



Original research article

How can local energy communities promote sustainable development in European cities?

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ARTICLE INFO

Keywords:

Local sustainable development
Local Energy Community (LEC)
Social innovation
Energy transition

ABSTRACT

In the context of the current planetary environmental and social emergency, it is essential to seek strategies for sustainable development. In line with the Social Development Goals (SDG), these strategies must facilitate action from an energy perspective and give citizens a central role. Given that global challenges must be addressed through local action, the transition towards energy decentralisation through Local Energy Communities (LEC) is of central importance. The general objective of this research is to identify characteristics that are key in order for a LEC to act as a driver of local sustainable development and social innovation. This paper has deepened knowledge around these structures in order to identify the keys to their effective operation. Attention is also focused on actions carried out by these communities in the field of energy and beyond. This research corroborates that while some of them only engage with energy, others are more integrative. These latter implement a number of different actions – in line with SDGs— that promote local sustainable development. This study concludes that LECs are high-potential structures that can act as drivers of local sustainable development.

1. Introduction

Climate change is affecting every region on Earth, with many of the changes becoming irreversible. Extreme weather and climate disasters are increasing in frequency and intensity [1]. In 2016, as indicated by the International Energy Agency, 71% of greenhouse gas (GHG) emissions and 60% of resource consumption were associated with urban areas [2]. The present era of fossil-fuel economies, societies and civilizations has a negative impact on contemporary humanity and the biosphere [3]. Due to both this context and the expected global population growth by 2030, determining lines of action towards urban solutions resilient to climate change by detecting vulnerable areas is vitally important [4]. For this purpose, the European Union (EU) has defined goals to reduce CO₂ emissions via the use of renewable energies [5] in order to reach carbon neutrality. Cities are key sites for achieving the transformations needed to address this crisis and make the development and well-being of the worlds' population compatible with the planet's limited capacity. Contemporary mega-transitions (technological-digital, energy-environmental and demographic-social) represent an opportunity to change the existing model of urban development and promote social cohesion. In this transition, redefinition of the social

roles and responsibilities of citizens should be taken into account [6].

Focusing on energy and citizens' role in this area, it should be highlighted that rise of coal as an energy source gave working-class people and their unions unprecedented power, becoming a catalyst for democracy and progress. Nevertheless, in the twenty-first century, the oil-based forms of modern politics have become unsustainable, this model cannot survive the exhaustion of these fuels and associated climate change [7]. New models should be developed to give power back to citizens, which had been gradually lost through the centralisation processes of energy. In this purpose, it should be included a transformation of the socio-technical systems that form the basis of citizens' everyday lives [6]. At the end of 2016, the European Commission proposed placing citizens at the centre of energy transition. Concretely, the Directive on the Promotion of Energy from Renewable Sources requires member states to guarantee consumers the right to produce, consume, store and sell their own renewable energy [8]. So, therefore, during the last few decades, so-called “community”, “local” or “territorial” initiatives in the domain of climate energy have been developed [9]. In addition, as commented by the United Nations, this transition in this area must be fair, planned, and democratic and must contribute to achieving the Sustainable Development Goals stated in Agenda 2030

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<https://doi.org/10.1016/j.erss.2021.102363>

Received 12 May 2021; Received in revised form 18 October 2021; Accepted 20 October 2021

Available online 11 November 2021

2214-6296/© 2021 The Author(s).

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[10].

Despite this institutional recognition, crucial issues such as unequal agency and access to resources are usually not addressed through the concept of “energy-consumer citizens” concept, and resultantly many citizens are disconnected from and disempowered by energy transition process. Energy citizenship therefore needs to be reconceptualised to incorporate more collective and inclusive contexts for action [6]. Neoliberalism and the principle of rational self-interested decision making, can be combined with neocommunitarianism technocratic government taking into account psychological behavioural motivators, wellbeing and the cultural nature of economic activity, including markets [11]. Ultimately, the challenge is to promote a proactive role for citizens as prosumers, developing their social potential and benefiting communities through a transformation of the energy model.

At a European level, citizen participation has historically materialized through different energy cooperatives, municipal initiatives and citizen movements created principally in periods of cultural change, economic crisis and/or political opportunity [12]. Many of these initiatives emerged in the 1970s due to the activism of environmental groups and as an alternative response to deal with the effects of the oil crisis. This movement was reactivated in the 90s due to the incentives granted in particular countries, with greater impact on those that had a history in this regard. More recently, another rebound occurred following the economic crisis of 2007.

We are currently in another period of opportunity. Since the publication of the 2016 Directive, the figure of Local Energy Communities [hereinafter LEC] has been recognized by the theoretical and normative corpus of the European Union and its member states. In the present manuscript the LECs is considered as:

“an association, a cooperative, a partnership, a non-profit organisation or other legal entity which is effectively controlled by local shareholders or members, generally value rather than profit-driven, involved in distributed generation and in performing activities of a distribution system operator, supplier or aggregator at local level, including across borders” [13].

LECs can be categorized in multiple ways depending on the geographical scale at which they operate, the group of agents participating and the role that each plays, and the type of energy system promoted, amongst other factors. Depending on individual characteristics and modes of operation, the structures of LECs, in addition to dealing with energy management and contributing to energy transition, can be drivers of other types of urban transformation processes. LECs can also be catalysts of social innovation (SI) and local sustainable development, [12,14] ensuring that social and environmental good work together. According to Hewitt, [12], in the present project the SI concept is defined as the action of “reconfiguring of social practices in response to societal challenges, with the aim of improving societal well-being through the engagement of civil society actors”. Furthermore, it is understood sustainable development (SD) as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [15]. Both SI and SD are essential in facing current challenges.

In this context, where conditions exist for new LECs to emerge, it is essential to be aware of existing projects in order to identify best practices and the keys that have enabled some organizations to achieve results, through social innovation, beyond the field of energy. SI and SD do not necessarily go hand in hand. Many LECs (and other social innovation initiatives) are not primarily motivated by sustainability. Similarly, a number of sustainability initiatives, which can address the environmental crisis in a transformative way, are neither local nor community-based. Are the SDGs the key to linking sustainability and democratic localism? It is valuable to understand the characteristics of cases where both are present in order to explore this possibility.

According to Petersen, [16] “Case studies help to understand applied

methodologies and could show available energy potentials in different local settings.” Accordingly, several publications focus on the study of pre-existing experiences [16-25]. This research encompasses both a review of existing literature and a selection of the most important current projects. The general objective of this research is to identify characteristics enabling a LEC to act as a driver of social innovation and local sustainable development.

Below, the contextual framework guiding the research is presented, followed by a description of the objectives and the methodology used. Subsequently, the results are presented and the main conclusions are detailed.

2. Analytical framework

Although the European energy market is still dominated by large companies, LECs are acquiring a growing presence as part of an essential shift towards energy transition. In the literature this phenomenon is addressed from a diversity of perspectives.¹

In both European legislation and documents drafted by other relevant entities, there are multiple definitions of what can be considered a LEC. As the *Instituto para la Diversificación y el Ahorro de la Energía* [Institute for Energy Diversification and Saving] (IDAE) [26] states, this concept first appeared in EU legislation in 2016, and has evolved since then [27]. The terms “Local Energy Community” and “Citizen Energy Community” [hereinafter, CEC] have been included in legislation referring to common rules for internal electricity markets and the term “Renewable Energy Community” [hereinafter REC] appears in the context of legislation on the promotion of the use of energy from renewable sources [8].

With respect to the terminological issue present in the literature, this research finds the definition proposed by Rodrigues et al. interesting. This definition emphasizes the collaborative and social nature of these initiatives and their potential beyond what is strictly energy related [28]:

‘Community Energy’ refers to people working together to reduce and manage energy use and increase and support local energy generation. It has the potential to support the infrastructural, social and cultural changes needed to reduce the impact of climate change and increase energy security.

Behind this question lies the meaning of the concept of “community” itself, which has been explored thoroughly by other authors [29]. In this sense, Creamer et al [30] who argue that “community is defined and only makes sense contextually”, go a step further by exploring, through other research, the meaning of Community Renewable Energy and warn about the need to pay more attention to its role in achieving fair transitions.

In this context, local initiatives have been presented as “developers of new articulations to market and market-making (...) and “of New ways of «commoning» around energy” [31]. However, approaches to LECs can be diverse and this issue has been addressed by Debourdeau and Nadai [29,31] who have analysed this initiatives according to their epistemological and/or thematic degree of proximity, based on three entries through which relationships operate: the first is centred upon technology, the second focuses on collective issues and the third has a more institutional bias.

Other research is also relevant in this area, including a publication by González Ríos [32], which focuses on the on the variety definitions included in the current regulatory framework and other legal aspects relevant to LECs, with an emphasis on the Spanish context. This research

¹ Rescoop, founded in 2011, is the European federation of renewable energy cooperatives. It represents more than 1,500 cooperatives and 1,000,000 citizens and operates as a distributor at a regional level. More information: <https://www.rescoop.eu/network>.

is significant, as it signals the potential scope of action of these structures. Specifically, it identifies a range of activities that, according to legal definitions, can be carried out with the legal frameworks defined for CECs and RECs. González Ríos looks deeper into legal forms that would allow CECs and RECs to act around “regeneration and urban renewal” through the administrative associations established in existing land use legislation and corresponding urban legislation [32]. Thus, the author accepts the involvement of local administrations as “drivers” promoting LECs and highlights a need to find new models of collectively owned property.

This concept of “shared ownership” which Goedkoop and Devine-Wright [33] define as a “hybrid idea that could be considered disruptive both to normative ideas and practices of «commercial energy» and «community energy»” is addressed, for example, by the Community Power Program (Co-Power) which, on the basis of earlier European experiences, seeks to address the lack of community property models in the legislation of many EU countries [34]. It is also interesting to read about the pros and cons developed by the abovementioned Goedkoop and Devine-Wright, who conclude that it is difficult for this formula to work “when instrumentally motivated developers engage with community actors less willing to compromise on the ‘principles’ of community energy” [33], pointing out the possible tensions that can be generated in this type of collaboration.

Scale of action is another differentiating factor among existing LEC initiatives, which is reflected in the debate between researchers. Thus, Magnani and Osti, who analyse the role of civil society in Italy’s energy transition, defend cooperatives that operate at the national level, insofar as these are better able to challenge the centralized system. These researchers affirm that action at a local level can be easily tolerated by the dominant system and, therefore, does generate systemic change towards more sustainable and innovative ways of producing and distributing energy [35]. At the other extreme, other authors support local action at the neighbourhood level, deploying concepts including “sustainable and inclusive local energy planning” [36] and “locally balanced energy system” [37].

As stated by Nadaï [31], “Local initiatives in the energy climate field have gained importance, visibility and support in many countries”. However, the author also warns that localism is being promoted “without a steady resolve with respect to political changes and cycles”, and that, beyond its idealisation, “should warn us again against idealising the “local” as a scale for political action”.

While taking this warning into account, a defence of the local and in tune with the geographical law that says that “everything is related to everything else, but near things are more related than distant things” [38] the existing consensus around the key role of local administrations in the context of the energy transition is worthy of note [39-41]. In this regard, the European Committee of the Regions [42], has commented that local and regional authorities are key actors when it comes to bringing Europe closer to its energy and climate objectives. In that purpose, they have asked for the removal of existing barriers that impede the full deployment of local energy communities in Europe [43].

Similarly, other researchers including Melica et al. [44] and Eslamizadeh et al. [45] focus on proposals for collaboration between agents. They are committed to energy policies based on a multilevel governance model and look into the possibility of industry participating in LEC collective action. In this context, it is worth mentioning the “quadruple helix” concept that advocates for collaboration between public administrations, universities, society and the business sector. This brings together multiple supporters [22,46]. However, it should be noted that the different basic principles of the various actors can hamper collaboration in terms of equity [Goedkoop y Devine-Wright 33].

In this sense, in line with the new governance model promoted in Europe which places citizens as active agents at the centre of transitions, several authors focus on the importance of citizen power and the need for models of governance and participation that allow social innovation and action from LECs around issues that go beyond those strictly energy

related [12,14,28,47]. With respect to this question Bauwens et al. [14] emphasize that energy cooperatives act on the basis of “collective interests” and bring the economic and political impacts that these initiatives can produce into the debate. In this context, Hewitt’s work [48] is particularly interesting, questioning whether the LECs that have proliferated to such an extent across Europe have really been transformative in terms of their stated goals. They analyse different initiatives by categorising them in terms of the “participation level” according to Arnstein’s (1969) [49] “ladder of participation”.

The tendency identified above suggests the possibility of linking the field of energy from a local perspective, where citizens play a crucial role, i.e., to the search for local solutions to respond to global challenges. Authors sharing this perspective argue in this way for pursuing an energy system that, in addition to reducing environmental impacts, “raises opportunities for economic and social development, taking a longer-term perspective, as the basis to achieve greater sustainability” [36]. Lee and Erickson (2017) [50] also link the global problem of greenhouse gas emissions (GHG emissions) with “local economic development” policies. However, they include through this concept areas of action that go beyond strictly “economic development” including “improving quality of life and local environment” and “maintaining and improving utility infrastructure” [48]. We are, therefore, talking about promoting local sustainable development, addressing environmental, social and economic issues from a local perspective.

By contrast, Blythe et al [51], present the concept of “the dark side of transformation”. They point out the link between the concepts of development and transformation and they warn of a gap between the original meaning of the term and its application in reality, listing five risks that emerge:

- Risk 1: Transformation Discourse Risks Shifting the Burden of Response onto Vulnerable Parties.
- Risk 2: Transformation Discourse May Be Used to Justify Business-As-Usual
- Risk 3: Transformation Discourse Pays Insufficient Attention to Social Differentiation
- Risk 4: Transformation Discourse Can Exclude the Possibility of Non-Transformation or Resistance
- Risk 5: Insufficient Treatment of Power and Politics Threatens the Legitimacy of Transformation Discourse

Considering these risks, it must be questioned whether LECs generally contribute to a fairer and more democratic approach to energy systems and can even contribute to local sustainable development. In fact, initiatives whose motivations are far from the principles of sustainability do exist [9] and there is a strategic misappropriation of ‘community’ to manipulate or sugarcoat decisions and impacts relating to energy developments [30].

The literature reviewed suggests LECs can play an active role in local sustainable development and contribute to just energy transitions. Nevertheless, key factors enabling this to happen have so far not been identified. This research aims to contribute to this area. To this end, it engages in a review of a number of LECs, deepening in their general characteristics or operating mechanisms, as well as in the actions that each initiative addresses and their alignment with the SDGs, considered as the main guidelines for sustainable development

3. Objectives and methodology

The general objective of this research is to identify characteristics that are key for a LEC to act as a driver of social innovation and local sustainable development. To this end, the work was divided into consecutive 2 phases as shown in Fig. 1 and described below.

In the first phase, work has been carried out to deepen the knowledge of the characteristics of the LECs in order to understand their modes of operation, objectives, structures, etc., and thus identify mechanisms and

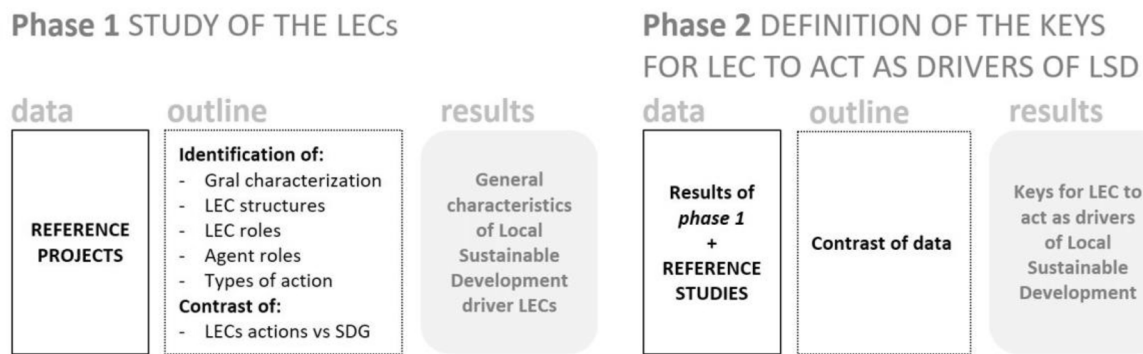


Fig. 1. Outline of the methodology applied.

keys to success that guarantee their contribution to local sustainable development. To this end, in addition to looking at the start-up strategies of each initiative, their implementation has been taken into account, with regard to the actions carried out and the results obtained.

Reference projects were chosen on the basis of a selection of initiatives that Rescoop (European federation of citizen energy cooperatives) identifies as references for best practice for being pioneers in the field.² Rescoop is one of the benchmark agents in the area, and represents a network of more than 1900 European energy co-operatives. Basing this study on existing research made it possible to overcome difficulties in accessing primary data. Based on the criteria established by Rescoop³ for the selection of these good practice projects, the following selection criteria have been defined for this research:

- Involvement of stakeholders and alignment of their interest with the aim of driving a citizen-led energy transition.
- Technical and economic sustainability.
- Participation of citizens as shareholders.
- Integration in the local environment.
- Cooperation between LECs.
- Community engagement by LECs.

A temporal filter was also applied, discarding projects founded prior to 2007. This date was established as the 3rd wave of LECs emerged with the 2007 crisis⁴ and it can be intuited that projects established from this date forward more accurately represent the current reality. Although this research does focus specifically on cities, we decided not to exclude rural cases because we consider that some dynamics and strategies of rural origin are exportable and can contribute to the improvement of urban environments (e.g. agrifood). Finally, 16 projects based in 9 countries were characterised in detail. These constitute a diverse sample in terms of the number of members, scale and nature of field of action, energy source and type of initiative.

For the first phase of the research, a general characterisation of each project was drawn up. In addition to gathering general data, the structure of each LEC was systematized into graphic diagrams, as shown in

² These projects are presented in two reports where information is compiled based on interviews with various people involved in each initiative. <https://www.rescoop.eu/toolbox/best-practices-report-part-1-and-2>.

³ *Idem*.

⁴ LECs are not new. Three waves can be identified in relation to historical periods of cultural change, economic crisis and/or political opportunities: **1st wave**, 1960s/70s. Growth of environmental movements and oil crisis; **2nd wave**, 1980s/90s. Incentive policies that expand the opportunities for the creation of the ECs, although they are configured as entities far from the energy market due to the monopoly of the large companies; **3rd wave**, 2007/08. With "the crisis" and the consequent increase in the cost of energy, a citizen reaction is generated aimed at achieving the democratization of energy, citizen empowerment and the reduction of the power of large companies.

the example in Fig. 2. Likewise, the role of each LEC and the role of each LEC agent within the energy process (generating, selling, buying, distributing, advising, installing, providing energy services or consuming) was analysed. In addition, the types of action addressed by each LEC both in the energy field and beyond were identified. It was also considered that LECs that address actions that go beyond the energy sphere and systematically promote more diverse actions -social, educational or promoting other cultural initiatives, etc. - show greater comprehensiveness and promote local sustainable development. Finally, the actions of LECs were assessed in terms of their contribution to SDGs, understood as the main guidelines for the achievement of a more sustainable future.

This general characterisation followed on to a quantitative comparative exercise. This allowed for a clearer identification of when, how and why a CEL can be an enabler of local development.

Finally, having corroborated that the LECs can act as structures for activating local sustainable development, in phase 2 the identification of the key factors that allow LECs to endure and achieve this integrating impact were identified. This assessment was based on both the learnings from the study of reference projects and the learning derived from the literature review, which focused on works produced by key agents in the area.

The engagement with theory covered an analysis of various studies, reports and research of interest promoted by entities and organizations that have consolidated experience and trajectory in the field [12,48,52-55]. From this material, lessons were extracted along with innovative characteristics and keys and barriers to success. The study of the documents focused on the following factors:

- Environmental, social and political values behind a LEC.
- Territorial, social, political and management factors, etc.
- Social conditions
- Collaborations: types of agents that are involved and the way in which they interact with each other towards the achievement of common objectives.

Therefore, in phase 2, a qualitative exercise has been carried out to contrast the learning acquired from both theoretical and applied approaches, so that it has been possible to define the Keys for LEC to act as drivers of Local Sustainable Development.

4. Results

This section presents the results in the order established by the outline of the methodology.

4.1. Study of LECs

As explained in the previous section, LECs were approached through the analysis of objective data and the results that allowed us to

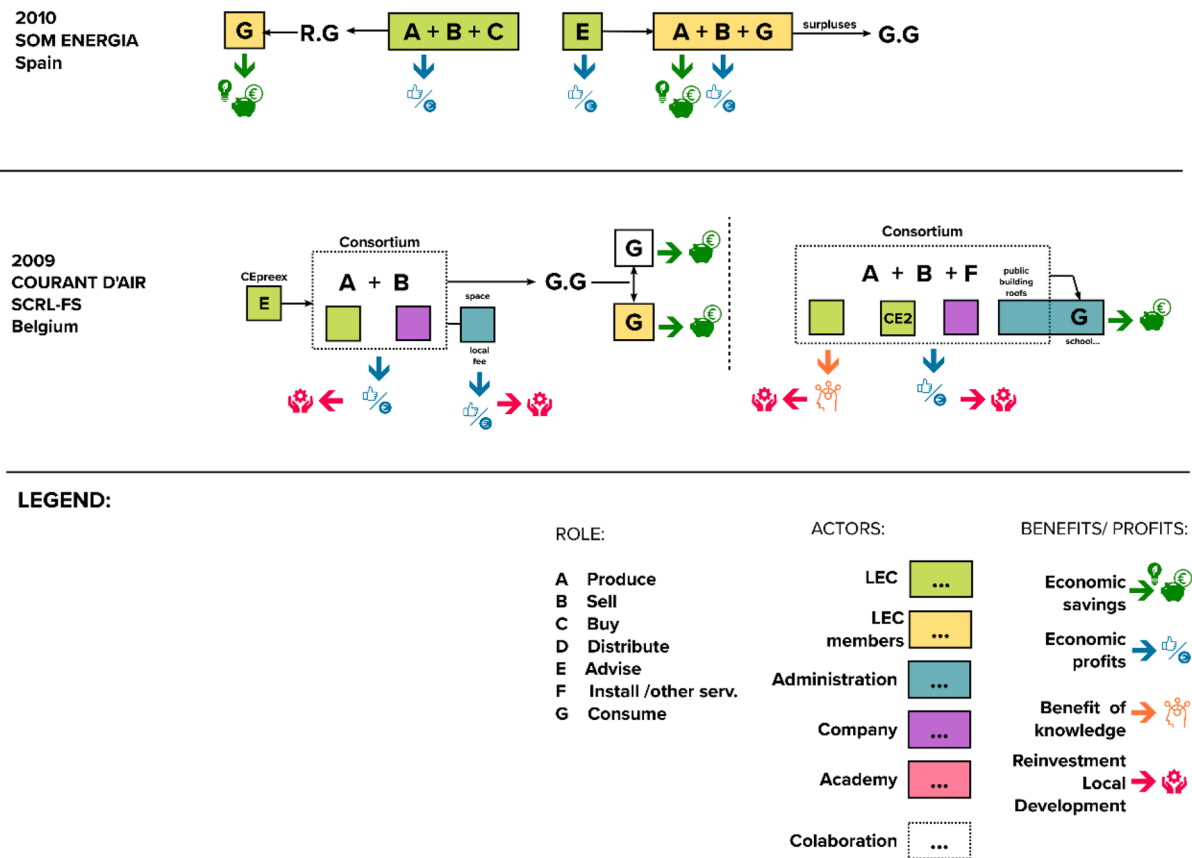


Fig. 2. 2 examples of characterisation diagrams of LECs according to the role of the actors involved.

understand their modes of operation, objectives, structures, etc. and subsequently identify mechanisms and keys to success that guarantee innovation.

4.1.1. General characterization

To deepen the study detailed characterization of 16 reference projects from 9 countries was carried out: Germany, Belgium, Denmark, Scotland, Spain, France, Holland, England and Italy (see Table 1).

As can be seen in Table 1, there was significant variation **membership numbers** between LECs. This ranged from 17 to 67,500. Focusing on the scale of action, most LECs operate at the municipality or region level —7 and 4 cases respectively. In only one case is the scale smaller, and in one, a nationwide project, larger. Most of the initiatives were created in relation with a green energy generation project, with the exception of 2 of the cases studied which, as will be seen later, are not energy producers. With respect to **technology and energy sources**, in 6 of the 14 projects different solutions are combined. Photovoltaic technology is used in 7 initiatives, wind and hydro energy in 9 and 6 projects respectively, and biogas is used in 4. The context of most of the LECs studied is rural, although 4 of the projects are located in urban areas and another 4 are in a combined rural–urban context. It is noteworthy that a rural context coincides in many cases with regional scale initiatives, which take advantage of wind energy.

Finally, although most projects began as bottom-up **initiatives**, a quarter were a top-down. Two of the 2 of the 7 comprehensive projects were top down.

In order to meet the general objective of identifying the characteristics that are key to enabling LECs to act as drivers of local development, the process of general categorization went beyond looking at basic descriptive data. Attention was also focused on specific data that allowed an understanding of the **level of comprehensiveness** in the fields of action addressed in each of the projects. Thus, observing the

types of actions addressed by each LEC and focusing on those that go beyond lines of action strictly linked to energy and the promotion of energy saving, the projects were **classified** into two groups. Projects identified as activating local development were placed in one group, while the second group contains the less comprehensive initiatives. Projects that systematically address actions along more than 4 lines of action beyond their foundational scope were classified in the first group, as projects selected for activating local development. The second group includes other projects of a less comprehensive nature (see Table 2).

As can be seen in Table 2, some projects that demonstrate a very integrative vision and act as clear activators of local development were identified. Others were less comprehensive and their scope of action is more narrowly limited to the field of energy.

This said, it was observed that LECs in general tend to diversify and expand their scope of action as they grow and consolidate, thus taking on a more comprehensive vision. In terms of related actions linked to the field of energy, many LECs promote energy saving measures and new energy generation initiatives, develop and promote new services related to electric mobility, or have supported research projects.⁵ However, the projects with a more comprehensive vision also engage in actions of a

⁵ In this respect, among the projects analysed, we can cite as an example Coöperatie LochemEnergie U.A [Netherlands], which starts by producing, distributing and selling the energy produced, and ends up reinvesting the profits in various projects such as: advisory processes on energy issues, installation of electricity and gas consumption meters, a car-sharing platform or educational projects. Another interesting example is the Courant d’Air scrl-fs project [Belgium]. In this case, starting with the production of green energy, it goes on to develop highly diversified local sustainable development projects such as: actions to boost the local economy and electric mobility, energy rehabilitation processes, educational programs and even projects to generate employment at local level or to promote local consumption.

Table 1
Projects studied classified according to their capacity to promote local sustainable development.

YEAR	NAME	COUNTRY	NO. OF MEMBERS	SCALE	CONTEXT U: urban / R: rural	SOURCE OF ENERGY				INITIATIVE	
						Photovoltaics	Wind power	Hydraulics	Biogas	Bottom-up	Top-down
2007	Torrs Hydro New Mills Limited	England	230	Municipality	U			X		X	
2008	Bioenergiedorf Heubach eingetragene Genossenschaft	Germany	85	Municipality	R				X	X	
2008	Combraillies Durables	France	341	Region	R	X	X			X	
2008	Kilbraur Wind Energy Co-op Ltd	Scotland	528	Region	R		X				X
2009	Courant d'Air srl-fs	Belgium	2117	Municipality	R	X	X				X
2009	Energiegenossenschaft Odenwald eG	Germany	–	Region	R	X	X				X
2009	Hvidovre Offshore Wind	Denmark	2248	Region	U		X				X
2010	Lucéole Société Coopérative à responsabilité limitée	Belgium	801	Region	R		X	X		X	
2010	Som Energia Societat Cooperativa Catalana Limitada	Spain	67,445	State	U-R	X	X	X	X	X	
2011	Brixton Energy Coop	England	–	District	U	X					
2011	Coöperatie LochemEnergie U.A.	Netherlands	900	Municipality	U-R	X	X	X		X	
2011	Energy Saving Co-operative Limited	England	200			–	–	–	–	X	
2011	Hillerød Biogasification	Denmark	17	Municipality	U				X	X	
2011	Südtiroler Energieverband (SEV)	Italy		Region	U-R	–	–	–	–	X	
2011	Whalley Community Hydro	England	219	Municipality	R			X		X	
2012	Coöperatie Hilverstrroom en Gas	Netherlands	55	Municipality	U-R	X	X	X	X	X	

more diverse nature. They participate in the broad consensus around the types of actions that can be addressed beyond energy itself:

- **Educational programs:** involvement of schools in activities and visits to LEC facilities, creating resources for primary education...
- **Environmental conservation actions:** supporting local environmental projects, planting vegetation...
- **Promotion of cultural heritage:** reuse of heritage assets, support for local cultural heritage projects...
- **Agri-food:** promoting community gardens, collecting food for food banks...
- **Awareness raising and involvement of citizens:** delivering training, dissemination of energy data, organization of activities for the local population...
- **Improvement of public spaces:** creation of resilience zones...
- **Social contribution:** improvements in aged care and supported housing infrastructure, promoting social housing...
- **Job creation:** creating business incubators, offering youth internships...
- **Other local development actions:** subsidy systems for local projects, construction/support of new facilities...

4.1.2. LEC structures

As affirmed by a number of authors, social innovation is achieved if new ways of working are adopted [12]. LECs' comprehensiveness and their capacity to promote local sustainable development has been identified as linked to this issue. For this reason, the analysis of these initiatives must go beyond the basic question of "what" and "when". It must identify the particular organizational forms of individual projects and determine the different roles of different agents. These roles include generation, selling, buying, distributing, advising, installing, providing energy services and consuming.

For this analysis, some graphics were designed. These also indicate which of the abovementioned roles have produced what benefits,

including savings, economic gains and/or a benefit derived through knowledge or training. Similarly, cases where profits are directed towards local development actions are indicated.

In an initial reading, it can be observed that the general outlines do not differ significantly. This suggests that differences may lie in the governance and task development models. However, a quantitative study, the results of which are set out below, reveals the importance of other issues.

4.1.3. LEC roles

In Fig. 3 two graphics differentiate the different roles played by LECs. These graphics address both the selected group of more integrated LECs recognized as activators of local development, and the remaining projects. Although the general data provided in the two graphics is the same, 3b- on the right shows the percentage of cases in which a LEC acts, for each role, in consortium with other agents.

As can be seen in Fig. 3a, in the case of both the more comprehensive projects and in the rest of the projects, a majority take on the role of generating and selling energy: 100% in the first case and the 89% in the second for the two roles. Notable differences appear with respect to the roles of distribution (D), advisory services (E) and of offering other energy or installation services (F). While there are no cases in which more integrating projects adopt roles D and F, for other projects 44% and 33%, successively, exercise these roles. Similarly, while only 14% of catalyst projects exercise the role of giving advice, 67% of the remaining projects do so.

The prominence of these roles in projects with a less comprehensive vision is evident. This can be linked to the involvement of for-profit energy sector businesses in the social structures behind these projects. Furthermore, Fig. 3b shows that in these projects, the majority of LECs act in consortium with other agents, including the aforementioned companies. In the case of distribution and installation roles and other services, among the projects studied, no cases were found in which a LEC acted autonomously. However, while 33% of LECs take on advisory

Table 2

Projects studied classified according to their capacity to promote local sustainable development, in terms of the actions they promote.

YEAR	NAME	ACTIONS PROMOTED BY LECs											
		Social contribution	Research	Job creation	Improvement of public space	Citizen involvement	Agri-food	Promotion of cultural heritage	Educational programs	Environment Conservation	Electric mobility	Other local development initiatives	Energy saving actions
PROJECTS ACTIVATING LOCAL SUSTAINABLE DEVELOPMENT													
2007	Torrs Hydro New Mills Limited		x	x		x	x	x	x	x		x	x
2008	Combrailles Durables			x	x	x	x		x	x		x	x
2009	Energiegenossenschaft Odenwald eG		x	x				x	x		x	x	x
2009	Courant d'Air scr-ls		x	x		x	x	x	x	x	x	x	x
2011	Coöperatie LochemEnergie U.A.			x		x			x		x		x
2011	Brixton Energy Coop	x		x		x			x				x
2012	Coöperatie Hilverstroom en Gas	x				x				x	x		x
PROJECTS FOCUSING ON ENERGY ACTIVITY													
2008	Kilbraur Wind Energy Co-op Ltd							x	x	x			
2008	Bioenergiedorf Heubach eingetragene Genossenschaft					x						x	
2009	Hvidovre Offshore Wind					x			x				
2010	Som Energia Societat Cooperativa Catalana Limitada					x					x		x
2010	Lucéole Société Coopérative à responsabilité limitée									x		x	
2011	Energy Saving Co-operative Limited												x
2011	Whalley Community Hydro									x		x	x
2011	Hillerød Biogasification			x						x		x	
2011	Südtiroler Energieverband (SEV)										x		

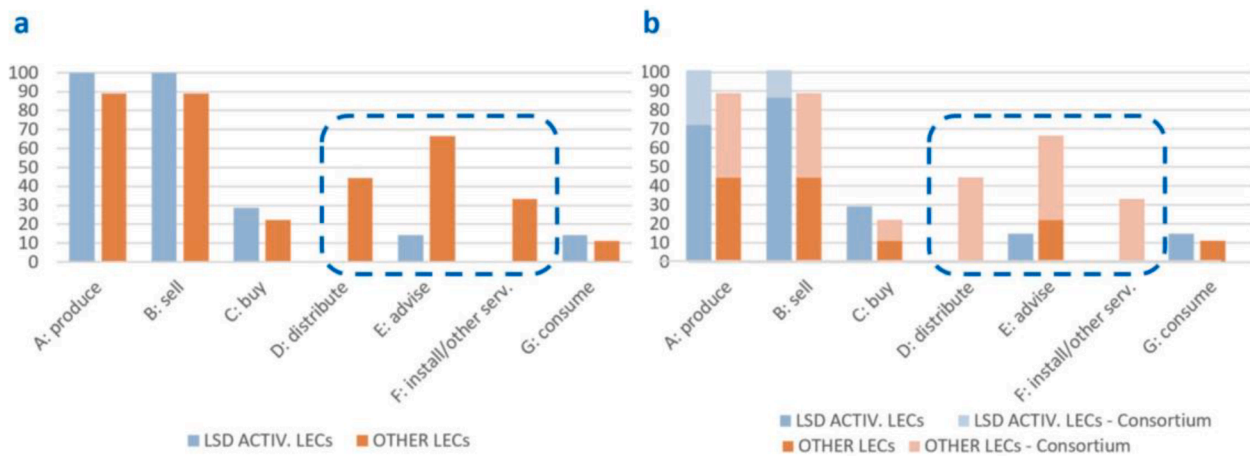


Fig. 3. Role of LECs in the characterised projects. a: Role of the LEC in general. b: Role of the LEC separating cases where it acts independently from those where it acts in consortium with other agents.

roles, 67% do so in consortium with other agents. It follows from the above that the citizens involved in these communities do not have as much capacity in terms of decision-making and / or project management.

4.1.4. Agent roles

Taking a step further, Fig. 4 shows the presence that different agents have in each role, in both the projects activating local development (left) and in the less comprehensive projects (right). This data reinforces earlier conclusions, as in comprehensive projects a balance is observed in the participation of different agents, while in other projects the leadership of the business sector is evident. A more detailed reading shows that private companies, which have a presence five times higher than that of LECs, do so in a homogeneous way in most roles. They do not, however, acquire a role in purchasing or consumption.

Apart from this, is noteworthy that the participation of universities only occurs in some of the projects that activate local development, in an advisory role. Finally, the role played by local administrations should be emphasized. This occurs much more frequently in the case of integrative projects and, furthermore, their role here is more heterogeneous and active, as can be seen in Fig. 5.

4.1.5. Types of action

To go deeper into the comprehensiveness of the projects classified as activators of local development, Fig. 6 facilitates a better understanding of the types of action that are most often addressed by these LECs. For each line of action, the number of initiatives is shown in (blue), and the number of LECs working in each line is shown in (orange).

In relation to the number of total initiatives promoted by the projects studied (104 initiatives), in coherence with the *raison d'être* of LECs, initiatives to promote actions encouraging energy savings account for more than 23% of the total, while initiatives related to electric mobility account for about 10%. However, as part of the more comprehensive vision set out above, other lines that each account for more than 10% of the total number of initiatives are also noteworthy. These include job creation and the promotion of educational programs (around 11%) and a category including other local development initiatives, which is positioned second in the rankings, accounting for more than 12%.

In contrast to the above, looking at the number of LECs that promote actions of each type (orange) it is evident that interest in local development initiatives is of comparable interest to actions to promote energy saving, as both these areas are addressed by 9 of the projects. Similarly, LECs widely engage in educational programs, environmental conservation actions and job creation.

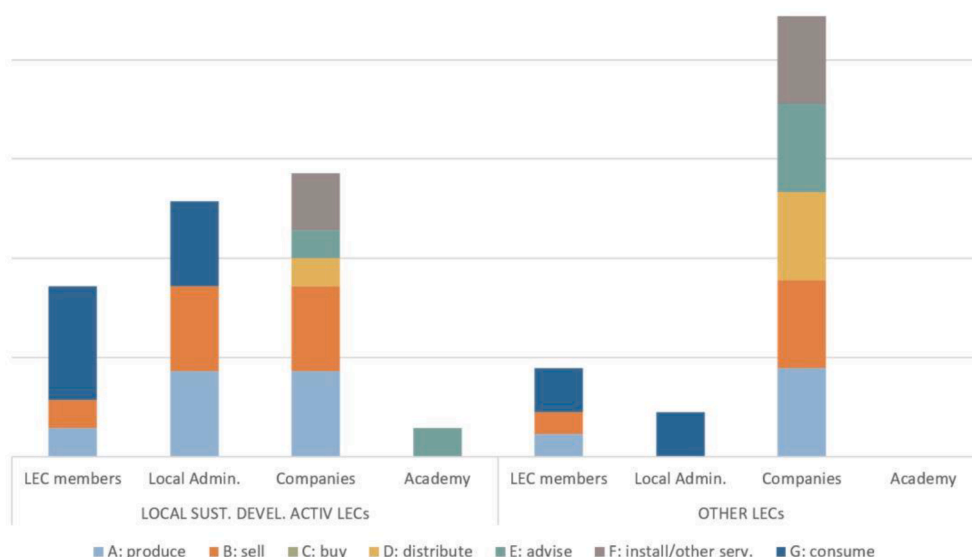


Fig. 4. Roles of the actors involved in the characterised projects.

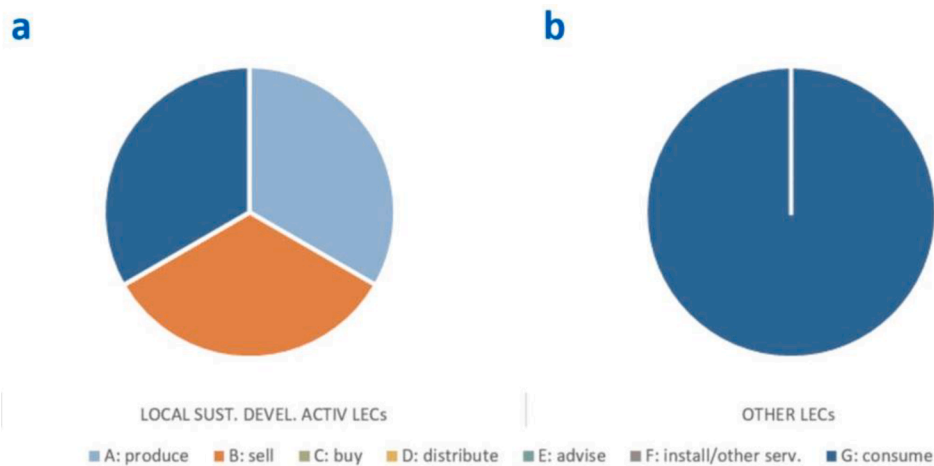


Fig. 5. Role of Local Government in the characterised projects.

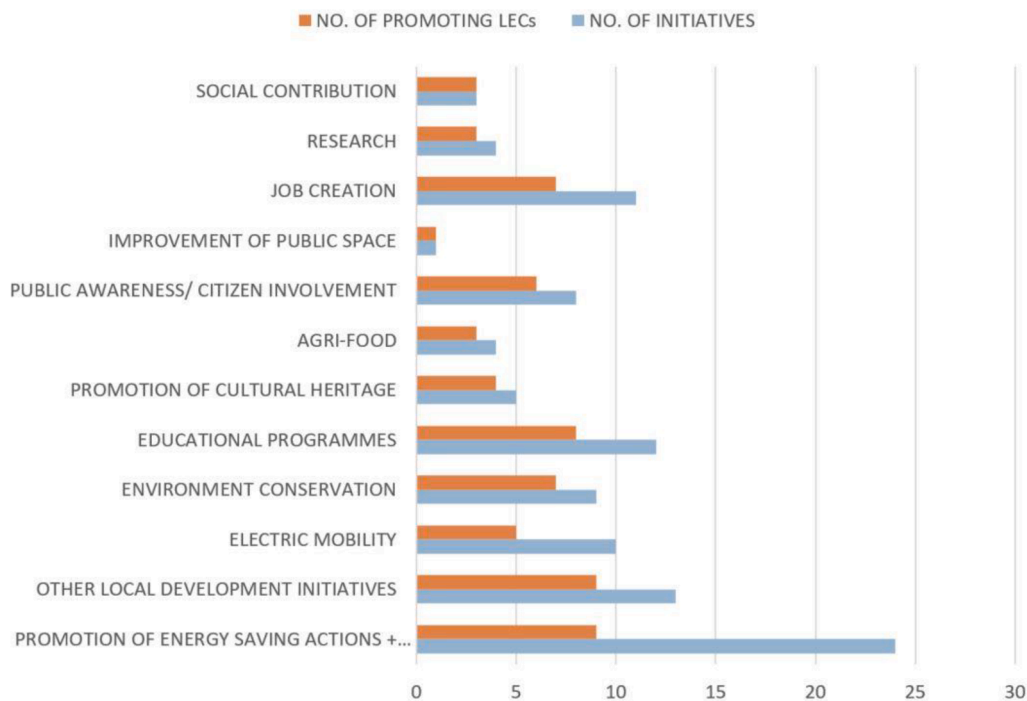


Fig. 6. Initiatives promoted by LECs.

4.1.6. LECs as drivers of local sustainable development

Finally, re-reading the actions promoted by LECs that activate local sustainable development and examining their alignment with SDGs (see Table 3) produced interesting results. It was effectively corroborated that these entities have the potential to act beyond the sphere of energy itself. They are transformative structures that act at an urban level to implement desired changes from the local through an integrative approach.

This approach supports SDG 7: *Affordable and Clean Energy*, which states the need to invest in clean energy sources and improve energy productivity. It also aligns with SDG 11: *Sustainable Cities and Communities*, which, among other objectives, seeks to improve public transport, create green public spaces and improve urban planning and management in a way that is participatory and inclusive. Similarly, transformative structures of this type can be part of the implementation of other SDGs, promoting actions that, in most cases, affect more than one objective simultaneously.

SDG 3 *Good Health and Well-Being* promotes healthy lifestyles and well-being for all people throughout their lives. In this context, actions including building renovation, the promotion of electric mobility and car-sharing on a local scale, collective planting and maintenance of vegetation in urban environments, support for projects to monitor water quality, and noise-related damage reduction efforts are key projects.

SDG 4 *Quality Education* defends education as a key training mechanism to promote upward socioeconomic mobility and escape from poverty and marginalization. Within this framework, initiatives such as the organization of workshops for the manufacture of solar panels, the organization of site visits as part of children’s science education, education in local sustainable development, educational programs on environmental issues, and the reinvestment of profits in creating resources for primary education stand out.

SDG 8 *Good Jobs and Economic Growth* promotes a new model of inclusive and sustained economic development through the generation of “good” jobs for everyone, improving living standards. Reinvesting

Table 3
Alignment between SDGs and actions promoted by LECs that activate local sustainable development.

		SDG																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		No poverty	Zero hanger	Good health and well being	Quality education	Gender equality	Clean water and sanitation	Affordable and clean energy	Decent work and economic growth	Industry, innovation and infrastructure	Reduced inequalities	Sustainable cities and communities	Responsible consumption and production	Climate action	Life below water	Life on land	Peace, justice and strong institutions	Partnership for the goals
INITIATIVES PROMOTED BY LECs	Social contribution			X	X				X		X	X						X
	Research			X	X			X	X		X			X				X
	Job creation							X	X		X	X	X					
	Improvement of public space			X					X		X	X	X	X				X
	Public awareness/ Citizen involvement			X	X			X			X	X	X	X				X
	Agri-food			X	X				X			X	X	X				X
	Promotion of cultural heritage				X			X	X									X
	Educational programs							X	X					X	X			
	Environment conservation			X				X	X			X	X	X				X
	Electric mobility			X				X				X	X	X				X
	Other local development initiatives			X				X				X		X				X
	Promotion of energy saving actions			X				X	X			X	X	X				

profits in the creation of jobs and internship opportunities at the local level is essential to achieve these objectives, as is reinvestment the creation of business incubators and grant systems for local projects. All these actions are aimed at developing new services for the community and contributing to the local economy.

SDG 10 Reduced Inequalities seeks to guarantee equal access to spaces, services and resources so that “no one is left behind”. Within this framework, the promotion of social housing, improvement of facilities and infrastructure, collection of donations for food banks, the development of new local services for the community and improvements to housing for people at risk of social exclusion were identified as key actions.

SDG 12 Responsible Consumption is aimed at decoupling economic growth from environmental degradation, increasing the efficiency of local resources and promoting a green low carbon emission economy. Here, the creation and management of community urban gardens and education in sustainable development models were identified as important contributions.

SDG 13 Climate Action supports a green transition starting from cities, as these are the main cause of the current environmental emergency. In this regard, key actions include support for the generation of urban resilience zones, projects aimed at reducing flood damage and risk to birds and fish, and promoting sustainable forestry policy.

The SDG 17 Partnerships for the Goals encodes a belief that establishing inclusive partnerships from the global to the local around common principles and values and clear and shared objectives is key to an effective implementation of the SDGs. In this sense, it has already been seen that one of the keys characteristics of LECs, especially those that promote local sustainable development, is the implementation of active collaboration between different actors: members of the community itself and other local actors within a democratic management model. Thus, it can be affirmed that integrative LECs contribute to SDG 17 through their very composition, operation and ability to promote actions that act towards achieving more than one specific SDG.

On the basis of the above, corroborating that the actions promoted by the LECs described in this research are clearly aligned with different SDGs, **the figure of the LEC is identified as a possible driver and catalyst of structures that, while starting out from energy issues, are capable of influencing local development at all levels in an integrating manner.** This in turn can contribute to the simultaneous implementation of different SDGs, going beyond a single sector approach.

4.2. Keys for LECs to act as drivers of local sustainable development

From the in-depth analysis of key literature of reference and best practice cases studies, a series of lessons were obtained. This made it possible to define the keys for a LEC to be able to act as a driving force for local sustainable development.

The concepts of **democratization and decentralization** [12,54] and the strategic importance of presenting a **comprehensive vision** stand out, **going beyond a strictly energy related sphere of action** to contribute to the wider assemblage of urban development policies. However, **the generation and management of benefits** is also important, as well as implementing **holistic intelligence and digitization** in these processes. Similarly, **the governance model, start-up processes and management structures** are key, as is placing emphasis on **communicating and explaining these structures in Local areas.**

4.2.1. Democratization and decentralization

Democratization, starting out from energy issues, should be extended to the entire city in order to achieve equity in access and enjoyment of resources, and local interconnection. Thus, citizen leadership is made possible with respect to the definition, implementation and management of a new development model that will recovers and revalue human scale relationships.

It has been seen that one key area that can produce changes in terms creating an energy management model that advocates for democratization and supports citizen leadership is increasing transparency and community management of LECs. The traditional energy system is very opaque because of its centralized perspective [54] and, within it, the power roles of the neoliberal system are reproduced. Transparency. In terms of information and policies, in conjunction with community management, is one of the keys for a LEC to be solidly established and, above all, to last over time, leading local sustainable development and providing support in energy transition. In this regard, it is important to be aware of the risks noted by Blythe [51] and to avoid “transformation discourse” becoming a mechanism for disempowering citizenship [56], marginalising vulnerable groups and reinforcing existing power structures. At the same time, as Lennon [6], emphasises, it is also noteworthy that the concept of energy citizenship is often co-opted to reflect neoliberal discourse, ignoring inequalities related to access to resources and creating obstacles on the path towards real democratization. It should also be considered, as Van Veelen [57] points out, that community management does not guarantee a higher level of democratization. Thus, at the community level, power roles can be reproduced, leading to the excessive prominence of leaders or the exclusion of lower socio-economic groups. In order to address these risks in community management, the authors consider crucial to identify the different interests in an area and the power relations between different actors. However, Burke [3] reminds us that energy transition will not be effective if the dominant power systems are not destabilised. Energy democracy [58] and decentralisation will only happen if power is transferred to individuals, households and communities, defining policies and programmes that seek to empower these actors to face the resistances of the traditional energy and political system.

4.2.2. Management of benefits

In order for LECs to contribute to local development, one key issue to be addressed is around their role in energy transition is the **generation and management of economic benefits.** This includes decision-making processes around this issue and is central in determining how, where and to whom these economic benefits are directed. This said, benefits for communities are not exclusively economic, but also include knowledge and training which are essential tools for empowerment and autonomy.

In some cases, benefits consist simply in savings or the provision of 100% renewable energy. In the most successful cases, savings have in turn led to the generation of reinvestment opportunities in other community spheres. The condition for this to occur is that there is a community that is committed to the commons. As seen from the analysis of the cases selected as references, some LECs offer economic benefits to member-investors while others are oriented to mutual benefit, demonstrating that **energy projects can be used to directly finance the development of communities and their environments.**

To achieve this, it is important that a community is locally rooted and that community members have access to the benefits and are able to make decisions on how to reinvest them. Is therefore desirable that members be at least part owners of facilities.

4.2.3. Comprehensiveness

With respect to **comprehensiveness**, the LECs that have the best chance of bringing about real change, counteracting the monopolistic system, are those that grow over time, acquiring a more comprehensive vision. They tend to act in local development initiatives, addressing areas including:

- Boosting the local economy: jobs, new forms of business, etc.
- Supporting circular economy processes
- Implementing self-managed community gardens
- Promoting electric mobility
- Launching educational programs

- Implementing the comprehensive rehabilitation of buildings

4.2.4. Holistic intelligence and digitalization

The application of “**holistic intelligence**” [54] can be seen as a strategic step in order to practically implement the changes demanded to achieve the above goals. This intelligence adds the intelligence of social, administrative, political and economic systems to the intelligence of technological systems. It is about understanding that **technology** has to be seen and used **as a means** at the service of the citizen collective, avoiding its implementation as a system of social control that privileges the access of a few over the exclusion of many other diverse subjects and with limited capacity for action that neither the state nor the market tends to take into account [6]. This is, a key structural issue in making systemic change possible.

Related to an approach that understands technology as a means, **digitization** can be a strategic tool not only for the efficient management of systems, but also to guarantee their transparency. This includes monitoring and digitizing not only data on production, consumption, savings, etc., but also the socio-economic profile of each community and the development of all kinds of related projects, etc. Thus, digitization can be a tool for monitoring and evaluating impacts and for supporting the aforementioned transparency. For this reason, it is important that everything digitized be available **open source (open data)** and transmitted intelligibly to the entire population affected in a specific context, not just those involved in the relevant LEC. This can promote awareness and the progressive dissemination of this model.

4.2.5. Territorial system and core communities

Although the number of LECs and associated participants is considerable at present, this type of structure is still a **minority system in the energy market** and, in some contexts, quite marginal. The promotion of LECs is about promoting **collaborative and experimental processes** that can enable this model of social energy management and, through it, local sustainable development, to become structural.

For LECs to become a systemic engine of energy transition, their **progressive territorial expansion** is important. To achieve this, it is strategically valuable to promote **model actions** generating **Core Communities**. These are communities that are supported by agents with existing prior commitment to environmental and social justice issues where a process of “social empowerment” has taken place. In some cases, this has enabled the removal of structural barriers in political, social and economic systems in order to allow populations to have greater control over their own destinies [56]. Among these, some of the most recurrent are the following:

- **Education Centres** Where the community can be the driving force and school buildings can function as production and distribution centres, this can contribute to social awareness, using education facilities as a basis for educational programs.
- **Public facilities.** Where local administrations make a commitment with respect to the community and use publicly owned buildings as generators, distributors and support structures for the management of a LEC.
- **Social movements with environmental and social commitments.** Where a group of collectively committed people becomes the driver of a LEC, spreading its values. Normally these cooperatives have a headquarters that can function as generation and distribution centres.

These Core Communities can promote an expansion processes for the generation of additional nuclei, **enabling an energy transition and not just a structural one.**

4.2.6. Governance based on collaboration and citizen power

The scenario foreshadowed by these systemic approaches and specific characteristics can only be achieved if supported by another

structural change: moving from a **collective to a collaborative approach** as “collective efforts are the result of aggregating the individual efforts of many people, sometimes around the same service, but they do not have a common goal or effort” [35]. By contrast, collaboration involves sharing goals and working together to achieve something that provides a common benefit, beyond individual interests.

That is to say, collaboration represents an effort aimed at promoting local sustainable development through the active action of a rooted, empowered and cohesive citizenry working for their community of belonging and to improve their quality of life and the environment they inhabit. This means that in the creation and maintenance of a LEC over time it is strategic to guarantee a **model of governance based on “citizen power”** [35,39]. It is important to guarantee the autonomy of communities with respect to the other agents involved at all times. That is, these must allow themselves to self-manage their own initiatives in energy matters, as well as the reinvestment of profits in other projects.⁶

However, another of the keys to innovation identified as guarantor of success is the **quadruple helix model** [46,48]. This involves collaboration between public administrations, local businesses and the university. In order for this collaborative model to guarantee the aforementioned autonomy and self-management—that is, democratization itself—and, at the same time, be viable, it is appropriate that this type of process is generated and developed as a **hybridization between Bottom-Up and Top-Down models**. The objective is to avoid contradictions and impositions. Serious difficulties have occurred in that in projects where attempts were made to act from above without participatory work and consensus with neighbours, in which people who should have been participants were instead acted on [36]. Collaboration with other agents can be formalized in different ways. These include the creation of a consortium, stipulation of a contract, etc. The *sine qua non* condition in each case is to guarantee democratic management and autonomy of each local citizen community. It is in this context that the actual extent of public participation in achieving real democratisation comes into play. According to some researchers, in some countries there is “a broad tendency towards closure in what is open for discussion in decision-making processes, and a wider tendency to frame publics as ‘local communities’ and recipients of benefits rather than active citizens, there are marked differences to be observed”. [59].

In short, the aim is to promote a model of “polycentric governance” which, as Cobut [56] reminds, it is based on a series of characteristics including: self-organisation, specific local conditions, experimentation and learning, trust and local action. In this framework, the author points out that, although the European energy system is more polycentric than before, it still maintains its *status quo* to continue integrating large energy companies. They suggest that CELs, in their initial establishment phase, should be directed by involved citizens in order to guarantee their autonomy and development. Once LECs are consolidated, they could open up the possibility of collaboration with more powerful actors in the market.

4.2.7. LEC start-up and management structures

In this framework, it is important to bear in mind that the creation of a LEC may be easier when based on the existence of a conscious collective, which has undergone a prior process of “social empowerment” [56]. Similarly, support is needed to facilitate collaborative processes with other agents involved in energy transition processes. In this way, in

⁶ In the document Social Innovation in Community Energy in Europe. A Review of Evidence [Hewitt 2019] different initiatives are classified by level of citizen participation using a modified version of the “Arnstein Ladder” [40]. “Level 8: Citizen Control” is described as following: “Citizens are energy self-sufficient and generation and supply are wholly owned.” Thus, LECs should follow a citizen power model. This is the ultimate objective and is achieved when a community itself generates, distributes and consumes energy, defining and developing additional projects adapted to local conditions.

addition to strengthening the community itself, the foundations are laid for durability and progressive stabilization. It should be clarified that a community is defined as "a group of people who share common objectives—which can be diverse in nature—as well as a feeling of joint belonging, nurtured by their relationships and interactions" [60]. For this reason, it is strategic for a **multidisciplinary team**, in strict collaboration with local administrations, to assume responsibility working closely with a potential community, following proven methodologies such as Living Labs [61]. Thus, in this context, a community can be considered a potential community because it brings together a conscious and united collective, because it has a cooperative tradition, because of its active history in promoting local actions or because it has a proactive attitude towards transitions and local sustainable development, etc. This is in line with Cowell & Devine-Wright who state that "scope for reflexivity and public engagement in governance of energy choices should be pursued in diverse extant collectives of participation, not through creation of new but detached arenas" [59].

Taking into account that LECs are communities formed by citizens and that in many cases they are based on volunteering, it is strategic to establish a **work team that functions as a facilitator**. This team is a **core group** that includes representatives all the agents involved. It is in charge of creating the community, advising it in a multidisciplinary way, and accompanying it over time, taking into account the tendency of the neoliberal system to resist real change, using transformational discourses as a new mechanism of control of the society in such a way as to strengthen the current energy market [51].

Finally, all that which was mentioned above still leaves out one further area was identified as demanding effort and a commitment with respect to achieving systemic change. That is, there is a need to generate, inclusively, **new methodologies and work tools** that go beyond more traditional procedures and enable innovation [55]. In this sense, there are studies that corroborate the existence of social structures of diverse nature, called Urban Action Structures (UAS), which implement actions aligned with the priorities of the SDGs and from which promising suggestions can be extracted [60].

5. Discussion/conclusions

In the context of the current planetary environmental and social emergency, there is a broad consensus around the need to act from an energy perspective to provide a synergetic response to the two aforementioned crisis dimensions. To this end, it is strategic for citizens to acquire an important role in this process. Currently, there is a broad commitment to the decentralization of energy through LECs, despite the various existing barriers, most of which are related to the resistance of a political and economic power system to real change. This could result in the responsibility for the energy transition falling on those affected by the current model, without existing power holders losing their control over the energy market. In parallel, the generalised search for strategies for sustainable development - in accordance with the SDGs - is ongoing. Here, the defence of addressing global challenges from local action is gaining strength in order to facilitate the goals effective implementation.

This research combines these two lines of study, from a quantitative and qualitative point of view, and has included an analysis of an extensive range of literature it concludes that LECs are high-potential structures that can act as a driving force for local sustainable development, towards the achievement of SDGs.

The quantitative analysis has shown that LECs capable of acting beyond the energy sector play a more transformative role at the local level. They are characterised by the participation of a wide range of actors, and local administrations often plays a key role in facilitating implementation and future development. These are projects that, besides energy savings, promote other initiatives including sustainable mobility, local employment, educational and dissemination programmes, building renovation and/or urban regeneration projects.

Regarding the qualitative results of the study, these have allowed the

definition of a series of key ideas to be considered in the processes of implementation and consolidation of LECs in order that they be an effective driving force in the processes of change in the current energy model. They must be entities that can effectively promote the decentralisation and democratisation of energy, influencing the market and reducing the monopoly of large energy companies. To make this possible, it is necessary to support autonomous community management that promotes transparency and manages and reinvests benefits at the local level, promoting sustainable development processes that go beyond energy. To make this change feasible, a political commitment to a real change in the current energy system is needed. The aim is to effectively and unambiguously promote a new governance model that enables citizen power and the dissemination of LECs, eliminating the structural barriers imposed by the market. In this scenario, experimentation processes are essential. Thus, one possible approach could be to promote model actions capable of generating core communities and progressively extending this figure throughout the territory, adapting the identified keys to each context, thereby enabling its scalability.

Model actions, contrary to what has been stated in much of the studied literature, should define a systematised process of monitoring and evaluation of LECs, making it possible to obtain more accurate primary data, in terms of quantity and heterogeneity of the sources and data itself. Consequently, it becomes possible to collect updated data at the implementation level and data about the impact of each initiative.

For these reasons, at the present time, LECs can constitute the seeds of more deeply rooted and comprehensive future structures. Therefore, it is important that European, state and urban policies promote their creation in the terms in which they have been defined here, counteracting, in a coordinated way, the barriers identified.

In view of the above, it is proposed that the next phase of this research be conducted through the application of learning in a specific local context, proposing a model action. This will enable specification and evaluation of key factors, identifying specific barriers and thus advancing towards the scalability of a possible, flexible and adaptable LEC model. The model action will also address the data access barriers encountered in this study, broadening the scope of the results.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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