A comparative analysis of the costs of onshore wind energy: Is there a case for community-specific policy support?

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Highlights:

- Policy support for community energy projects should be targeted at reducing early costs and risk factors.
- Hurdle rates are critical in determining the financial viability of projects.
- Shared ownership arrangements may help remove some of key challenges to community-only projects.

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Abstract

There is growing policy interest in increasing the share of community-owned renewable energy generation. This study explores why and how the costs of community-owned projects differ from commercially-owned projects by examining the case of onshore wind in the UK. Based on cross-sectoral literature on the challenges of community ownership, cost differences are attributed to six facets of an organisation or project: internal processes, internal knowledge and skills, perceived local legitimacy of the project, perceived external legitimacy of the organisation, investor motivation and expectations, and finally, project scale. These facets impact not only development costs but also project development times and the probability that projects pass certain critical stages in the development process. Using survey-based and secondary cost data on community and commercial projects in the UK, a model is developed to show the overall impact of cost, time and risk differences on the value of a hypothetical 500kW onshore wind project. The results show that the main factors accounting for differences are higher pre-planning costs and additional risks born by community projects, and suggest that policy interventions may be required to place community- owned projects on a level playing field with commercial projects.

Keywords

Community energy, onshore wind, ownership, economic costs, risk

1. Introduction

In order to inform the debate over the desirability of different low-carbon energy scenarios in the UK, recent research has started comparing the relative costs and benefits of policies aimed at maximizing the cost-efficiency of national energy infrastructure on the one hand, versus decentralised, place-based socio-economic regeneration on the other (Bolton & Foxon, 2013; Catney et al., 2014; Foxon, 2013; Johnson & Hall, 2014). Community-owned renewable energy projects are thought to be able to generate a number of local economic, social and environmental benefits over and above those which arise from commercially-owned projects, although benefits incurred are context-specific (Berka and Creamer, 2016; Seyfang et al., 2013). These benefits may range from socio-economic regeneration (Callaghan and Williams, 2014; Entwistle, Roberts and Xu, 2014; Gubbins, 2010; Hain *et al*., 2005; Hinshelwood, 2001), to improved access to affordable energy (Callaghan and Williams, 2014; Gubbins, 2010; Chmiel and Bhattacharya, 2015; Yadoo and Cruickshank, 2010), knowledge and skills development (Armstrong, 2015; Hicks and Ison, 2011; Martiskainen, 2016;), social capital (Allen *et al*., 2012; Armstrong, 2015; Gubbins, 2010; van der Horst, 2008), empowerment (Callaghan and Williams, 2014; Hicks and Ison, 2010; Radtke, 2014) as well as improved energy literacy, environmentally benign lifestyles (Cox et al., 2009; Hamilton, 2011; Hauxwell-Baldwin, 2013; Letcher et al., 2007; Middlemiss, 2011; Rogers et al., 2012) and increased local support for renewable energy (Warren and McFadyen, 2010; Musall and Kuik, 2011; McLaren-Loring, 2007).

Discourse around community benefits has generated varying degrees of policy support for community energy across the UK (Walker et al., 2007; Slee and Harnmeijer, 2017). Unlike in Germany or Denmark, where community energy was more integral to national renewable energy strategy from the onset, community energy in the UK emerged at the periphery through replication of demonstrator projects, a gradual emergence of regional intermediaries that worked to lobby and adjust market support mechanisms designed primarily to facilitate large-scale commercial development and, eventually, the more systematic adoption and expansion of support frameworks pioneered by a pro-active devolved Scottish Government (Berka, 2017; Mitchell, 2004; Nolden, 2012; Smith, 2014). Because of this ad-hoc and bottom-up pattern of emergence, UK community energy today encompasses an array of motivations, ownership and organisational structures, and financial arrangements (see Berka and Creamer, 2016 for a characterisation of different types of community energy projects and their relative size and distribution). However, despite the introduction of Feed-In-Tariffs and various grant and public loan programmes to date, the total share of community-owned renewable energy in the UK remains limited (DECC, 2014).

In order to support further growth in community ownership, policy makers require evidence of not only the benefits but also how the costs of community owned renewable energy (CRE) projects compare to their commercial counterparts. If there are additional costs associated with CRE projects, further support may be required in order to realise increased community-owned energy capacity and level the playing field vis-à-vis other ownership models.

The cost structure and factors influencing the cost of commercial renewable energy projects are well established (International Renewable Energy Agency (IRENA), 2012b; Kobos et al., 2006). However, very little research has explicitly analysed cost differences across different ownership models within the renewable energy industry. There has been some research on the costs of CRE in the context of studies comparing the financial viability or local economic impacts of different types of local ownership models (Entwistle et al., 2014; Lantz and Tegen, 2009). Most relevant to the study at hand, Wiser (1997) uses a standard financial cashflow model to compare the project costs of (vertically integrated) utility-owned wind projects with non-utility privately-owned projects (Wiser, 1997). While these approaches have demonstrated that the nature and terms of finance and tax incentives associated with different ownership models can have a substantial influence on overall development costs, they fail to account for a number of factors that may contribute to cost discrepancies between commercial and community-owned schemes. These include the reliance of community schemes on voluntary labour and outsourced expertise, and differences in the perceived risks associated with the two different ownership models.

Against this background, this paper explores the origin and magnitude of cost differences in community-owned and commercial-owned renewable projects, asking: how might social, economic and political risks described in community energy literature translate into probabilities of success at key stages of the project development process? In addition, how do these risks influence actual project costs and viability, compared to commercially owned projects? Based on the findings, the paper explores whether there is there a case for CRE-specific policy support in the UK. Following established definitions of CRE in the UK, we limit our analysis to renewable energy projects that are owned and managed by constituted for- and not-for-profit distribution community organisations established and operating across a geographically defined community (including Community Benefit Societies or Bencoms), and commercial projects as owned and managed by professional private entities (Dóci, Vasileiadou, & Petersen, 2015; Kobos et al., 2006; Ruggiero, Onkila, & Kuittinen, 2014; G. Walker & Cass, 2007; G. Walker & Devine-Wright, 2008).

The analysis is based on an economic model of a hypothetical 500kW onshore wind project, parameterised using data collected from a survey of community and commercial renewable energy projects in combination with information from secondary sources. Both the Net

Present Value (NPV) and Levelised Cost of Energy (LCOE) [1] of a commercial and community-owned project are calculated in a manner that allows for differences in costs, development times and risks at different phases of project development. The financial viability of commercial and community projects are compared at different stages of the development process and the sensitivity of the results tested through a Tornado analysis.

The results show that not all of the cost differences are biased against CRE and not all give rise to substantial differences in project financial viability. However, CRE projects exhibit a number of characteristics that negatively influence financial viability as compared to an equivalent commercially-owned project, particularly when valued at point of project inception.

The paper is structured as follows. Section 2 reviews literature on the challenges and constraints of community-led projects to identify reasons why the costs faced by CRE organisations may differ from those of commercial developers, where possible drawing on relevant theoretical concepts in transaction cost economics, organisational ecology, and technology innovation systems. Section 3 describes the economic model used in the comparative analysis and the data collection process. Results are presented and discussed in section 4 while section 5 considers the implications of the findings for community renewable energy policy in the UK and beyond.

[1] Expected LCOE is the total discounted cost per unit electricity over the lifetime of the generating asset (in £/MWh), and can be interpreted as the break-even value required by a producer for the project to be financially viable.

2. The influence of community ownership on the cost of renewable energy projects

Table 1 provides an overview of categories of capital expenditures and operating costs of onshore wind energy projects at key stages of the development process, along with the associated risks. Costs that enter directly into project financial evaluations are technology choice, size of the project, the cost of finance, tax and support incentives, grid access and capacity, as well as site location. Economic risks influencing project costs are factors such as interest and exchange rates (influenced by the general economic environment and market context), the ability to find viable project sites, and the nature of contracts associated with the particular project. Non-financial risks inherent to the development process do not typically enter project evaluations but can nevertheless be decisive by increasing costs and uncertainty (Lüthi & Prässler, 2011; Valentine, 2010). These include social risks, such as levels of civic activism and anti-big-wind sentiment, as well as political and technical risks, such as levels of political support for diffused alternative energy and thermal headroom at the nearest grid connection point. These factors affect the perceived risk, bankability and cost of capital, but can also increase scoping and planning costs for instance through the need for planning appeals or alternative development sites (Klessmann et al., 2013; Wiser, 1997).

INSERT TABLE 1

While community and commercial renewable energy projects share common generic cost categories, literature on community ownership across a range of industries (forestry, water and urban sanitation) suggests that community projects in both the developed and developing world face common challenges that can influence both project costs and the risks to which projects are exposed. These challenges can be categorised as internal process costs, transaction costs, legitimacy costs, and internal diseconomies of scale. These are discussed in turn.

First, communities face higher internal process costs arising from the need to manage their activities to the satisfaction of all members (Aggarwal, 2000; Bank, 2006). Wellens & Jegers (2014) call this challenge a multiple principles situation in which various stakeholders may not only have different expectations of what should be done but also of how decisions should be made. Internal process costs are likely to be particularly high for new organisations, or organisations that have no prior experience in managing complex projects and have not developed decision-making processes and internal conflict resolution strategies. This may make community organisations less able to respond effectively to windows of opportunity and is likely to translate into increased project management and consultancy costs. It is also likely to lead to longer development times, for early project stages in particular (Adhikari & Lovett, 2006; Meshack, Adhikari, Doggart, & Lovett, 2006). Overall, these factors increase the risk that developments do not make it past the initial feasibility stage of the development process, due to unresolved impasses in the negotiation process.

Second, communities can face significantly higher transaction costs as they may lack in-house skills or knowledge and, as a result, external contractors must be sought. Resulting transaction costs can be compounded by the issue of asymmetric information vis-à-vis commercial players, where an absence of up-to-date market knowledge brings additional search and information costs associated with identifying competent suppliers and negotiating contracts. In addition, community organisations may lack bargaining strength due to a lack of experience in negotiating, for example, the terms and costs of land lease, service or power purchase contracts. Finally, the need for outsourcing results in additional policing and enforcement costs associated with monitoring quality of service. Community groups can suffer significant costs from poor service delivery as a result (de Blas et al., 2009; Vega & Keenan, 2014). Together, these transaction costs are likely to increase project costs and the time taken for certain stages of the development process, as well as generating additional risks.

Third, communities may suffer from a *lack of external legitimacy* which in turn affects their ability to access commercial, public or private finance, especially if the community group is only recently established or in sectors where commercial development is the norm. For example, there is evidence that banks in the US were more likely to lend to well-established community-based corporations than recently established groups and there is evidence that pre-existing community groups are better able to benefit from government support mechanisms (de Blas et al., 2009; Lowe, 2008). Legitimacy is also a core component of trust required to enable local private investment in community projects, where older better established groups are perceived as more efficient, effective and more legitimate recipients of funding from residents (Bremer & Bhuiyan, 2014; Chand, Kerr, & Bigsby, 2015; Chhetri, Lund, & Nielsen, 2012).

Both technology innovation systems theory and organisational ecology set out the importance of the density of organisations and the 'liability of newness' in relation to legitimation, organisational success and sectoral growth (Hannan and Carroll, 1992; Hekkert and Negro, 2009). Theory predicts that legitimacy costs decrease in contexts where community-led management becomes perceived as the norm. However, the process of legitimisation can take considerable time in particular when it conflicts with competing interests (Gautam, Shivakoti, & Webb, 2004; Makino & Matsuda, 2005). For instance, there is anecdotal evidence that

CRE projects have been classified as high risk by commercial lenders, and that community organisations have faced unfavourable terms, conditions and cost of finance even after the introduction of Feed-In-Tariffs in 2009 (Pepper & Caldwell, 2010).

Fourthly, CRE organisations in the UK currently have fewer assets, lower turnover and smaller less specialised workforces compared to commercial developers and thus *lack internal economies of scale*, making it more difficult to finance high-risk phases of projects prior to financial close. In contrast, commercial renewable developers often enjoy economies of scale such as bulk purchasing, administrative savings and can borrow more cheaply. Compared to CRE organisations which tend to implement one or two projects at a time, larger commercial developers have certain risk-bearing economies with a wide portfolio of different renewable energy projects. Until recently, the Non Fossil Fuel Obligations (NFFO) and ROC support mechanisms adopted by the UK government favoured commercial developers as they required financial reserves large enough to sustain long planning cycles and large uncertainty over project outcomes (Mitchell & Connor, 2004; Stenzel & Frenzel, 2008; Szarka & Bluhdorn, 2006). In conclusion, community organisations, by virtue of facing higher internal process costs, higher transaction costs, lower external legitimacy and lower economies of scale, are likely to face higher costs relative to commercial projects overall, but particularly prior to financial close.

Literature on local opposition and acceptance points to a fifth cost discrepancy between commercial and community models. Commercial development in the UK typically involves a technocratic ‘decide-announce-defend’ model of development in which local opportunities to express social or environmental concerns and highlight trade-offs with national infrastructure development objectives can be very limited (Groves et al., 2013). Planning governance and the historical legacy of infrastructure planning in the UK has invariably generated strong local opposition and high planning costs for commercial wind projects (Toke et al., 2008; Wolsink, 2007; Breukers and Wolsink, 2007). In contrast, community-led projects, especially where they are inclusively and effectively managed or managed by locally trusted parties, have been observed to be motivated and designed on the basis of local needs and preferences (Bomberg and McEwen, 2012; Walker, 2008). To the extent that community ownership represents both procedurally and substantively more effective participation in energy infrastructure planning, it can result in perceived ownership over a project within the wider community, as well as higher levels of local engagement and support for local and renewable energy projects more broadly (Callaghan and Williams, 2014; McLaren-Loring, 2007; Mussall and Kuik, 2011; Warren and McFadyen, 2010). Through broader community support and the ability to leverage local political opportunities, community energy projects may face lower planning risks, reducing planning costs and, while there is no data to substantiate this claim, lower land rent (Haggett et al., 2013).

A sixth and final cost discrepancy between community and commercial projects may arise from different investor motivations and expectations of returns, where there is anecdotal evidence and expectation that sourcing finance locally in the form of community shares can manifest itself as a relatively low cost of capital, although hurdle rates may be highly specific to the culture of any given community organisation (Entwistle, Roberts and Xu, 2014; Maruyama, Nishikido, Iida, 2007). The net impact of this and the other factors on the financial viability of community versus commercially-owned projects remains unclear and forms the focus of this paper.

3. Methods and data

To explore the nature and magnitude of cost differences between community and commercially-owned renewables, an economic model was developed for a hypothetical 500kW wind single-turbine onshore wind project. This specification was selected because it was the most common in our data set and provided us with the most comprehensive basis for estimating detailed costs and time estimates. The model was designed to be consistent with the Ricardo-AEA modelling framework developed as part of the Scottish Governments CARES programme[2] but extended to allow for differences in a) project labour costs (particularly during the project feasibility and development phases), b) the time taken to complete each project phase, and c) differences in the probabilities of progressing beyond key stages of project development. This extension towards risk analysis is well-established in corporate finance and decision analysis (e.g. Berk & DeMarzo, 2007; Newendorp & Schuyler, 2000).

Figure 1 shows the probability tree upon which the model is based. The model captures both project development and operational phases but excludes costs associated with decommissioning. This is because there is very little data on decommissioning costs and because we have no clear expectations of how costs at this stage would differ by ownership type.

INSERT FIGURE 1

[2] Ricardo AEAs CARES Investment Ready Tools can be found at http://www.localenergyscotland.org/investmentready. The Ricardo-AEA model includes a detailed representation of financial flows associated with loan repayments and taxation. These were suppressed in the model to allow for the other extensions and to facilitate the interpretation of findings.

The model measures the financial viability of a project at each successive stage of its development. Let *i* be the stages of the project, specified as 1) inception, 2) development start, 3) planning decision, and 4) financial close. The start times and time taken (in days) for each stage are defined as s_i and t_i, with by definition $s_{i+1} = s_i + t_i$. For each stage, we define the expected net present value for the project from time s_i as $E\left[NPV_i\right]$. For example, $E\left[NPV_2\right]$ is the project expected value from the development stage onwards as evaluated at the start of project development, once feasibility assessment is completed but prior to a planning decision. $E\left[NPV_3\right]$ is the expected value of the project from the planning decision onwards as evaluated once the projects planning decision has been made. The net present value of net revenue (or costs) of each stage i relative to start time s_i is defined as NR_i. This simple framework allows us to assess how the financial viability of a project changes by calculating the expected values for each stage in a recursive manner as follows:

$$E\left[NPV_i\right] = NR_i + \frac{\left(1-P_i\right)}{\left(1+r\right)^{t_i/365}} E\left[NPV_{i+1}\right]$$

where $\left(1-P_i\right)$ is the transition probability of the project progressing from stage i to stage i+1, and *r* is the annual discount rate (or hurdle rate).

The probability of failure is incorporated at three points in project development: (i) after feasibility work is completed before the project applies for planning (P1); (ii) a planning application is prepared and submitted but the project fails to receive planning permission

(P2); and (iii) the project receives planning permission but fails to reach financial close (P3).[3] Based on the literature, the probability of failure at stages i) and iii) is expected to be higher for community than commercial projects, but most likely lower or equal at stage ii). Given the lack of empirical data for the magnitude of probabilities, this forms the focus of the sensitivity analysis.

In the base case, it is assumed that the project is commercially owned and the expected pre-tax NPV and expected LCOE are calculated accordingly. The parameters of the model are then adjusted to reflect the costs and risks associated with community ownership and the same two measures of financial viability (NPV and LCOE) are re-calculated. This allows the difference between the two ownership types to be calculated. Finally, Tornedo analysis is used to show the sensitivity of the results to key model parameters including transition probabilities, and assumed hurdle rate. The hurdle rate or cost of finance used for both ownership types reflects the return an investor would expect from an investment in a comparably risky financial asset, where the higher the systematic risk the higher the required return. This is a standard approach to the valuation of energy projects (PwC, 2012).

To validate the model, we checked that the results were comparable to those produced by both the Ricardo-AEA model and the LCOE offshore wind model made available by the Crown Estate[4]. While this provided assurance that the model is robust, there are limitations to the model and subsequent analysis. In particular the analysis does not account for any differences in the terms cost and terms of debt finance, or the opportunity costs of investment

[3] There is also a probability of failure between financial close and commissioning with literature suggesting that local opposition can increase as projects become closer to completion, however this was not explored in the current analysis.

[4] http://www.thecrownestate.co.uk/energy-and-infrastructure/offshore-wind-energy/working-with-us/strategic-workstreams/cost-reduction-study/

in a project. It also fails to allow for temporal changes in costs over time, as well as positive and negative externalities from the developments. Other shortcomings and areas for model extension are considered in Section 6.

Data collection and initial parameter values

Detailed cost data were collected from a survey of 9 community and 11 commercial onshore wind projects in 2015. This was used to supplement existing data on 31 community owned or community partnership projects collected in 2011 and 2012 and updated in 2014 (Harnmeijer, 2012). Timescales and expenditure profiles vary from project to project, making it difficult to account for inflation in the absence of accurately dated cash-flow data. To simplify calculations, all project costs were treated as if they were incurred in the year of commissioning. This is likely to have exerted a downward effect on costs reported for projects with longer development histories.

Finally, a selection of average cost data were taken from range of industry publications (BVG Associates, 2014; Renewable UK, 2015; GL Garrad Hassan, 2010; DECC, 2011). Where necessary, costs were adjusted for inflation using the retail price index inflation measure. From this, average cost data was compiled and used to specify the costs for a typical commercial and community 500kW project (Table 2).

Average cost data along with the initial transition probabilities used in the model are shown in Table 2. Cases where there are differences in costs the between the two ownership models are highlighted in bold. Pre-planning costs are higher for CRE projects, and the time taken to progress through the various stages of development is also shown to be longer, substantially so in some stages. This is reflected in similar total labour costs, despite the fact that CRE projects have lower labour costs per day due to volunteer contributions. The data collected did not suggest significant differences in operational costs.[5]

INSERT TABLE 2

The initial value for the hurdle rate used for both ownership types was 8% consistent with that used by DECC in their LCOE calculations (2013) for onshore wind. Sensitivity analysis is used to explore the implications of community developers benefitting from a lower hurdle rate.[6] Consistent with the approach used to value voluntary activity in the UK (Foster, 2013), the cost of labour for community owned projects used in the model is based on the median wages for personal and professional workers reported in the ONS Household Satellite Accounts. For the reported NPV calculations, the assumed FIT rate of 0.184 is consistent with a commissioning date of 1 April 2014.

Expert opinion was used to identify the initial base transition probabilities. The values suggest that the probability of a community project of proceeding beyond feasibility stage (1-P1) is half that of a commercial owner, reflecting differences in the expertise and resources available to target viable sites as well as the potential pool of sites assessed for development. Community project risk perception remains high up until planning consent stages as organisations (particularly in early stages of group formation) face steep learning curves and have historically faced difficulties in obtaining pre-planning finance (BRE, 2010; Pepper and

[5] There is an argument that land rents for community developments might be lower as a result of negotiation with local land owners. However as these have only a very small impact on total net revenues in the operation phase of a project, this has not been explored further.

[6] Analysis of community wind shares issued in the UK over the period 2012–2016 suggests that these projects may gain access to relatively low cost of capital with a mean projected IRR to individual shareholders of approximately 6%.

Caldwell, 2010). In contrast, the chances of planning being unsuccessful (P2) are assumed to be the same for community and commercial projects and set at 0.3 for the base case. Both ownership models face a risk of not proceeding past financial close (P3) but community projects are assumed to have a higher chance of failing progression through this stage (0.2 compared to 0.1 for commercial developers), reflecting variable capacity in managing construction, grid connection and commissioning. As noted above, given limited empirical grounding, Tornado analysis was conducted to explore sensitivity of results to the assumed probabilities.

4. Results and discussion

Table 3 shows expected NPV and LCOE values from the economic model at each of the four project development stages (project inception, development start, planning decision, financial close). Values represent all costs and returns incurred from a particular stage in project development onwards. For example, the values for inception represent all costs and returns accrued from the start of the project onwards; values for the development start are those immediately following the successful completion of the feasibility stage and represent the value of costs and returns from that point onwards, and so on. Values for financial close are comparable to values for LCOE and pre-tax returns that do not account for conception and development phases. From this stage onward, there are no differences between the costs of the two types of owners and thus the estimated NPV and LCOE values for the community and commercially-owned developments are identical. The first panel in Table 3 reports the Pre-Tax NPV and LCOE results for the base case commercial project. The remaining panels show the impact of allowing for the differences between commercial- and community owned projects in a stepwise manner, providing an indication of the sensitivity of the results to each factor.

INSERT TABLE 3

Panel II shows the results when pre-planning and planning costs are set to the community values specified in Table 2, changing the value of expected NPV and LCOE with the percentage difference between the community and commercial values shown in brackets (Δ%). As expected, higher pre-planning and planning costs of community-owned developments decreases the expected NPV of the project and increase the LCOE of electricity at both project inception and start of development. While the change in LCOE is small (+1%), the reductions in expected NPV are significant and as high as 24% when considered at inception phase, while somewhat less but still large just after the feasibility stage (-17.7%).[7]

Panels III and IV show results when, in addition to higher pre-planning and planning costs, we take into account the additional time taken for community projects (Panel III) and the labour input and associated labour costs are set to the community values (Panel IV). Allowing for the increased time for community developments has only a small marginal effect on expected NPV or LCOE and in fact increases NPV and decreases LCOE somewhat compared to the results in Panel II. This is due to a combination of effects; while increasing the time taken to conceive and assess project feasibility delays revenues and decreases overall discounted income, it also pushes pre-planning and financial costs into the future, reducing

[7] The values reported at planning determination and financial close remain unchanged in Panel II because there are no differences in costs incurred after these points in the process.

the overall discounted costs at each future project stage when valued from project inception. Panel IV shows that allowing for differences in the labour input and cost of labour between community and commercial developments has only a marginal impact on overall project values; valued at project inception, this slightly decreases overall project NPV and increases LCOE. Valued from the planning determination stages the project NPVs actually increase. This is due to two opposing effects, namely, a relative increase in the labour input required at each stage and a decrease in the day rate used (reflecting the lower valuation of volunteer time). The combined effect of changing the relative labour costs is that the net present value of labour costs of conception and feasibility increase, but the expected NPV of labour costs associated with pre-planning and from the planning decision to financial close decrease.

Finally, Panel V reports results when pre-planning and planning cost, time taken, labour input and cost assumptions plus community-specific transition probabilities are taken into account. Consistent with the project development challenges outlined in the literature review, this scenario best captures the overall impact on expected returns and costs associated with community ownership. The results are shown diagrammatically in Figures 2 and 3. Allowing for higher risks of community ownership has a significant effect on the overall expected value of the project and, under the assumptions used in this analysis, a community project would exhibit a negative NPV and not be economically viable. The required LCOE to make the project viable increases to £0.185/kWh, which is above the net price used in the revenue calculations (i.e. the FIT). The difference between these two provides an indication of the increase in FIT that would be required by community projects to put them on the same cost basis as a commercial developer for this type of project. The relative difference in NPV and increase in LCOE when assessed at latter stages of the development process declines but remains substantial, with expected NPV almost 8% lower than that of the commercial scheme even after having secured planning approval.

INSERT FIGURES 2 and 3

Tornado analysis

The results from the economic model are clearly dependent on the parameters used in the model. Given the importance of the transition probabilities on the results, and because their values are imperfectly known, a Tornado analysis was conducted focusing on the impact on expected NPV of variation in (1-P1), (1-P2) and (1-P3)). In addition, the sensitivity of the results to hurdle rates was explored because there is evidence that they vary between commercial and community–owned schemes reflecting differences in access to credit markets and risk appetite. The Tornado analysis explores, for the base community-owned project, the implications for NPV of the hurdle rate varying from 6% to 10% while each of the probabilities is varied by +/- 0.2 from base values. In other words, the probability of (1-P1) varies from 0.3 to 0.7, (1-P2) from 0.5 to 0.9 and (1-P3) from 0.6 to 1.0. The results are shown in Figure 4.

INSERT FIGURE 4

The results show clearly the importance of the hurdle rate on the model outcomes with relatively small changes leading to large differences in expected NPV (net impacts range from -£42.7k to +£54.8k from the base NPV value). It follows that if hurdle rates are lower for investors in community projects than commercial owners, this will compensate to some extent for other observed cost or risk factors associated with community projects.

Of the three transition probabilities, the Tornado analysis suggests that the probability of the project achieving financial close is most critical in influencing expected NPV. In particular, an increase in the probability of failure at this point of the development process (by 0.2) reduces the expected NPV of the project by £17k while a decrease in the probability of failure increases expected NPV by £10.5k. This transition probability has a larger impact than the other two probabilities in the model because it influences the revenue generating stages of the project only (whereas an increase in the probability of failing to progress from the feasibility stage of a project or failing to secure a planning application will both reduce costs associated with earlier stages as well as affecting expected revenues further along the development process). Of the remaining two probabilities, variations in the probability of getting planning approval has the greatest influence on overall expected NPV. However perhaps the most important finding from the Tornado analysis is that the sensitivity of results in relation to all three probabilities is much less than the sensitivity of the results to hurdle rates.

5. Conclusion and policy implications

While there is a growing literature on the social and economic benefits of community renewable energy, little work has been done on the costs and risks of community renewable energy developers or, in particular, how these compare to those of commercial developers. This paper aimed to address this gap in knowledge, and in doing so, has highlighted several issues that may be restricting the expansion of the community-owned sector.

A cross-sectoral literature review on community ownership suggests that cost differences can be attributed to various facets of an organisation or project: higher internal process costs arising from the need for communities to manage their activities to the satisfaction of all members; higher transaction costs due to a lack of in-house skills or knowledge; costs associated with a lack of external legitimacy, especially for recently established groups or in sectors where private commercial developments are the norm; and a lack of economies of scale with community organisations having fewer assets, lower turnover and smaller less specialised workforces than their commercial counterparts. These aspects were anticipated to increase the costs and/or risks of community renewable projects, thus placing them at a disadvantage relative to commercial developers. However, community projects may to some degree benefit from higher degrees of local legitimacy, benefitting from lower hurdle rates, lower planning risk and potentially from lower land rents, with projects likely to be held to be motivated and designed in the interest of the local community.

A model consistent with those used in corporate finance and decision analysis was developed to compare the NPV and LCOE of a single 500kW onshore wind development owned by commercial entity to that of community group. The model parameters were based on information from a survey of renewable energy projects plus information from secondary sources.

The data confirm that community projects face higher costs and longer project development times than commercial projects. A lack of legitimacy and higher internal process costs increases the probability that community projects fail to get past early stages of the development process and also reach financial close. However, the overall impact of community ownership on project viability are *a priori* unclear.

The results from the model demonstrate that the main source of variation in the viability of commercial and community projects is the higher risk faced by community groups. In contrast, the differences arising from the additional labour input used in community schemes has little impact on overall project NPV or the LCOE. When valued from the point of project inception, the model suggests community owners would need an increase in FIT in order to make projects financially viable and to provide them with the same expected returns as a commercial developer.

The Tornado analysis confirmed the significant influence of hurdle rates on project viability. If, as anecdotal evidence suggests, community investors are willing to accept lower hurdle rates, this will have a significant positive impact on the expected NPV of community-owned schemes, compensating for some of their other cost disadvantages and risk factors. Further, there is some evidence that the chances of planning being successful (1-P2) are higher for community than for commercial projects (Haggett et al., 2013). This too would reduce the difference in expected NPV between the two ownership models although the Tornado analysis suggests the impact will be less than the reduction associated with lower hurdle rates.

The results provide useful insights for policy makers, suggesting that policy support for community energy should be targeted at reducing specific costs and risk factors. Potential policy mechanisms include those that help build local capacity for community energy projects (this can range from the development and targeted dissemination of regionalised pre-feasibility studies, to guidance on effective inclusive decision-making processes around local collective action), knowledge platforms that serve to disseminate essential technical, financial, legal, project management information and reduce search and monitoring costs of subcontractors, and those that actively promote community organisations as legitimate players in the energy market. In accordance with the findings of others (Capener, 2014) the results of the sensitivity analysis suggest that the financial viability of community projects remains most vulnerable to legislation that directly or indirectly influences access to low-cost capital. To this end, the 'one-stop shops' for information and low cost finance for community projects and low risk public loan schemes for community energy projects pioneered by the Scottish Government in the last decade are well targeted. The results suggest that, allowing for some adaptation to specific regional needs and contexts, these could usefully be extended to other parts of the UK.

However, the findings also suggest that for community energy to be more broadly adopted, policy support may need to go further still in order to ensure consistent access to low-cost capital, and to address or compensate for higher internal process costs, higher transaction costs and the perceived lack of (non local) legitimacy experienced by community projects that influences their access to credit. The need for community-specific policy support is likely to have become even more pertinent following the 2015 reforms to UK renewable energy policy support mechanisms which have reduced the number of remaining viable sites for onshore wind development and increased competition for remaining sites.

Shared ownership arrangements between commercial (or public) and community organisations may help to remove some of key challenges to community-only schemes. Where carefully managed, shared ownership may offer a market-led means of eliminating some of the cost discrepancies identified in the analysis, at the same time achieving the policy goal of increased community engagement in renewable energy generation (Slee, 2015). In contrast, the auction-based mechanisms recently introduced at UK- and EU level (see Harnmeijer, 2016) would place further risk on the pre-commissioning phase of project development, exactly where community projects are already disadvantaged.

Apart from a number of data limitations, discussed in Section 3, the analysis presented could usefully be extended in several ways. First, following on from the discussion above, the Contract for Difference (CfD) auction system recently introduced in the UK renewable energy sector poses an additional sector-dependent transition probability, which could be explored using the same modelling architecture as in the current analysis. Second, the modelling approach could be used to explore how the costs and risks of different types of renewable energy vary by ownership type. For example, different types of renewables have varying degrees of social acceptance and this affects the likelihood of community-led schemes being initiated and progressing through the early stages of the development process. The pre-planning work required for hydroelectric developments requires complex environmental assessments not needed for most other technologies which may act as a disincentive for community groups more that commercial developers while, for both types of developers, other things being equal, the probability of not receiving planning permission for a ground-mounted solar photovoltaic (PV) installation is lower than that for a wind farm of equivalent nameplate capacity. The probability of finding suitable local sites varies between different types of renewables as does the relative complexity of operations once the schemes are complete with, for example, the ongoing demands of Anaerobic Digesters likely to be less attractive to community groups than commercial or local business developers.

Third, and more significantly, a broader analysis would be useful, comparing not only differences in the costs and risks faced by community and commercial energy developers but also the value and spatial distribution of economic benefits arising from projects. This is because project net income will be reinvested in very different ways according to ownership type. Even community owned schemes can have very different patterns of reinvestment depending on community priorities with some communities focussing on investment in business infrastructure, others improvements in community amenities (Entwistle et al., 2014). Both can give rise to negative displacement effects on other communities. Such an analysis should allow for this and other potential positive and negative externalities including, for example, environmental costs (Hanley and Nevin, 1999).

Taking a longer-term perspective, considerable changes have occurred in the on-shore wind energy sector over the last decade including increases in the cost-efficiency and scale of turbines, the gradual development of more local expertise, and improvements in the nature and availability of monetary and non-monetary assistance to developers. Community- and commercial projects have to some degree developed as semi-independent sectors, comprised of separate actors, networks and institutions and may have been subject to different learning processes and different cost changes. The community energy sector in the UK and many other countries can still been seen as a new (nursing) market. It follows that over time, cost savings may arise as a result of positive externalities and learning-by-doing (Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2008; International Renewable Energy Agency (IRENA), 2012a) which may erode at least some of the cost discrepancies identified in this paper. On the other hand, many community developments are of a “one of a kind” nature, perhaps limiting learning-by-doing effects relative to commercial development. This, increasing competition for new economically feasible sites, and the changing external economic environment may justify the need for continuing community-specific policy support.

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Table 1: Typical risk and cost components for onshore wind projects at different phases of development.

	PROJECT STAGE				
	Capital cost (CAPEX)			**Operating cost (OPEX)**	
COST CATEGORY	**Feasibility**	**Planning**	**(Pre)-Construction**	**Operation**	**Decommissioning**
Management	Project management; Legal fees	Project management; Legal fees	Project management	Project management	Project management
Technology	Grid appraisal	Utility upgrades, transformers, protection, metering and wiring; Design engineering	Turbine and tower acquisition and transport ; Wiring to turbine base ; Turbine erection	Insurance & Warrantee, Operation and Maintenance	Technology decommission and transport
Scoping, design and permission	Technical feasibility study;	Environmental Statement/Impact Assessment and Planning Fees	-	-	-
Other material inputs	-	Land acquisition	Construction contracts, construction of access roads and foundation; Land lease	Land lease	-
Financing	-	-	Interest, equity returns, financing fees	Interest, equity returns, financing fees	-
Risks	Erroneous pre-feasibility assessment; lack of viable projects sites	Planning rejection; Grid connection queues and terms of Power Purchase Agreement	Landing delays; delays in commissioning; Changes in support mechanisms	Export/generation tariff; Down time; Resource variability; Electrical losses; Wake effects	-

Table 2: Costs and transition probabilities for the commercial and community-owned 500kW on-shore wind development in 2015.

1. Expenditure (£)	***Commercial***	***Community***
Feasibility	10,000	10,000
Pre-Planning and Planning	**37,000**	**48,100**
Financial Close	50,000	50,000
Grid costs	150,000	150,000
Plant	785,000	785,000
Engineering	272,000	272,000
2a. Time Taken (months)		
Conception to submission of planning application	**14**	**24**
Conception and Feasibility	**3**	**6**
Pre-planning to Planning Submission	**11**	**18**
Planning	11	11
Planning Permission to Commissioning	**20**	**33**
Planning Decision to Financial Close	**8**	**21**
Construction Time	12	12
2b. Labour Input (person days)		
Feasibility	**15**	**150**
Pre-Planning and Planning	**30**	**60**
Financial Close	**40**	**120**
2c. Labour Cost per Day (£)[b]	400	100
Hurdle rate[a]	8%	8%
3. Transition Probabilities [c]		
Moving Feasibility to Full Planning Application (1-P1)	**1.00**	**0.50**
Planning Application Successful (1-P2)	0.70	0.70
Financial Close Achieved (1-P3)	**0.90**	**0.80**
4. Revenue FiT(£)		
Feed in Tariff rate[1]	*0.184*	*0.184*

Sources: Based on survey data with the exception of: [a]DECC, 2013. Nominal costs are recalculated in terms of 2015 pounds using RPI time-series (Office of National Statistics, 2015). Where applicable, exchange rates prevailing at the time of transaction were used. All costs are presented exclusive of VAT.
[b]Commercial value based on survey data, community value based on ONS, 2013.
[c]Initial estimates based on expert opinion.

Table 3: Expected Pre–Tax NPV and LCOE Results. % difference over base case shown in brackets. Values in **red** (**blue**) show a cost **disadvantage** (**benefit**) over the commercial base case.

	Inception	*Development Start (Post-feasibility, pre-planning)*	*Planning Decision*	*Financial Close*
Panel I: Base Case				
ENPV (£)	43,671	60,734	178,032	283,700
LCOE (£ / kWh)	0.177	0.174	0.167	0.161
Panel II: Extra Preplanning and Planning Cost				
ENPV (£)	33,124	49,981	178,032	283,700
Δ%	*(-24.2)*	*(-17.7)*	*(0.0)*	*(0.0)*
LCOE (£ / kWh)	0.179	0.176	0.167	0.161
Δ%	*(+1.0)*	*(+1.0)*	*(0.0)*	*(0.0)*
Panel III: Preplanning and Planning Cost, Development time needed				
ENPV (£)	33,906	51,616	186,686	283,700
Δ%	*(-22.4)*	*(-15.0)*	*(+4.9)*	*(0.0)*
LCOE (£ / kWh)	0.178	0.175	0.165	0.161
Δ%	*(+0.4)*	*(+0.2)*	*(-1.4)*	*(0.0)*
Panel IV: Preplanning and Planning Cost, Development time needed, Labour input & day rate				
ENPV (£)	31,751	58,583	188,893	283,700
Δ%	*(-27.3)*	*(-3.5)*	*(6.1)*	*(0.0)*
LCOE (£ / kWh)	*0.178*	*0.174*	*0.164*	*0.161*
Δ%	*(+0.6)*	*(-0.5)*	*(-1.6)*	*(0.0)*
Panel V: Preplanning and Planning Cost, Development time needed, Labour input & day rate, Development probabilities				
ENPV (£)	-3,359	44,170	164,104	283,700
Δ%	*(-107.7)*	*(-27.3)*	*(-7.8)*	*(0.0)*
LCOE (£ / kWh)	*0.185*	*0.175*	*0.165*	*0.161*
Δ%	*(+4.7)*	*(+0.4)*	*(-1.3)*	*(0.0)*

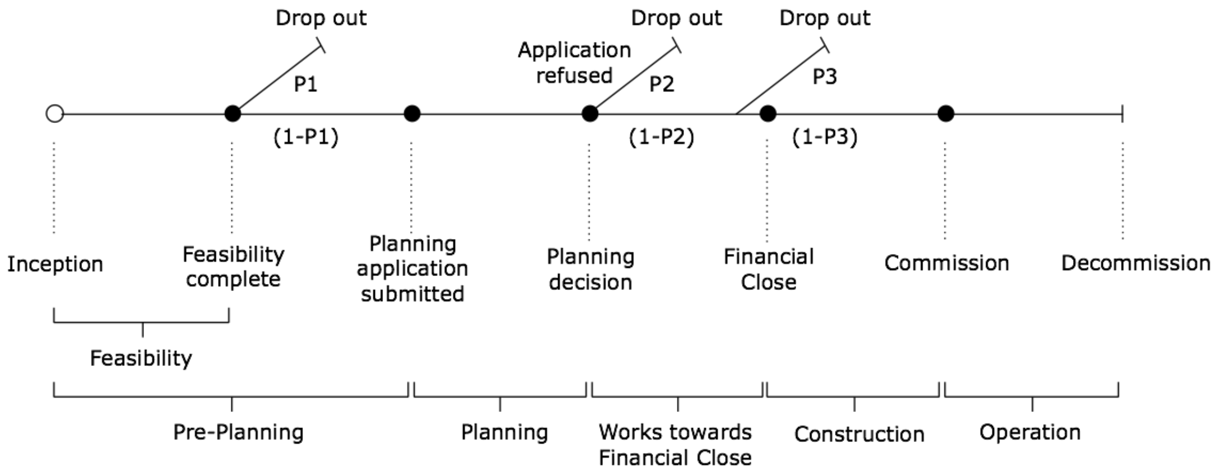

Figure 1: Renewable energy generation development decision tree upon which valuation model is based.

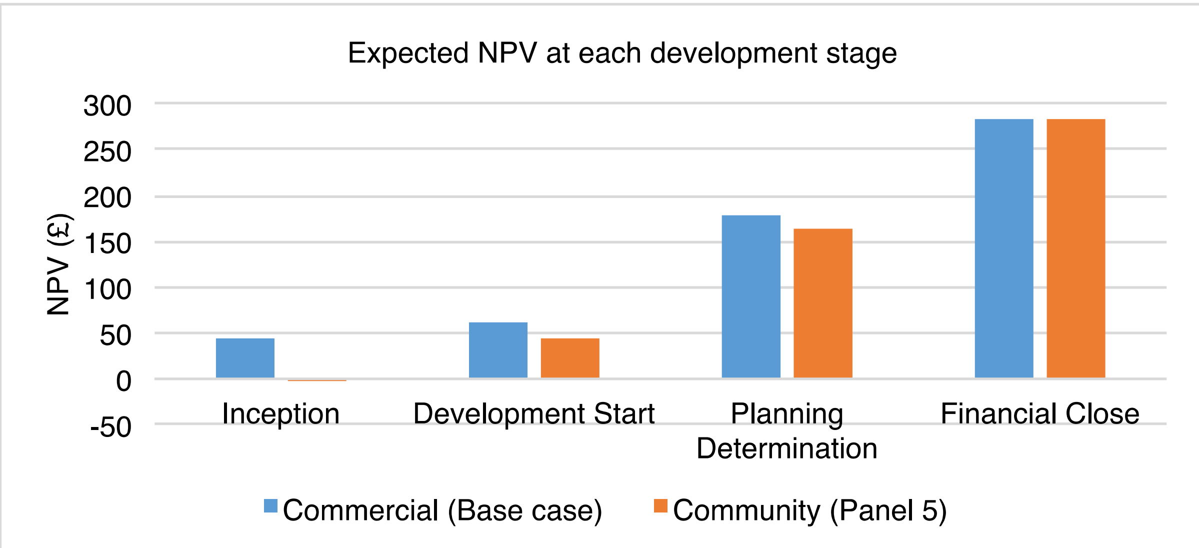

Figure 2: Comparison of expected NPV from commercially-owned and community owned development at each project stage (£).

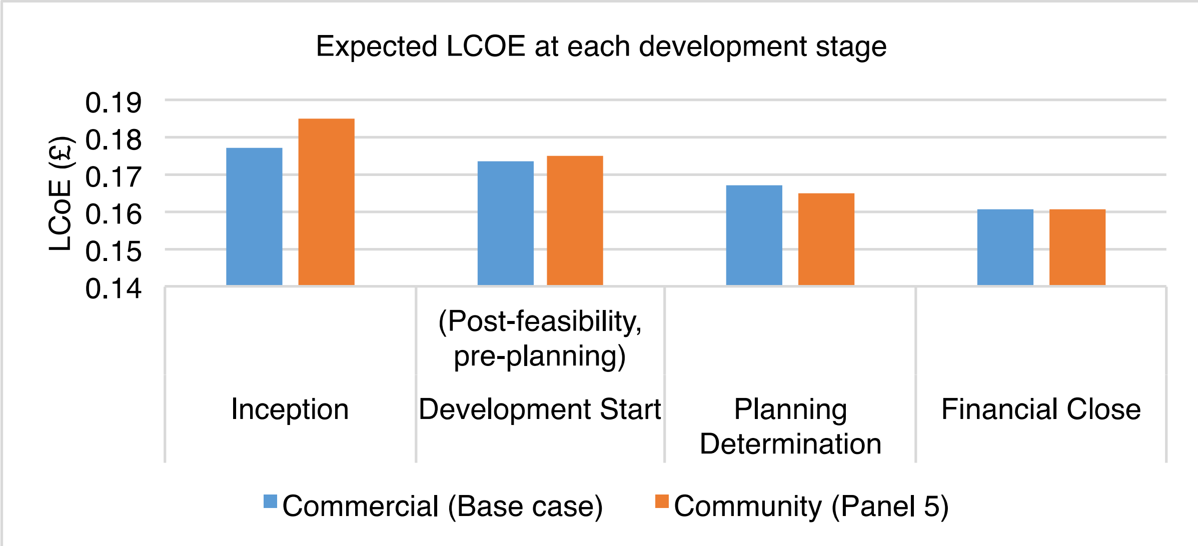

Figure 3: Comparison of LCOE from commercially-owned and community owned development at each project stage (£).

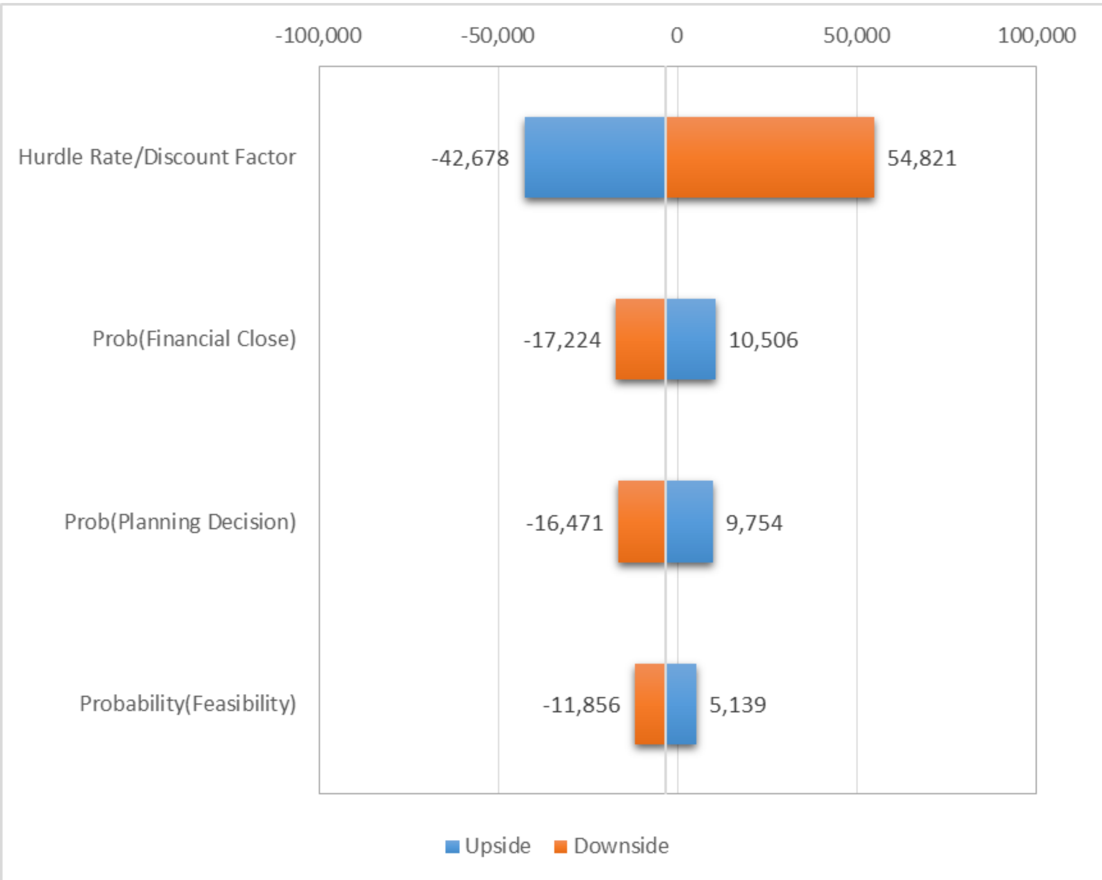

Figure 4: Results from the Tornedo analysis showing the net impact on the expected NPV for a community-owned project by parameter value.