

## Article

# Smartening Local Energy in Europe: A Comparative Analysis of Three Cases and Their Implications for Supporting Transformative Governance Practices

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**Abstract:** Achieving global sustainability goals, while maintaining or increasing access to energy services, calls for agile and many-faceted responses. The pursuit of ‘smart local energy systems’ is one such response that involves a paradigm shift, taking the concept of an energy system away from large-scale power plants and fuel stores towards more flexible configurations to harness renewable energy flows, with highly distributed physical assets, actors, skills and controls. Smart local energy requires citizens, industry, utilities and government bodies to collaborate and learn together in order to develop effective modes of governing that meet sustainability goals and provide reliable, accessible energy services. In this article, we introduce practical implications of creating more localised energy systems with the aid of digital technologies. We then analyse three emerging European energy communities in terms of their actors, activities and alliances, to build an understanding of governance practices within and beyond the communities that are capable of fostering transformative change towards sustainability. From this, we argue that maintaining progress towards smart local energy systems requires transformative governance within and beyond initiatives. It requires local governance arrangements that are agile and responsive to new actors and activities as well as to broader external circumstances.

**Keywords:** socio-technical system; smart local energy; governance



**Citation:** Barnes, J.; Darby, S.; Hansen, P. Smartening Local Energy in Europe: A Comparative Analysis of Three Cases and Their Implications for Supporting Transformative Governance Practices. *Sustainability* **2024**, *16*, 3922. <https://doi.org/10.3390/su16103922>

Received: 12 March 2024

Revised: 30 April 2024

Accepted: 4 May 2024

Published: 8 May 2024



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## 1. Introduction

To achieve global sustainability goals, governments are faced with the sometimes-conflicting challenges of providing access to reliable modern energy services and decarbonising them [1]. While the focus tends to be on energy supply vectors and technologies, these challenges relate equally to demand-side infrastructures and practices [2]; social practices, culture and norms [3,4]; and forms of social innovation [5,6]. They, therefore, cover a wide range of issues, including the ability to harness renewable power and fuel sources, the state of transport systems and the built environment, and the fundamental question of what an energy system is expected to deliver in terms of services [7]. Both demand and supply are the products of physical infrastructures, social networks, climate, politics, rules and skills [8,9], which are experienced and addressed at different geographical and political scales [10] and which change at different speeds. In short, energy systems are complex in terms of their makeup and operating contexts and attempts to make them more sustainable have to be able to recognise, analyse and work with complexity.

Transforming energy systems towards sustainability involves adopting new technologies or adapting familiar ones to new purposes, with new forms of interaction between people and artefacts [11]. Information and communication technologies (ICTs) are expected to play an important role within sustainable systems, allowing for the smarter use of energy when it is generated and the smarter use of existing infrastructure. Incorporating ICT within ‘dumb’ systems will require experimental and relational approaches, building the

capacity for learning and developing skills: acquiring, developing and sharing tacit and explicit knowledge while innovating in specific situations [12].

To succeed, new governance arrangements, processes and practices will be required at multiple scales capable of supporting system transformation [13,14]. We understand governance as the combination of institutions, mechanisms, processes, and policies through which economic, political and administrative power is exercised [15]. This understanding builds on an extensive literature that recognises important roles for actors beyond government, including civil society and business, at multiple scales. In practice, this implies making and upholding rules and managing socio-technical operations and interactions. It therefore has both creative and adaptive roles. For example, in the early years of this century, some national governments (notably Germany) introduced a feed-in tariff to reward the owners of solar photovoltaic (PV) panels, and by doing so, they altered their energy landscapes, literally and figuratively. This single act of governance opened up the market for PV technologies, brought down their system costs, and set in motion many side-effects for which adaptive thinking was needed, in areas such as land-use planning, customer acceptance of system change, job creation, and skill acquisition; policymakers were compelled to learn rapidly and make policy on a number of fronts in order to adapt to the technical changes taking place [16]. But governance arrangements, processes and practices capable of supporting system transformation for sustainability (henceforth ‘transformative governance’) are not only required nationally; they are also needed at regional and local scales, and within the initiatives driving change.

At a time when energy system innovation is taking place in many directions, with many actors and at various scales, there is an urgent need to learn from recent experiences about how transformative governance practices might support energy system transformation and enable productive local initiatives. To examine how transformative governance practices can be supported, we explore three cases of energy communities in which smarter local energy systems were developed. We start from the propositions that (a) energy communities comprise a particular type of smart local energy initiative grounded in a particular (community) logic, (b) energy systems are socio-technical entities, and (c) energy transition is, therefore, a complex process of socio-technical/socio-material change [17,18].

Our analysis aims to generate insights about governing local energy system change both within and beyond energy communities as a form of smart, local energy initiative. The research is guided by two questions:

1. What governance challenges arise in the development of smart local energy systems by energy communities and how are they dealt with?
2. What implications arise from these cases for fostering transformative governance practices within and beyond smart local energy initiatives?

The results contribute novel insights about the governance challenges of creating increasingly smart, local energy systems and about some of the governance practices being adopted to overcome them. From the case-study experience, we argue that fostering transformative governance—that is governance capable of supporting the transformation of energy systems to meet global sustainability goals—will depend more on addressing the social complexities of managing smart technologies and on building effective alliances than on developing technological solutions, *per se*.

This paper is structured as follows. Section 2 introduces practical questions arising from the creation of smarter, more localised energy systems and what they mean for energy management practices and local governance. In Section 3, we outline our methodology. Section 4 presents the results of our case study analyses in terms of their socio-technical relations, illustrates their business models and outlines the governance challenges involved. In Section 5, we compare results across cases and derive more general insights about what is required to navigate emergent governance challenges within and beyond initiatives, arguing that more attention needs to be paid to local transformative governance in order for smarter, more localised energy systems to be developed in response to global sustainability goals. Section 6 concludes the paper.

## 2. Practical Questions of Smartening Local Energy

In addressing questions of sustainability and energy system change, innumerable issues arise. Here, we focus on practical questions posed by creating smarter, more localised energy systems, to derive insights about how change can be supported through effective governance at multiple scales.

### 2.1. Smartening Local Energy

Integrating new forms of supply and demand with the aid of appropriate technologies, business models and governance, is a major challenge facing electricity system operators, policymakers and citizens [19]. System planners, operators and regulators are seeing the need to adapt and innovate, with approaches that rely to varying degrees on citizen/business (bottom-up) and industry/government (top-down) imperatives and initiatives [20].

Most new renewable power is connected to medium- or low-voltage local distribution networks rather than high-voltage transmission grids. These networks were designed for one-way flows of electricity—from generator to user—but are now having to cope with two-way flows, as users become involved in generation and storage, exporting power as well as importing it. To do this, two-way flows of information are needed [21] and ‘smart grids’ are emerging to assist in managing these increasingly complex, renewables-reliant systems—interlinked networks of electricity and ICT in which digital technologies, sensors and software are employed to match supply and demand in real time whilst seeking to minimise costs and maintain grid stability [22].

A ‘smartened’ system will be considerably more complex than what went before, requiring new data transfer and storage infrastructure allied with relatively sophisticated control systems. There will be new bi-directional links between technical devices (connectivity); between technologies and humans (via controls, and making data visible to system users); and between human actors, individual or collective [23]. All three forms of communication raise socio-technical issues: who designs and controls the technologies, controls and data, and to what ends? Who carries out functions such as system operation, regulation, advice, training, insurance, accountancy, and data protection? And how accountable are they for the outcomes?

Smart grids thus require expert knowledge, along with new forms of economic, political and regulatory support. Electrical power and ICTs each have their own characteristics and forms of governance [24]. Crucially, smart grids also require customers to become, to some extent, ‘active participants’. Previously, an electricity system was managed exclusively by experts to serve customers, who responded by paying bills at regular intervals. Now, increasingly, the system will still be managed by expert practitioners—the Distribution Network Operators (DNOs) or Distribution System Operators (DSOs)—but they will be aiming to co-opt customers to assist with system management by ‘flexing’ their demand to help in matching it to available supply, and by contributing generation and storage capacity. This shift is gradually being codified through new tariffs, contracts, technical standards and business models [25,26]. All these considerations are relevant to electricity governance and network management at the local scale [27].

It is equally important to recognise that all smart grids are implemented in specific places, each with a unique mix of physical infrastructures, social networks, climate, politics, demand patterns, rules and skills [10]. In human terms, they will rely on people in each locality to influence change, individually or collectively, in systems that are likely to be dominated by a legacy of ‘centralised’ thinking [28,29].

What constitutes ‘local’ in energy systems is highly contested [30]. Here, we understand ‘local’ as referring to a district or area within which energy supply, storage and demand can be ‘flexed’ to better match demand with available supply—that is, an area served by a primary electricity substation, or something smaller. The precise scale will vary on a case-by-case basis and depend on the challenges to be met in the physical and socio-economic ‘landscape’ within which an energy subsystem sits [31].

## 2.2. The Need for Transformative Local Governance

Transforming energy systems to meet sustainability goals thus raises a variety of practical issues, which, in turn, generate political and institutional demands that go well beyond minor adjustments to the status quo [32]. Transforming energy systems involves remaking governance institutions and practices at various scales [13,33]. Here, we agree with Patterson [34] on how governance institutions and associated practices are likely to change and how this might be studied. He presents changes to governance institutions as an ‘unfolding trajectory . . . where outcomes in each moment are often provisional and indeterminate, and pathways of structural change are created rather than followed’. This suggests that insights on transformative governance practices capable of fostering smart local energy are likely to be situated and provisional; transformative governance will therefore have to be adaptive. We are likely to study it best through ‘learning by doing’ in new situations in which initiatives challenge and potentially remake local governance arrangements and practices.

The wider literature on system transitions teaches us that altering governance is most likely to occur when diverse coalitions pursuing similar aims are formed [35]. In general terms, individual initiatives can be ‘empowered’ through embedding in supportive networks [36]: they need to develop relationships and form networks with others to challenge the institutions and socio-material contexts that have shaped them. On a more granular level, much less is known about how initiatives overcome the many practical issues that arise in smartening local energy systems [22] and about the transformative governance practices required within initiatives and more broadly. As yet, there is considerable uncertainty over the shape, control and distributional impacts of the ‘networks of power’ [37] that are evolving from the old centralised systems and are still shaped in part by incumbent actors. As patterns of supply and demand change, as ownership of electricity system assets and the ability to deploy them profitably becomes more of an issue [38,39], and as the policies and rules governing system operation evolve [40], each new local development is a move in the interplay between individual and organisational actors, the technologies they use and the rules that govern their activities. Below, we turn to explore these issues through three case studies.

## 3. Methods

At this early stage of smart-enabled local energy, knowledge is limited, especially where practicalities are concerned. In this context, case study methods involving intensive analysis on a clearly defined unit of analysis (i.e., a case) and its context [41,42] are likely to be able to teach something new about fostering transformative governance practices to underpin local initiatives. Case studies can contribute to filling a gap in knowledge noted by [36]: the lack of clear accounts of substantive, material changes in systems targeted for transformation. Agreeing with these authors that system transformation emerges from ‘bricolage’ rather than being constructed from blueprints, the analysis here aims to identify elements of that bricolage and inquire into what it means for local governance practices capable of supporting transformative change.

Below, we analyse three case studies of new European energy communities. Energy communities have gained prominence in the European Union following the European Commission’s ‘Clean Energy for All’ package, launched in 2016 and revised in 2019. Within this package, energy communities are thought important for ‘enabling collective and citizen-driven energy actions to support the clean energy transition that will help pave the way for a clean energy transition [whilst] providing flexibility services through demand-response and storage’ [43]. Here, we define new energy communities as ‘associations of actors engaged in energy system transformation through collective, participatory and engaging processes, seeking collective outcomes,’ following [44]. Whilst most research on new energy communities views them as phenomena in their own right (e.g., [45,46]), here, we conceive them as examples of smart local energy, following [47].

### 3.1. Case-Study Selection and Case-Study Characteristics

The three case studies analysed here participated in the NEWCOMERS study of ‘new clean energy communities in a changing European energy system’. They are purposely selected from a sample of ten case studies carried out in the project on the basis of diversity and because of their potential to generate knowledge on transformative governance practices. The wider research project demonstrated that energy communities, as experienced in Europe, are a diverse phenomenon and that this diversity derives from:

- The country contexts in which they are located, including government policies as well as market rules and regulations influencing what is possible;
- Their origins and motivations, though all shared a common motivation (contributing to the energy transition);
- Actors involved, including their roles and responsibilities and their individual and collective actions [48].

Collectively, these factors resulted in local initiatives with varying social and technical complexity, which in turn affected what and how much expert and/or external assistance was needed to bring each initiative to fruition. Following these factors, three cases were selected based on knowledge of each case and its potential to generate new knowledge about transformative governance practices; differing assemblages are likely to generate varying emergent governance challenges and responses, with the potential to generate insights of wider value. Table 1 introduces and summarises the three case studies according to these factors.

**Table 1.** Summary of case study characteristics.

	<b>Buurtmolen Tzum</b>	<b>Project Z</b>	<b>Energy Local</b>
Country	The Netherlands	Germany	United Kingdom
Origins	Relatively traditional local energy community, harnessing environmental concerns to replace a 1990s wind turbine. Relies on some national government support and alliance with a green energy supplier.	More technocentric project, reliant on high-level technical expertise, conceived and managed by large incumbent electricity supplier.	A flexible model of ‘energy clubs’, adapted to local conditions and using locally generated electricity equitably to benefit generators and users. Relies internally on a coordinating body and externally on a licensed supplier.
Decision-making	Collective, bottom-up, largely from citizens	Commercial, top-down, largely from incumbent supplier	Small social enterprise in conjunction with local communities
Actors	Investors, turbine manufacturer, engineers, members of governing body, community activists	Licensed supplier/network operator, technology providers, software engineers, citizens	Energy Club members; professional staff in central office; licensed suppliers, expert advisers for each Energy Club.
Individual actions	Investment in community-owned resource	Need solar PV and a suitable meter for imports + exports. Signing up to a neighbourhood electricity tariff.	Joining, managing own demand and (in some cases) generation; investing in assets
Collective actions	Members are on the governing body	No collective action required.	Members have shared visibility of local generation; have voice in Energy Club governance
Complexity	Fairly straightforward	Technically complex, organisationally simple.	Medium complexity, organisationally and technically.

### 3.2. Data Collection and Analysis

The analysis performed below builds on multiple sources of data collected during the project. Investigation of each case lasted approximately two years, from 2020 to 2022. The main sources of data collection were:

- Workshops with practitioners: one per case held in April–May 2020, to collect data on actors and technologies involved, business models used and enabling or disabling conditions;
- Semi-structured interviews with practitioners and/or project managers, partners and associated actors (e.g., local network operators) involved in each case (June–September 2020). These were used to deepen the understanding of actors, relationships, technologies and initiative development;
- Survey on technologies employed and services provided by cases to community members and local networks (November to December 2021);
- An international stakeholder workshop (October 2021), which helped researchers to reflect on and validate findings in conversation with practitioners from across all cases.

In addition, regular exchanges between consortium partners helped build our understanding of each case. These exchanges were focused on a range of tasks, including documentation of distributed energy resources in each community and quantitative modelling of their potential to benefit the community and the electricity system [49]; an analysis of knowledge and skills available in and required by each community [50]; and analyses of community business models, activity systems and participation [51]. Due to COVID-19, most of this work had to be carried out online, but each community was visited in person at least once by a local project partner. Full details are given in [51].

## 4. Results

Below, we present the results of our individual case study analysis in terms of their origins and context, the actors involved and their relations with each other, and the technical and organisational complexity involved. We then outline emergent governance challenges faced within each case and how they were navigated, as well as implications for management and governance both within the case and beyond.

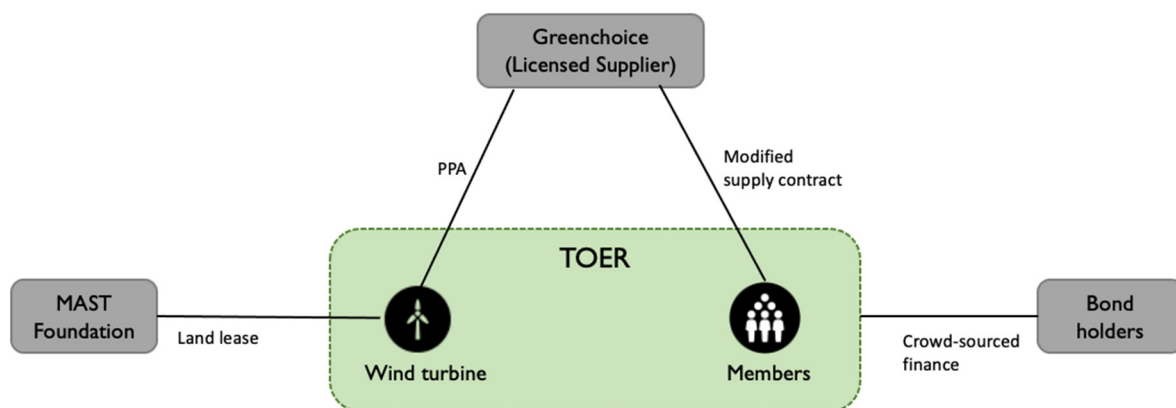
### 4.1. Buurtmolen Tzum, The Netherlands

‘Buurtmolen’ translates as ‘neighbourhood mill’. There has been a wind turbine in the Tzum district of The Netherlands since 1994, and revenues from selling its electricity supported community causes. The turbine came to the end of its life in 2016 and a new one was planned so that local people could continue to own renewable generation assets and participate in energy transitions. This is a cooperative project run by a local foundation: the Foundation for Environment and Support Activities (the MAST foundation).

Obtaining approval for a larger turbine and developing a business model has been challenging, with a lack of government support and a complicated, fast-changing regulatory environment. However, in 2019, a new cooperative, Tzum Organization for Energy in the Region (TOER), was set up as a legal governing entity and over 400 people expressed their interest at an early stage, making it possible to launch crowdsourcing to fund the new turbine (~EUR 1.2 m). The project is supported by Greenchoice, a cooperative green energy supplier, who was to act as the licensed supplier for the project. It was anticipated that the turbine would become operational in 2022. The primary actors and their relationships are set out in Figure 1.

This energy community was relatively simple in structure, technically and organisationally. It was the least ‘smart’ of the three case studies but required data flows that would have been unavailable until recently. These linked Buurtmolen Tzum to a national scheme that made it financially attractive—the Dutch national ‘Postcoderoos’ (postcode-rose) scheme. The scheme closed in 2021 and was open only to cooperative enterprises. It offered partial electricity bill tax exemption for owners of distributed renewable generation who lived in the postcode area of an installation/project or areas adjacent to it (the ‘rose

petals'). Householders could thus invest in cooperatively owned distributed assets in their own or a neighbouring postcode area. Their generated electricity was sold exclusively to an energy supplier (in this case, Greenchoice), who then sold it back to cooperative members. A portion of members' electricity imports was matched to their share of the power generated by the cooperative, and this was eligible for a tax deduction of approximately EUR 12 c/kWh (at 2020 tax rates) up to 10,000 kWh/year, for 15 years. ICT made the calculations relatively simple. The Postcoderoos thus promoted distributed generation and released money into the local economy that would otherwise have gone to an external generator.



**Figure 1.** Actors and relationships in Buurtmolen Tzum.

We interpret Buurtmolen Tzum as an example of a relatively straightforward energy community, bringing together investors to set up and manage a turbine that will use an abundant local resource (wind) to provide energy services in the area. Nonetheless, it still experienced a range of formative governance issues that had to be navigated. It needed a critical mass of residents to be willing to invest in the turbine, a legally constituted group (TOER) to be responsible and accountable for the project, and a partnership with a licensed supplier (Greenchoice) to access supportive national policy (Postcoderoos) and backend energy supply activities, as well as project accounting.

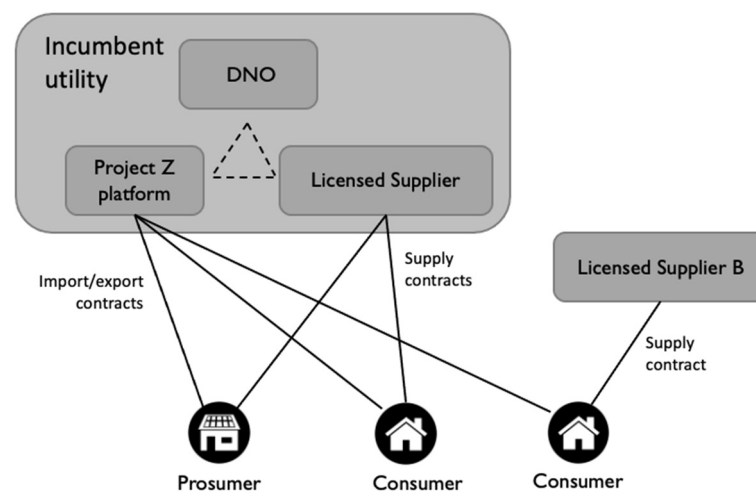
In broader governance terms, the Postcoderoos illustrates how national legislation and ICT, combined, can enable local action that would not otherwise have been possible. Supportive national policy was essential; it underpinned the initiative. Yet national policy also generated uncertainties for the initiative (could it be implemented before national policy changed?) and its potential replication (would government policy continue?) Incorporating ICT presented its own governance challenges, including questions over the continued reliability of software and a need for expert skills in setting up and maintaining the project. Addressing these uncertainties resulted in the initiative taking certain decisions and following particular governance paths. Crucially, this included partnering with Greenchoice, with associated outsourcing of responsibilities for data management. More broadly, navigating these uncertainties appears to require governance arrangements that provide ongoing institutional support, including involvement in training on ICTs and accreditation.

#### 4.2. Project Z, Germany

Project Z was a 'peer-to-peer' electricity trading trial in two neighbourhoods, bringing together households with and without solar PV. The trial enables the former to sell their surplus and the latter to buy 'green' locally generated electricity from the neighbourhood, using a distributed ledger (blockchain) technology to capture and process data and a 'private wire' from the public network to connect households that signed up to the project (Figure 2).

Project Z was the most technically ambitious of the case studies outlined here, also the most market-oriented. It was set up by a large electricity supplier/retailer that also owned the local DNO, in 2019. All functions were provided and performed by the supplier,

including the distributed ledger technologies that provided a ‘chain of trust’, linking sensors and smart meters to the Project Z market platform and to the company’s billing software.



**Figure 2.** Actors and relationships for Project Z.

The arrangement was simple from a customer perspective; the technology was intended to handle the complexities of trading. In terms of joining the Project Z community, once a participant had adopted solar PV and a smart meter, they simply signed up for a special neighbourhood electricity tariff with access to an online platform that offered real-time tracking of electricity use (whether sourced locally or via the grid). Additional, non-locally generated power could be supplied by the Project retailer utility or another licensed supplier.

In structural and organisational terms, Project Z was seen by the supplier as a potentially attractive new service to customers in a changing market. From a customer perspective, no direct energy trading occurred between households, but each had the familiar arrangements of a bilateral contract with Project Z, which offered import and export tariffs slightly more favourable than the normal tariffs from the suppliers who provided any additional (non-locally sourced) electricity and who handled regulatory and compliance issues. To incentivise participation, a reward scheme paid ‘community coins’ to customers for using electricity generated within the pilot. These could be spent on goods and services from local affiliated companies. The pilot thus involved sophisticated control, monitoring and billing arrangements while maintaining familiar supplier-customer relations.

In governance terms, Project Z can be seen as a top-down attempt to innovate at a micro-scale that was novel for a large energy utility. It represented a shift in thinking in that respect but relied on high-level policy and agency (e.g., the technical expertise behind the blockchain arrangement), and required little local knowledge, skill or decision-making. Much of its potential impact was therefore likely to depend on the effectiveness and cost of the new technology (distributed ledger/blockchain) and on whether customers accepted the outcomes. The initiative experienced a variety of emergent governance issues. They included creating and coordinating a space to develop and trial peer-to-peer energy trading at the interface between the energy supplier and local network operator. This emergent issue was largely dealt with in-house, across different divisions of the multi-national utility company. The initiative thus benefitted from operating within a single company that owned and operated both the local network and a licensed supplier, each providing concessions and space for the initiative to operate. Given these unique circumstances, it is not clear how the initiative could be replicated where such an alignment does not already exist; at the least, this would create additional governance issues.

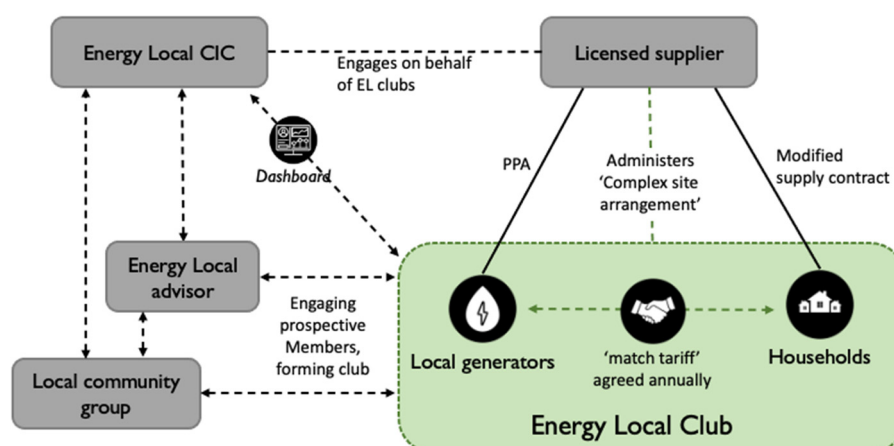
A further governance issue is the management of blockchain technology and its accountability to customers. There would seem to be tensions between claims made for blockchain—that it is largely self-sustaining and removes the need for trust between

parties—and requirements for accountability, intelligibility and ease of operation in a blockchain-based system [52]. In this case, trust and acceptance appear to have allowed the initiative to proceed. If it is to be used more widely, then new governance practices are likely to be needed to meet such requirements.

#### 4.3. Energy Local, UK

Energy Local offers a flexible, federal-style model for local renewables-based energy initiatives—Energy Local Clubs (ELCs). Each club is set up as a registered cooperative of generators and consumers (mostly households) and operates a ‘complex site’ arrangement in partnership with a licensed supplier. Within each ELC, the locally generated renewable electricity is shared equally by members and paid for on a ‘match tariff’ agreed by them annually. This results in a higher income for the generators and lower bills for households than would be the case if electricity were exported to the grid and then purchased in the normal way from incumbent retailers.

The first club was set up in 2017 in Bethesda, North Wales, enabling 100 households to access electricity from a local hydro plant. At the time of this study, there were approximately 20 ELCs at different stages of development, with the Energy Local Community Interest Company (CIC) acting as a development ‘hub’ that coordinates stakeholders, shares knowledge, and adapts the basic model to different situations. Expert Energy Local advisors act as ‘bridges’ between the CIC and each ELC. Central actors and relationships are more complex than in the preceding case studies, as illustrated in Figure 3.



**Figure 3.** Actors and relationships for Energy Local.

Smart meters are needed for all members to record half-hourly generation and demand data. The licensed supplier handles billing and supplies ‘additional’ power (imported from the National Grid) on a time-of-use tariff. The supplier also covers regulatory compliance issues and performs back-office functions including wholesale trading, metering and customer services. To allocate electricity distribution under the ‘match tariff’ to each member, the supplier runs a ‘fair share’ algorithm. A ‘virtual meter point’ at the boundary of the ELC is also used to measure the club’s electricity imports and exports to and from the grid, which are then taken to a national body (Elexon) for settlement, as the collective outcome of the complex site arrangement.

In governance terms, the EL model reveals further governance challenges and opportunities. It relies on community spirit, expert knowledge from the central hub and Club Advisers, and ICT for tariffing and visibility; it also relies on a licensed supplier—a crucial relational point. The model is designed to work within current regulatory protocols, yet it has taken several years to establish the necessary alliances, technological capabilities and ‘back office’ services. To work, it had to identify a little-understood and little-used regulatory exception (rules around ‘complex sites’) and align a range of actors around its founding idea (using locally produced renewable energy in local households). In large part,

this emergent governance challenge was navigated by using a cooperative structure and governance model to unite local producers and consumers in a single new organisation, which could then partake in a complex site arrangement.

Further governance issues arose while establishing and using the necessary smart metering, in developing and using the ‘fair share’ algorithm to allocate generation with demand, and in using this information to provide real-time information to members and generate accurate bills. Accordingly, there appeared multiple points of tension between the simplicity of the concept and the complexities of coordinating actors and technologies to make it work. Whilst financing the development and implementation of the model is an ongoing challenge, changes to national rules and regulations governing complex site arrangements have the potential to be more important for the model’s ongoing viability. Nationally supportive governance arrangements are required for the EL model to expand.

## 5. Discussion

A variety of governance challenges emerge in creating smarter, more localised energy systems by developing energy communities. In the following, we first summarise the emergent governance challenges across cases in answer to our first research question. Employing comparative analysis, we then address how cases responded and explore what general lessons for supporting transformative governance practices within and beyond local initiatives emerge.

### 5.1. Emergent Governance Challenges and Solutions across Cases

Table 2 summarises the emergent governance challenges identified in each case and their formative responses. Though each case is unique, there are commonalities between the broad challenges experienced and the points at which they emerge. They included:

- *Financing initiatives*, including pieces of kit such as turbines, and wider financing including staff time and community engagement;
- *Implementing and using ICTs*, including communication between ICTs as well as responsibility and oversight for their operation;
- *Coordinating between actors involved*, including identifying and engaging relevant actors, aligning actors with clear roles and responsibilities according to expertise;
- *Relationship between individuals, organisations and the community*, including role and responsibilities community members would play in initiatives.
- *Policy and regulation*, including locating supportive national policies, rules and regulations, understanding how they operate, and implementing projects within policy timeframes.

**Table 2.** Emergent governance challenges and responses within case studies.

	Buurtmolen Tzum	Project Z	Energy Local
Emergent governance challenges	Financing new turbine; implementing within policy window; regulatory changes reducing replicability; loss of government support	Coordinating between divisions of multinational company; management of blockchain technology and accountability to customers.	Identifying regulatory space for experimentation; aligning multiple actors and managing relationships; financing model development via the core team; uncertainty about continued viability of regulatory conditions
Formative governance responses	New governing body legally recognised; developing new forms of collective financing (i.e., crowdfunding); partnering and support from an innovative licensed supplier; national Postcoderoos scheme to promote local use of locally generated electricity	Collaboration between company divisions; new commercial relationships between participants as traders; trust	Adopting a cooperative structure for new club; external hub to guide development; partnering with local community organisations; cooperation with an innovative incumbent energy retailer who supplied expertise in tariffs and billing.

Initiatives responded to these challenges in different ways. A new governing body was established in Tzum, creating new relationships with community members, and a partnership with a licensed supplier was established to access national policy. Developing Project Z required collaboration between different divisions of the parent company, which effectively created a powerful ‘institutional home’ to provide technical and legal support for blockchain technologies. It also resulted in new commercial relationships between participants as traders. Meanwhile, Energy Local adopted a cooperative structure as a means of accessing a supportive national regulation. Both Buurtmolen Tzum and Energy Local relied on institutional support from national government policy and regulation as well as translocal networks in order to learn, develop and advocate for wider institutional change. Conversely, Project Z was constrained by a lack of national institutional support.

## 5.2. *Fostering Transformative Governance Practices within and beyond Initiatives*

Though limited in number, these cases, we argue, provide a variety of insights into governance arrangements and practices required to support system transformation.

First, the cases affirm what several previous researchers have found (for example, [53,54]): local initiatives to smarten local energy most closely resemble a process of bricolage rather than develop singular blueprints that can be translated to new contexts. Multiple socio-technical elements need to be assembled in varying socio-material contexts at particular times in order for initiatives to work. These needs correspond to one of the most fundamental governance challenges faced by smart local energy initiatives: assembling multiple socio-technical elements into configurations that work.

Beyond this grounding argument, we propose that creating effective governance of community-scale energy will depend more on addressing the social complexities of managing technologies and on building effective alliances than on developing technological solutions per se (too often assumed to be the case). None of the case studies could have functioned without new forms of cooperation between various actors including, most importantly, supplier/network operator and customers. In Buurtmolen Tzum, there is also a formal arrangement with an organisation leasing land for the wind turbine, while the Bethesda Energy Local Club operates through relationships between generators and consumers in the community, the Community Interest Company, the supplier, and Energy Local advisors, with additional support from the central Energy Local office.

Setting up such partnerships can be extremely difficult without professional help, which must often be brought in from beyond the community [51]. Mid-level established energy system actors, with their experience and networks, may prove very significant in bringing about workable and socially acceptable change [55]. These actors need training, and this is likely to require central, regional, and local government action—for example, training for market design and regulation, planning, and building management.

This, in turn, suggests that the boundary around an initiative, as well as who is involved and how it is governed, is not as clear cut as might be assumed from the outside. To work, all initiatives involved negotiated accommodations between various actors, some with strong connections to the locality, others with few if any connections, though all had knowledge and expertise of critical importance. Whilst this finding is conceptually unfortunate—as it suggests the boundary between the initiative and its wider context is often blurred—it has important implications for fostering transformative governance. It suggests that action to foster transformative governance capacities within initiatives is insufficient, needing to be accompanied by actions to support local transformative governance capacities.

To new interpersonal/interorganisational relationships, we can add a related point: Establishing smart local energy systems creates new human/technology alliances that need to be carefully managed. As a recent analysis of shared solar PV management in Australia concludes, ‘smart technology needs smarter management’ [56]. Members of an energy community will need to know who is responsible for its operation and outcomes. This may be local volunteers, with the risk that they may not be able to manage technical malfunctions

or organisational crises, or they may leave the community without an adequately qualified person to take their place. Technically sophisticated systems may rely on ‘black-boxed’ algorithms, and it may be difficult or impossible to identify those responsible for any shortcomings or failures and to hold them accountable [56,57].

These two crunch points—building effective alliances and addressing the social complexities of managing technologies—strengthen the case for a closer inquiry into governance capable of supporting transformative change that can match the technical and organisational innovations already underway. Our findings call for local governance that is agile (responsive to an experimental approach in a sector that urgently needs to learn and change), adaptable and responsive to new actors, activities, and circumstances. Such local governance arrangements need to facilitate interorganisational connections to similar local initiatives and to established, resource-rich institutions. Such local governance needs to bring together different modes of action and to be open to learning and reconfiguration. There was some evidence that translocal networks (e.g., MAST and the Energy Local CIC) enabled learning among communities, strengthening their ability to assemble smart, local energy systems in and beyond their immediate locality.

The different scales and types of activity found in our case studies, and the many individual and organisational actors, would seem to support the argument for forms of polycentric governance, as proposed by Goldthau [14]; one where ‘Government holds the reins, but other parties can hold them alongside government’ ([58] p. 7). From the issues arising during the study of the NEWCOMERS energy communities, it became clear that local energy governance needs to address juridical, economic, technical, social and political dimensions of energy systems during the lifetime of an energy community. For example, specific issues relating to smart local energy may call for energy planning to be integrated with land use and general infrastructure planning, and for expertise in relatively new fields such as data protection and cybersecurity. Some such changes in governance are already underway [58,59], opening opportunities to adapt their lessons to local conditions.

## 6. Conclusions

In this paper, we have explored practical issues arising from a move towards increasingly smart local energy and derived some lessons from three case studies for fostering governance arrangements, processes and practices that are capable of supporting such system transformations. Two questions guided the analysis.

In answer to the first question—what governance challenges arose and how were they dealt with?—we identified five central points at which challenges emerge: (1) financing, (2) implementing and using ICTs, (3) coordinating between actors involved, (4) relationships with the community and (5) policy and regulation. In answer to the second question—what implications can be derived from this for fostering transformative governance practices within and beyond local initiatives?—the cases affirm how developing smarter local energy initiatives involves a process of assembling multiple socio-technical elements—in particular, socio-material contexts. Smart local energy cannot be simply translated from elsewhere; it must be assembled anew in each locality. We identify this as a foundational governance challenge for all smart local energy initiatives.

Beyond this, our research suggests that creating governance capable of supporting system transformation of community-scale energy will depend more on addressing the social complexities of managing technologies and on building effective alliances than on developing technological solutions per se. In each case studied, multiple actors needed to be aligned for smarter, more localised energy to work, such that differentiating those within an initiative and those outside an initiative was problematic in analytical and practical terms. Such difficulties in bounding initiatives from their local contexts have important implications for supporting change. They point to a need to develop transformative governance arrangements and practices both within individual initiatives and in the socio-technical contexts in which they operate. Our cases suggest both local and national levels of governance are important.

The case studies thus offer insights into characteristics, possibilities and challenges to be found in smart local energy and into the importance of alliances between actors in order to gain access to skills, expertise, legal validity and operational support. They also call for and point towards the need for local governance within and beyond initiatives that is agile in operation and responsive, as well as able to learn quickly in order to negotiate through rapidly evolving regulatory, policy and technological environments.

That said, smart local energy is an elastic concept, and smart local energy systems are still in the early stages of development. Our cases and findings need to be considered in this light. Further investigation beyond Europe and analysis of smart, local energy systems developed by different actors could test and strengthen or refute the findings presented here.

The direction of travel for our energy systems is being shaped in part by the international climate and development goals, in part by the changing economics of supply and demand, and in part by political and geophysical interests, events and emergencies; it is far from settled. We conclude that the future of smart local energy will depend to a large extent on willingness and skill in opening up appropriately scaled forms of governance both within and beyond local initiatives.

**Author Contributions:** Conceptualisation, S.D., J.B. and P.H.; methodology, S.D., J.B. and P.H.; formal analysis, S.D., J.B. and P.H.; investigation, S.D., J.B. and P.H.; resources, S.D. and J.B.; data curation, J.B. and P.H.; writing—original draft preparation, S.D.; writing—review and editing, J.B.; visualisation, J.B.; project administration, S.D.; funding acquisition, S.D. and J.B. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the Horizon 2020 Programme, grant number 837752.

**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the School of Geography and the Environment at the University of Oxford (SOG 1A-2020-16 on 18 February 2020).

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** Data are available on request.

**Conflicts of Interest:** The authors declare no conflicts of interest.

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