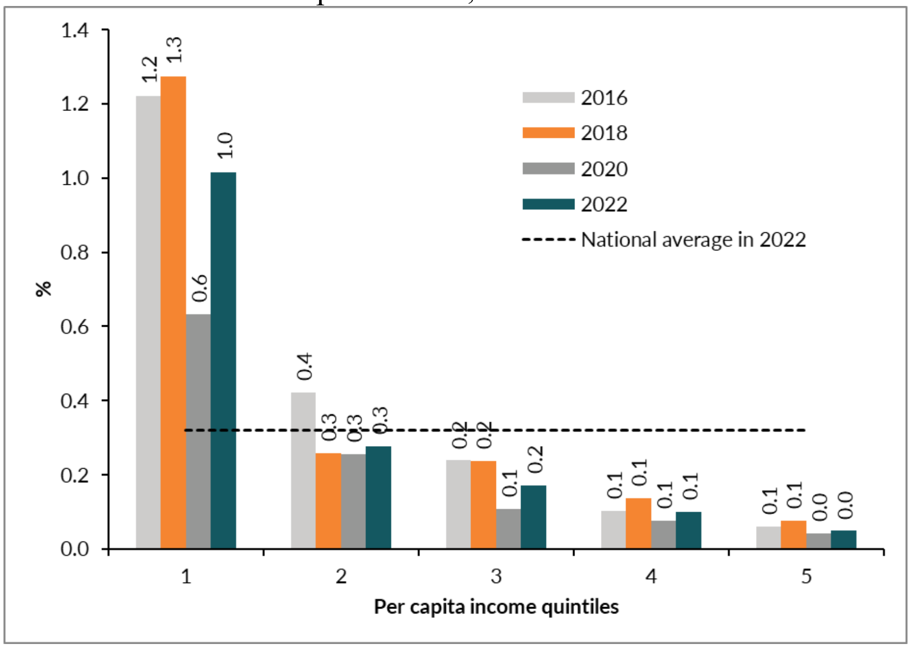
Source: Own elaboration using data from the National Household Income and Expenditure Survey (ENIGH 2022), following the multidimensional poverty measurement methodology of CONEVAL (2019).

Figure A4. Percentage of people lacking access to drainage by total current per capita income quintiles, 2016-2022



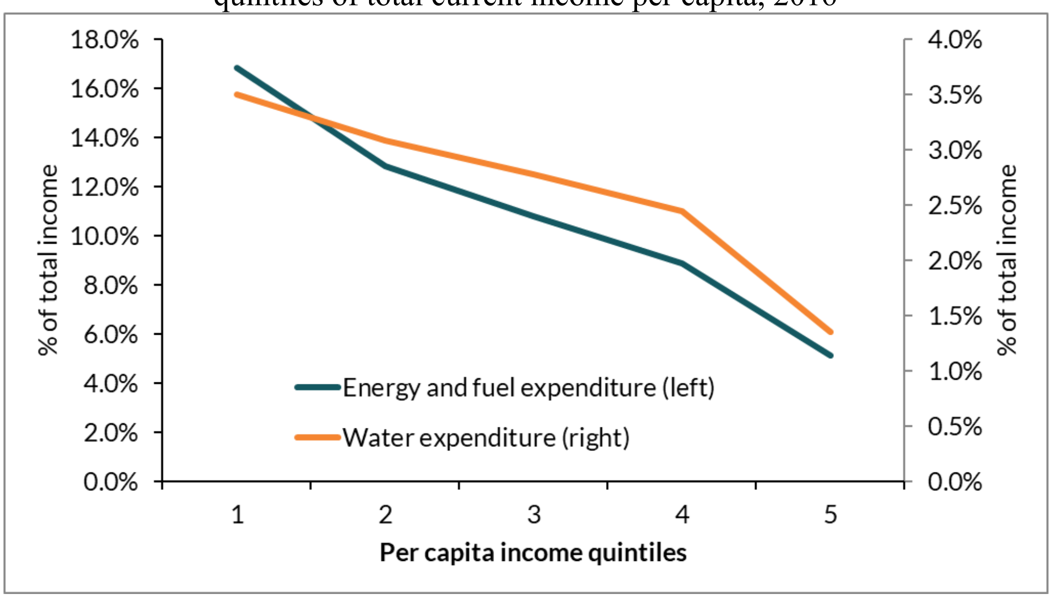
Source: Own elaboration using data from the National Household Income and Expenditure Survey (ENIGH 2022), following the multidimensional poverty measurement methodology of CONEVAL (2019).

Figure A5. Percentage of people lacking electricity services by quintiles of total current per capita income, 2016-2022



Source: Own elaboration using data from the National Household Income and Expenditure Survey (ENIGH 2022), following the multidimensional poverty measurement methodology of CONEVAL (2019).

Figure A6. Average expenditure on water and energy as % of total current income, by quintiles of total current income per capita, 2016



Source: Own elaboration using data from the National Household Income and Expenditure Survey (ENIGH 2016), following the multidimensional poverty measurement methodology of CONEVAL (2019).

Appendix II. Summary of decentralized energy and distributed electricity generation in Mexico and its relationship with social market economy in the just transition framework.

The traditional electricity utility structure has been the dominant way to generate and supply energy. However, this structure has been changing due to the increasing decentralized generation by other energy resources connected to the distribution network (Mehigan, Deane, Gallachóir & Bertsch, 2018). Specifically, there has been an increase in individuals installing renewable-based distributed generators and energy storage units in residential buildings, increasing the number of agents participating in energy generation (Kirthiga et al., 2013, cit. in Paudel et al., 2018). This new approach implies that the energy is rationed by small units that might be located close to consumers and connected to the energy network (Alanne & Saari, 2006).

Distributed energy generation usually requires an integrated energy system involving small units connected to transmission lines or public energy networks (Alanne & Saari, 2006). Some of these systems require special knowledge and expertise to operate and maintain local staff to maintain the infrastructure. Importantly, geographic and socioeconomic characteristics such as population density, location, and land use must be considered when planning and installing distributed energy systems (Mehigan, Deane, Gallachóir, and Bertsch, 2018).

AII.1. Mexican legal framework

The National Energy Control Center (CENACE) is the entity that coordinates the energy market and provides stability. The energy market is integrated into three stages: generation, operational control, and consumption. The first stage is integrated mainly by the

Federal Electricity Commission (CFE) and Mexican Oil (PEMEX), and, in the second place, the Independent Energy Producers (PIEs) and private sellers. Then, the second stage is integrated by the CENACE. Finally, the third stage comprises qualified and basic users (Gobierno de México, 2013).

The Energy Regulatory Commission (CRE) regulates the energy market, determining the contract models, compensation calculation methodologies, and administrative provisions for marketing electrical energy obtained through distributed generation (Comisión Reguladora de Energía, 2017).

Finally, there is another actor that is part of this market and has an important role in promoting the energy transition, the National Institute of Social Economy (INAES), and it has the Nodes to Promote the Social and Solidarity Economy (NODESS), as a strategy to develop social and solidarity economy ecosystems in their territories, through which territorial solutions to collective needs are proposed, designed and implemented (Instituto Nacional de la Economía Social, 2023).

Appendix III. Current INAES projects relevant to the energy transition and social economy

AIII.1. Solar Ice Cooperative – Sociedad Cooperativa Manuel Cepeda Peraza

This initiative aims to acquire and install ice production systems (ice machine and cold chamber for ice conservation) using solar energy. The cooperative's plans are twofold. First, to create a business plan that includes women and youth from the community in all stages of the project, from planning to developing new business activities. Second, to secure the wellbeing of the cooperative workers and their locality through strengthening their governance and the cooperative's management capacity in implementing the project, following the principles and values of the social economy.

The community is also planning to create a summary of practices and lessons learned to promote the exchange of experiences and lessons learned with national and international cooperatives and organizations in the field of community energy.

To this end, the National Institute for Social Economy provides them with Social Technology and Financing Management, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) provides technical assistance in energy, the Institute for Renewable Energy provides technical assistance in cooling, and the Small Grants Program provides financing.

AIII.2. Solar Farm Cooperative – Playa Ventura

This project developed a solar power plant to generate electricity. The National Technological Institute, Acapulco campus, developed the project. It will be donated to a cooperative formed by people from the Juan N. Álvarez community, in the municipality of Copala, Guerrero.

The National Institute of Social Economy provides support for social organization and management. GIZ provides technical assistance in energy. The "González Calvillo" lawyers' association provides pro bono legal assistance.

The objectives of this project include: 1) strengthening the cooperative's governance and management, which will allow the production of solar energy, 2) developing a business model to produce and sell energy, and 3) creating a sales agreement.

AIII.3. Additional information on the two cooperatives

Table A1 shows the socioeconomic characteristics of the two cooperatives and the characteristics of the municipalities where these cooperatives are located.

Table A1. Socioeconomic characteristics of energy cooperatives

	Sociedad Cooperativa Manuel Cepeda Peraza (Solar Ice Cooperative)	Sociedad Cooperativa Granja Solar Playa Ventura (Solar farm cooperative)
Panel a) Cooperatives information (Source: INAES)		
Members of the cooperative (partners and workers)	155	35
Primary Members	148	4
Secondary Members	7	31
Men	149	13
Women	6	22

Funding year	1970	2022
Locality	Río Lagartos	Playa Ventura
Municipality	Río Lagartos	Copala
State	Yucatan	Guerrero
Panel b) Socioeconomic information (Source: INEGI, 2020)		
Population in the municipality	3,974	14,463
Female population	1,941	7,479
Male population	2,033	6,984
Population who speak an indigenous language	785	351
Population who identify themselves as Indigenous people	2,997	3,217
Proportion of employed men	45.8	41.4
Proportion of employed women	17.6	18.9
Average years of schooling accumulated (men)	6.6	6.2
Average years of schooling accumulated (women)	7.0	6.3
Social lag index	-.54 (Low)	0.18 (Medium)

Source: Own elaboration.

Appendix IV. Case example field instruments

AIV.1. Qualitative Instrument for Focus Groups

Moderator's Introduction and Study Explanation:

"Hello, my name is […] and I am participating in the project Just Energy Transition, Structural Inequities, and Social Mobility: The Case of Mexico, in which we aim to listen to the experiences and perspectives of individuals who are part of this energy-producing cooperative. We believe your knowledge is valuable for discussing the transition to clean or renewable energy with an equality perspective. We appreciate your participation in this focus group.

The information provided will be completely confidential and anonymous, and will only be used in an aggregated manner to support the aforementioned project. We inform you that your participation will be recorded, and written records of your interventions will be kept; however, you have the right at any time to ask for the recording and written record to stop. Finally, we inform you that you can refuse to answer any question or stop the exercise. With this understanding, we kindly ask that you read and sign the consent form to begin the activity:"

Focus Group Structure:

- Section 1: General Information about the Cooperative and Its Relationship with the Community
    - Could you describe why you decided to organize the founding of this cooperative?
    - Could you describe a typical day in your life within the cooperative?
    - How does the cooperative's work benefit the Río Lagartos community?

    - Given the recent adoption of clean energy in the cooperative's production process, what were the main challenges in incorporating this type of energy?
- Section 2: Social Organization within the Cooperative
    - How is decision-making carried out within the cooperative?
    - To what extent does the Río Lagartos community contribute to the cooperative's decision-making or production?
    - How are the cooperative's profits distributed among the workers and the community?
- Section 3: Use of Renewable Energy
    - Are clean energy sources more accessible to people than traditional energy sources? How is the Solar Ice project an example of this?
    - Have you ever received support from the Mexican government to facilitate the transition to clean energy? If so, what type of support?
- Section 4: Perceived Benefits of Social Mobility among Cooperative Members
    - Since you joined the cooperative, do you think your financial situation has improved?
    - If you compare your financial situation with your parents' situation, do you think you are in a better, worse, or the same situation as them?
    - Can the cooperative's benefits from transitioning to clean energy continue, so that new generations can dedicate themselves to this?

Sociodemographic Questionnaire of Participants

The following information will be collected regarding their sociodemographic conditions and social mobility.

Age: ___________________

Sex:

[   ] male

[   ] Female

[   ] I prefer not to say it.

School level:

[   ] Primary or less

[   ] Completed middle school

[   ] High school

[   ] College or more

Mother's school level:

[   ] Primary or less

[   ] Completed middle school

[   ] High school

[   ] College or more

Father's school level:

[   ] Primary or less

[   ] Completed middle school

[   ] High school

[   ] College or more

Mother's occupation: ____

Father's occupation: ____

Do you speak any indigenous languages? Which one?: ___________________________

Do your parents speak an indigenous language? Which one?: ______________________