Title:

Community energy business model evolution: a review of solar photovoltaic developments in England

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Abstract
The ongoing energy system transformation process is placing citizens and communities at the heart of future energy systems. To date, their participation has focused on the ownership and control of renewable energy installations facilitated by supportive national policies. Yet across many European countries, policies that have previously supported the deployment of small-scale renewable projects are being withdrawn. Social innovation and the evolution of business models are needed if citizen participation is to continue and succeed in this new policy landscape. At the same time, few business models stand still. This paper reviews the evolution of community energy business models in England to provide insights into the potential of community participation in the energy system post subsidies. Concentrating on community solar photovoltaic projects as the cornerstone technology, this review identifies and critique three archetypal business models as sequentially dominating English community renewable energy to date. Using insights from both Science and Technology Studies and Transaction Cost Economics, it explores the drivers and origin of these models as well as resulting community benefits. Looking forwards and by reviewing current activity, this paper identifies new intermediary actors as playing a key role in facilitating and brokering new, increasingly complicated and commercial community energy business models. We argue that this marks a significant break from the past and may, in time, offer more opportunities for community participation in energy system transformation. Moreover, it offers some communities the possibility of staying small and retaining their more radical potential.

Word count: 8582

Keywords: community energy; business models; solar photovoltaic; power purchase agreements; transaction costs; intermediaries

Abbreviations: CAfE, Community Action for Energy; CE, community energy; CE PV, community solar PV; CIC, Community Interest Company; DNO, District Network Operator; EIS, Enterprise Investment Schemes; EST PV, Energy Saving Trust PV programme; FITs, Feed-in Tariff scheme; LCBP, Low Carbon Building Programme; NDA, non-disclosure agreement; O&M, operation and maintenance; PPA, Power Purchase Agreement; RCEF, Rural Community Energy Fund; RESP, Renewable Energy Support Programme; ROCs, Renewable Obligation Certificates; SEIS, Seed Enterprise Investment Schemes; SITR, Social Investment Tax Relief; UCEF, Urban Community Energy Fund

1. Introduction

After years of being marginalised as consumers, citizens are being placed at the heart of energy systems. In its most recent energy package – Clean Energy for all Europeans – the European Union for example seeks to place citizens at its core, empowering them to become 'fully active players' in the energy transition [1]. This implies an increasing involvement of citizens in the production, storage, distribution, and use of energy, as well as potential ownership of distribution networks, participation in energy markets and energy service supply. Achieving this ambition relies on social innovation, including the development of new community energy business models. For its part, the EU has pinned its hopes on the continued development and diffusion of community-based approaches to the sustainable production and consumption of energy.

Community activity, as well as policy and researcher attention, has for the most part focused on community control, deployment, and sometimes use, of renewable energy, such as onshore wind turbines and solar photovoltaic (PV) installations [2–4]. Nonetheless, community renewable energy projects typically remain a 'niche' part of overall energy systems [5,6]. This is the case across a variety of European countries, including 'pioneer' Denmark, where community action began in the 1970s and is largely viewed as being responsible for the development and success of onshore wind energy projects [7,8]. In 2002, community ownership of onshore wind in Denmark peaked at approximately 40% of turbines installed, with over 150,000 households owning shares in wind power cooperatives. In Germany, another pioneer of community energy, the technology of choice has been solar photovoltaic (PV) installations. In 2015 there were an estimated 973 energy cooperatives active in renewable energy generation, mainly from solar PV installations [7].

Solar PV has also dominated community renewable energy projects in England and the UK in general, which is considered to be an 'early adopter' of community energy [9,10]. In 2009, communities owned approximately 4% of solar PV installations in England as a result of pioneering projects in a comparatively nascent solar PV market. Although the community share of this rapidly growing market has subsequently declined to less than 2% in 2017 (Figure 1), community energy has nonetheless experienced rapid growth in this period (Figure 2). Solar PV now accounts for over 80% of community energy projects in England [9,10].

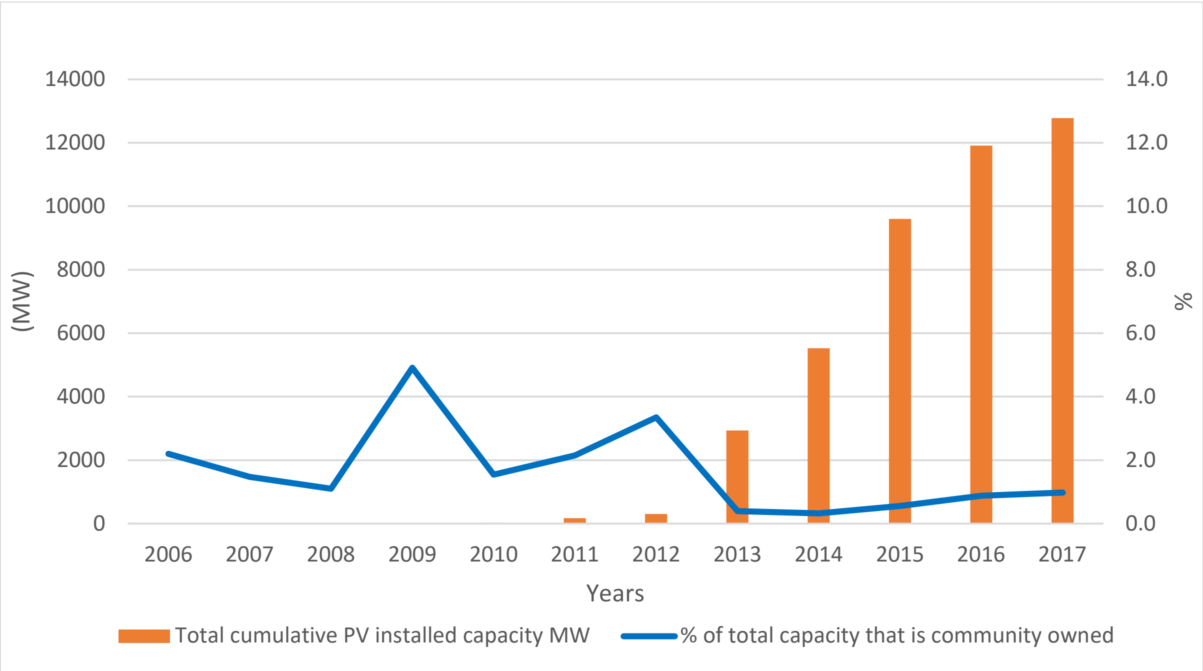

Figure 1: Share of CE PV generation capacity in England (compiled by authors based on data kindly provided by Scene Connect and own data sources, details of which are provided in section 2)

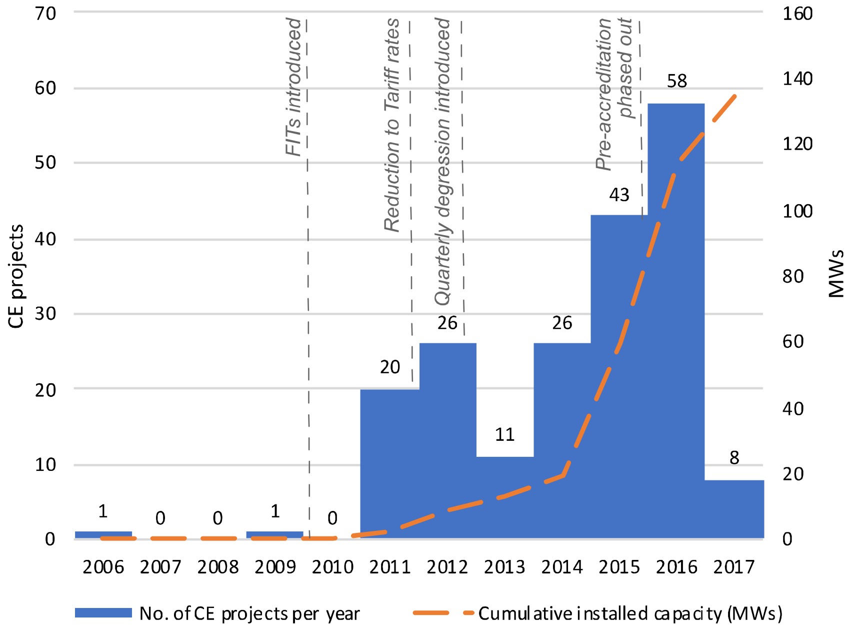

Figure 2: New community projects per year and cumulative community PV generation capacity in England

(compiled by authors based on data kindly provided by Scene Connect and own data sources, details of which are provided in section 2)

The abovementioned countries have a common history of national policies designed to support the deployment of renewable energy technologies, which have provided communities, as well as commercial developers, a space in which to develop renewable energy projects. England and the UK in general are no exception. The introduction of a Feed-in Tariff scheme (FITs) to the UK in April 2010 is widely regarded as having spurred the rapid expansion of community renewables projects [10–12]. Subsequent changes to the FITs and surrounding policy, in 2012 and 2015 in particular, are widely acknowledged to have been the cause for decreased community activity in the following years [2,10]. Despite these setbacks, business model innovation around the FITs provided the basis for developing community renewables projects where a dedicated and skilled team could provide the necessary input to keep the project going despite policy, regulatory and planning uncertainty at various stages of the development process [5,13–15]. Since 2015, community renewable energy in England and the UK in general is widely believed to be in a state of flux, since 'community energy is not quite subsidy free and remains reliant upon government support' [9].

Community energy therefore appears to be largely dependent on a supportive policy and regulatory landscape. However, this conclusion puts the future of English and overall UK community energy in doubt. In April 2019, the UK FITs closed and with it the number of new community energy groups and projects is expected to further decline from already low levels although a peak in activity is anticipated before the FIT cut-off date (April 2020) for pre-registered community energy projects. Continuing social innovation and business model development is needed to survive in this new policy context. This leads to this paper's primary focus: the development and evolution of community renewable energy business models. To date, there have been no longitudinal studies reviewing how community renewable business models have evolved, the reasons for their evolution or the effect on the associated community benefits. Moreover, given that many national policies that have supported community energy projects have closed, a deeper understanding of the evolution and present state of community renewable business models is pertinent, if not overdue. The paper therefore addresses the question: how have English community renewable business models developed over time?

The first contribution of this paper is to review the evolution of community renewable business models in England between 2000 and 2019. In doing so, this paper charts the increasing commercial focus of community action and addresses how the benefits associated with community renewables projects have evolved. Its analysis focuses on the development of community PV projects as this has dominated activity to date and comprises 80% of installed community energy capacity [9]. This review subsequently outlines three archetypal community PV business models as having played a key role in the evolution of community renewable energy to date (henceforth, CE refers to community solar PV). The second contribution of this paper is to review current activity and possible future development pathways given major shifts in the policy landscape. It subsequently outlines a fourth emerging business model archetype, based on the increasing involvement of intermediary actors.

The paper is structured as follows: Section 2 introduces the analytical framework and conceptual foundation on which community energy evolution has been approached. Section 3 reviews the evolution of CE business models in England from 2000 to 2019. Section 4 discusses key trends in this longitudinal investigation of community business models. Section 5 outlines a fourth potential business archetype in which intermediary actors are taking a leading role. Section 6 concludes.

2. Analytical framework and research approach

This paper draws on three separate research projects, undertaken between 2009 and 2020, and on experience working with UK community energy initiatives as well as with the former UK Department of Energy and Climate Change (DECC). These projects addressed the rapid expansion of community activity following the introduction of the FITs, the ways in which community projects develop, and the emerging forms of community engagement in energy infrastructure. In total, over 100 semi-structured interviews were undertaken with community representatives, community members, installers, and local and national policymakers. These contacts and the websites of individual community energy projects provided qualitative data that underlie this analysis of business model evolutions, and quantitative data used in Figures 1 and 2.

To review and critique the evolution of CE business models we draw on the literature from Science and Technology Studies, which conceives technologies, such as solar PV or wind turbines, as embedded components of socio-technical systems [16]. Under this framing, attention is directed not only to the characteristics of technologies but also how they are mobilised within given institutional and social structures. Following this approach, we conceive of CE projects as comprising new arrangements of technologies, competences, institutional arrangements, business models and policy support which have come together in a particular, viable formation for that point in time [17]. Such configurations may appear to be 'temporarily stable' and their evolution need not be radical: in most cases, changes involve gradual altering of practices, of steady improvements in technology design and performance, or of minor adjustments to business models. Over time, these changes can amount to larger shifts in practice or 'socio-technical configurations'.

Viewed in this way, CE projects typically combine market available technologies with novel technical and social ideas, such as business models, in context-specific arrangements. In so doing, communities are said to perform 'configurational work' [18] and are influenced by learning processes internal to the community [19] and from the wider flow of ideas, knowledge and competences via intermediaries moving from project to project [13]. This implies that no two CE projects are alike. Rather, they share common elements, such as technologies, business models, funding sources etc., that are packaged together according to local circumstances and needs, and according to available policy and regulatory support at a given time. What distinguishes community-orientated projects from developer-led projects is the extent to which they follow participatory processes and deliver local and collective outcomes [20].

In applying elements of this approach, this paper seeks to review the key socio-technical dynamics that have influenced the evolution of CE business models over time, identify prevalent business models and critically examine the community benefits derived in order to provide insights into the future development of community renewables. This analysis is guided by prior work on community renewables that suggests national government policies play a central role in determining the successful development of projects [11,21], and by work on science and technology policy which shows how national renewables policies are heavily influenced by the rate of technological development and progression [22]. In the review, particular emphasis is placed on understanding how these two dynamics (shifting policy support and technological development) have influenced the development of CE business models and their associated benefits in England, and the UK in general.

In practice, this approach focused on identifying, explaining and critiquing periods where qualitatively different business model archetypes were utilised (Figure 3). Its initial analysis was guided by the authors' prior knowledge of national policy developments, through which three periods were differentiated: pre, during and post the UK Feed-in Tariff scheme (FITs). Further, in-depth analysis led to the identification of a fourth, qualitatively different period, which splits in two the period covered by the FITs. This analysis was reviewed by community practitioners to validate and refine the proposed differentiation of CE business models with changes made in response to feedback.

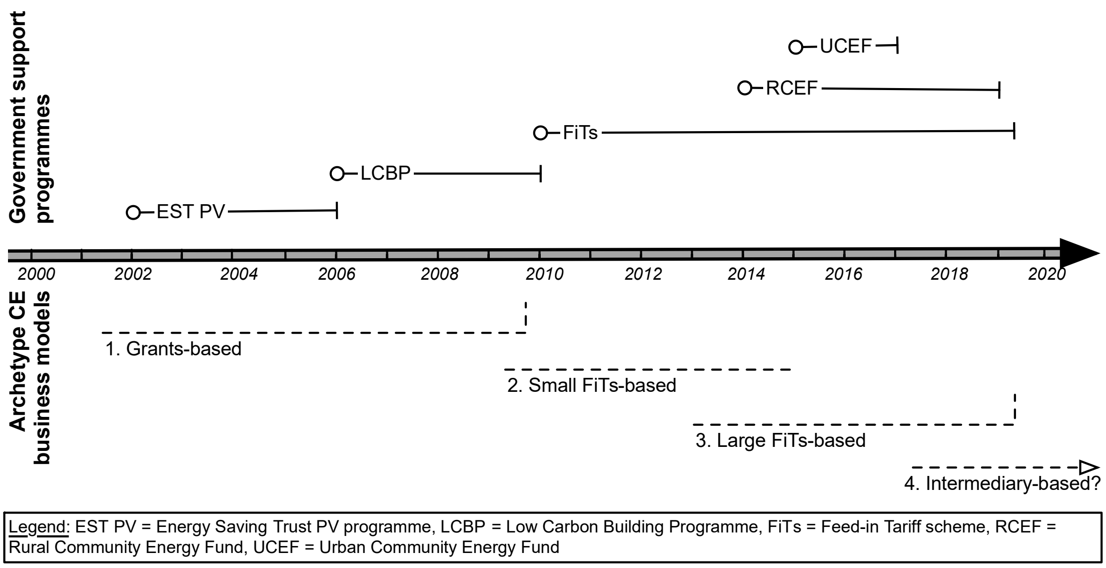

Figure 3: Timeline of direct government support programmes and archetypal CE business models identified (authors' own figure)

Finally, to further understandings of CE business model evolution, insights from transaction cost economics (TCE) are mobilised [23–27]. TCE is a central theory in the field of business strategy and explains why businesses exist, what their boundaries might be, and how they might govern operations. TCE focuses on the cost of voluntary exchanges, such as contracts between a business and client. Key transaction costs include [24]:

- *'Search and haggling costs* associated with tendering, identifying a potential client or contractor, verifying their suitability, preparing and evaluating bids, and selecting a preferred contracting partner';
- *'Bargaining costs* associated with negotiating and preparing the contract, monitoring contract performance, enforcing compliance, negotiating changes to the contract when unforeseen circumstances arise, and resolving disputes'; and
- *'Opportunism costs* associated with either party acting in their self-interest'.

TCE is used to help explain the operation of community renewable business models and why some models are more likely to succeed than others.

3. The evolution of CE business models

3.1 Community renewable business models based on grant funding (pre-2010)

3.1.1 Technological progression and policy support

Solid state solar PV devices have been under development since the late 1940's. From 1958 onwards, solar PV devices were being deployed in the space market to provide electrical power to satellites. By the early 2000s, and through continuous research and development activities, PV costs had dropped to the extent that various governments started providing incentives for deploying solar PV [28].

In the UK, piecemeal and inconsistent policy support meant that solar PV deployment was largely driven by niche innovators [11,22,29], including communities, typically as part of the alternative technology movement [30,31]. Grants provided the majority of support. Early grant programmes such as the Renewable Energy Support Programme (RSEP), launched in 1974, were intended to help develop and demonstrate a range of renewable energy technologies [32]. Specific support for solar PV emerged in the late 1990s with the SCOLAR Programme, through which £1m was provided for 100 small solar PV systems. From the turn of the century onwards, a range of government support programmes, such as Community Action for Energy (CAfE), were launched to help community initiatives to form, network and develop capacities before taking on a range of energy efficiency and renewable energy projects[1]. In 2002, the Energy Saving Trust Photovoltaics programme was introduced, providing grants to support PV installations. The first government programme specifically designed to support solar PV deployment at community and household scales was the Low Carbon Buildings Programme running from 2006 to 2010 (LCBP).

In this period, governmental support for community engagement with renewable technologies was the result of various, largely instrumental, policy needs and objectives [33]. Frequently led by different government departments, support was often uncoordinated, poorly designed, hurriedly administered and regularly cut short. Each programme was typically oversubscribed and limited participation to grant winning organisations [34]. As a result, CE came to occupy a malleable space in which a variety of actors were able to participate, concurrent to the dominant, centralised technologies, actors and institutions responsible for mainstream energy provision [33]. Communities had to be nimble and resilient to make the most of these opportunities within a shifting policy landscape.

3.1.2 Community PV business models

[1] For a good account of this early policy history see [33].

The result of years of technology development and varying government support meant that by the turn of the century, an archetypal CE business model had coalesced (Figure 4). Reliant upon grant funding, it began with an application by a community group to a grant awarding body. Eligible communities subsequently received Grant Offer Letters. A consultant was then hired by the community to complete a feasibility study, followed by a delivery partner (usually an installer) if the project was thought viable. Permission for a grid connection from the District Network Operator (DNO) was subsequently obtained before the solar PV system was installed. With evidence of project completion, the community group received certification and was able to cash in their grant [35].

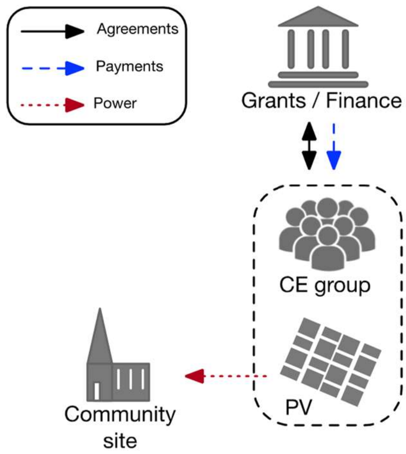

Figure 4: CE business model archetype based on grant funding

These PV installations were typically small (less than 4 kWp) and were installed on community buildings with that building benefiting from the electricity generated. Surplus electricity was fed into the grid, but at very small amounts, and was considered inconsequential to the District Network Operator (DNO). The business model was underpinned by grants and was 'savings-based', deriving its revenue from substituting power purchases on the community site [36].

Grants provided support for communities aspiring to own renewable generation projects and certainty for winning groups. They facilitated access to market finance, making projects economically viable. The resultant business model focused on grant specifications and the application process. Groups benefited where they had previous grant writing expertise. Grants also proved surprisingly good at developing a thriving community ecosystem despite the fact they could only ever support single projects: further grants were required to expand group activities.

3.1.3 Community benefits

Towards the end of this period, academic and policy attention increasingly sought to better understand, assess and quantify the diverse benefits frequently associated with CE projects [33,35,37–39]. Reducing carbon emissions, increasing social cohesion, changing behaviours, tackling fuel poverty and developing energy independence include a few of the many benefits thought to stem from community activity on energy. Multiple research projects subsequently showed how no single factor dominated the motivation, expected results or realised outcome of community projects [38]. Over time, it became accepted that the potential benefits of community activity were diverse, hard to pin down, qualify and quantify [40,41].

Within policy and academia, discussion of benefits spilled over into a questioning of what counted as CE. The interpretive flexibility with which government had supported activity to this point meant there was little coherence over what constituted 'community energy' within government policy or practice. For instance, available data from this period under the label 'community' or 'community energy' often included local authorities, housing associations and schools as well as community associations and un-constituted neighbourhood groups [35,42]. Academics were also trying to identify the diversity of understanding that make community renewable energy projects different from other renewable energy installations [20].

Despite this ambiguity, the primary benefit of CE projects appears to have been environmental. The evaluation report of the LCBP suggests that environmental reasons scored highest for installing renewables (22.7%) while reducing energy bills (15%) and self-sufficiency (14.4%) were deemed less important [35]. Environmental benefits also topped the list of a survey of community projects in 2008 [43] which found saving money was considered the third most important benefit while conserving energy/resources and benefitting/strengthening the community were deemed more important. These findings suggest that community groups were not primarily driven by the possibility of earning a return on investments.

3.2 Small community PV projects based on FITs (2010-2015)

3.2.1 Technological progression and policy support

Between 2009 and 2014 solar PV module costs declined by 75% [36]. Mass deployment, especially in Europe, and rapid growth of solar PV cell production, especially in China, provided the main stimulus. In April 2010 the UK Feed-in tariff scheme (FITs) was introduced. The new policy resulted from a rare period of agreement across political parties as to how the country was to power itself: the dual challenges of climate change and energy security meant a move away from large-scale fossil fuel power stations to increasingly small, decentralised local and community energy technologies. The 2009 Renewable Energy Strategy, written by the then Labour government, stated that the purpose of the FITs was to bring 'renewable electricity generation into communities around the country' [44]. The Conservative opposition agreed: power was to be put in the hands of the people [45].

The FIT was designed specifically to encourage electricity generation by actors inhibited from doing so by the traditional producer/consumer divide [46]. The FIT was open to all, including community organisations but also householders, businesses and schools[2]. Community projects, it was anticipated, would fall into the small (below 10 kWp) to medium size scale of solar PV systems (below 50 kWp)[3]. Multiple changes were subsequently made to the FITs over the years as a result of falling technology costs, higher than expected deployment and subsequent attempts by government to reduce 'excessively high' rates of return and limit scheme expenditure [47] (Table 1).

Table 1: Summary changes to UK FIT policy of relevance to CE project development

Nov. 2011	Proposed changes to Tariff rates, sparks legal challenge
Mar. 2012	Reduction to tariff rates (top rate by over 50%) after successful legal challenge
Apr. 2012	Minimum building energy efficiency requirement introduced for installations below 250 kWp; Multi-installation tariff rate introduced at 80% of relevant single tariff
Aug. 2012	Reduction to tariff rates (top rate by around 25%)
Dec. 2012	Pre-registration for communities and schools introduced, providing tariff guarantees and relaxation of building efficiency requirement; introduction of quarterly degression mechanism
Apr. 2015	Revised definition of 'community organisation' introduced

[2] Local Authorities were the only exception up until August 2010, when a ban preventing them from selling renewable electricity was overturned.
[3] Personal communication with a representative from the UK Department of Energy and Climate Change, 2011

Aug. 2015	Revised Levy Control Framework calculations force sharp reductions to PV tariff rates (ultimately cut between 64% and 85%)
Oct. 2015	Removal of tariff guarantee for CE installations applying for pre-registration
Feb. 2016	Deployment caps for all technologies and capacities
May. 2016	Updated minimum EPC requirement for installations less than 250 kWp
Aug. 2018	Decision taken to close scheme at end March 2019
Apr. 2019	Closure of scheme to new applicants
Apr. 2020	Closure of scheme to pre-registered applicants

CE projects were also indirectly supported through Social Investment Tax Relief (SITR), such as the Enterprise Investment Scheme (EIS). EIS has been accredited with levering community investments in renewable energy because it rewarded investors who took on extra development risk: it enabled community groups to attract investment at a rate which allowed a significant reinvestment of profit for community benefits, increasing the overall viability of community renewable energy investment [48]. In 2015 however, community solar PV and wind projects were excluded from these tax advantages which resulted in a significant downscaling of CE ambitions [49].

From November 2014 onwards, aspiring community groups were also able to access the Urban Community Energy Fund and its rural equivalent, the Rural Community Energy Fund (UCEF and RCEF). These funds helped de-risk projects and get them ‘investment ready’ by providing funding for pre-planning development and third party (consultation) feasibility studies. In this way they acted in a similar way to grant funding under the previous period [50].

3.2.2 Community PV business models

The introduction of FITs significantly altered the landscape in which community PV projects were designed and delivered. It removed community groups’ previous reliance upon grants and encouraged the formation of ‘community enterprises’ with revenue-based business models. The FITs combined with EIS allowed community groups to develop their business cases and secure additional finance around a guaranteed source of income and grid connection [11].

With the introduction of FITs, a new CE business model archetype emerged (Figure 5). CE groups first procured at-risk finance (later also UCEF and RCEF) to hire a consultant to undertake a feasibility study and to arrange a roof lease. Transaction costs during this phase of project development were associated with identifying a suitable site before arranging finance. Transaction costs also arose from the need to identify suitable delivery partners (installers), verify their suitability, prepare and evaluate bids, and select one (*search and haggling costs*). A grid connection was then negotiated with the DNO, before the delivery partner installed the solar PV system. The group then submitted evidence of project completion to Ofgem (Office of Gas and Electricity Markets – the regulation authority) for accreditation and upon provision of a funding certificate, received the regular FIT revenue stream. Generated power was used by the host (community) building with excess electricity passed to the grid. The new business model, underpinned by FITs generation and export tariffs, thus enabled the community group to repay investors.

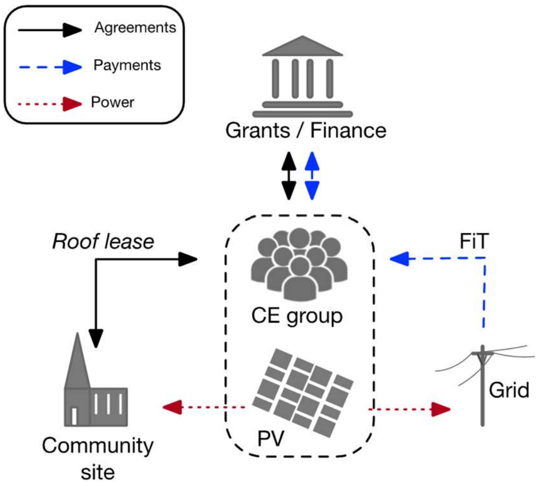

Figure 5: Small project CE business model archetype based on FIT finance

Between 2012-2015, 'tariff guarantees' for <50 kWp community solar PV installations shielded small-scale projects from tariff changes. In most cases, voluntary labour and strong commitment were the driving forces behind CE projects [38] but success also depended on becoming 'essentially pretty business-like about things'[4]. This business model, although requiring continuous adaption (e.g. as tariffs were reduced), proved remarkably resilient in the face of frequent policy changes, reductions to tariffs and changes to surrounding regulation (EIS, UCEF and RCEF).

3.2.3 Community benefits

Under the FITs, associated community benefits from installing PV systems were to gradually shift focus. Social and environmental benefits continued to be emphatically vocalised but economic benefits became increasingly salient. In 2011, a survey of community energy projects in the UK found that economic objectives, which included saving money on energy bills and generating money for the local community, were among the most prominent [38]. In 2013, income generation was ranked as the fifth most important reason for installing renewable energy alongside promoting renewable energy generation, improving self-sufficiency, reducing carbon footprint and regenerating economic, social and environmental aspects of the community [51]. The rise of FIT-backed community renewables projects also provided an opportunity for local residents to invest in, and benefit from, local assets through the use of community share offers. Such share offers increased 20-fold between 2009 and 2014 with energy the largest sector of investment [52]. Further local economic benefits arose during project delivery where local companies were used for planning, surveying, engineering and installation work [52]. Collectively, these economic benefits coalesced into a narrative of 'keeping money within the local economy' [53] and reducing energy 'leakage' where upfront investment and returns are retained within the local economy rather than passed to (often) international energy companies [54].

To many people, FITs heralded a new golden age in which empowered community groups were free to realise their potential unshackled from the inconsistent and frequently truncated policy support. Regular, guaranteed incomes streams meant that CE groups could subsequently undertake further energy projects, when otherwise they would have had to prepare new grant funding applications. "The concept is simple, a community develops a renewable energy scheme (helping to cut carbon emissions) and make money from energy sales, that revenue is then available to fund further carbon emission reduction measures in homes, businesses and community building" [55]. The extent to which this was realised remains unclear although anecdotal reports suggest that £2

[4] Personal communication with CE practitioner.

were saved from every £1 invested[5]. Nonetheless, planning and installing PV systems remained a formidable challenge to many community groups, which had to demonstrate grit and perseverance to succeed, even under conditions that look favourable with hindsight. As a result, delivering PV projects became the primary goal for many groups, and 'community benefit funds' the primary mechanism through which wider social and environmental benefits were to be derived [56].

Near universally promised, community benefit funds were often slow to materialise. Planning and installing the PV system took significant time and effort, after which CE groups had to wait for revenue to trickle in and accumulate, before deciding how it was to be allocated. The size of the fund was directly linked to the size of the PV system installed. An annual income stream of £80-£280 per kW of installed capacity provided modest returns for reinvestment into the local community: a typical 20 kWp solar array on a community building would thus generate between £1,600 to £5,600 per annum. The projected lifetime funds were significantly bigger: in 2015, 30 CE groups with operational funds were expected to generate £23m over their lifetimes [2]. Despite their initially modest size, such funds have been used to support an increasingly diverse range of organisations and activities, predominantly but not exclusively under the theme of 'sustainable living' [2]. Energy audits of community buildings, 'draught busting' events and fuel poverty advice have all been financed as well as remedial repairs for community buildings, insulations works, community gardening and heritage projects [2,57].

3.3 Large community solar PV projects based on FITs and PPAs (2013 +)

3.3.1 Technological progression and policy support

Following increased government interest and consultation with many sector representatives, the UK government launched the Community Energy Strategy in January 2014. The first of its kind and thick on rhetoric, it positioned community energy activity as desirable but essentially peripheral to mainstream energy generation, supply and use [58]. The strategy was described as 'unapologetically practical' by Ed Davy, the then Secretary of State for Energy and Climate Change, and yet was slim on new policy support [41]: it promised new funding to establish the UCEF, it pledged the creation of a 'one-stop' information resource for advice and support, and it committed the government to consider the recommendations from a number of national barrier-busting working groups. These steps provided some limited preferential treatment to community groups seeking to set up PV projects.

Meanwhile, further changes were made to FITs (Table 1). In 2015, the government again moved to cut tariffs due to concerns over scheme costs. Tariffs were subsequently cut harder and faster than expected, due to changes in how the national Levy Control framework was calculated [11,59]. In 2018, the decision was taken to close the FITs to all new applications in April 2019 [60]. For communities, regular tariff reductions encouraged the development of larger projects and the selling of electricity not only to host buildings but also through private wire connections (in the case of ground mounted systems) as a means to supplement income where previously it had been gifted. The sharp drop in tariffs in 2015 made this compulsory, as an increasing share of revenue was derived from electricity sales rather than FITs. As focus shifted to the selling of electricity through PPA contracts, large-scale solar PV developments and partnering with potential clients grew in importance. Overall, and despite a national strategy effervescing encouragement and support for community energy activity, from 2013 onwards, UK policy continuously pushed CE projects to operate in the same area as commercial players.

3.3.2 Community PV business models

[5] Personal communication

Reducing margins for small-scale PV projects subsequently pushed communities towards larger installations and encouraged further business models adaptations, which concentrated on the sale of generated electricity through long-term PPA contracts (Figure 6). PPA contracts require a two-step process involving complex legal negotiations which increases demand for at-risk capital. The ability or nature of borrowing also depends on the PPA contact, which makes it significantly more difficult for community groups to attract investors. This greater emphasis on client-contractor relations increases complexity and transaction costs.

The first step (Figure 6) in developing a large community PV project is the identification of a suitable client willing to commit to a PPA contract in close proximity to a suitable location to either host the solar PV system or just to purchase the electricity, which are associated with *search and haggling costs* for both client and CE developer. With an initial agreement in place, either the client or the CE developer source project finance for the feasibility study and pre-planning development. A non-disclosure agreement (NDA) is subsequently agreed between community group and client, to limit the risk of *opportunism* that either party pursue alternative business opportunities, and the client releases data for sites suitable for solar PV development. A third-party consultant is subsequently hired to undertake a feasibility study regarding site suitability. The community then contacts a delivery partner and the DNO, over the suitability of grid connections.

The second step of large-scale FIT and PPA backed CE business models commences with the client signing a PPA contract (Figure 6). With a PPA contract, the CE developer can then access finance, usually through a combination of a community share issue or bond offer plus loans, bonds/debentures and grants. With finance in place, the delivery partner is commissioned to install the solar PV system. Upon installation, evidence of project completion is submitted to Ofgem for accreditation, which triggers the provision of FITs upon delivery of power. The simultaneous delivery of power to the client enables the CE developer to start fulfilling its contractual PPA performance obligation. The client subsequently pays for metered electricity according to the PPA which covers installation costs plus interest to the community shareholders and the social investors.

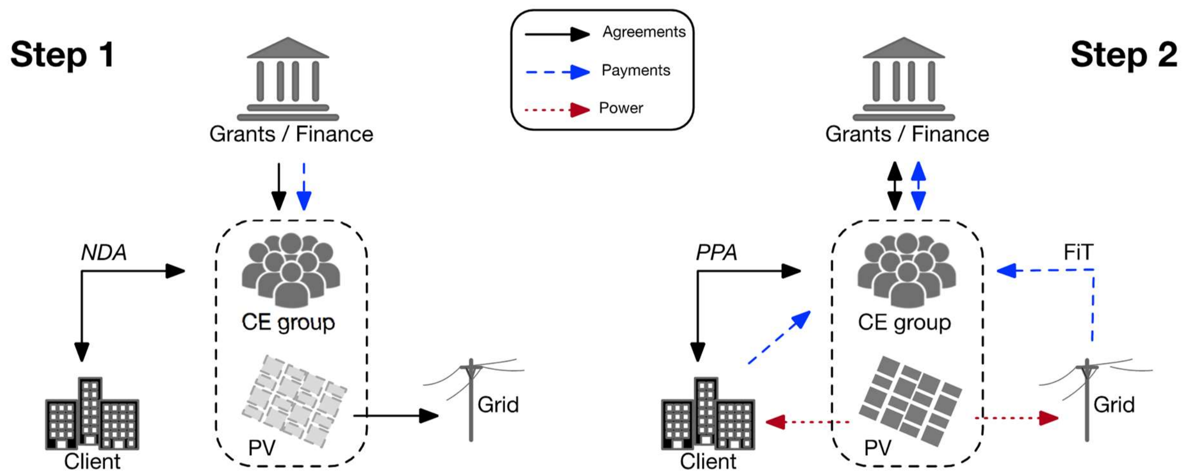

Figure 6: CE PPA archetype business model supported by FITs finance

Under this business model, the client also incurs transaction costs and these costs tend to be higher than partnering with commercial developers. This is because of the *search and haggling costs* associated with ensuring that the community group is a trusted partner and *bargaining costs* to mitigate against the risk of partnering with an organisation with an unfamiliar constitution, such as a Community Interest Company (CIC). Overall, transaction costs increased under larger, FIT supported, community PPAs because of the need to structure finance, evaluate proposals, (third party) operation and maintenance (O&M) and (third party) monitoring, reporting and verification [29].

However, these costs do not necessarily alter the overall development economics. Transaction costs remain high, but some are internalised compared to commercial developers, because of the voluntary time and dedication of community directors, and because of the understanding third party service providers that can accommodate delayed payments once the development has started generating income.

3.3.3 Community benefits

Larger CE projects entailed two principal benefits. Larger capacity systems displaced more fossil fuel generated electricity. They also entailed greater economic benefits. Just like small FiT-based projects, large PPA-backed projects also provided local business opportunities and opportunities for local investment. However, investment returns did not increase as projects got larger. At best, they stayed roughly the same. Large community PV projects also continue to provide financial savings to 'clients' but unless this is a local authority or school for instance, this benefit accumulates to the business rather than achieving wider social or environmental objectives [9]. Meanwhile, community benefit funds still play an important role and justification in project development but can no longer be guaranteed. For large, community FIT-supported PV projects, the sums generated can be significant: some CE groups, typically with multiple large projects, have been reported as generating £50,000 per annum in benefit funds [9]. But under PPA supported projects, a lot depends on the client. Commercial clients may demand lower electricity tariffs which reduces the potential for surplus funds to be used for community benefit. Where possible, community benefit funds have been used to support a wide range of local projects, as outlined above.

Large CE projects also have a number of negative outcomes rarely recognised by existing literature. Grid defection, through behind the meter generation or private wire supply, conveys benefits to the client and the community business, but not to the wider community or the grid as a whole [61,62]. Where clients receive energy directly through behind the meter generation or private wire supply, they avoid the taxes and environmental and social levies which are levied on electricity grid users, increasing the burden on the remaining electricity bill payers. These taxes and levies are collected by energy suppliers, and account for approximately 20% of residential energy bills (2017 data) and are used to fund network costs, renewables deployment (i.e. the FIT), energy efficiency programmes and social policy (i.e. tackling fuel poverty). In the future, local residents may benefit from CE business models that supply electricity directly to their property by bypassing the grid infrastructure and doing so has the potential to financially benefit households involved and in some cases alleviate fuel poverty. Nonetheless, the wider societal impact is potentially catastrophic (see Australian experience [63]). Ofgem [64] also takes this issue seriously and is looking to ensure grid defection does not spiral out of control, increasing the financial burden of the public grid on users in the future.

3.4 Emerging post subsidy community PV business models (2019+)

The FITs subsidy closed in April 2019 although communities and schools who applied for pre-registration before this date are still entitled to accreditation if they complete their application within their pre-registration validity period (up until April 2020). Once this validity period ends, there will be no provision to support community renewables projects in place. Despite promises of a 'Smart Export Guarantee, for many commentators the future of community PV projects looks bleak [10,65]. However, a variety of post subsidy business models are emerging. Four principal models exist:

1. One model sees existing assets acquired post-construction. In 2017, this accounted for the majority of new solar PV installations brought under community control [9,66]. The acquisition of existing assets removes transaction costs associated with planning and

installing new solar PV installations while new *search and haggling costs*, *bargaining costs* and *opportunism costs* arise from searching for and negotiating the purchasing of existing installations. In many instances, such acquisitions are being brokered by intermediary organisations, such as Communities for Renewables[6], who both negotiate on behalf of the community group and assist in raising finance. The costs associated with professional services may increase development costs in the case where community groups had worked previously on a voluntary basis, as transactions are no longer internalised. Under this model, a PPA contract for selling energy to a licensed third-party electricity supplier may be transferred as part of the acquisition deal.

2. A second model sees community groups partnering with an established utility to develop renewable energy projects. Such partnerships minimise transaction costs because *search and haggling costs* are restricted to identifying a company with a track record of partnering with CE developers. Similarly, *bargaining costs and opportunism costs* can be kept to a minimum where community groups have experience with partnering. This model neither challenges incumbent systems nor replaces existing infrastructures.

3. A third discernible business model sees the refinement of existing PPA models through the incorporation of onsite electricity storage. This business model enables more sophisticated PPA contracts with the same transaction costs described above. At the time of writing, a number of business models are under development and this avenue promises some protection from diminishing financial returns in the future, although additional income streams through the provision of grid services (flexibility) are currently not sufficient to warrant the installation of storage.

4. A fourth business model currently discussed (e.g. [9]) involves 'sleeving'. Sleeving is reminiscent of virtual power stations and allows generation to be matched with remote clients to create a proxy supply relationship without geographical constraints. It is variant of a standard PPA contract between a licensed electricity supplier and a generator although its purpose is to link generation with clients. Despite sleeving requiring partnering with an electricity supplier, clients may purchase electricity directly from the generator. Imbalance risk is managed by the licensed electricity supplier whilst using the grid also incurs a cost [67]. There is not much experience with sleeving among community groups, but it is clear the transaction costs of arranging a sleeving contract are likely to be high in the absence of appropriate intermediaries capable of avoiding search and *haggling costs, bargaining costs, opportunism costs* and the 'reinvention of the wheel' in general.

4. Discussion

This analysis makes an important contribution to existing research, which to the authors' best knowledge has not addressed the evolution of community renewables in England nor the UK in general in any depth before [e.g. 9,30]. It also provides a means to critically interrogate the evolution of community renewables projects over time and highlight the following observations.

First, whilst reductions in the price of PV panels has played an important role (increasing access to the technology and bringing overall costs down) CE businesses have to a greater extent been shaped by national policy support. Pre 2010, the provision of various grants provided a valuable, if fluctuating, means for aspiring community groups to unlock project finance and deploy small-scale PV projects locally using a grant-based savings business model. The introduction of FITs in April 2010

[6] http://www.cfrcic.co.uk/

created the possibility for further communities to develop projects on the back of guaranteed returns, using a subsidy-based revenue business model. This support has provided the cornerstone to community engagement with PV projects since then but not without issue. Whilst community engagement with FITs has received support through pre-registration, the relaxation of energy efficiency requirements and the RCEF and UCEF, frequent policy changes and the introduction of quarterly digressions have subsequently determined which communities could, in practice, negotiate and install PV systems.

Reducing government support has progressively pushed CE projects to operate in the same area as commercial developers, using contract and revenue-based business models (see Figure 7). In short, changing government policy has been the key, if not sole, driver that has shaped the evolution of CE projects. This is not unexpected, as the incorporation of renewable generation technologies have largely been undertaken as an exercise in technology substitution. Old fossil fuel power stations have gradually been replaced by renewable generation technologies within a highly regulated market.

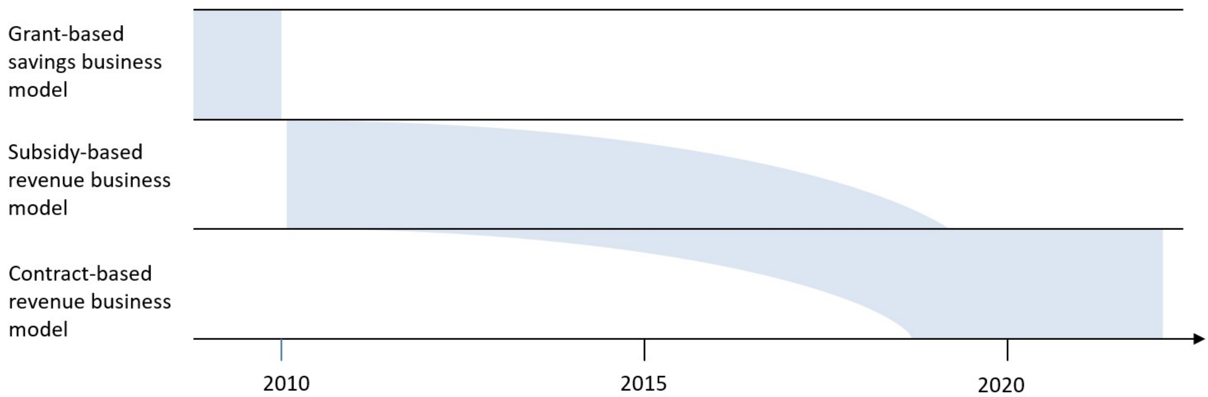

Figure 7: The evolution of English CE business models from saving and grant-based through subsidy to contract and revenue-based business models

In practice, the shifting policy and regulatory landscape has meant that the space in which communities could operate has narrowed. Our review clearly demonstrates how community PV business models have become more complicated over time. Emerging business models include more components (e.g. batteries, private wires), stakeholders or steps than those employed under FITs, and associated contractual arrangements are vastly more complex than saving-based business models supported by grant finance. In turn, community groups have had to adapt from loose community action associations into community enterprises into highly agile, commercial operations backed by expert knowledge, which need to compete with more profit orientated business operations [4,9]. The entry barrier for new groups has risen concurrently. Whilst the introduction of FiTs opened the possibility of many more community groups aspiring to own and control PV installations, the number of new groups successfully completing projects gradually declined. It now seems only those communities with prior experience and knowledge are able to develop further projects. This underlines how aspiring communities have had to be nimble, developing projects quickly where opportunities arose and resilient to frequent policy changes, adapting their business models as prices reduced and policy support shifted.

Adapting CE business models has further entailed revising community expectations about what they could do and what benefits could be derived from owning PV installations. As demonstrated in this review, expectations and associated benefits have shifted radically. Where previously communities were strongly motivated by environmental benefits of renewable energy deployment, opportunities for lowering bills and increasing social cohesion through savings-based business models, the focus is increasingly being concentrated on economic benefits, predominantly returns to shareholders and to a lesser extent local economic regeneration or growth. This focus has co-evolved with the increasing necessary emphasis on the sale of electricity and the growth of revenue-based business models.

This change has had implications for the nature of community participation in renewable energy generation. Previously the idea and basis of community action had roots in ecologically minded, deep green motivations of people coming together to challenge incumbent energy systems and develop more sustainable lifestyles [30,31,68]. Our review provides an explanation of why and how the current community renewables scene has been altered by its inclusion within national energy policy, shaped by pressure from the incumbent policy, regulatory and business regime to become increasingly professional and commercialised. Whilst recognising there remains a variety of motivations for engaging in CE and undertaking projects, this review indicates how the founding basis and critical edge of community action challenging incumbent practices has been reduced, if not entirely lost.

We find that this presents a challenge to current developments. A maturing cohort of communities are slowly becoming professional non-profit, social enterprises and in some case energy service companies, that enjoy high-level of trust, low transactions costs and self-sustaining business models. Yet the total number of ‘community-based’ enterprises is likely to remain low, with the vast majority of communities excluded from participating because of the need for expert knowledge and commercial experience which creates a high barrier to entry. As such, the previous political consensus, to ‘bring renewable electricity generation into communities around the country’ [44] and put power in the hands of the people [45] in England, is fading. Equally, the 2014 UK government aspiration [41], to see 0.5-3 GW of community owned renewable energy capacity in the UK by 2020 has largely been forgotten. If more communities are to engage with and set up their own locally owned and controlled renewable energy installations, then the direction of travel looks bleak but for a few developments.

Most newly emerging business models are being facilitated, configured and brokered by social enterprises with similar social, environmental and economic aspirations to those community groups. These organisations appear to share a common focus on facilitating and brokering new business models and contracts and enabling aspiring communities to own, control and benefit from PV installations. In large part, this is because the complexity of newly emerging PPA-based community business models is necessitating expert knowledge and commercial experience. We suggest that this represents a significant break from the past, where communities initiated and managed project development. In the next section we look at the emergence of these organisations, commonly referred to as intermediary organisations [e.g. 17,64], working to broker and facilitate community participation. We subsequently outline a fourth, emerging business model archetype.

5. An emerging intermediary-facilitated CE business model?

In the UK, several studies on the role of intermediaries in supporting the growth of community energy have been published in recent years [5,14,69–71]. In 2014, Seyfang et al. [14] deemed intermediaries important but insufficient for the development of a community-based approaches to energy. Tacit knowledge, trust and confidence were considered more important for project success, but are difficult to diffuse. Today, the roles associated with intermediaries appear to be equally diverse, if not more so. They are also likely to be evolving rapidly as a result of a maturation of activity and the shifting governance and regulatory landscape. For CE projects, one role in particular, brokering and managing relationships, is taking on increasing significance.

Table 2: A selection of contemporary CE intermediary actors and the roles they undertake (CE intermediary roles adapted from Hargreaves et al. (2013) with authors analysis of CE intermediary activities based on organisation websites)

	Centre for Sustainable Energy	**Community Energy England**	**Community Energy South**	**Communities for Renewables**	**Energy4All**	**Low Carbon Hub**	**(Pure) Leapfrog (Launchpad)**	**Regen**	**Share energy**
Initiating new groups	✔		✔	✔	✔	✔		✔	
Sharing information and networking	✔	✔	✔		✔	✔	✔	✔	
Providing tools/resources	✔	✔	✔	✔	✔	✔	✔	✔	✔
Offering professional services (legal/financial etc.)				✔	✔		✔		✔
Managing or evaluating funding programmes	✔							✔	
Interfacing with policy	✔	✔				✔		✔	
Brokering & managing relationships			✔	✔			✔	✔	✔
Raising finance			✔	✔	✔	✔	✔		✔

In brokering and managing relationships, intermediaries can perform the role of an enabler, combining legal, commercial, financial and technical expertise through framework agreements to de-risk contractually complex PPAs, and to create replicable and financeable community business models. Another intermediary role is to facilitate the purchase of existing solar farms as alluded to in section 3.4. However, such intermediaries are less likely to have emerged out of existing community energy groups and hence are not considered for further analysis in this section. Local supply models, whereby PV electricity generated on multi-occupancy social housing is sold to the tenants, are also under consideration and in trials, but high transaction costs may limit their feasibility.

In brokering and managing such partnerships, these community intermediary organisations are providing dedicated, professional and informed assistance. They are combining legal, commercial, financial and technical expertise through framework agreements to de-risk contractually complex PPAs and create replicable and financeable CE business models. In doing so they help to lower the transaction costs that would normally be incurred by both client and contractor in establishing and executing the contract [29,77,83,85,86]:

- *search and haggling costs* by facilitating and coordinating transactions, often through established partnerships with key stakeholders such as DNOs;
- *bargaining costs* by reducing information asymmetries between clients, contractors and other stakeholders; and
- *opportunism costs* by reducing risk and getting different parties to commit to providing guarantees.

In practice, such intermediaries are developing standardised templates for PPA contracts and bundling of multiple projects within a single PPA contract to lower transaction costs and facilitate more community PV installations. Depending on the scale, these installations can be community owned but in cases of large demand underlying PPAs, ownership is de-risked by spreading it across multiple parties. These standardised templates can be considered Community Energy Framework Agreements (CEFAs).

Similar to the UK energy service market [29], CEFAs lower transactions costs by combining legal and organisational frameworks to facilitate PPA contract negotiation between individual CE developers and clients. Many of the intermediaries providing these agreements have emerged from successful community energy groups. For example, Community Energy South emerged out of OVESCO, a local community initiative from the town of Lewes in East Sussex following national funding to help set up 12 further local community groups. Others have emerged through their history of engagement with CE groups. For example, Leapfrog Launchpad emerged out of Pure Leapfrog to combine the expertise required by individual CE groups to succeed in a post-subsidy environment.

Where the intermediary is an established CE developer with a track record of project completion and brokering PPA contracts, they are more likely to be trusted by potential clients. Their status as a social enterprise facilitates the raising of capital more cheaply than potential commercial competitors could do, yet it is evident that these community intermediaries are pursuing an increasingly commercial approach. Their primary aim is subsequently to engage potential clients and develop projects to make them community 'investor ready' (see [72] and Figure 8).

An emerging intermediary-facilitated community PV business model can subsequently be outlined (Figure 8). An intermediary facilitated CE business model involves two steps, akin to a PPA-backed business model supported by FITs finance (described in section 3.3.2). The central difference being the intermediary organisation displaces the community from the centre, brokering sites, technologies, clients, NDAs and PPA Heads of Terms (HoT) and so forth. The intermediary can have varying levels of involvement and corresponding responsibility but may include the fostering of a 'community' to take on the project by signing an 'investment ready' PPA contract with clients. The CEFA recovers its costs by variously taking a share of the finance raised for feasibility studies or generated returns.

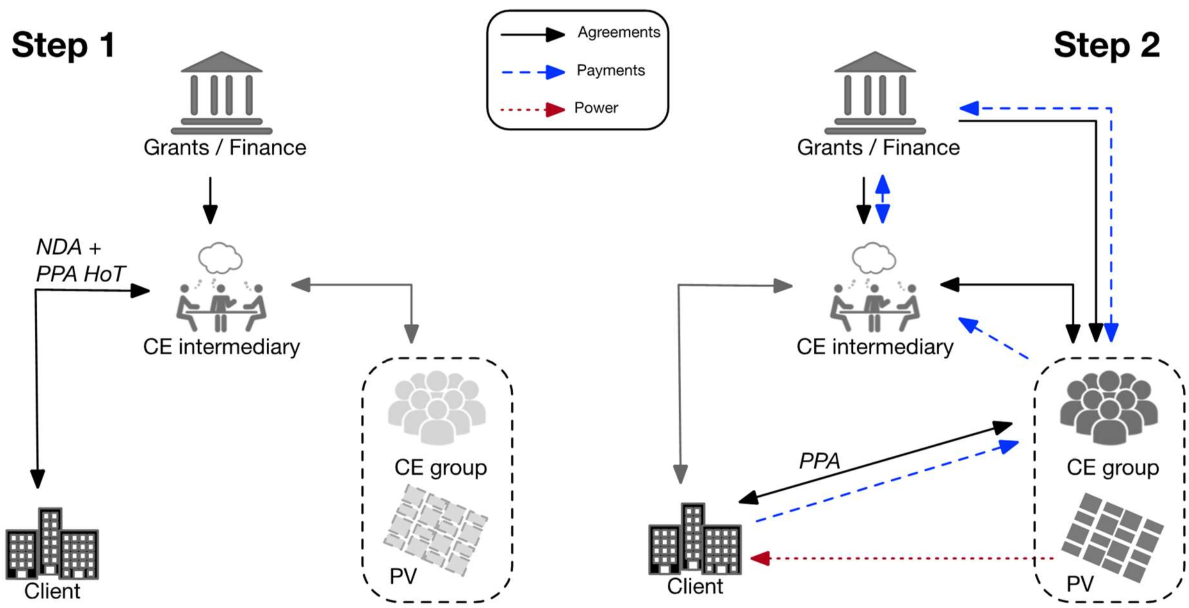

Figure 8: An intermediary-facilitated CE business model archetype

Deviations to this model exist. Leapfrog Launchpad for instance enables the establishment of a CEFA which takes responsibility of all commercial arrangements, including establishment and management of PPAs [87]. Others require a more active community role in land rights acquisition and feasibility studies. The emergence of such CEFAs points towards the increasing importance of intermediation and aggregation for sustainable energy systems in general [81,84,87,89]. They improve CE economics, although this is dependent on professional services fees against the overall profitability of the CE development. In future, and especially if the intermediary facilitated CE business model proves successful, less-community minded consultancies might enter this space to benefit from professional services fees and to act as a gatekeeper to knowledge and services. At the moment, however, margins do not seem attractive to commercial intermediaries.

6. Conclusion

With supportive policies such as FITs drawing to a close in many countries, questions are being raised about the future viability of community renewable energy projects. This paper reviewed the development of community PV business models in England as a means to critically investigate how community energy business models have evolved in the UK, the role of national policy and regulation therein, and the shifting benefits derived from both community action and business model innovation. In this process, a number of key trends have been revealed. First, this review supports previous contention over the highly influential role government policy and regulation has played at shaping how and where communities could own and manage PV systems. Second, it demonstrates the extent to which successful communities have had to be agile and resilient in the face of frequent policy changes and changing economics. Third, the review provides evidence of extensive and continual social innovation by communities to continually refine and adapt business models in order to make projects viable. Fourth, the review hints the extent to which community participation has been altered during this process, becoming increasingly professional and commercialised, with fewer players as barriers to entry have risen. Fifth, it points towards the emergence of intermediaries capable of improving the economics of community energy in a post-subsidy environment.

These trends are presenting a possible divergence of activity. On the one hand community energy is becoming the preserve of highly professionalised social enterprises backed by experience and expertise. On the other hand, the increasing complexity of community renewable business models appears to be spurring the growth of new intermediary organisations and business models that take much of the burden off aspiring communities to develop projects by themselves. This offers some hope for a wider variety of communities to get involved, particularly those with limited or no experience of engaging with the energy system or of managing infrastructure projects. Such intermediaries and their Framework Agreements lower transaction costs through their brokering services combining legal, technical, engineering and financial expertise alongside secondary market acquisitions and disposals. Through project bundling and financial market access, they also succeed in lowering production costs. But unlike before, there is no internalisation of costs, so not all production costs are reduced.

Such intermediaries therefore improve the economics of community energy and create routes to market in challenging post-subsidy environments. If such intermediaries succeed in de-risking the contractual agreements necessary for the sale of community generated electricity further, community energy will have a strong role to play in emerging local energy systems but it is unlikely to maintain its current form. Moreover, the next phase of energy system 'reconfiguration' will represent new opportunities and challenges for community action: as the variety of potential and necessary technologies rise, as more commercial players begin operating in this space, and as new roles and responsibilities emerge. The rise of intermediary organisations seeking to facilitate the involvement of new and existing communities is therefore a welcome development. Their rise could facilitate community access to owning renewable energy installations and help maintain a more critical edge to community participation in energy system developments.

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