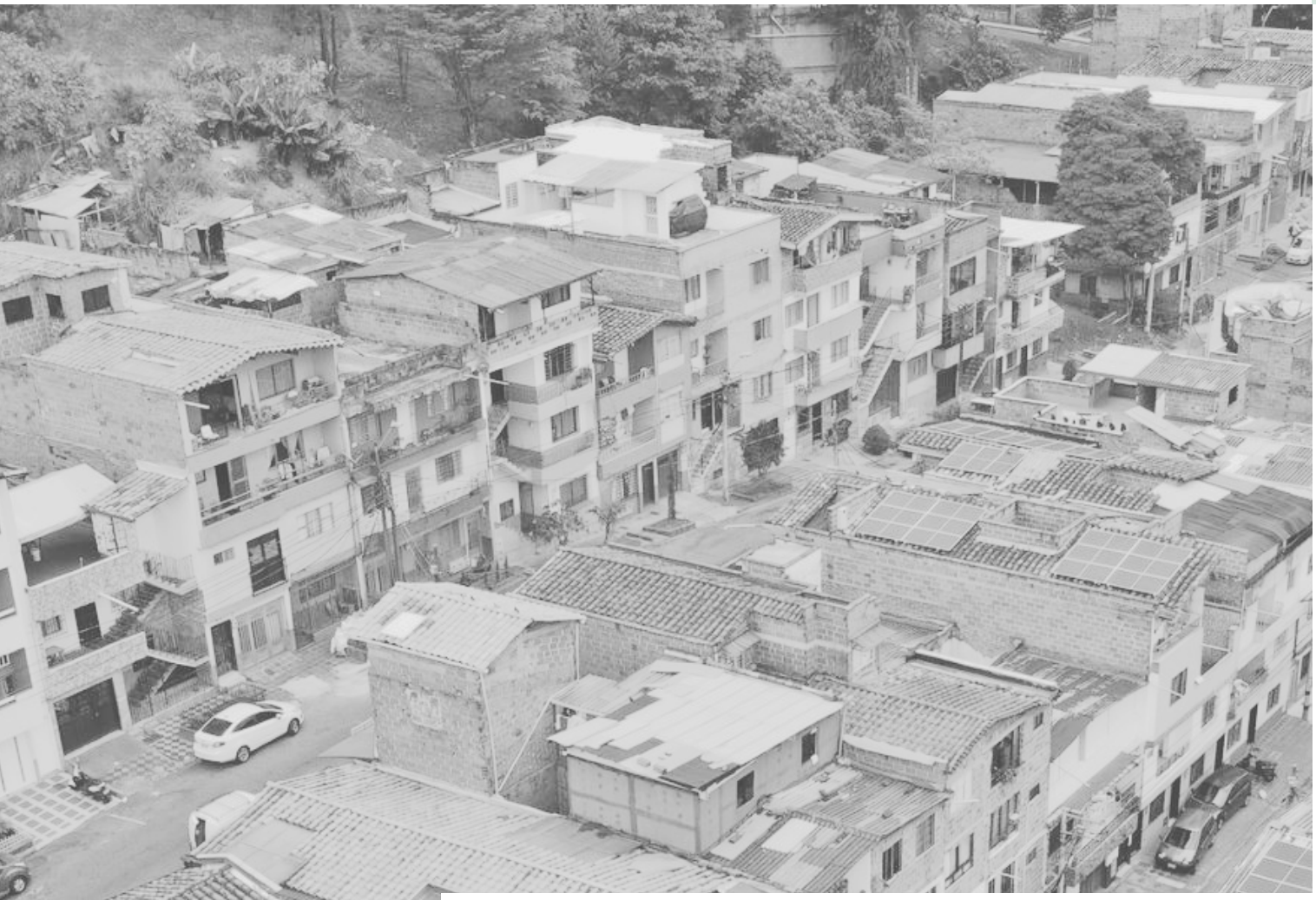

RETHINKING ENERGY COMMUNITIES FOR A JUST TRANSITION

A critical view on La Estrecha Solar Community in Medellín, Colombia.

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

In energy communities, individuals come together, organise, and cooperate to implement activities in the energy sector, including generation, storage, demand-management, and distribution. Energy communities typically involve collective ownership and sharing of decentralised energy resources. In other words, citizens work together to manage and benefit from renewable energy resources rather than relying solely on traditional utility companies.

As models that place end-users at the centre of the transition, energy communities are gaining relevance as an innovative way of involving disadvantaged communities in a just energy transition. In those cases, the initiation, installation, financing, and operation will require significant intervention from external entities. These are top-down energy communities, in contrast to bottom-up or grassroots energy communities where the energy solution's ideation, financing, and deployment originate within the community.

This report aims to nourish the current discussion about the role of energy communities in a just energy transition and raise awareness of the potential risk of community washing, meaning using the "community" label to make an energy project more attractive or socially acceptable, but where people do not participate meaningfully. The report explores the implications of top-down energy communities based on a real case study: La Estrecha Solar Community, where a university and energy companies cooperated with local citizens to create Colombia's first energy community in a lower-middle-class neighbourhood in Medellín, Colombia.

La Estrecha Solar Community achieved to bring economic benefits to the local community, opened a space for participation and learning about the energy sector, and became the first on-grid energy community project in Colombia. However, significant barriers to these models were identified, such as the high investment costs, the complexity of the connection procedures and the lack of appropriate regulatory frameworks. The conclusion is that the La Estrecha community and most communities in Colombia cannot implement a solar community independently as bottom-up initiatives.

By discerning the features of bottom-up and top-down communities and reviewing the La Estrecha Solar Community case study, this report proposes two main challenges for policymakers: lowering the complexity of the legal and technical procedures and pass regulation to improve financial conditions to enable more citizens to create bottom-up energy communities and setting clear guidelines for top-down communities to prevent community washing.

The report is organised as follows: Section I defines how energy communities originated as grassroots, bottom-up models. Section II explains how energy communities are considered relevant tools to solve energy poverty and vehicles for including traditionally marginalised groups in a just energy transition. Section III explains a framework to distinguish bottom-up and top-down energy communities. Section IV provides a detailed description of the La Estrecha Solar Community. Section V discusses emerging risks and provides recommendations to avoid them.

1 ENERGY COMMUNITIES

Origins

The earliest energy communities were often small-scale hydropower projects in rural areas of Europe and North America in the late 19th and early 20th centuries. Local communities owned and operated these projects to meet their energy needs under the rationale that if the state can't bring us electricity, we will do it by ourselves. These community efforts became the main driver of electrification in remote areas. They often owned generation, distribution, and transmission assets, effectively becoming citizen-owned energy companies [1]. Even today, electrification in rural western Canada is mainly provided by rural electrification associations. In the United States, in 2021, citizen-owned utilities had over 13 GW of renewable installed capacity to provide to their members [2], besides having 42% of the country's distribution line miles and 5% of electricity sales [3].

By the 1970s and 1980s, with the oil crisis, the early environmental movement, and the advent of new technologies, new energy communities emerged, powered by biomass, solar, and wind energy, and driven by independence and sustainability motivations [1].

Definition

In recent years, energy communities have become increasingly important as solutions that prioritise end-users in the energy transition. Thanks to advancements in digitalisation and the growing affordability and efficiency of distributed energy technology, energy communities are now becoming viable for widespread implementation.

There is still no universally agreed-upon definition of energy communities. Instead, there are shared characteristics among activities, organisational structures, and how end-user groups can engage with new energy alternatives [4].

A common understanding is that energy communities are groups of citizens that actively cooperate to perform activities in the energy sector. The activities include generation, storage, demand management, and distribution, among others. These communities typically involve collective ownership and sharing of decentralised energy resources [1]. Citizens initiate energy communities for various motivations. Economic reasons include reduced electricity costs, more efficient consumption, and additional income sources. Environmental reasons stem from the desire to contribute to climate change mitigation and have more sustainable living spaces. And political reasons boil down to a wish for independence from traditional suppliers and the grid [5].

Energy communities' life cycle

There are many possible configurations on how citizens can implement activities as energy communities. The following flowchart, adapted from an Australian guide on community renewable energy projects [6], intends to give an overview of the main steps required for the constitution of an energy community. The energy community stages are grouped into two categories, the *Processes* necessary for establishing the community and the *Outcomes* where the benefits are materialised and distributed [7].

Processes

Initiation

A group comes together - Who initiates it? → Setting a goal - What needs are they trying to solve? → What is their primary motivation?

Social feasibility

Is there support from the community?

What types of skills or knowledge will be required? → **Stakeholder mapping:** network operators, regulators, overseeing institutions, asset distributors, local authorities, incumbent retailers, ITC suppliers, and third-party energy buyers.

Technical fesibility

Technical study: types of assets, location, regulatory requirements, legal form definition, energy model (collective self-consumption, community generator).

→ **Organisational structure:** decision-making, governance structure, meetings schedule, internal roles and responsibilities.

→ **Business model:** asset financing, buy-in for participants, revenue, savings, targeted payback period, and distribution of benefits.

→ Initial negotiations and agreements with key stakeholders.

Capital raising → Securing the funding for the implementation phase. → Where does the money come from? Who has ownership over the assets?

Implementation → Seek approval for required regulatory and administrative requirements. → Construction process → How are conflict, materialised risks or unexpected costs handled? → How do the participants engage with the project construction?

Outcomes

Operation → Technical, administrative, financial monitoring and maintenance. → How involved are participants in the operation and maintenance? → Is the distribution of benefits automated/standard, or does it require the attention and participation of the participants? → Are there communitarian objectives beyond collecting benefits?

Closure → End of the assets' lifespan or community dissolution. What long-lasting effects remain within the community?

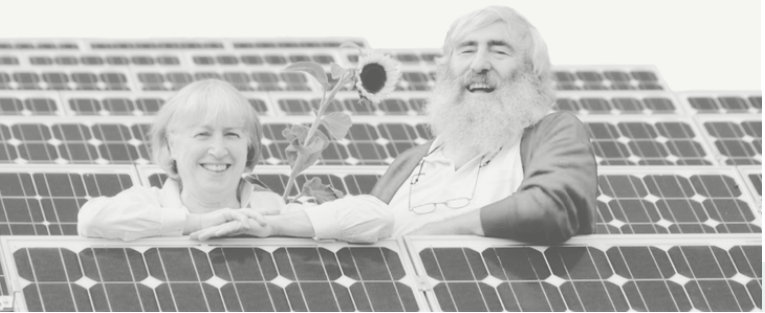
EWS:
the grassroots origin of Germany's solar capital 11

After the Chernobyl nuclear disaster in the late 1980s, Ursula Sladek, a schoolteacher and her husband, Dr Michael Sladek, a physician, started a community-based struggle for Germany's energy transition. From their rural town of Schönau, the Sladeks began a grassroots movement that would become the most important energy cooperative in the country and an influential driver for the German *Energiewende*.

The Sladeks championed a collective effort to transition away from nuclear energy and towards renewable sources. They started with an energy efficiency campaign to reduce community consumption and reliance on the traditional grid. Then, they began to develop local and community-initiated renewable energy projects and established the cooperative EWS - Elektrizitätswerke Schönau - Power Company Schönau in 1994.

As they gained momentum and national recognition, funding and expert volunteers started to pitch in to help EWS achieve their independent and citizen-driven revolution to a clean energy future. In this case, through collective action, regular citizens acquired the means to navigate the complexity of the energy sector. Eventually, they earned the right to operate the local electric grid and supply its members with renewable energy. EWS, driven by strong environmental and "local patriotism" motivations, became the world's first "democratically legitimated" energy company [8].

Today, EWS is collectively owned by 6,500 members and produces and distributes renewable energy to 185,000 customers nationwide. Schönau has become the town with the country's densest presence of PV systems. Germany's solar capital is driven and owned by its local community [8].



Ursula and Dr Michael Sladek, co-founders of EWS Schönau
Source: Electricity Works Schönau (EWS).

Current situation

Energy communities range from small-scale solar plants to larger-scale microgrids, wind farms, district heating networks, virtual power plants, peer-to-peer exchanges, and large regional or nationwide organisations, many of them in the legal form of cooperatives. The number of energy communities that exist today is undoubtedly multiplying.

According to the European Commission, there were over

3,500

energy communities

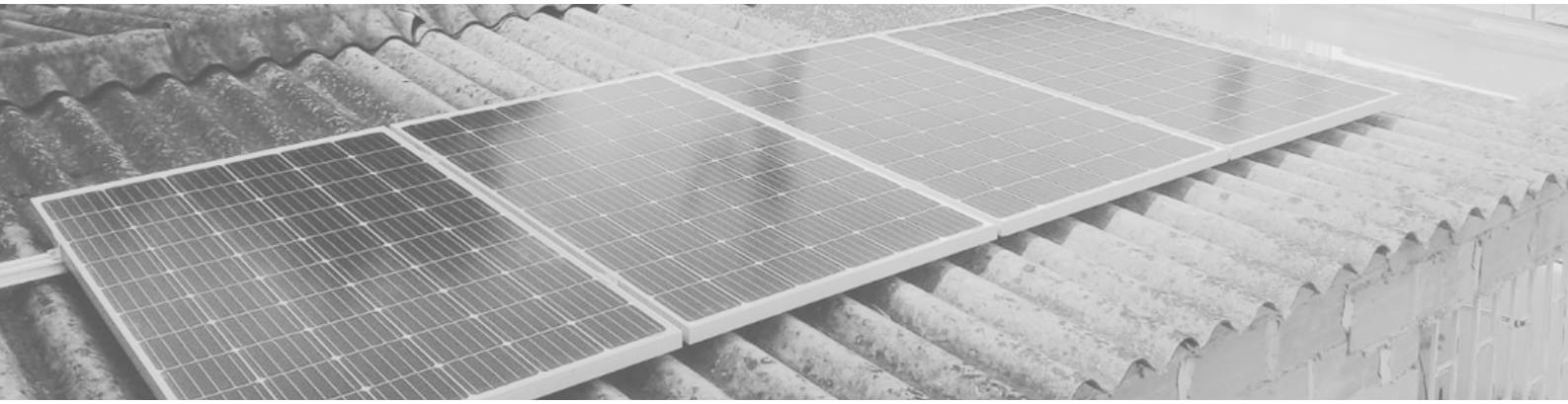
in the European Union by 2020.

European countries, particularly Germany and Denmark, have had a long tradition of cooperativism, and energy communities have operated successfully for decades. In 2019, the European Commission created forward-looking legal directives for formally defining and encouraging the participation of energy communities in the European energy sector[1]. The framework described two energy community figures: Renewable Energy Communities and Citizen Energy Communities. Both intend to promote citizen participation in the energy transition by generating, consuming, sharing, or selling electricity and through flexibility services such as demand-response and storage.

In the UK, community energy projects focus on local engagement, local leadership, and collective benefits. Between 2010 and 2015, community energy initiatives were motivated by government subsidies, such as feed-in tariffs and renewable heating incentives. Also, communities received support from funds and intermediaries to invest in assets, causing the creation of at least 5,000 community groups in the first five years [9].

On the other hand, local, neighbourhood-based solar communities are becoming increasingly popular in the United States. In these models, participants invest in PV systems through subscriptions and receive the benefits as savings or energy credits. As of 2020, there were 811 projects across the country, most of them concentrated in states with supportive legislation, such as Minnesota and Massachusetts. Supportive regulation facilitated the adoption of energy communities, usually with a market-based approach, where incumbent companies are incentivised to engage with new businesses to develop community projects [3].

1. Revised Renewable energy directive (2018/2001/EU) RES II and Directive on Common Rules for the internal electricity market ((EU) 2019/944) IMED.



Finally, local and regional governments in Australia are supporting community-owned renewable energy projects, defined as projects where a community *"is involved in initiating, developing, operating and benefiting from a renewable energy installation"* [6]. In 2009, there were three projects, increasing to 45 in 2014, and currently, they are over 130 community energy groups across the country [10].

The previous descriptions of the origin of energy communities and how they are understood today shed light on specific characteristics and contexts promoting their creation. To summarise, a traditional energy community is "entirely driven and carried through by a group of local people and which brings collective benefits to the local community (however that might be defined) —a project that is both by and for local people" [7].

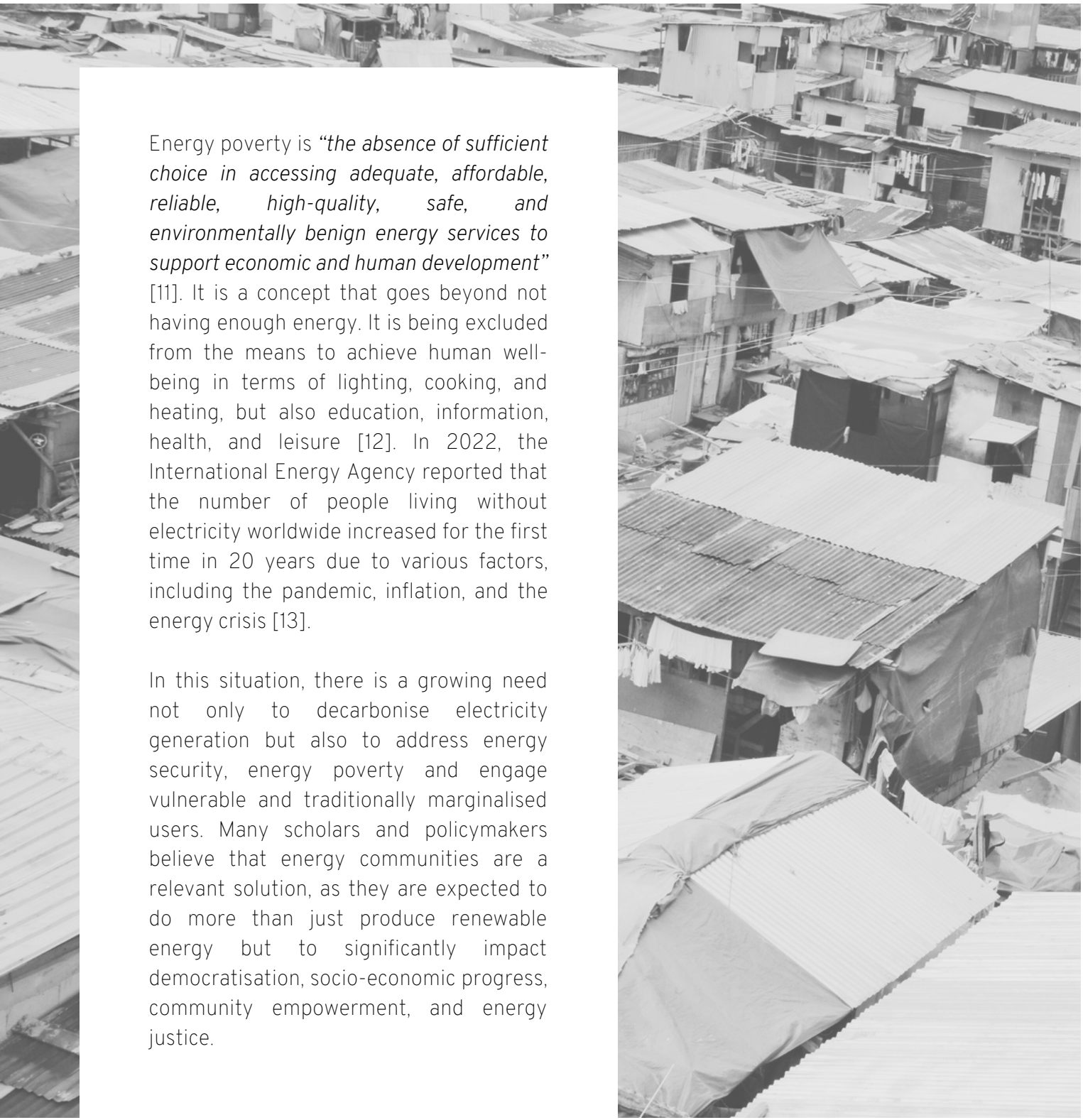
What is missing?

As we understand them so far, energy communities are bottom-up institutions that rely on their members' knowledge, motivation, and financial contributions (or capacity to access funding) for their development.

At this point, critical questions arise. What about citizens who lack access to knowledge and economic resources? What about citizens with pressing living needs preventing them from devoting time or being intrinsically motivated to participate in community action? How can energy communities play a part in a just energy transition by engaging with vulnerable and marginalised groups? How does the traditional bottom-up idea of energy communities need to change for that? Is this scheme feasible in the Global South, where the financial and education conditions are very different to those in industrialized countries?

In the following section, these issues are explored further and shed light on the potential of energy communities in addressing the issue of energy poverty.

2 ENERGY COMMUNITIES
FOR A JUST TRANSITION



Energy poverty is *"the absence of sufficient choice in accessing adequate, affordable, reliable, high-quality, safe, and environmentally benign energy services to support economic and human development"* [11]. It is a concept that goes beyond not having enough energy. It is being excluded from the means to achieve human well-being in terms of lighting, cooking, and heating, but also education, information, health, and leisure [12]. In 2022, the International Energy Agency reported that the number of people living without electricity worldwide increased for the first time in 20 years due to various factors, including the pandemic, inflation, and the energy crisis [13].

In this situation, there is a growing need not only to decarbonise electricity generation but also to address energy security, energy poverty and engage vulnerable and traditionally marginalised users. Many scholars and policymakers believe that energy communities are a relevant solution, as they are expected to do more than just produce renewable energy but to significantly impact democratisation, socio-economic progress, community empowerment, and energy justice.

As energy communities gain recognition as a potent vehicle for a just energy transition, it becomes crucial to grasp the meaning of energy justice and how energy communities could contribute to it. A helpful approach is to start with the three central energy justice tenets[2]:

Three central energy justice tenets

Distributional justice

Procedural justice

Recognition justice

Distributional justice

Ensures that the benefits, costs, and risks associated with the energy value chain are distributed fairly. These benefits can be direct, such as access to reliable and affordable clean energy, and indirect, such as creating new jobs and improving living conditions. On the other hand, there is the equitable distribution of system costs and the protection of groups affected by the installation or decommissioning of energy infrastructure. Ultimately, distributional justice aims to rectify unjust outcomes resulting from the energy value chain.

In terms of distributional justice, energy communities have the potential to:

- Improve energy access.
- Increase the amount of renewable energy (electricity and heat) available.
- Reduce household energy costs, e.g., via self-consumption.
- Educate households about energy efficiency.
- Provide additional sources of income and building up funds to tackle other forms of poverty.
- Create local economic progress, local skill development, and job creation.
- Promote built environment improvement.

2. We built the energy justice diagram based on the work of Kirsten Jenkins [31] and Benjamin Sovacool [32] on Energy justice. And the work of Caramizaru [5], Cuenca [4], and Hanke [33] on energy communities for just transitions.

The three central energy justice tenets

Procedural justice

Ensures that decision-making processes leading to system outcomes are non-discriminatory and democratic. This involves promoting inclusive participation in the planning, implementation, and operation activities. The main objective of procedural justice is to ensure that fair and inclusive processes occur throughout the system's activities.

For procedural justice, energy communities can:

- Strengthen citizen participation and democratic processes.
- Increase social capital, community empowerment and cohesion.
- Contribute to stronger climate action and community resiliency.
- Improve equality in access to local ownership, governance, and decision-making.
- Provide better access to educational and training spaces.
- Increase political mobilisation.

Recognition justice

Focuses on identifying and acknowledging groups of people who have historically been disenfranchised or are likely to face prejudice and bias. This involves unveiling and recognising these groups and ensuring that they have the right to express their opinions and participate in the system's processes. The goal of recognition justice is to identify those who have been left behind and ensure they are included in the system's activities.

For recognition justice, energy communities can:

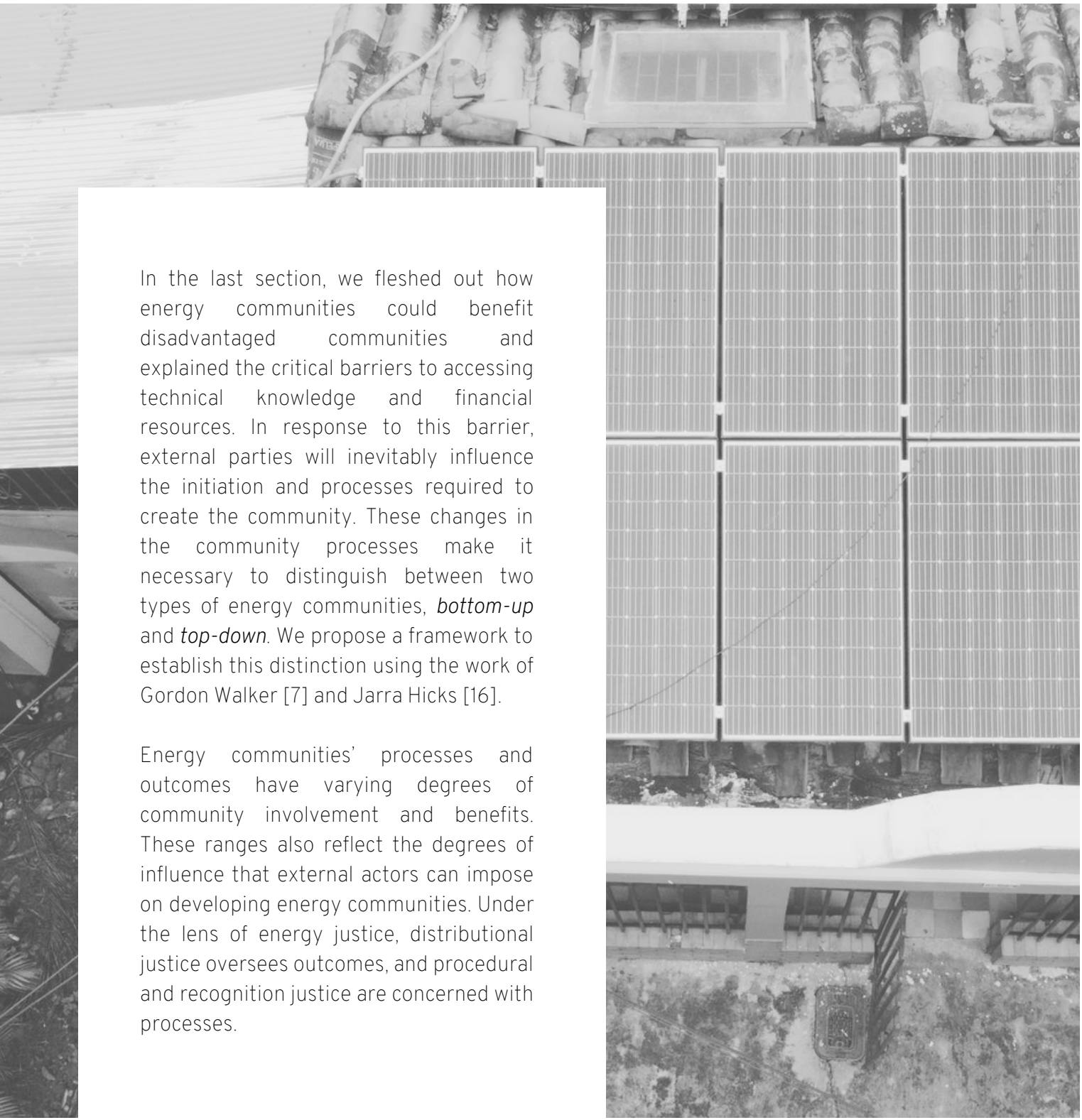
- Provide a space for acknowledging and including individuals with different backgrounds and socio-economic characteristics.
- Promote diversity and inclusion of traditionally marginalised groups and define targeted participation mechanisms.

Despite these numerous benefits that energy communities could bring to vulnerable users, evidence of how these benefits could materialise in practice is scarce. In reality, vulnerable groups often do not have the necessary knowledge, access to information, and, more importantly, the financial resources to initiate or invest in an energy community project [14].

Developing an energy community implies high upfront investments for power installations, equipment, materials, and expert labour costs. Low-income households have limited financial resources and do not qualify for traditional financing options. Hence, a significant financial barrier exists for low-income citizens to participate in or lead energy communities [15]. Disadvantaged households often lack technical knowledge, shy away from taking financial risks and have multiple priorities that leave them with little time for volunteering in community activities [14]. The socio-economic reality of low-income households creates an insurmountable barrier for energy communities to emerge spontaneously as grassroots associations.

Therefore, low-income citizen groups will need external support to finance and establish energy communities. Here, a crucial tension arises between the goal of promoting vulnerable citizens' participation and the purist concept of grassroots energy communities by and for citizens with community ownership and community decision-making. This tension calls for distinguishing between the traditional bottom-up concept and rethinking energy communities in their top-down relationship with external sponsors.

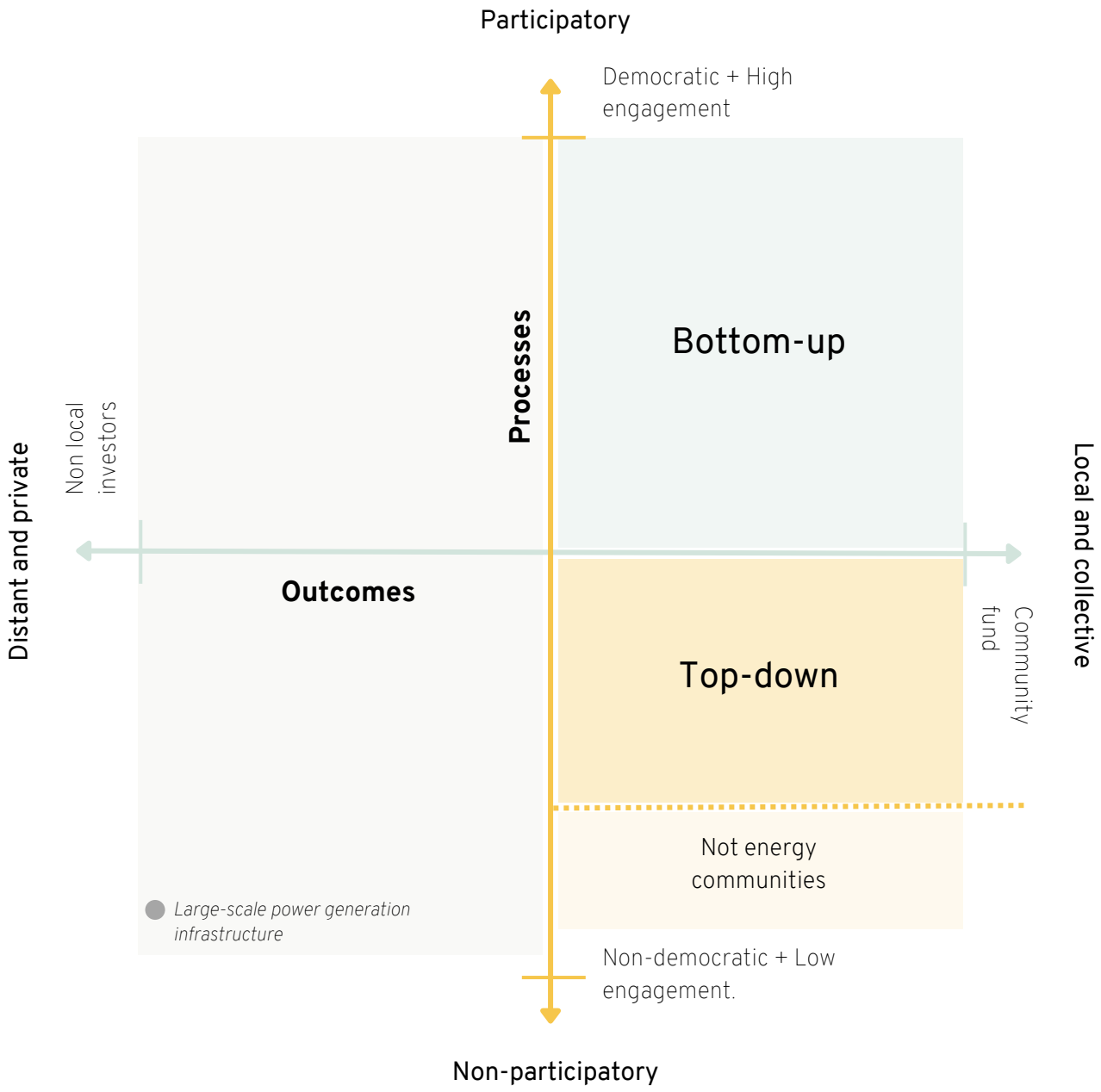
3 BOTTOM-UP VS TOP-DOWN ENERGY COMMUNITIES.



In the last section, we fleshed out how energy communities could benefit disadvantaged communities and explained the critical barriers to accessing technical knowledge and financial resources. In response to this barrier, external parties will inevitably influence the initiation and processes required to create the community. These changes in the community processes make it necessary to distinguish between two types of energy communities, *bottom-up* and *top-down*. We propose a framework to establish this distinction using the work of Gordon Walker [7] and Jarra Hicks [16].

Energy communities' processes and outcomes have varying degrees of community involvement and benefits. These ranges also reflect the degrees of influence that external actors can impose on developing energy communities. Under the lens of energy justice, distributional justice oversees outcomes, and procedural and recognition justice are concerned with processes.

In the Processes vs Outcomes graph, the x-axis represents the *Outcomes* spectrum indicating who benefits from the actual outcomes of the energy community. Outcomes can be local and collective as a community fund devoted to communal purposes. In contrast, as external entities get involved in the community models, there may be a shift towards a more market-based benefit allocation, causing the outcome axis to move towards a private and distant outcomes distribution.



The y-axis represents the *Processes* spectrum. It is related to the type of actors involved in the community, the decision-making mechanisms, and their level of engagement. The shift from participatory to non-participatory processes occurs when external actors get involved in the community, assume decision-making power, and reduce participants' engagement levels. External actors may vary from local governments, NGOs, local utility companies, grid operators, technology companies, national governments, and international companies.

Traditional large-scale generation projects, such as large hydropower plants and wind farms are on the bottom-left quadrant. They have distant and private benefits, and they are developed mainly through centralised and non-participatory processes.

Bottom-up energy communities are grassroots citizen movements that initiate and fund the shared energy solution by themselves, as explained thoroughly in Section I. They are generally led directly by citizens, without substantial intervention from external parties, and the outcomes are intended to stay and benefit the local community. Bottom-up communities are mainly on the upper-right quadrant of the Processes-Outcomes graph.

In contrast, *top-down* energy communities are initiated by external institutions or companies and are extensively funded by third parties resources such as development banks or government funds [17]. These energy communities may be motivated by a welfare purpose to tackle energy poverty and bring development to rural areas or vulnerable neighbourhoods. In these cases, the external entities' motivation will be to benefit the local population, but a critical difference arises with bottom-up communities regarding the processes' axis.

Top-down communities are in the bottom-right quadrant of the Processes-Outcomes graph. The benefits remain towards the local and collective, but the processes and decision-making shift to the hands of external entities, hindering community engagement and decision-making. Top-down communities challenge the concept of energy communities because it is unclear whether social development and just transitions can be achieved while maintaining meaningful community involvement, which is crucial in traditional bottom-up communities. As community models move further down the Processes axis towards non-participatory processes, they may stop being energy communities entirely. Such models are distributed energy solutions that service a vulnerable community, but they do not involve any collective engagement or bring indirect community cohesion benefits.

Third-party non-financial motivations to fund energy communities.

Stakeholder	Motivation
Grid operators	Tackle illegal power connections; Improve non-payment rates; Local balancing.
Energy retailer companies	Tackle illegal connections and improve non-payment rates; Enhance the relationship with customers.
Local government	Empowering communities, safer neighbourhoods, education, and job creation.
National government	Contribution to the Paris Agreement and the Sustainable Development Goals (SDGs).
Local and national banks	Increasing the share of the population holding bank accounts; New clients for micro-financing.
International financial institutions	Financing local sustainable development projects.
Private companies	Contribution to Corporate Social Responsibility goals, public relationships, and green marketing.
Academia	Access to information; Intersectoral collaboration; Local knowledge and research.

The following section describes a top-down energy community in Medellín, Colombia, to illustrate this tension further. In this case study, project sponsors, working closely with residents and community leaders, built the first energy community in the country, bringing benefits to the local participants and testing energy communities in the Colombian context.

4 LA ESTRECHA
SOLAR COMMUNITY IN MEDELLÍN, COLOMBIA.

Colombia's electricity comes mainly from hydropower plants, making it vulnerable to drought seasons intensified by climate change. Recently, the country has taken concrete steps towards diversifying its energy mix, introducing non-conventional renewable sources (wind and solar), and modernising its electricity sector. Key milestones in Colombia's energy transition include two national laws promoting investment in non-conventional renewable energies, auctions for renewable energy projects, goals for advanced metering infrastructure, and net balance mechanisms for large and small-scale self-consumption. This progress manifests in the increase from 1% in 2019 to an expected 12% in 2023 of wind and solar generation capacity [18] and going from 0 small-scale prosumers in 2018 to over 3,500 by 2022 [19]. In addition, the current government aims to build a roadmap for a Just Energy Transition [20] to include civil society, academia, and local communities in the sector's decision-making.

In this context, where industry–academia–government cooperation is essential to draw implementation paths for new energy models, Transactive Energy Colombia[3] was created to contribute to the knowledge gap of user-centred renewable energy systems.

In 2020, Transactive Energy Colombia started a pilot project to build the country's first solar community to produce empirical evidence on energy communities in Colombia. The pilot set out to test how to establish an energy community under the current regulatory conditions. The project's premise was to involve everyday low-to-middle-income citizens that do not have access to renewable energy resources. The main design principle of the solar community in Medellín was that energy communities in the Colombian context must also address socio-economic imperatives.

Initiation

Medellín is Colombia's second city, with 2.4 million inhabitants, and it is in the centre of the Aburrá Valley, a metropolitan area of 4.3 million inhabitants distributed across ten municipalities. El Salvador neighbourhood is perched on the valley's eastern hill, overlooking Medellín's downtown. It comprises around 4,000 households of primarily lower-middle-class families [21].

A main reason for choosing this neighbourhood was the connection to Rodrigo, a lifetime resident of El Salvador. Rodrigo participated in a previous Transactive Energy Colombia pilot where they simulated a peer-to-peer energy exchange with different prosumer types across the city [22]. In that pilot, a small PV system was installed on his rooftop, which caught much of his neighbour's attention. Rodrigo lives on a block everyone knows as *La Estrecha* (the narrow one); a dead-end road surrounded by multifamily houses facing each other.

La Estrecha did not have a formal community structure or a specific leader, but they have gathered before around community efforts to improve their block, like implementing CCTV for security. Rodrigo is a natural leader and well-known to his neighbours. He assumed the role of community leader, connecting the project developers with the residents and spreading the idea of creating the solar community. Rodrigo knew the benefits of PV systems and had perceived the savings in his pocket for many months. Motivated by his positive experience, he was pleased to spread the word to other families of La Estrecha so they could also benefit.

3. Transactive Energy Colombia - https://www.transactive-energy.co/ is an initiative by EnergEIA research group at EIA University in Medellín, Colombia.

Motivations and roles of project partners

Partner	Description	Motivations	Role
Transactive Energy Colombia – EIA University	Local academic institution	*Produce evidence for scaling energy communities in Colombia	*Project lead *Community interaction *Research, educational strategies, and result analysis
EPM - Empresas Públicas de Medellín[4] - Local utility company	Grid operator and incumbent energy retailer Local funder	*Improve relationships with customers *Explore new possible business models and value proposals *Corporate social responsibility	*Provide funding for assets *Grid operator and energy buyer *Advice on grid requirements and legal connection procedures
NEU	Technology company and digital energy retailer	*Test technology, UX/UI, smart metering management, and tokenisation *Explore new possible business models and value proposals	*Energy retailer for the users *ICT support: digital platform to monitor consumption and energy generation *Distribute economic benefits through tokens
ERCO	Distributed energy resources installer and power generation company	*Possible new market opportunities *Explore new possible business models and value proposals	*Design, installation, operation, and maintenance of the PV systems *Enable the electricity sale in the wholesale energy market
UCL - University College London	International academic institution	*Learn from new contexts *Create new research collaborations and outreach	*Provide advice on research and methodological aspects
UK Royal Academy of Engineering	International funder	*Promote sustainable development and collaboration with partner countries	*Provide funding for project management and research

4. It is important to note that EPM is the main shareholder of ERCO and NEU. This facilitated collaboration across different companies.

Social feasibility

With Rodrigo's help, all residents of La Estrecha were invited to the first gatherings, where the project developers explained what a solar community is and the benefits and responsibilities they would acquire if they decided to participate. After the initiation phase, twenty-four households agreed to join the pilot.

Participants joined mainly motivated by potential savings on their energy bills. They were also attracted by the fact that La Estrecha would become the first energy community in the country, and they would be a pioneer community. Other benefits included the installation of a smart meter, access to a digital application to monitor their consumption, and participation in workshops on energy-related issues.

Solar community offer

What will you get?

Savings on your energy bill, a smart energy meter, educational workshops on energy topics and being part of the first solar community in Colombia.

What do you need to do?

Sign a consent form, participate in meetings and decision-making, switch energy retailers, and support the energy equipment' installation (i.e., lend your rooftop for the PV installation, and allow technical visits).

La Estrecha Solar Community participants

95% of households are single-family, and 5% are multi-family.

45% of participants are between 27-54 years old, and 28% are over 55.

Households are classified in socio-economic stratum[5] three, representing a low-medium income level where users receive a 15% subsidy on their electricity bill.

21% of community members only have a primary school degree, 28% have a high school degree, 36% have a professional degree, 2% have a postgraduate degree, and the remaining 13% did not provide information.

51% of the individual community members contribute to their household economic income.

90% of families have lived there for over five years, and 95% are homeowners.

5. In Colombia, the government classifies city sectors depending on their wealth levels from one (lowest) to six (highest). Based on this socioeconomic-strata system, electricity users must pay a tax or receive a subsidy on their electricity bills.

Educational and engagement strategy

An educational and engagement strategy was developed for the planning, implementation, and operation phases. The strategy aimed to increase community knowledge on energy issues and create frequent discussion spaces for decision-making, answering questions, asking advice, and reporting on the project's progress. These workshops are the most relevant and direct engagement spaces where the community participates in the project.

The monthly workshops included topics such as climate change, energy transition, energy systems, interpreting the electricity bill, how electricity tariffs work, and why they were increasing (in the context of inflation and the energy crisis in 2022). Workshops also included an essential technological component where users learned how to use the NEU app to understand their consumption and how it relates to their behaviour. Additionally, the workshops included energy communities, their global development, and their importance in the Colombian context.

Technical feasibility

Connection to the grid

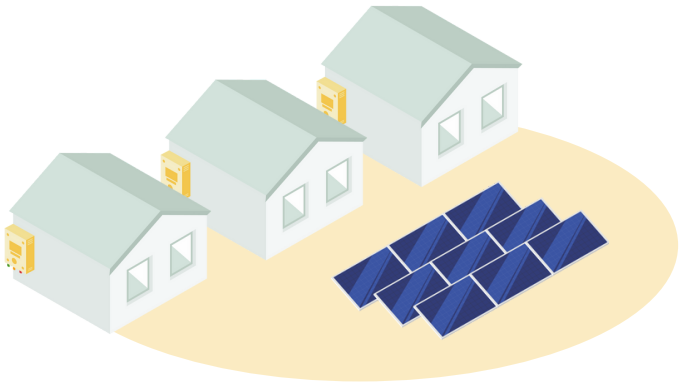
In Colombia, there are two legal ways in which small-scale distributed generation can connect to the grid [23].

Small-scale self-generators

Are individual users that self-consume first and then sell the surpluses back to the grid under a net-billing mechanism.

Distributed generators

Are standalone power generators (up to 1 MW) near energy consumption sites. Distributed generators feed all the electricity to the grid at wholesale market price. Distributed generation is only allowed for registered public utilities companies and is subject to the same regulations as large-scale generators.



Self-generators

- They produce energy to meet households needs (self consumption) and can sell surplus to the grid.
- Net billing scheme.
- It can be any user of the electrical grid (residential, industrial, commercial users).

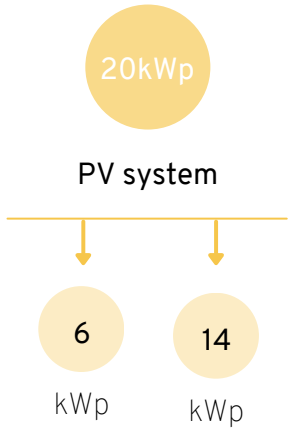
Distributed generator

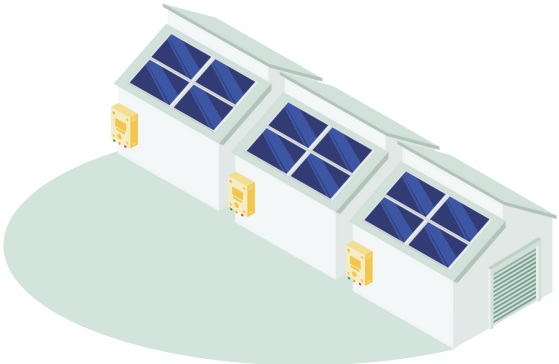
- They deliver all the energy generation to the grid and are close to the places of consumption.
- Its installed capacity must be less than or equal to 1 MW.
- Must be represented by a utility company.

In Colombia, collective self-consumption or aggregated generation and consumption at the residential level are not allowed. The small-scale self-generator connection is inadequate for a community because it is, by definition, for single prosumers. Consequently, Distributed generation was the only possible connection mode for the community.

Installed capacity

A 20 kWp PV system was designed for the community. The primary scaling criteria were budget constraints and the physical conditions of the community's rooftops. The 20 kWp was divided into two 6 and 14 kWp systems installed on three rooftops. No batteries were considered.





Legal form

The option of constituting La Estrecha as a public utilities company to fulfil the *Distributed generators* requirement was discarded. It was not feasible for the community to establish this legal form, navigate the complexity of the procedures or assume the hefty legal responsibilities. As a solution, ERCO registered the distributed generators to represent the community members. Until today, community members do not have a legal entity type.

Energy model

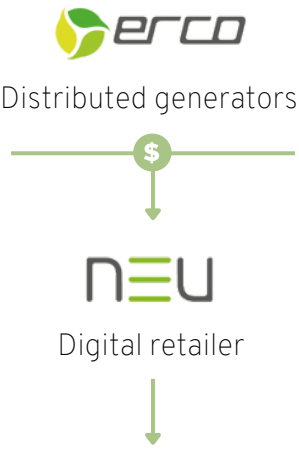
Selling the energy

100% of electricity is injected into the grid. ERCO represents the distributed generators and sells the electricity to EPM (integrated retailer and grid operator) at wholesale market price (around 30% of the retail price users usually pay).

Tokenising and sharing energy profits

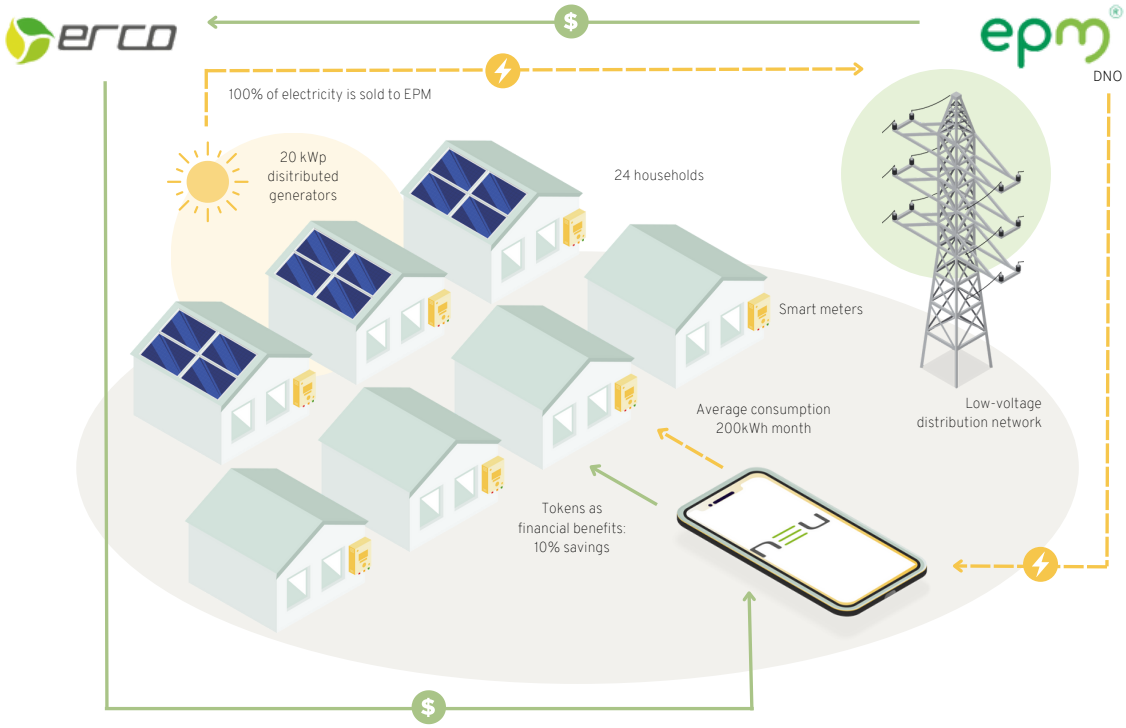
ERCO transfers the money to NEU, the digital retailer, who transforms it into tokens and disburses them into each member's account. Then, the participants can use these tokens to pay their energy bills. The community members agreed to move to NEU as their new energy retailer to gain access to the digital platform and receive the energy tokens.

Tokenisation was necessary to transfer profits to users while complying with regulations. Transferring cash to customers is complicated due to administrative and accounting limitations. In contrast, using tokens enables a seamless transfer of benefits framed in an existing customer loyalty scheme.



It is essential to highlight that there is no self-consumption in this energy model. Each household consumes energy from the grid and receives a discount on their energy bills according to the distributed generator sales. However, this model allows users to obtain direct economic benefits from energy systems functioning in their own block. 100% of the profits go directly to each household in the form of tokens. The distributed generators are expected to produce approximately 2100 kWh/month, approximately 40% of their energy consumption, but that represents only a 10% reduction on each household's monthly energy bill.

Operation diagram



Organisational structure

EIA University is the project lead. The project partners, EIA, EPM, NEU and ERCO, hold weekly meetings to discuss technical and legal issues. Decision-making was optimised to ensure technical viability to get the community operating as soon as possible and seek the highest benefits for the community.

Community members do not participate in the internal technical and project management discussions. However, the participants are the centre of the monthly engagement workshops, where the project developers report and put into discussion relevant information regarding the project, technical decisions, progress, difficulties, and decision-making involving the community. A WhatsApp group is the main communication channel between the project partners and the community members.

For instance, the technicians had to set up an electrical enclosure (electrical equipment relatively large that had to be installed somewhere in the public space) during the PV system installation. The community had to determine a place to install it, which was critical for connecting the distributed generator to the grid. The subject was dealt with in one of the monthly meetings, where technical experts discussed with the community possible locations and finally arranged where to install it.

Capital raising

Costs were covered 100% by external funding, including the PV assets, designing, planning, project management, labour, workshops, and educational strategy. Most of the funds, covering project management and research costs, came from an international research grant by the UK's Royal Academy of Engineering *(7)*. EPM covered the PV system installation costs (30% of the total project budget). It is important to note that the energy assets remained EPM's property. Additionally, EPM, NEU, and ERCO contributed with in-kind labour time.

The community participants did not make financial contributions to participate.

Implementation

In November 2021, ERCO installed the two photovoltaic systems on La Estrecha's rooftops, but the first kWh was injected into the grid only in March 2023. For 16 months the PV system was turned off as we dealt with the legal connection procedures.

La Estrecha community had the first Distributed generators (legal connection form explained earlier) in the country. The novelty implied challenges regarding legalising the connection because none of the involved institutions, including the relevant authorities, had standardised procedures for this type of connection. Regulations had to be interpreted and translated into concise steps within and among the companies. The process required multiple verifications from external companies and authorities, and the distributed generators had to be officially registered in Colombia's wholesale energy market. Institutional inexperience, the inherent complexity and long delays caused the community to remain on standby for over a year.

The delays affected the relationship with the community because the benefits did not timely as expected. During this standby time, the communication channels and the monthly meetings were critical to calming concerns, sharing progress, and keeping the participants engaged and motivated.

(7) UK Royal Academy of Engineering Grant: Transforming Systems through Partnership (TSP) programme grant in 2020. The project: TSP1171 - Community Solar Energy: ownership, co-governance and development of peer-to-peer and community self-consumption energy trading models in Medellin, Colombia

Operation

As of March 2023, the distributed generators in La Estrecha are the first of their kind and the only ones injecting renewable energy into the grid in Colombia. The project is now 100% operational, and the community members will start collecting their first discount tokens.

During the operation, community members' savings, interactions and behaviour will be monitored to assess the energy community outcomes. The monthly engagement sessions will continue, focusing on the benefits, exploring ideas about what community purposes might be fulfilled, and, especially, preparing for the inevitable handover and closure of the external parties' involvement.

Closure

After some months of active operation, the project is expected to finish, and the solar community must be either dismantled or transferred to the participants. The project partners strive for the latter, as a way to consolidate the project and transcend from merely a pilot. However, there are many challenges in transferring the assets (and the responsibility to operate them) to the community, mainly because of the public nature of EPM and not creating an economic or legal burden to the community. Nonetheless, after almost two years of constant engagement, there has been an improvement in the community's knowledge and commitment to the project. In that sense, the project developers hope they can find a solution for La Estrecha to become a self-reliant solar community sustainable over time.

Key takeaways – challenges and impact

La Estrecha Solar Community pilot is a top-down project where a university and energy companies cooperate with local citizens to create a solar community model. The process required coordinated efforts across disciplines and navigating complex and restrictive regulations.

Critical barriers to the deployment of these energy communities are:

- High investment costs for energy assets and expert labour.
- The complexity of the connection to the grid procedures.
- Lack of appropriate regulatory figures on collective self-consumption.
- Legal prerequisite of being a public utilities company to set up distributed generators.
- Lack of incentives or institutional support to motivate communities to develop this type of scheme.

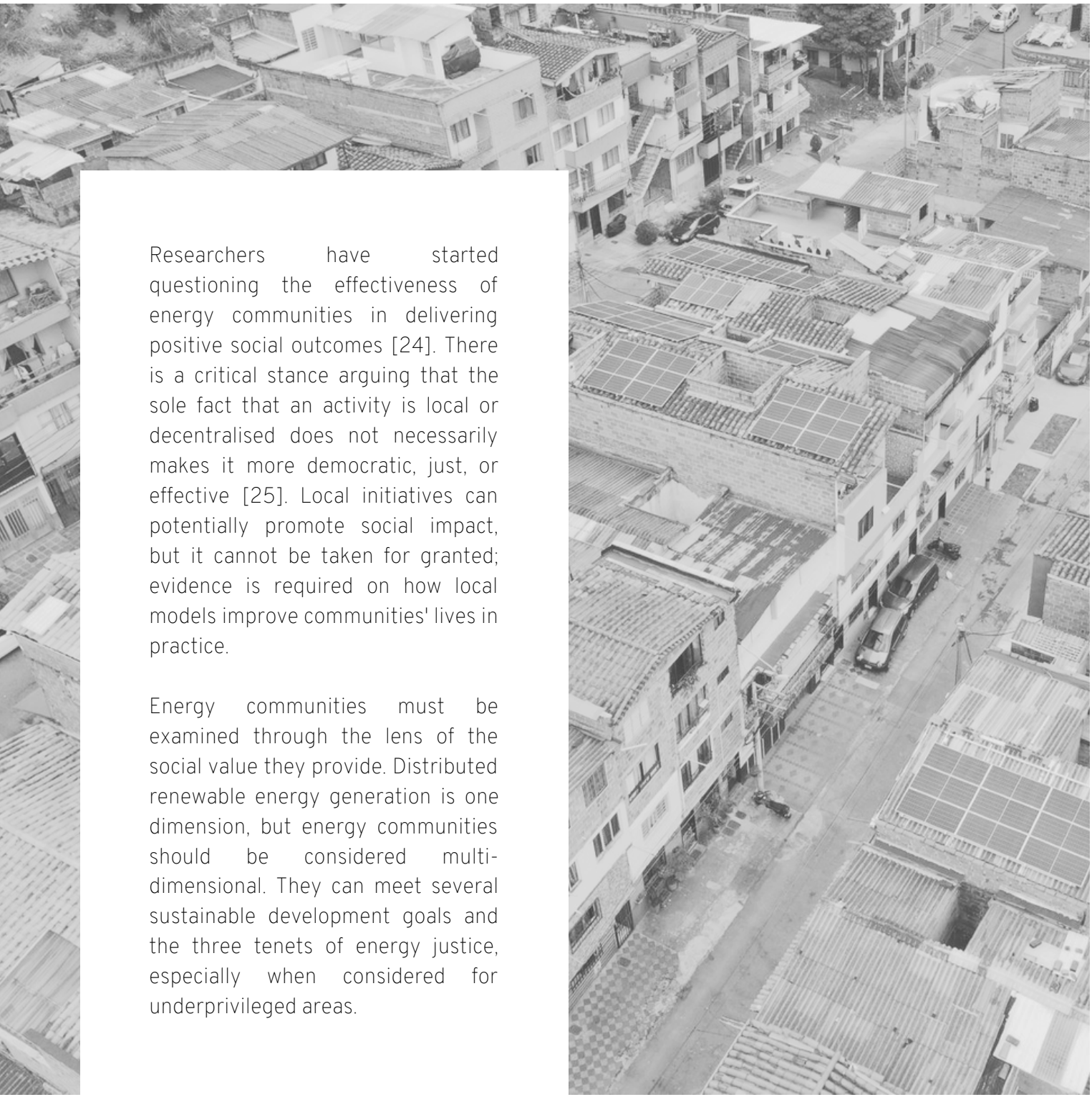
These barriers led to a situation where the community's participation, autonomy and decision-making were limited, and the implementation relied on expert intermediaries.

The main conclusion is that La Estrecha community (and practically any other community in the country) would not have been able to implement a solar community by itself.

The research pilot fulfilled the objective of setting up an energy community with lower-middle-class citizens and identifying crucial challenges and opportunities.

- Bring economic benefits to the local community.
- Open an inclusive space for participation and learning about the energy sector.
- Build solid evidence on barriers and limitations to energy communities in Colombia.
- Present findings to the government to promote policy and regulatory changes.
- Become the first energy community project in Colombia.

5 DISCUSSION



Researchers have started questioning the effectiveness of energy communities in delivering positive social outcomes [24]. There is a critical stance arguing that the sole fact that an activity is local or decentralised does not necessarily makes it more democratic, just, or effective [25]. Local initiatives can potentially promote social impact, but it cannot be taken for granted; evidence is required on how local models improve communities' lives in practice.

Energy communities must be examined through the lens of the social value they provide. Distributed renewable energy generation is one dimension, but energy communities should be considered multi-dimensional. They can meet several sustainable development goals and the three tenets of energy justice, especially when considered for underprivileged areas.

In those contexts, it is unlikely that individuals with high levels of poverty and social exclusion can pool efforts and participate in energy communities without substantial external assistance [26]. Therefore, these highly influenced top-down energy communities fundamentally differ from the traditional bottom-up concept. Top-down communities require special attention to address the tensions between external sponsors and community autonomy and participation. If unattended, these tensions could end up in *community washing*, namely, project sponsors installing distributed energy solutions and referring to this as an energy community without involving the community in any meaningful way.

What is community washing?

Community washing means using the "community" label to make an energy project more attractive or socially acceptable while maintaining complete centralised control and decision-making and without providing meaningful social value and community participation.

The authors do not disregard the relevance of external support for developing energy communities, but are raising awareness about the risk of them not fulfilling their true potential. Top-down energy communities will have a role in the fundamental paradigm shift required for a just transition. They can create more horizontal and participatory processes between sponsors and the local groups they are trying to support, avoiding paternalism, and taping into an immense opportunity for synergistic effects in education, resiliency, and socio-economic development.

Nonetheless, these energy solutions must stand the test of the three energy justice tenets to be considered energy communities. Beyond guaranteeing that the communities will profit either from energy access or financial gains, procedural and recognition aspects must come into the picture to ensure that the community tag is earned, and it is fulfilling its aims. In that sense, La Estrecha's case is an useful example of the challenges of avoiding community washing and integrating strategies for community involvement and development within a top-down community.

A critical view of La Estrecha Solar Community

Existing local leadership

La Estrecha's neighbours did not come up with the idea of having a solar community. External stakeholders chose La Estrecha and presented them with the opportunity to build a solar community. In contrast to the Sladeks in Schönau, who began their energy citizen movement with internal motivations and then gathered the necessary resources. In top-down communities, the initiation process is vital because it sets the tone of planning, implementation, and operation. Crucial questions must be asked during initiation: to whom does the energy community belong? Does it belong to the local citizens? Does it belong to the funders? Or to the project developers?

The external initiators of the community have the almost full decision-making power to shape how the community will be implemented and how it will operate. The external initiator may bring its own rules and beliefs, affecting who can participate and how the processes will be conducted [14]. In La Estrecha, Rodrigo's leadership was critical in mediating between the project sponsors and the community during the initiation phase. Through Rodrigo's knowledge and experience, a unilateral initiation process was prevented, and community members had a more active involvement. Collaborating with existing local leadership is crucial to create trust in the initiation phase of a top-down community.

The power of education

When approaching a community, there may be low interest and a lack of social networks, skills, and knowledge [25]. Community members probably won't know much about energy or their rights as energy users at the initiation stage. A top-down energy community must gradually empower local citizens through knowledge and skills development. Project sponsors must define an education and engagement strategy for distributing knowledge and, more importantly, open a space to learn from the participants and their unique context.

In La Estrecha, the education and engagement sessions started early, and they were consistent throughout the implementation, especially when the project was on pause, waiting for the connection approval. These sessions varied in topics and interactive methodologies. The workshops have been the central contact point of the participants with the energy community.

Even though the La Estrecha case study developed an educational strategy with concrete learning outcomes, it lacked a way of measuring the strategy's success other than the subjective observations of the external facilitators. Energy communities should define objective success indicators for educational strategies. On the other hand, La Estrecha's educational strategy was limited to knowledge sharing, discussions, and co-creation spaces. Energy communities should develop ways in which knowledge can transcend and become actionable skills for the community members that eventually could translate into job creation.

An example of education and engagement strategies is the Repowering London initiative in the UK. This project offers low-income households the opportunity to participate in energy communities. An integral part of the project is a comprehensive community engagement, education, and training programme. They developed a Youth Training Programme, a paid internship for young students learning about low-carbon and renewable technologies, energy efficiency, and community engagement. They also have a programme for primary school children to learn about energy and climate change [27].

The decision-making conundrum

In La Estrecha, the community members did not participate in the energy model design. Besides facilitating equipment installation in their houses, they had a passive involvement in all technical issues. Yet, there was not much to decide upon in the first place. Instead of being selected from different alternatives, the energy model was restricted by the only available regulatory option—Distributed generators.

In comparison, in European countries, there is a broad range of possibilities for energy communities, including co-ownership, sharing, and trading energy or demand response and policy support mechanisms like feed-in tariffs, virtual net-metering, remote self-consumption, and district heating associations, among others. Another example at the regional level is Brazil, where regulations allow conventional net-metering, but also virtual net-metering, remote self-consumption, condominium net-metering and community net-metering [28].

On the other hand, the location for the PV system was chosen based on structural safety and the size was determined by the project's budget constraints. In bottom-up communities, where capital is sourced from members or through debt providers, many factors are important for scaling energy assets. These variables include generation estimates, aggregated consumption, self-consumption goals, export prices, interest rates, and return on investment for community members [15]. In top-down communities, as external sponsors cover the totality or most of the costs, the community may be excluded from these considerations, as happened in La Estrecha.

The low decision-making power of community members in La Estrecha came from regulatory restrictions in the Colombian context and technical imperatives rather than an imposition or preference from the external stakeholders towards a specific energy model.

The fundamentally technical aspects of energy installations and businesses pose a critical question: in practice, how involved can a community be in installing distributed energy resources? There is a crucial need for equilibrium in decision-making power. Participants in top-down communities will not necessarily make decisions about purely technical aspects. Still, the external experts are responsible for conducting the planning and implementation process openly and transparently. Community decision-making should go towards using and allocating benefits for community purposes. They should also have a say in any technical aspects that involve their property or communal spaces, such as the location of the electrical enclosure in La Estrecha.

The financial barrier

Financial barriers such as high initial costs and insufficient financial incentives are critical for energy communities [29]. German energy cooperatives' average minimum buy-in price is 545€ per member [14]. This is more than twice the monthly minimum wage in Colombia, a considerable amount, especially for low and middle-income communities.

Surpassing the financial barriers is the main source of the distinction between the types of energy communities discussed in this article. Either community members in bottom-up communities can assume the costs because the market and regulatory conditions are suitable for a financially viable business model with a desirable return on investment and payback period. Or an external entity invests in distributed renewable energy to promote sustainable development in a top-down community.

In this sense, ownership becomes a contentious aspect for top-down energy communities. Is social ownership necessary for an energy community? A study on energy communities for off-grid areas in sub-Saharan Africa concluded that communities could not build and manage their own projects. Ownership remained in the hands of the government or "elitist groups" [30]. However, top-down energy communities need alternatives for co-ownership. In the case of La Estrecha, the assets are EPM's property, but, in practice, 100% of the generation remains in the community. If the participants from La Estrecha had self-financed the energy community, the 10% savings associated with the profits from the distributed generators would be insufficient to make the investment financially viable.

La Estrecha's model depended on the fact that EPM has no financial expectation on this investment other than the interest in deploying the pilot project. Hence, the benefits went to participants at no cost. Erco and NEU are also not charging the community for their services or platform use. It is relevant to note that, in this case, developing a top-down energy community does not provide a viable business model for the capital providers either. If top-down communities reach implementation on a larger scale, the companies developing the projects will require sufficient financial and non-financial (see third-party non-financial motivations to fund energy communities in Section III) incentives to build the communities. Policymakers should consider this aspect and adapt incentives for stakeholders to engage in top-down energy community projects. Examples of such incentives could be tax reductions or the eligibility of green certificates for the energy produced in these communities.

Another consideration is the range of transitions that may occur when and if the external sponsor transfers the assets to the community once it is prepared to assume operation and has the legal requirements to perform in the energy sector. Here, the issue of complexity is highly relevant. In the case of La Estrecha, if professional project developers from the Colombian energy sector struggled to set up the community, it is unlikely that a group of ordinary citizens could do it independently. It is worth noticing that being a pilot project, such struggles were expected and the learning curve will be less steep for next projects.

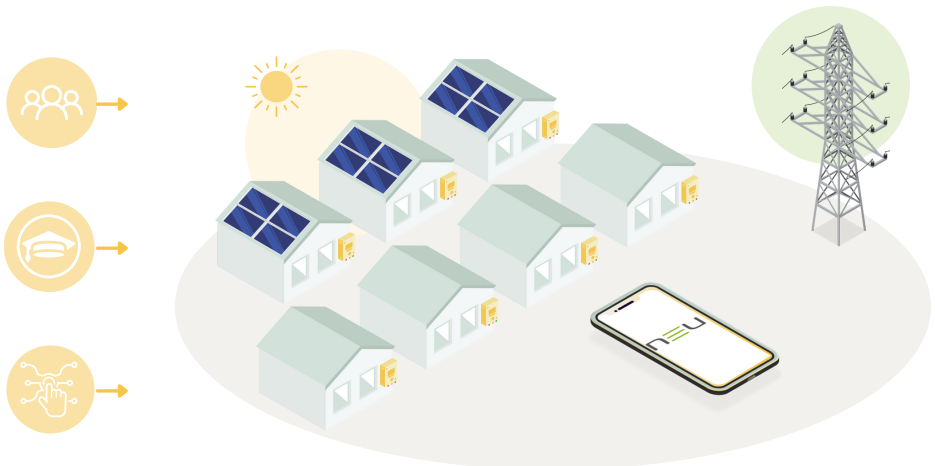
The challenge for policymakers

Distributed renewable energy solutions may be ideal for promoting decarbonisation, improving energy access, and tackling energy poverty. But the deployment of such assets is not sufficient to create energy communities. Energy communities are more; they go beyond electricity supply and attempt to achieve synergistic effects related to social impact, technology, and education.

Governments should define forward-looking support policies for adopting community energy schemes in their contexts. Policies should include guidelines and easy-to-understand checklists to support citizens in taking the first steps to implement the projects that best suit their circumstances. Further, an enabling policy framework for energy communities should determine its expected social impacts. In this sense, the challenge for policymakers is twofold:

I. Lower the complexity of the connection procedures and pass regulation to improve financial conditions to enable more citizens to create bottom-up energy communities.

- Create legal figures for community self-consumption, self-generation and community sharing/trading with simple grid connection, registration and legalization procedures and clear guidelines to support users.
- Public policy instruments should define attractive tariffs (close to the price at which users buy energy) that reflect the benefits that these projects generate for the electricity system.
- Access to external financing can increase the commitment of communities, and support schemes reduce financial risks. As seen in Europe, incentives such as energy subsidies, access to credit, low-interest or interest-free loans linked to membership, and education through coaching and training programs enhance community initiatives [24].



II. Set guidelines for top-down communities regarding how to effectively engage participants, promote social impact and prevent community washing.

Policymakers need to define the line separating top-down energy communities and not-communities-at-all in the Processes vs Outcomes graph, explained in Section 3. Policymakers must answer the question: How exactly is an energy community different from a traditional distributed energy solution?

How policymakers define energy communities will be critical for focalising government support to worthy projects. A narrow definition is problematic since energy communities are fluid, socially oriented, and must adapt to contextual particularities. In contrast, a broad definition lacking clear guidelines and expectations of what an energy community should do and how, opens the door for community washing [16].

Policymakers must judge top-down energy community projects by how they:

Understand the social context and community capacity.

Engage, collaborate, and enhance local leadership.

Promote diversity and inclusion of marginalised groups.

Prioritise community-led initiatives.

Conduct open and transparent processes with community members.

Design, implement and measure educational and skill development strategies.

Distribute financial and non-financial benefits.

Ensure that decision-making genuinely involves the community and reflects their values and priorities.

Final words

The notion that economic disadvantages and social exclusion will be magically solved with borrowed distributed energy resources and the hope for spontaneous community empowerment is doubtful [25]. The claims that energy communities can be a vehicle for a just energy transition need to be carefully tested in the light of different contexts and target groups.

Policymakers must determine the intended social role of energy communities, how this can be measured and reported, and what supporting mechanisms should be provided. Institutional support policies should focus on high-standard projects regarding how they incorporate, assess, and report social impact in their processes and outcomes [24].

We advocate for a critical non-romanticised view of top-down energy communities, which are created collaboratively and foster local communities' sustainability, equality, and empowerment. We call on policymakers, researchers, and industry leaders to avoid community washing and the implementation of shallow solutions for the sake of good advertising and instead understand and promote the true potential of energy communities as vehicles for a just energy transition.

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