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Accountability implications for intermediaries in upscaling: Energy community rollouts in Portugal

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ABSTRACT

With the increasing diffusion of solar energy, its conditioning by intermediaries merits attention. Depending on the accountability relations between stakeholders, intermediaries can influence the speed of diffusion. We examine these aspects in the intensifying solar rollout in Portugal, a country with high energy prices, relatively low wages, and ambitious climate mitigation plans. Competitive modular photovoltaic costs and enabling energy community legislation have recently prompted several intermediaries to participate in developing energy communities. We analyse the roles of four types of organisations as intermediaries: non-profit institutions, municipalities, new entrant companies with innovative business models and the renewables arm of the incumbent. Their activities influence market structuration and, thus, the nature of the solar PV rollout. Each intermediary legitimises its role through various practices. Whereas some leverage existing networks, others combine innovative business models with the facilitation of energy infrastructure to advance replicable prototypes. Based on three months of multi-sited fieldwork in 2022 featuring 36 interviews, we analyse the emergent roles of intermediaries. In concert with the scholarship on market creation and diffusion pathways, we advance understanding of diffusion in a financially constrained context.

1. Introduction

Innovative solutions for harnessing energy from renewable sources have gradually become economically competitive. This condition is especially true for solar photovoltaics (PV), which outcompete non-renewable sources at the utility-scale in several parts of the world (Sareen, 2020). This cost reduction, combined with the modular potential of solar PV that enables decentralisation, has prospects for promoting the rapid decarbonisation of electricity production. Distributed solar PV is attractive for self-consumption and can provide benefits, such as energy efficiency, democratic ownership and control and electricity supply security, in the context of rising energy prices. Moreover, decentralised production lowers investment requirements for transmission infrastructure, such as high-voltage transmission lines (Campos and Marín-González, 2020; Cain and Nelson, 2013). Thus, interest in energy communities based on collective self-consumption has proliferated because they promise access to cheap solar power for people without sufficiently large individual roofs; however, implementation has been slow.

As the diffusion of energy communities gathers pace in financially constrained contexts, such as Portugal—which is among Europe's poorer countries and underwent an economic recession during 2008–2015, the lingering effects of which have reduced public spending—intermediaries are starting to condition this in ways that merit attention (Hargreaves et al., 2013; Corsini et al., 2019). Intermediaries are agents who link actors and practices by serving as go-betweens or mediators and are not limited to the role of coordinators. In sustainability transitions, intermediaries employ practices that shape their speed as they affect the rollout modalities (Mignon and Broughel, 2020; Aylett, 2013; LaBelle, 2017). For intermediaries to diffuse a model, they must enable the technocratic framework. This process can be analysed through a relational conceptualisation of accountability regarding observable legitimation practices (Bovens, 2007). Accountability refers to 'a relationship constituted by practices of legitimation, through which some actors hold others to account' (Sareen, 2020, p.31). Accountability regimes (constituted by laws, bureaucratic frameworks, financial incentives, and sanctions) form the playing field where actors interact to advance their interests (Bovens, 2007; Sareen, 2020). Certain actors are legitimised by formalised governance arrangements, for instance, by being allocated more funds, whereas other actors seek to gain legitimacy. Different

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actors utilise various practices to assert themselves as legitimate actors in a given transition and try to reconfigure accountability relations to benefit themselves (Sareen, 2020). These practices include speaking positively or arguing for favourable legislation for activities that align with specific interests. Intermediaries exhibit diverse sustainability-transition practices (Mignon and Broughel, 2020; Aylett, 2013; LaBelle, 2017), which have implications for upscaling energy communities. By unpacking these practices and implications, we seek to elucidate the consequences of accountability relations on upscaling sociotechnical changes in financially constrained contexts.

The niche diffusion or generalisation of sociotechnical systems based on renewable energy sources for decentralised production has often been studied in frontrunner countries (Naber et al., 2017; Caniels and Romijn, 2008). In these settings, generous financial incentives have typically provided ample possibilities for learning about these technologies' technical and sociocultural integration (Sengers et al., 2019); however, in countries with greater financial constraints, including those characterised by high sectoral debt, high energy prices and low-income levels, such large public subsidies are less common, and incentives for small-scale solar production may be more motivated by energy savings than decarbonisation. Thus, in a financially constrained context, the means and motives of energy communities differ and merit close investigation. Solar PV lends itself to energy communities due to its modular nature and potential for decentralised production near energy demand. In this text, the term 'energy communities' refers to collective models in general; however, Portugal has different economic models associated with it. A set of legislative barriers to energy communities were removed when EU directives were transposed into Portuguese law at the end of 2019. As legislation evolves, pilot projects benefit from flexible regulatory sandbox exemptions, making Portugal an ideal case to study diffusion through intermediaries in a financially constrained context. The literature on intermediaries in the diffusion of socio-technical solutions has focused on decarbonisation contexts rather than cost reduction and energy poverty issues (Aylett, 2013; Mignon and Broughel, 2020). Certain intermediaries may be well-positioned to address social equity-related needs in financially constrained contexts, where cost and social justice effects are crucial. Our analysis of the Portuguese case addresses how intermediaries condition the diffusion of community energy in financially constrained contexts.

We focus on four identified types of intermediaries—municipalities, non-profit institutions, entrant companies and a division of an incumbent energy company—regarding their business components as intermediaries for the diffusion of energy communities. We draw on three months of fieldwork in Portugal in 2022, featuring 36 semi-structured interviews, complemented by visits to emerging energy community initiatives; thus, we elucidate the shifts in accountability that can facilitate the rapid diffusion of low-carbon initiatives in financially constrained contexts.

The following section reviews and combines scholarship on decentralised niche diffusion and accountability, an important novel pairing for our argument. The subsequent section provides an overview of data and methods, followed by a section covering our empirical analysis of the roles of intermediaries in energy community rollout. We then discuss the findings regarding accountability and upscaling potential, followed by a conclusion of the implications for the roles of intermediaries in a changing accountability regime.

2. Decentralised niche diffusion and accountability

2.1. Background on energy communities

Conventionally, electrical energy has been produced at centralised facilities and transported through the grid to areas with energy demand. Due to its modularity, solar PV has the potential to bring production closer to energy demand. The simplest form of such decentralised production is individual self-consumption or prosumption, where one production unit is directly connected to and powers a single consumer unit. A fundamental limitation to individual prosumption is that if it is primarily limited to single-family homes (in the case of the residential sector); thus, many residents living in multi-family homes will be excluded from accessing its benefits.

Collective production ameliorates some issues, thus benefiting from economies of scale because production units can be placed on multiple rooftops or common areas. Collective projects also create possibilities for investing locally beyond individual needs, including those with limited household budgets or rooftop space (Pontes Luz and Amaro e Silva, 2021; Schaube et al., 2018; Reis et al., 2021). The reduced need for high-voltage transmission lines avoids the subsequent public opposition due to land-use concerns and potentially reduces future public energy infrastructure expenses by limiting the need for high-voltage grid developments (Cain and Nelson, 2013). Therefore, energy communities are attractive for upscaling a low-carbon technological solution and including a traditionally marginalised part of the population in solar energy transitions.

Diverse motivations inform energy community projects; thus, the priorities and models developed vary with context. Most insights and motivations on energy community diffusion models stem from studies in frontrunner countries, which are primarily premised on objectives of energy citizenship through participation and decarbonisation motives (Conradie et al., 2021; Rahmani et al., 2020; Yildiz et al., 2015; Walker et al., 2010). These findings cannot be extended to financially constrained contexts with distinct incentives and barriers. This recognition is consistent with a nuanced conceptualisation of generalisation as context-specific, constituting a research gap on what motivates and enables energy community diffusion models under financial constraints.

Scholars suggest combining energy transition upscaling with enhancing energy supply (Delina and Sovacool, 2018, p.3). Such provision relies on synergies between different sets of actors, some of whom are traditionally uninvolved in the energy sector. Despite the multiple benefits of energy communities, establishing and running a project requires organisation and cohesion. Diverse mobilisation models for energy communities are emerging and include 'community-scale projects', 'peer-to-peer (P2P) energy exchange', 'virtual power plants', 'integrated community energy systems' and private microgrids (Gui and MacGill, 2018, p.96). A shift in modalities from centralised production to decentralised prosumption has become well-established in a technical sense (Gui and MacGill, 2018); therefore, related diffusion dynamics and associated justice effects merit scholarly attention.

2.2. What is known about the role of intermediaries in niche diffusion?

Energy communities can be scaled up through different diffusion pathways with different levels of success. Naber et al. (2017) link the degree of success in upscaling with the extent to which a pilot project is replicated, increases participation, leads to institutional changes and becomes exemplary. We approach diffusion with a point of departure from Naber et al. (2017, p. 344). They define 'growing' as getting more participants involved or increasing the installed capacity; 'replicability' as a project model being similarly usable elsewhere; 'accumulation' as improving an approach by learning from other projects, typically through intermediaries; and 'transformation' as changing energy practices beyond the immediate project scope, affecting governance arrangements (Naber et al., 2017).

Scholarship on the diffusion of sociotechnical innovations emphasises niche management. For a niche innovation to diffuse, Schot and Geels (2008, p.540) highlight three necessary processes: 'articulation of visions and expectations […] social network building, […] and learning processes'. Intermediaries play vital roles in these processes by connecting actors, transmitting information, and building networks (Kivimaa, 2014; Naber et al., 2017). Kivimaa et al. (2019) distinguish between *niche intermediaries*, who network different actors, and *process intermediaries*, who play a large part in implementation. Whether

intermediary or not, an actor needs a business model, including funding, to exist. Still, how intermediaries emerge and facilitate rollouts in a financially constrained context is not yet well understood, and their specific roles may differ. Notably, financial constraints are always relative. For example, Portugal is financially constrained relative to other countries in the European Union; however, it is less financially constrained from a global perspective.

Bergek (2020, p.384) argues that intermediaries actively promote different agendas and that diffusion intermediaries can be 'dedicated, dispersed, integrated and diversified' contingent on their integration, relationship, and active sectoral role. Other scholars argue that this positionality makes intermediaries 'filters or gatekeepers' (Mignon and Broughel, 2020, p.393). In some cases, intermediaries exclude certain actors, whereas in other cases, they strengthen communities by synergising their goals and common interests (Aylett, 2013; Mignon and Broughel, 2020); however, how intermediary involvement conditions certain forms of diffusion merits critical attention.

Moreover, the literature on niche diffusion covers many case studies from countries like Germany, the UK, and the Netherlands, where 'protective policy measures and strategically exploiting existing market niches can facilitate this innovation journey' (Sengers et al., 2019, p.155). These are frontrunner countries in various sociotechnical innovations with the means to implement such measures; however, niche diffusion dynamics in financially constrained contexts have been understudied. Here, innovations cannot necessarily create protective policy measures (Sengers et al., 2019); thus, one can expect intermediary roles to diverge from the limited range of practices studied in frontrunner countries.

2.3. How does accountability relate to diffusion?

Practices of legitimation take place within an accountability regime, and the accountability regime is the sum of rules and standards set by governance arrangements that actors face and the degree and form to which they are sanctioned (Sareen and Wolf, 2021). Thus, analysing diffusion through the lens of accountability allows us to understand how the practices of actors in diffusion are shaped by the accountability regime these actors face. Jointly, they can elucidate the dynamic interactions with intermediaries that characterise market structuration. These so-called 'practices of legitimation' are conducted within an accountability regime, or four worlds of accountability, set out as the LASH matrix by Sareen and Wolf (2021) (Table 1), based on whether these practices embody deliberative assessment and whether this is backed by the ability and willingness to sanction.

An emergent recognition is that informal practices significantly shape the governance of niche diffusions and evolving power dynamics (Kraft and Wolf, 2018); thus, new actors compete to gain legitimacy, whereas incumbents struggle to maintain it (Stirling, 2014; Kraft and Wolf, 2018). The literature on intermediaries is prolific, and intermediaries have been shown to impact the market structuration of decentralised solar energy production in different ways (Aylett, 2013; Lacey-Barnacle and Bird, 2018). For example, Sareen (2020) established an analysis procedure for incumbent actors' legitimation practices; however, the practices utilised by intermediaries in niche diffusion also require attention. Diffusion necessarily affects existing dependencies between actors; however, the relationship between governance and how actors on the ground aim to upscale a project is not well understood. Sareen and Wolf (2021) suggested that mapping the four forms of accountability in the context of diffusion would yield insight into how forms of accountability affect upscaling and diffusion actors. This article contributes to the existing literature by linking governance choices to creating a given accountability regime and diffusion outcomes.

Table 1
'The LASH matrix for accountability analysis: assessment and sanctions' (Sareen and Wolf, 2021, p.5).

	Ability and willingness to sanction	No ability and willingness to sanction
Deliberative assessment	(S) Strong accountability	(H) Hollow accountability
No deliberative assessment	(A) Authoritarianism	(L) Laissez-faire

3. Data, methods, and case background

3.1. Data and methods

This study's data were collected through ethnographic fieldwork over three months in Portugal in 2022, using semi-structured interviews and multi-site field observations. These ethnographic methods elucidated the processes from different perspectives (Hammersley, 2006), especially those of the people involved in niche diffusion. Interviews lasted 30–120 min each, encompassing different aspects of governance and the diffusion of solar PV at various scales. Open-ended questions were asked in the interview guide, along with more structured questions regarding the barriers both intermediaries and energy communities faced and how they were enabled. Furthermore, many informal conversations were held with Portuguese citizens participating in or living near solar PV projects to capture a broader perspective than formal institutional narratives. While this does not represent the general population's opinion, a few key concerns were thematically triangulated with other sources, such as newspapers. Additionally, participatory observation in a meeting for a community energy project enabled further insights into the dynamics at play. The fieldwork was preceded and complemented by a desk study and a review of grey literature, including policy briefs, energy sector websites, peer-reviewed journal articles, technical reports, official documents, newspaper articles and national roadmaps related to solar energy rollouts. Grey literature based on interviewee suggestions was also included, combined with structured reading before and after the interviews. The literature ranged from law articles, white papers, documents produced by the regulator and governance, company websites and reports, including important documents like the roadmap for carbon neutrality by 2050 and the national plan for energy and climate.

Interviews were conducted with 36 people in the Portuguese solar PV sector and other affiliates. While several actors in the energy community ecosystem had different roles, thematic analysis (i.e. coding activities of actors that highlighted intermediation practices) allowed us to identify those that had intermediating activities between energy community adopters and governance institutions. The thematic analysis allowed for mapping the barriers to upscaling and related challenges. The practices through which intermediaries supported upscaling were analysed against the backdrop of the accountability regime. This approach allows us to analyse the extent to which various intermediaries, each with different barriers to overcome, played specific roles in the diffusion process.

Actors with intermediating activities included five municipal actors, one company with alternative financing solutions, two non-profit institutions, four new entrants (small intermediating companies) and one interviewee at the intermediating arm of the incumbent company. Most interviewees were leaders or project managers, and more than half were specifically selected due to their direct involvement with energy communities, either by being part of a community energy project or based on their interaction with such a project. All the interviewees were selected for their involvement with solar PV in general in Portugal. Interviewees included members of the Portuguese government, project managers involved in the rollout of small and large-scale solar PV projects, top and mid-level leaders in energy companies (both incumbents and challengers), energy researchers, energy community participants and developers (residential and industrial), energy cooperative members, municipal energy agency representatives, experts in energy legislation

and solar PV retailers, installers and manufacturers. Most individuals were interviewed in person. Specific interviewees' identities and institutional affiliations were anonymised because the sector is small and well-networked.

Interviews were conducted with intermediaries and community energy stakeholders to determine the processes and barriers they must overcome. We also interviewed governance actors and stakeholders who dealt frequently with these actors to understand their challenges, perspectives, and practices. This approach facilitates analysis of intermediaries' interactions with the changing accountability regime of energy communities, including identifying key barriers to the diffusion of energy communities and potential future directions.

3.2. Case background

Portugal was chosen because recent legislative and regulatory changes make it possible to establish energy communities. Portugal has relied on imported natural gas and other fossil fuels for a long time, and to a large extent, continues to do so. In the electricity sector, Portugal has a large share of hydropower and a growing share of wind starting in the 2000s. Furthermore, growth in the solar PV sector was accelerating by the end of the 2010s. The major part of the growth in solar PV capacity was based on large-scale solar projects, which still constitute a dominant share of the electricity produced from solar PV (Sareen, 2020); however, new forms of solar PV and ownership have gradually emerged.

The transposition of EU directives into Portuguese law was the starting point for 'Decree 162 of 2019' (Pontes Luz and Amaro e Silva, 2021). This law was Portugal's first legal framework for energy communities and recognised two legal forms. This legislation is evolving, and in 2022, Decree-Law 15 of 2022 further clarified the legal elements for energy communities, laying the groundwork for accelerating diffusion. Decree-law 15 of 2022 further established new changes for decentralised solar PV models. These changes included clarifications numerous actors welcomed regarding economic energy-sharing models and the definition of proximity between production units and consumption; however, a range of challenges remains to be addressed nationally for fast diffusion on the ground. The foundation for further regulatory developments was laid by actors engaging early with the new legal-regulatory framework established by the legislative changes' dispositions. New regulations followed these legislative changes, and some are still pending. The Energy Service Regulatory Authority (ERSE) hosted a webinar on new models for energy communities attended by over 400 participants (ERSE, 2021), indicating a solid interest in energy communities. Thus, the Portuguese case around the diffusion of energy communities is ideal for analysing how diffusion challenges interact with accountability relations and the role of intermediaries in such a financially constrained context.

4. Empirical background, results and analysis

4.1. Accountability regime and related barriers

An interviewed energy community developer suggested that the biggest problem for Portugal's energy production is 'high prices and dependence on natural gas'. Other actors also mentioned the fluctuation in energy prices as a significant issue, especially for low-income households. Several interviewees and project participants indicated that this has created uncertainty and an increased willingness to gain control over the means of energy production. The high and unpredictable energy prices incentivise communities to produce their energy, mainly through the self-consumption of solar PV, to be more resilient to high energy prices and price fluctuations.

While these incentives and interests exist, the accountability regime modulates intermediaries' potential in upscaling, as summarised in Table 2.

Table 2
Accountability analysis of community energy diffusion in Portugal.

	Ability and willingness to sanction	No ability and willingness to sanction
Deliberative assessment	*(S) Strong accountability* Decree-Law 162 of 2019 and 15 of 2022 (mandatory transposition from EU directives) facilitate better economic models of energy sharing, clarity on proximity and define roles and responsibilities of actors (e.g. Public institutions, DSO)	*(H) Hollow accountability* Lack of resources for enabling energy communities (human resources at public institutions, financing support for experimentation, etc.);
No deliberative assessment	*(A) Authoritarianism* Dysfunctional top-down efforts to provide a basis for effective energy community models, unresponsive licensing protocols and unfavourable regulations for collective housing buildings	*(L)* Laissez-faire No systematic promotion of energy communities as a way to reduce energy bills, energy poverty or carbon emissions; rather, a reliance on ad hoc initiatives

(Adapted from Table 1 by Sareen and Wolf, 2021, p.5).

Table 2. Although significant advances were made with Decree-Law 162 of 2019 and 15 of 2022, the lack of accountable governance is noteworthy and imposes several barriers to implementing energy communities. For instance, all interviewees involved in attempting to licence an energy community with the new legislation mentioned an arduous and opaque process. As one intermediary claimed, 'The process of getting the community approved takes so much time, and you cannot get feedback on how much more time it will last. I put in a project last April and still haven't heard back' (January 2022). Another failure of accountability is the lack of facilitation of energy communities through knowledge sharing or agile regulation, which the interviewed intermediaries deplored. REScoop, the European Federation of Citizen Energy Cooperative, reported that in the case of Portugal, for energy communities, 'A number of issues have been raised regarding the DSOs' implementation of their responsibility to connect projects to the grid and to share data with relevant parties' (Rescoop, 2023). Decree-Law 15 of 2022 specifically, and prior legislation, defined the roles and responsibilities of public institutions and energy sector actors regarding implementation of energy communities; however, delays in the licensing processes required for such energy communities have not faced any significant sanctioning. A project manager knowledgeable about the energy market claimed (March 2022) that the Directorate General for Energy and Geology (DGEG), a public institution responsible for issuing licences, 'need more human resources, more tools, and good leadership to answer the challenges we are facing in the energy sector'. Therefore, while revised regulations should help to address the backlog and clear up some requirements, a bias towards individual prosumption is still notable in the selective removal of barriers without providing similar solutions or resources to problems that pertain to energy community projects.

Another more indirect but important limitation that several entrants and some municipalities encountered was the high fee for grid infrastructure use (depending on the lack of proximity between production and consumption) and high costs across other stages of the process. Furthermore, we found a financing bias towards individual installations in the residential sector at the time of the resilience and recovery plan funds. These were eligible for a subvention of 85 % up to €7500, compared to a compensation limit of only twice that, €15,000, for multi-household buildings, which typically house far more inhabitants. These funds were not limited to energy efficiency upgrades (such as energy self-consumption or energy communities) but could be used for these purposes. This situation reveals that the problem lies in the practical and accountable allocation of state-controlled resources informed by equity

principles rather than the unavailability of public funds. All of this reveals a lack of solid accountability by the government to the energy communities, contributing to forming and maintaining a financial barrier to the emergence and diffusion of the latter.

The abovementioned legislative developments allowed for pilot projects with flexible regulation to test emergent possibilities that were not yet regulated in detail: 'This regulation establishes the possibility of carrying out pilot projects, under the request of interested parties in self-consumption and upon approval of ERSE' (translated from Portuguese, Regulation N.° 8/2021, p.3). Several interviewees and intermediaries revealed that it was wise to approach this legislation flexibly, as it allows the development of a framework suited to ground realities; however, one interviewee was more cautious and expressed concerns that, with this approach, the early adopters and most prominent players in the field might have a disproportionately larger influence on the final regulation. The application and approval process for pilot projects was lengthy and challenging for some actors to understand and navigate. All the interviewed intermediaries that required pilot project authorisations complained about the long and uncertain bureaucratic process, which intermediaries struggle to overcome due to the lack of government accountability.

These slow and complicated processes led to very few projects being licensed. An interviewee (February 2022) noted that limitations came in many forms, and actors face diverse constraints despite an 'interest in dynamic sharing rule, other limits arise, such as how one can engage people'. A representative of an energy agency within a municipality interviewed the same month explained that a rapid decentralised solar rollout requires 'more to capacitate people and companies to understand that and help them, in order to overcome the procedures and perceived barriers; otherwise, this will not take off'.

Another limitation related to the lack of information about the possibility of forming an energy community is that the public is generally not included in and informed of energy-related decisions. People typically picture themselves as consumers rather than prosumers. As one municipal energy agency representative explained, 'in Portugal, citizens are not used to having active participation in the energy sector'. This situation represents a barrier to upscaling, namely the lack of readily available information, especially in projects that involve non-experts in the energy field. A municipality representative mediating a project argued that 'this can be overcome through communication in schools, television commercials, and information'. Thus, information and learning are seen as ways to overcome this limitation.

Despite the positive legislative changes enabling energy communities, several changes desired by different interviewees remained unaddressed. These included a combination of energy and mobility in the same law for more integration, an explanation of practical modes of energy sharing and communication with DGEG and the distribution service operator (DSO), simplified bureaucratic processes, transparency regarding grid access logics and a performant online platform to facilitate information access, licensing, and feedback. These obstacles adversely impact diffusion by inducing barriers, retarding pace, and introducing adverse effects (as intermediaries need to recover the cost of overcoming barriers). Overall, accountability is limited regarding supporting energy communities' diffusion, as summarised in Table 2.

Without strong accountability, the need for other supporting actors, such as intermediaries, to overcome numerous barriers increases. Various intermediaries address these barriers differently, each with distinct resources and incentives. One energy community project manager reflected that '[intermediaries] can see how we can help, but [there are] also difficulties and priorities on both sides and through their growing size and connection, they can give more inputs to policymakers'. In contrast, a project manager at a smaller company said they lacked the human resources to engage in public consultation processes and give inputs to government institutions; thus, emerging practices and diverse roles are essential to consider. The following subsection addresses how intermediaries handle barriers and opportunities during niche diffusion.

4.2. Intermediary action in overcoming upscaling barriers

The following subsections elaborate on how intermediaries proceeded in energy community projects and relate this to the accountability regimes and barriers described in the former section. These cases are treated anonymously.

4.2.1. Municipalities

Different municipalities have taken on varying roles in the energy transition in Portugal. For this study, five municipalities were visited, here referred to as A, B, C, D, and E. On this basis, generic cases are featured below to capture diversity while retaining anonymity.

Municipality A without a dedicated energy agency, had been involved in facilitating for an energy community-project. This initiative was led by a company whose model was to organise financing and implementation, sell the produced energy to the community at a reduced price and take a share of this revenue. When several residents, including a local PV module installer, were asked about their knowledge of the project or the installed panels, they answered that they were ignorant of both.

Municipal energy agencies B and C resemble several others across Portugal that have accessed external funding (often EU funding) to implement energy communities in social housing projects, including integrating other forms of decarbonisation (through energy efficiency retrofits) and socially oriented improvements. Such ventures regard and position energy community projects as poverty-reduction tools. Although some contextual elements vary across these projects, they face a common challenge in obtaining licences. Here, the municipal energy agency served as a project manager, overcoming barriers and coordinating different actors while promoting intervention and providing assistance in an advisory capacity.

Municipalities E and D disseminate information through their energy agencies. An interviewee (February 2022) opined that 'capacity building is the main way to upscale, participate and decide. Having more informed societies is the best way to have more productive societies'. This municipality organised cultural events to draw attention to solar energy and self-consumption possibilities. One of these was a leisure festival involving cultural activities to give what an interlocutor termed 'a broader view of solar energy'. The agency also aimed to equip people to handle financing and regulation. One interviewee argued, 'One thing we observe is that people have a lot of preconceptions, and at the same time, the perception of high barriers'. Therefore, these municipalities could help to overcome the barrier to information for the upscaling of energy communities.

Most municipal energy agencies drew on trans-local partnerships (e.g. through EU funded projects) to understand common issues and solutions and create guidelines and templates to share with inhabitants. These interventions remained contingent on political will and budget allocations. The municipal energy agencies used their positions to capture public attention and raise awareness of solar projects and possibilities. Table 3 indicates that they also foster diffusion by sharing more of their learning process, as they do not need to compete the way companies do. As a representative reflected, 'to get people to learn, you have first to catch their interest'.

Table 3
Intermediary types, practices of legitimation, positional advantages and shortcomings in the solar community energy rollout in Portugal.

Intermediary	Practices of legitimation	Positional advantages for upscaling	Positional shortcomings for upscaling
1. Municipalities	Discursive Through neutrality, helping in conceptualising and developing 'people-centric' models Information and learning Foster partnerships Build human capacity Financing Access public and European-level funding Legal-regulatory Clarify the legal aspects Bureaucratic Clarify the licensing process	Build on knowledge of the local community Spark interest in projects Reduce uncertainty by elucidating the benefits the model provides Bridge interests and lift barriers as a 'non-commercial actor'	Budget limits Legal limits Poorly positioned to access consumption data to evaluate potential project viability due to privacy regulations Differences in national legislation limit trans-local partnerships to the international level Geographically limited to its municipal territory
2. Non-profit institutions	Discursive Through neutrality, help imagine and develop 'people-centric' models Information and learning Promote awareness locally of the possibility of energy communities Build human capacity and competence in energy community solutions Financing Aggregate larger investment pools and secure funding Legal and regulatory Aid in understanding legal aspects Bureaucratic Aid in the licensing process	Knowledge of different models and methods from a wide geographical range Help educate citizens through seminars and activities Involved in many projects with scope to synergise solar PV with, e.g. electric mobility and energy poverty reduction	Promotion is limited to what they consider appropriate models Budget limits Legal limits
3a. New entrants – small intermediating companies	Discursive Reduce uncertainty and implementation time due to dedicated project resources Information and learning Promote viability of alternative energy models Financing Aids in obtaining finance Legal and regulatory Reduce uncertainty and implementation time due to technical project support Bureaucratic Reduces uncertainty and implementation time through streamlined licensing protocol	Established models increase the speed of implementation and reduce uncertainty Possibilities of implementing projects with no prior financing or need for investment capital for clients Because they are profit-driven, an intrinsic incentive to upscale exists Knowledge of how to leverage public funds for social projects Technical knowledge helps clients overcome legal and bureaucratic barriers Combine social projects with profit-driven activities, gain media coverage and widen the client base	Unwilling to share information on failures, limiting learning in the sector Limited incentives to cooperate with other entities Energy infrastructure at least partly owned (or for some time) by the company (depending on what has been negotiated), limiting community control Reduced return on investment for clients due to company cut The rapid diffusion of specific suboptimal models may reduce future heterogeneity
3b. Company with alternative financing solutions	Discursive Attract investors by providing risk assessment and promoting local investing through storytelling Information and learning Disseminate information about models to existing energy investors Financial Increase potential projects by widening financing options	Have an established platform to show projects to investors, thus reducing the cost of capital Promote community solar to crowdsourcing investors Help evaluate project risk and aid project initiators to reduce financial uncertainty	Limited control over projects beyond risk evaluation and securing financing Historical returns affect investor participation in high-risk projects
4. Incumbent energy company	Discursive Reduce uncertainty and implementation time by having experience, an established model and project resources Information and learning Promote visibility of alternative energy models Legal and regulatory Reduce uncertainty and implementation time of projects due to technical project support Bureaucratic Reduce uncertainty and implementation time of projects through sectoral experience	Have an established customer base and consumption data Established models increase implementation speed and reduce uncertainty Knowledge of how to leverage public funds, including for social and decarbonisation projects	Bias to increase energy consumption due to role as an energy provider Limited incentives to cooperate with other entities and share what they have learned Limited community control

4.2.2. Non-profit institutions

Non-profit institutions work closely with communities, especially on social projects, but their specifics vary. These typically provide advice and serve as coordinators for community energy projects. Table 3 indicates that this approach accelerates diffusion by establishing trust in the model when strong economic interests are absent. In one instance, a university-based research group combined the roles of an advisory board and project coordinator for various solar-related projects; their energy community project went well beyond solar PV to include funding for (and from) other sustainability and decarbonisation-related aspects. This actor had at that time not yet engaged with the licensing procedure despite installing community solar panels. While these results are based

on a limited number of cases, similar to municipal energy agencies, non-profit institutions took on the role of a coordinating actor, project manager (by overcoming barriers and coordinating different actors), promoter, adviser and R&D facilitator. The fact that non-profit institutions are not profit-driven helped significantly in gaining the trust of the project participants as well as in exploring less standardised (and potentially more customised) project implementation modes.

4.2.3. Entrant companies

A) Companies with emerging business models

Entrant companies either offered to conduct the whole process or to assist with a specific part, such as technical installation, sociotechnical model, sharing platform, bureaucratic process or financing access. The roles of entrant companies varied. We focus on those who exhibited intermediating practices. Companies can potentially accelerate deployment in the ways mentioned above; however, in models where these intermediating companies assist beyond narrow bureaucratic or technical aspects, they typically retain solar installation ownership for a negotiated time with the community and capture a revenue share. Different models between energy communities and intermediaries are being negotiated. Some models may decrease benefits for communities, although bulk purchasing by these intermediaries can harness economies of scale, and technical and bureaucratic support can make the deployment viable. However, these modalities can reduce the control energy communities have over their energy production.

An entrant company argued for heterogeneity in business models but specified the following:

> 'On the consumption side, the residential area is most interesting to sell to, while on the production side, big roofs, like the ones of companies, are most interesting to put the panels on. Selling energy to a residential area brings maximum profit. You maximise the profit when you bring different actors together'.

Thus, intermediating entrants can help to upscale by playing a positive sum game by minimising cost and thus maximising the model's attractiveness by coordinating activities. However, results are preliminary, and due to the on-going implementation process, whether all actors will benefit sufficiently to make the model desirable to replicate remains uncertain.

B) Company providing an alternative financing solution

Some entrants premised their roles on providing alternative financing solutions. Their business model involves a small fee for projects needing financing, contingent on raising capital, which allows for opening investments to a broader base of actors beyond energy community members. This situation can also lead to a more diversified set of actors benefiting from the potential redistributive effects of the energy community while leading to upscaling. Moreover, customised crowdfunding platforms raise both awareness of these possibilities and capital. One of these companies centred storytelling on small businesses and local communities and the benefits of energy communities, thereby discursively legitimising these as a means to secure cost savings and social justice through decarbonisation.

4.2.4. Incumbent energy companies

While entrants work to develop an emergent market, the renewable energy arm of the main incumbent energy company in Portugal approaches energy communities more conservatively. Many interviewees deem the model they promulgate as neither being sufficiently disruptive nor providing enough benefits. An energy community project participant claimed that the incumbent exploited people's interest in decarbonisation; however, a representative of the municipal energy agency acquainted with the model claimed that profit margins are low and that 'residential installations with one to three panels are not interesting for companies. They want to go for systems from 20 kilowatts upwards', which condominium roofs offer. Overall, the model pushed by the incumbent sought to limit the transformative scope of energy community projects.

The model of this incumbent is slow to roll out despite being one of the easiest to implement, as it builds on an existing customer relationship. An interviewee in a non-incumbent energy community project mentioned that control over energy infrastructure was the main reason for their participation, as dependence on energy consumption from the grid alone was too risky (in terms of price instability). As a company whose business relies largely on selling energy, the incumbent has little incentive to help reduce energy expenditure and relinquish control over the means of energy production. Several interviewees reasoned that this situation explains their limited promotion of energy communities, representing conflicting interests that potentially limit this intermediary's ability/willingness to scale up energy communities effectively.

4.3. Roles of intermediaries in niche diffusion

Our empirical analysis reveals that intermediaries implement diverse approaches to bridging the barriers faced by energy communities in upscaling. Many seek to address persistent constraints to energy community diffusion, including slow bureaucratic processes, ignorance regarding feasible models, poor financial support, complex legislation and an opaque authorisation process. Intermediaries work to address these barriers to upscaling, thereby legitimising their role. According to their nature and scale, these actors engage with barriers in distinct ways. While still in a very early phase of the rollout, some intermediaries have already positioned themselves strategically and started projects. Some work through existing and new networks using social capital, whereas others combine innovative business models with energy infrastructure provision to create energy community prototypes aimed at rapid replicability.

The primary incumbent (a large energy company moving into this niche) expanded its product and service penetration by selling a predefined version of an energy community to their existing client base using social capital. In contrast, entrants combined traditional financing models, new financing solutions and innovative business models centred on Energy Savings as a Service (ESaaS). With the legal-regulatory framework still in its infancy, projects can seek pilot status, which offers greater implementation flexibility. Some project types aimed to address energy poverty; however, the nature of the solutions and impacts varied. Some actors preferred a bottom-up approach, whereas others argued that this would cause delays and be impractical. A project participant explained that in middle-class neighbourhoods, people 'have some time and resources' (for potential energy community projects), whereas in poor neighbourhoods, 'they have so much going on'. A key for intermediaries to legitimise their role was overcoming barriers to participation and lowering the threshold for establishing an energy community. As one interviewee involved in energy community projects noted, 'after the first project is set up, you have a case that is easy for replication'. Thus, finalising a project can allow for its use as a blueprint for subsequent projects and continued learning.

Table 3 lists the identified legitimation practices (adapted from Sareen (2020) to suit our case) utilised by these intermediaries to address the challenges the accountability regime poses. We added an 'information and learning-based barrier' because energy communities often involve non-experts who are often unaware of options and suffer energy literacy limitations. Accordingly, we identify five types of barriers that intermediaries seek to lower through such practices: discursive, information and learning-based, financing, legal-regulatory and bureaucratic. We list manifestations of these legitimation practices for four categories of intermediaries: (1) municipalities, (2) non-profit institutions, (3) companies with (3a) new entrants as small intermediating companies and (3b) alternative financing solutions and (4) incumbent

energy companies. Additionally, Table 3 presents positional advantages, shortcomings and attendant effects for each type of intermediary.

Table 3 reveals that intermediaries have different positions and assets associated with their roles and actions for upscaling. These practices of legitimation are themselves structured to fill accountability gaps; they all do so by playing key roles in coordinating, aggregating and bridging several relevant concerns (poverty reduction, decarbonisation and energy-saving) with their specific resources (competence to overcome bureaucratic, legal-regulatory, financing and information barriers). While structural limitations exist, non-profit institutions, municipalities and companies with emerging business models exhibit the highest potential to accelerate learning on and diffusion of energy communities in financially constrained contexts.

Given the widespread desire to implement energy communities as sociotechnical systems of empowerment, unfavourable configurations have led to intermediaries needing to step into multiple roles to reduce these barriers to niche diffusion. These roles range from removing all barriers for an energy community, including acquiring licensing, securing financing, setting in place the economic model and deploying an installation, to focusing on one component, such as addressing financing aspects or providing advisory services to help energy communities navigate processes and implement solutions. This is an important aspect emerging from our study: *the generalisation of a new model entails the hybridisation of roles performed by intermediaries*.

Some emerging energy community projects utilise non-Portuguese funds and extend beyond focusing on energy communities to attract these, whereas others include solar PV as part of other decarbonisation or poverty-reduction processes; however, regulations render energy system integration difficult. Licensing processes for energy communities are slow and nontransparent, and an overly strict legal framework leads to delayed implementation. Intermediaries help by bridging different interests and trialling multiple models, thus widening participation and investment in transitions. Hence, the intermediaries analysed here see their role expanding from adviser, coordinator or implementer to bridging state failure on accountable energy community rollouts. The accountability gap raises the need for increased intermediation in energy community projects, thereby impacting the modalities in which energy community projects can be implemented. In addition to municipal actors fostering cooperation and learning, for-profit intermediaries can quickly diffuse energy community models and reduce energy poverty through potential energy savings. This approach can lower the need for energy transmission investments, enabling community awareness and gaining traction to get energy community projects off the ground.

The following section draws on the above empirical analysis to discuss accountability relations related to questions of upscaling.

5. Discussion: Intermediaries in a changing accountability regime for community solar rollout

Energy community models vary in degree of involvement, ownership and thus control of energy resources. Less transformative projects with weak involvement are easier to join; thus, they scale up because they ask less of members (less need for investment capital, self-organising, engaging members, dealing with bureaucracy and contractors for technical elements). More transformative projects visualise energy communities as offering greater benefits to people than companies carving out high profit margins; however, companies can harness economies of scale and actively pursue learning from their practices for efficiency gains. Therefore, their long-term involvement could be economically beneficial (Aylett, 2013) if benefit-sharing with households is ensured (e.g. through regulatory mandates). Following diffusion scholars (van der Laak et al., 2007; Naber et al., 2017), we agree that an unfavourable learning environment limits diffusion and the possibilities of generalising emergent niches. Intermediaries are key for niche diffusion in financially constrained contexts, spotlighting how accountability regimes shape actor involvement and ensure salutary justice effects. Elucidating how to maximise societal benefits by bridging niche diffusion with sustainability innovation is an essential research priority. For instance, emergent research has revealed how incumbent intermediaries can sometimes support transitions (Sovacool et al., 2020; Page and Fuller, 2021); however, while incumbent intermediaries can support transitions, their implementation may have varying outcomes regarding justice-related co-benefits compared to other actors.

Furthermore, our study reveals that intermediaries coordinate, aggregate and bridge several concerns (poverty reduction, decarbonisation, energy-savings) using resources (competence to overcome bureaucratic, financial and legal-regulatory barriers) to advance technical aspects and models. Mignon and Broughel (2020, p.393) found that intermediaries tend to act as 'fillers and gatekeepers'. Similarly, we found that intermediaries routinely fill the gaps left by an inadequate accountability regime, thereby accelerating and intensifying the rollout, which corroborated the findings of Naber et al. (2017). Delina and Sovacool (2018) claimed that different ways of upscaling a transition can be bridged by combining synergistic sets of actors. We found that noncommercial intermediaries, such as municipalities, non-profit institutions and some commercial entrants, essentially aid in successfully upscaling the transition to community solar energy by integrating funding streams and interests. This result is another key insight for policy: practice co-shapes unfolding community energy governance. In other words, informal relationships and legislation are vital to the rollout course.

The diffusion of a sociotechnical niche relies on incentives for participants and, correspondingly, their ability to support or hinder the diffusion. Kivimaa et al. (2019) distinguished between the types of intermediaries during niche diffusion; however, intermediary actors rarely take up a single role. As the interviewed intermediary actors reflected, they are trying to position themselves in the market to play a meaningful role precisely where they are needed, given the shifting accountability regime. Accordingly, they fill an accountability gap, but as transition scholars have indicated, substantial barriers still limit diffusion (Schot and Geels, 2008). The overall speed of the transition and the prospective justice benefits that could come with the diffusion of energy communities (like energy poverty reduction) are stymied by a lack of strong accountability. This finding resonates with Delina and Sovacool's (2018) conclusion that combining justice effects with upscaling can synergise for fast generalisation. Nonetheless, established commercial energy actors influence energy sharing and ownership models, thus promulgating solutions (e.g. virtual power plants) that are easy to implement but limit ownership and control for communities in their present form. Here, we note the danger of generalisation in that not all energy community models point in the same overall direction; some can limit community agency instead of increasing local control over energy resources.

The strategic niche management literature notes that a niche level innovation develops by the combination of the formation of imaginaries and expectations, often articulated in conjunctures where social networks are formed and learning takes place (Schot and Geels, 2008; Naber et al., 2017). We submit that our study unpacks different conjunctures involving various intermediaries during the 'experimentation' phase before rapid diffusion. The accountability regime has not incentivised incumbent firms to implement change beyond the incremental; thus, it does not support the niche to its full potential. The state has not promoted the model with the most social benefits or the most disruptive one for the fastest transition. Sengers et al. (2019) argued that the conditions under which incumbent firms benefit from green innovation experimentation in a niche phase are under-researched. Vested interests often prevent incumbent firms from contributing to disruptive change (Stirling, 2014; Naber et al., 2017). While emerging intermediaries drive niche diffusion to compete with the incumbent, the incumbent guards against conceding future positions to entrants in an evolving market (Matschoss and Heiskanen, 2018).

Our analysis complements the research on patterns of upscaling

(Naber et al., 2017) by revealing that patterns of upscaling benefit from being analysed in the context of the playing field that the accountability regime sets out. Different diffusion actors, such as intermediaries, in this case, have different resources, allowing them to approach upscaling differently. These challenges include the need for effective practical models to deal with many licensing applications, visibility and communication between the distribution service operator and intermediaries, efficient sharing of models and the need to integrate regulation of the digitalisation of energy production, electricity, and mobility sectors. Intermediaries' involvement in pilot projects conditions the diffusion of Portuguese energy communities. This recognition implies the need to assess whether the changes in the legal-regulatory framework are unduly pulled in specific directions due to the weight of select intermediaries' interventions, namely, if the playing field for generalisation is tilted at the outset.

6. Conclusion

The links between financial constraints and the accountability regime are founded on a combined analysis of niche diffusion and accountability relations. Our findings indicate that barriers like bureaucratic delay and legal-regulatory limitations aggravate the financial investment burdens of energy communities. Only highly resourceful intermediaries can use the new legal framework to implement energy communities, making intermediaries disproportionately important in a financially constrained context. The market formation is co-shaped by the types of actors and their playing fields; both are slanted here, which is a crucial bias for national policies on energy transitions to address by adding explicit multi-scalar elements and priorities that reflect a concern for resource distribution outcomes. In this financially constrained context, while proactive actors accomplish a modest diffusion, significant determinative power rests with the state. The approach set out in this paper clarifies that diffusion actors are most reliant on the playing field set in place by the government concerning their ability to foster diffusion, even though certain intermediaries are better positioned to do so than others. Therefore, the government's position in practice is highly relevant for assessing the accountability regime in which diffusion actors operate.

Highly resourceful intermediaries have positioned themselves to fill the gap left by the accountability regime, including as project managers, promoters and advisory board members for initiatives that also target low-income homes. This situation enables community energy projects and yields benefits. While some draw criticism for not favouring a strictly bottom-up approach, actors are cognisant that households in energy poverty can hardly establish energy community projects where experienced, well-connected project managers often struggle unless given structural support and lowered barriers.

Finally, we integrate accountability analysis to demonstrate how contextual elements beyond financial support conditions niche diffusion. This article highlights that the accountability regime significantly impacts learning and shapes the actors and outcomes prioritised during diffusion. The incentives set by the accountability regime are major factors that determine outcomes, and intermediaries step in to fill gaps left by sectoral governance. Future research can investigate how and which policy changes can construct accountability regimes where incumbents participate in more disruptive pathways to develop more sustainable and equitably oriented sociotechnical models. Integrating accountability analysis with niche diffusion the way done in this study should aid in such endeavors.

Declaration of competing interest

None.

Data availability

The data that has been used is confidential.

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