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Communitarian approaches to sustainable development: the governance, local impacts and costs of community energy

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Academic Dissertation

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ABSTRACT

This dissertation explores the governance, local impacts and costs of community-owned renewable energy (CRE). The objective is to understand if and in what context collective local ownership models represent a feasible and effective means to operationalising a more 'sustainable development' in the renewable energy sector and beyond. The articles draw on a range of fields, from energy governance and project economics to impact evaluation. Specific methodologies used are systematic literature review, discourse analysis, historical institutional analysis and risk-extended net present valuation. Unique contributions of this work are a meta-level understanding of the community energy sector in the UK and an understanding of its emergence in context of technological and institutional change. In addition, it provides an explicit assessment of Quality of Evidence problems in this subfield of energy and social science research, placing it firmly in the context of current literature and methods in project economics and impact evaluation. Findings show that ownership patterns in the energy sector are precarious and subject to changing narratives that emerge in response to domestic socio-economic and political dilemma's, exogenous shocks, and emerging economic schools of thought. CRE projects have the potential to generate a variety of positive local impacts that vary depending on the motivation and management of projects and project revenues. Under certain conditions CRE can empower community organisations to address systemic socio-economic problems in the public domain. Finally, in a competitive market setting and where CRE is implemented by newly-established grassroots organisations, projects face a range of risks that commercial projects do not, and that erode their financial viability. As such, the development and expansion of community renewable energy as a substantial proportion of the energy sector requires policy makers to assign it special status and provide policy support on the basis of its local social, economic and environmental benefits. Policy support for community renewable energy requires a willingness to integrate energy and social policy domains.

Key words: community renewable energy, ownership, inclusive process, impact evaluation, energy governance, political economy, Quality of Evidence, risk-extended net present value, United Kingdom.

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LIST OF ORIGINAL ARTICLES

This dissertation consists of the following two book chapters and two journal articles, hereby referred to using assigned Roman numerals, and a concluding summary.

I. Berka A. (2017). Community energy in the UK: a short history. Chapter 59. In: Holstenkamp L., Radtke J. (eds.). Handbook of Participation and Energy Transitions. Springer VS Wiesbaden. https://doi.org/10.1007/978-3-658-09416-4

II. Berka A., Creamer E. (2018). Taking stock of the local impacts of community owned renewable energy: a review and research agenda. Sustainable and Renewable Energy Reviews 82(3): 3400-3419. https://doi.org/10.1016/j.rser.2017.10.050

III. Berka A., Harnmeijer J., Roberts D., Phimister E., Msika J. (2017). A comparative analysis of the costs of onshore wind energy: is there a case for community-specific policy support? Energy Policy 106: 394-403. https://doi.org/10.1016/j.enpol.2017.03.070

IV. Berka A., Harnmeijer J., Slee B. (2017). Crossing the Rubicon: the 2015 UK renewable electricity reforms and implications for Scotland. Chapter 8. In: Wood G., Baker K. (eds.). A Critical Review of Scottish Renewable and Low Carbon Energy Policy: Implications for the Independence Debate. Palgrave Macmillan, London. https://doi.org/10.1007/978-3-319-56898-0

DIVISION OF LABOUR IN CO-AUTHORED ARTICLES

	I	II	III	IV
Concept & design	AB	AB	JH, DR	AB
Data collection	AB	AB	AB, JH	JH
Data analysis	AB	AB	EP, DR, AH, JH	AB, JH
Writing the article	AB	AB, EC	AB, DR, JM	AB, BS, JH
Reviewer amendments	AB	AB	DR, AB	AB
Overall responsibility	AB	AB	DR, AB	AB

AB – Anna L. Berka, JH – Jelte P. Harnmeijer, BS – Bill Slee, EC – Emily Creamer, DR – Deborah Roberts, EP – Euan Phimister, JM – Joshua Msika

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No-one has ever been outside of a local situation; and all our views of the world, all our gathering of data, come from here. Philosophical problems of the reality of the world, of universals, of other minds, of meaning, implicitly start with this situatedness.

Randal Collins - A global theory of intellectual change, 1998

INTRODUCTION

Motivation

Society today is posed the fundamental question of whether the set of rules currently directing the production and distribution of resources can allow for ‘sustainable development’. Broadly speaking since the 1980's our approach to dealing with biophysical limits has been to enable economic agents to express traditionally non-market social and environmental values through market mechanisms, allowing the market to correct for resource scarcity or for negative externalities through price-driven (tax or subsidy induced) technological innovation. Given the predominance of market institutions in the overall institutional landscape, the answer to this question largely depends on whether the social and environmental values that society is assumed to hold is recognised by this set of rules, since market institutions cannot themselves be said to be subject to democratisation. For instance, one can recognise that agricultural irrigation has contributed to water scarcity and damage of freshwater ecosystems, and respond by setting higher prices for water and allowing market exchange of water permits. It is however virtually impossible to exercise influence over the question of whether day-to-day consumer preferences and scarcities can generate a water price that is representative of its long term economic value and that allows exploitation at renewable rates.

If market institutions are neutral towards different values, public social and environmental values can influence the production and distribution of goods and services, and the allocation of finite natural resources across individuals and generations. This assumption is embedded in the field of environmental economics which has focused on extending orthodox economic methodology and theoretical models to incorporate environmental values. This scientific paradigm is integral to environmental policy in the 21st century, manifested in the form of valuation and commoditisation of environmental goods, quality differentiation mechanisms such as eco-labels, and various other market- based policy instruments, such as taxes on public bads or tradable permit schemes, or subsidies on renewable energy. More generally, the lack of paradigmatic pluralism in economics has translated into a lack of institutional diversity on the ground, where the rich diversity of existing informal institutions has eroded in the face of establishment of ‘formal’ institutions (Norgaard 1989; Soderbaum 1990; Spash 2010; Ensminger & Rutten 1991).

However, with the emergence of systemic environmental issues that do not seem to be responding to our customary institutional toolbox involving international treaties, market-based incentives and incremental technology change, there is a growing belief that this approach to environmental reform may ultimately not be sufficient (Spash 2012). Outside of environmental policy or ecological economics literature, this is also reflected in studies at company and supply chain level. Volumes have been written on the drivers and assessment of sustainability in supply chains and corporate sustainability, but literature suggests that the uptake and operationalisation of these concepts in the day-to-day management decisions of enterprises and enterprise networks has been slow and is often (not always) limited to superficial or symbolic interventions (Milne, Ball & Gray 2008; Cho *et al*. 2015). An annual survey of companies (representing 93% of global markets by market capitalisation) demonstrated that while a large proportion of enterprises engage in environmental reporting, half of all direct impacts are not being measured or reported, and less than 1% of these companies were shown to have decoupled net revenue growth from environmental costs (Makower *et al.* 2015). This suggests that while both awareness and uptake of social and environmental values in commercial enterprises is increasing, an in-depth consideration of how social and environmental values can be integrated into business strategy, operational management, organisational structure and product and process design is largely lacking. The complexity of systemic environmental impacts, such as biodiversity loss and climate change, precludes the possibility of simple, standardised or widely applicable measures.

This recognition has resulted in a flourishing of alternative epistemologies and methodologies for studying the economics of the environment and is also at the root of growing interest in other fields of social science, including social enterprise and communitarian approaches to economic activity (Defourny & Nyssens 2008). There is abundant literature and empirical evidence suggesting that institutional arrangements themselves affect individual motivation and the values driving individual decision making; institutions are not culturally neutral (Bowles 1998; O'Hara & Stagl 2002). Returning to the earlier example of water markets, a number of studies put forward cases in which the rationality of monetisation and water pricing were shown to subvert the plurality of values associated with allocation, use and conservation of water (see for instance Ioris 2012). This phenomenon can result in the crowding out of the voluntary provision of environmental goods and services, which is more likely to be observed in contexts where market institutions do not predominate, as in many rural developing country contexts (Reeson & Nolles 2009). Apart from the inherent and narrow definition of values imposed by market institutions, the effectiveness of this strategy of environmental reform is hampered by the uncertainty associated with estimation of marginal cost and benefits of abatement. Effects may be irreversible and extend beyond the actors involved in market transactions, and thus we are unable to define regulations to meet a societal optimum quantity of pollution, and avoid price manipulation (Soderbaum 1990; Spash 2010). Admittedly, it is dangerous to generalise on the pitfalls or skewed incentives associated with market-based institutions in relation to the environment. For instance, many common good markets are not nearly as unconstrained or decentralised as private good markets and there is a great deal of choice in design to match a given physical, social-economic and institutional environment (van Huylenbroeck 2009). Nevertheless, it is safe to say that the difficulties of implementing deep and structural institutional changes that can cope with the complexity and uncertainty of environmental problems are at the core of our global complacency towards them.

There have been a number of attempts at formulating theories of economic development that can take into account the relationship between institutions and biophysical constraints (Mayumi 2009). An individuals' preferences are not merely given from birth ('exogenous'), but are shaped endogenously by the set of rules that one learns to abide by as one develops. These rules not only specify what an individual needs to do to earn one's livelihood but carry implicit moral principles that are likely to imprint on what are seen as social norms for behaviour. For instance, the cultural imprints made by economic institutions have been shown to be reflected in distinct patterns of social values across different stages of economic development and wealth (Barclays Wealth EIR 2010). Since the ‘sustainable development’ paradigm essentially aspires to bring social and environmental values on equal footing with economic values, the cultural effects of institutions can and should inform discourses over the governance and transition towards ‘sustainable development’. The central motivation underlying this dissertation is therefore: *any form of (re)integration of social and environmental values into economic activities would benefit from carefully designing institutions in such a way that they encourage individuals to draw on such values.*

In this dissertation I turn to communitarian enterprise, asking: is the embedding of local community organisations in global market systems an effective approach for the fostering and expression of social and environmental values and the safeguarding of public goods? This conceptualisation of sustainable development is based on the premise that solutions for pressing social and environmental problems transgress the sovereignty of specific polities and require initiatives to emerge from sense and legitimacy-making processes within networks of stakeholders at formal, informal sub and supra-national level (Castells 1996; Tait & Lyall 1994). In other words, it views a transition to sustainable development as a cultural renegotiation process that ultimately manifests itself in the form of technological and behavioural change at local level, but that is facilitated and supported through regional, national and supra-national level actors. However, given that the focal area of this dissertation is renewable energy transition, it is worth reviewing alternative domain-specific conceptualisations for sustainable development. Lund (2007) defines ‘sustainable energy development’ more narrowly in terms of three outcomes: i) energy savings on the demand side, ii) efficiency improvements in energy production and iii) replacement of fossil fuels by renewable energy. As such, we may ask whether community renewable energy can contribute to these outcomes, how we create and maintain spaces for community enterprise, and how we most effectively embed community enterprise in regional, national and supranational governance frameworks.

The structure and design of this dissertation arose from the recognition that in supporting distributed ownership of renewable energy assets, policy makers face a trade-off between cost-efficiency arguments and unknown social and environmental benefits. In other words: ‘money talks louder’, and less tangible processes and welfare enhancing outcomes tend to fall through the cracks of the institutions that govern our daily lives. There is therefore a dire need for transparent and robust qualitative or mixed research to enable a systematic evaluation of more inclusive institutional frameworks in which local communities play a part, to allow sociology to regain legitimacy and a ‘seat at the table’ in institutional design. As such, in this field – call it sustainability science- knowledge for sake of knowledge is no longer good enough, and *it is our responsibility as publicly funded researchers not only to design research such that it is rooted in real life applications, but to personally take on the responsibility for its translation in further improved real life applications.* This is no small challenge because its involves understanding why ideas in sustainability science have had relatively limited effect on institutional change to date, from both a teleological and politics of science perspective. Based on that understanding, we can begin to set out a strategy for research and outreach processes that might enable sustainability science to break out of its academic echo chamber, as well as what kind of institutions might offer procedures for the realisation of its ideas. Within the context of this dissertation and its small contribution to sustainability science, this meant producing research that challenges and directly engages with dominant paradigms entrenched within our institutions, and exposing and explaining its anomalies in plain language, as well as setting high standards for Quality of Evidence.

Aims and objectives

The objectives of this dissertation were to explore the governance, local impacts and costs of community-owned renewable energy, pitching these against conventional commercial ownership models where possible. Specific research questions set out were:

- *How has community renewable energy developed and diversified over time and how was this shaped by the changing governance landscape? What drives 'paradigm' changes in energy governance? What can we deduce with regards to the institutional requirements for community renewable energy?*
- *What evidence does existing literature provide for local impacts of community renewable energy projects? What Quality of Evidence and what knowledge gaps do the literature present? What methodological approaches and lines of research are required to fill these gaps?*
- *What is the origin and magnitude of cost differences in community-owned and commercial- owned renewable projects? 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? How do these risks influence actual project costs and viability, compared to commercially owned projects? What are the policy implications?*

To address these questions and to present findings in a way that is relevant and relatable for policy makers in terms of methodological approach and language, this work necessarily extends beyond the disciplines and case-study based approaches of enquiry that have dominated research on community energy thus far, drawing on concepts and methodologies from a wide range of fields including historical institutional analysis, project- and transaction cost economics, and impact evaluation. Ultimately the aim of this work is to contribute to our understanding on if and in what context community-based ownership models represent a feasible and effective means to operationalising a more 'sustainable development' in the renewable energy sector and beyond. The reliance of this work on extensive documentation and country-level data on community renewable energy made the UK an obvious site for analysis, but the UK is also interesting for other reasons, such as the regional disparities in policy support frameworks that have arisen as a function of devolution.

Definitions

Informed by several existing characterisations of citizen collectives engaged in renewable energy in the UK, community renewable energy is defined as developments that are wholly or partially owned and managed by constituted (for- or not-for-profit) community organisations, established and operating across a geographically defined community (Walker & Devine-Wright 2008; Dóci *et al*. 2015; Ruggiero *et al*. 2014). Two defining features of community renewable energy in the UK are thought to be active community participation and local public benefits (Walker & Devine-Wright 2008; Phimister & Roberts 2012; Okkonen & Lehtonen 2016). Consequently, devolved governments and practitioners have pursued community energy for its association with positive local socio-economic benefits, equal opportunities, social justice, participative and economic democracy, as well as potential environmental benefits in the form of energy awareness and additional growth in renewable energy (Slee & Harnmeijer 2017; Cumbers 2012; Barton *et al.* 2015; Heiskanen *et al.* 2002; Warren & McFadyen 2010). As such, there is substantial overlap between discourse on community energy and that of social enterprise and the social economy, which focuses more broadly on business solutions and investment logics that combine economic with social and environmental goals (Amin *et al.* 2002; van der Horst 2008; Nicholls 2010). While community energy is foremost defined by its activities, social enterprise is defined foremost by its social mission, as manifested in how it reinvests its profits (DTI 2002). Neither community energy nor social enterprise is necessarily local, but their association with normative goals that are typically collectively negotiated through face-to-face interaction means that in practice they are often local (Seyfang *et al.* 2014; Seyfang & Smith 2013; O'Hara & Stagl 2002). Reconciling these definitions then, community energy can complement revenue generating strategies for existing social enterprises, as has been the case for many housing, sport and recreation associations, or it can be a primary revenue generation strategy and *raison d'etre* for local social enterprise, as it has been for rural energy co-operatives or energy service companies. Compared to social enterprise in health and service sectors, community energy also has unique characteristics; it is capital intensive and heavily dependent on access to finance, energy market structure and regulation, planning and renewable energy policy (Bauwens *et al*, 2016; Hain *et al.* 2005; Bolton & Foxon 2013; Hall *et al*, 2016; Morris 2013; Toke *et al*. 2008).

Given the paucity of both literature and data on newly emerging community-based energy storage, transport or demand-side management projects, the focus of this dissertation is on collective consumer-producer schemes in heat or electricity generation.

Specific contributions

This dissertation addresses four knowledge gaps within the literature on community and civic energy, set out below in turn.

(1) A meta-level understanding of the sector. Given the lack of a sector-wide understanding of project diversity, community energy literature is thus far inhibited by its inability to extrapolate findings beyond single case studies. Article I and II provide an overview of different types of projects within the UK and explain the emergence of these models in the context of their historical, policy, geographic origins as well as their local impacts.

(2) A better understanding of cost discrepancies between community and commercial ownership models. In supporting community ownership of renewable energy assets, policy makers face a trade-off between cost-efficiency arguments and poorly understood social and environmental benefits. Very little research has explicitly analysed cost differences or studied impacts 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 & 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 out-sourced expertise, and differences in the perceived risks associated with the two different ownership models. Article III identifies potential sources for positive and negative cost discrepancies between community and commercial ownership models based on theory and literature and uses this to interpret observed discrepancies in costs, project development timelines and estimated net present value.

(3) A better understanding of the local impacts of community renewable energy. Article II is a systematic review of evidence of the local social, economic and environmental impacts of community-based ownership models. It includes an assessment of the Quality of Evidence available and concludes by setting out a research agenda and methodological recommendations to guide future empirical investigations into the local impacts of community energy.

(4) A better understanding of the institutional requirements for community renewable energy and its potential contribution to sustainable development. There is little consensus over the role of civic energy in facilitating sustainable energy strategies, perhaps indicative for the lack of consensus of the role of localism in sustainable development more broadly (Brown & Purcell, 2005; Hess, 2008; North, 2010). There is also no clear understanding of what factors enable the sequential and sustained implementation of policy frameworks that are critical to civic or community energy development. The discussion and conclusion section of this dissertation summary asks whether community energy meets established definitions of sustainable energy development and sustainable development more broadly and identifies institutional design characteristics that have been amenable to the development of civic energy as a substantial proportion of the overall renewable energy sector. Specific policy requirements for civic and community energy are identified, building on a discourse analysis of recent policy reforms in the UK (Article IV) and pathways of institutional change that have shaped the community energy sector in the UK since the late 19^{th} Century (Article I).

The following sections outline data and methods (Section 2) and Results (Section 3). The final concluding section (4) summarises findings, discusses policy implications and asks if and in what context community energy ownership models represent a feasible and effective means to operationalising a more 'sustainable development' in the renewable energy sector and beyond. It also highlights limitations inherent to this work and sets out lines of future enquiry.

DATA & METHODS

All articles in this dissertation with an exception of Article IV draw on a country level database for community renewable energy projects and organisations compiled in 2011-2, and updated in 2014-5. This dataset was collected in as far as possible from existing literature, government resources and various old project directories, then complemented with digital and telephone surveys using Qualtrics. In addition, a range of open source spatial, grid capacity and planning data was compiled from a variety of sources, including Neighborhood Statistics, Indices for Multiple Deprivation and Urban-Rural classifications for Scotland, England and Northern Ireland (the data collection process is described in detail in prior work, see Harnmeijer 2012a and Harnmeijer 2012b). The dataset comprising 794 projects and over 400 data fields was used to compile country-level descriptive statistics for Article I, data on the size and frequency of different types of community energy projects for Article II, and project cost data for Article III. Articles I and II adopt qualitative methods and use the dataset in a purely descriptive manner to support the arguments made.

Additional qualitative and quantitative data was required to fulfil the specific objectives of this dissertation:

- Article I analyses a total of 114 peer-reviewed articles, primary and secondary material detailing socio-economic, technological, institutional governance and policy change processes between 1870 to 2015, in order to identify distinct historical periods in energy governance and their influence on patterns of ownership and institutional space for community energy;
- Article II is a systematic review of international peer-reviewed and grey literature on the local impacts of community energy. Following a systematic search for literature, 54 articles were included for review of evidence. A further 139 papers were used selectively to place results in context of best-practice approaches to impact assessment;
- Article III draws on international literature on the barriers facing community projects and uses a risk extended Net Present Value model to analyse the influence of specific risks facing community versus commercial energy projects on their financial viability. The economic data required for this analysis necessitated complementing the existing project cost data in the dataset with telephone survey data, as well as with published average cost data for commercial projects from RenewableUK (2015), DECC (2011), and BVG Associates (2014).

- Finally, Article IV uses discourse analysis to analyse a series of government statements and government commissioned reports released in 2015 in order to understand the context and rationale behind a variety of simultaneously implemented energy policy reforms at that time, drawing on further literature to place these reforms in historical context.

SUMMARY OF RESULTS

Characterisation of community energy in the UK

Community renewable energy in the UK is a recent phenomenon, with prevailing narratives and institutional governance structures limiting its emergence until as late as the turn of the millennium. It currently presents less than 1% of total installed renewable energy capacity in the UK. Articles I and II characterise the sector as dominated by wind and solar PV, and more common in South West England and Scotland than elsewhere in the UK. Owing to the unique resource requirements posed by bioenergy projects and the late introduction of heat incentives in 2011, bioenergy projects represent just 12% of projects. Of the bioenergy projects, the majority are small-scale woodfuel boiler based heat generation projects serving community facilities. The remaining bioenergy projects are community-owned CHP installations (4 projects in planning) and a half-dozen biofuel and anaerobic digestion projects.

Prior to the introduction of domestic policy support mechanisms, community energy was largely a rural phenomenon, heavily dependent on siting, scale and cost of alternative energy supply, and with little overlap with the UK's well established retail co-operatives. Table 1 below shows the current occurrence of different types of projects (2015) categorised on the basis of organisation mission and project function, including both installed and planned projects. The majority of projects are grid-export projects, facilitated by Feed-In-Tariffs and Renewable Obligation incentives; projects set up to consume generated heat or power on location ('self-consumption projects') are as of yet dominated by small-scale facility and microgeneration projects (Table 1). Overall, co-operative projects, community development projects, community facility projects and social enterprise-led microgeneration projects are the most common, with community development projects the largest in scale. There are as of yet no operational community-owned district heat networks, grid-integrated direct supply projects or grid-integrated microgrids. 10-30% of grid export projects are shared ownership projects, with predominantly private sector partners.

Local impacts

Article II identifies seven impact categories in the community energy literature: socio-economic regeneration, knowledge and skills development, social capital, increased local support for renewable energy, energy literacy and environmentally benign lifestyles, access to affordable energy, and empowerment. Results suggests that the least studied impacts are empowerment and access to affordable energy, with lack of robust qualitative evidence for socio-economic regeneration and lack of robust survey and statistical evidence across all impact categories identified. All of the local impacts identified are to some degree dependent on inclusively managed project processes, corroborating 'inclusive process' as a defining feature of what distinguishes community from commercial projects (Walker & Devine-Wright 2008). For instance, there is strong evidence that community ownership can have a positive impact on local support for renewable energy technologies if there is a high degree of trust in project leadership or far-reaching community engagement in the project development process. Furthermore, Article II concludes that community-based renewable energy projects do not in themselves deliver substantial environmental impacts in the form of energy awareness and behaviour change, although these impacts can occur as as a result of sequential initiatives over a period of years if organisations have explicit environmental mission statements and provide behaviour-oriented feedback and support. Finally, a number of impacts were found to be associated with specific types of community energy projects but not others (see Figure 1).

Based on the paucity of consistent evidence for impacts associated with project development processes and direct outcomes, Article II further suggests that the most substantial local impacts are likely to be associated with medium- to long-term indirect project outcomes resulting from the investment of project revenues in the local community. Finally, economic impact literature suggests that local economic impact is highest where earnings are locally reinvested in labour-intensive sectors and redistributive effects highest where invested in rural public sectors (Okkonen & Lehtonen 2016; Phimister & Roberts 2012).

Risks, costs and project viability vis-a-vis commercial projects

Article IV shows that community projects face on average higher costs and longer project development times than commercial projects. It attributes cost differences to six facets of an organisation or project: internal processes; internal knowledge and skills; perceived local legitimacy of the project; external legitimacy of the organisation; investor motivation and

Table 1: Overview of different types of CRE projects and their delivery in the UK (2014) showing and mean and standard deviation of project scale, proportion of projects that are set up by charitable organisations and proportion of shared ownership projects (Source: Article II).

Description		Technologies	Scale	% charitable	% shared ownership	Total capacity	Number of projects
Self-consumption projects							
Community facility projects	Charitable organisations building installations primarily supplying heat or power to community facilities, such as churches, recreation centres, community buildings	solar PV, micro-wind, ground/air-source heat pump, solar thermal, woodfuel boilers, (hydro)	μ=14kW σ=19kW	68%	0%	0.98MW	92
Social enterprise –led microgeneration projects	Energy provision for residential and facility buildings, serving as additional income generation for local non-governmental organisations providing health, housing, educational or recreational services.	solar thermal, solar PV, ground/air-source heat pump, wind, woodfuel (hydro)	μ=64kW σ=161kW	75%	0%	2.0MW	50
Community-owned micro-grids	Generation and supply on private wires or grids in remote areas or islands	wind, hydro, solar PV, integrated	μ=91kW σ=78kW	83%	0%	1.1MW	12
Community-owned district heat networks	Generation and supply of heat (and power)	woodfuel	μ=308kW σ=241kW	50%	0%	1.2MW	4
Low carbon micro-generation projects	Local organisations owning and managing local domestic micro-generation as part of broader carbon mitigation programmes, including ‘Low carbon’ and ‘Transition town’ organisations.	solar PV, solar thermal, ground/air-source heat pumps, micro-wind	μ=19kW σ=34kW	20%	0%	0.13MW	7

Electricity export projects							
Grid integrated direct supply	Direct supply to members of consumer co-operatives. No existing projects in the UK.	wind, hydro	No data	No data	No data	No data	No data
Custodian projects	Environmental and conservation organisations developing standalone renewable energy installations for grid-export to fund or complement their activities. Includes 'Low carbon', 'Transition town' organisations, forestry associations and community organisations aiming to keep local natural assets under local control or maintain local infrastructure.	hydro-electric, solar PV, woodfuel (solar thermal, heatpumps)	μ= 456kW σ=1099kW	42%	12%	11.9MW	33
Community development projects	Larger projects exporting electricity to the grid, run by charities and trusts owning privately constituted project entities that house income generating projects and earmark profits to a wide range of development projects	wind, hydro-electric, (solar PV, woodfuel, tidal)	μ=1326kW σ=1837kW	93%	31%	55.7MW	42
Community-owned grid - integrated microgrids	Microgeneration and storage units integrated in low voltage networks and interconnected to the upstream network, typically in tandem with demand management strategies. First pilot projects ongoing in the UK.	No data	No data	No data	No data	No data	No data
Co-operative projects	Larger standalone grid-export or installations directly supplying power to local industry, typically financed through industrial provident societies that offer citizens shares in renewable energy projects, with local, regional or national membership, including crowd sourced projects.	solar PV, wind, hydro-electric, woodfuel (solar thermal, anaerobic digestion)	μ=458kW σ=1000kW	9%	27%	44.9MW	100
Local landowner projects	Local farmers or estate owners collaborating to install projects	No data	No data	No data	No data	No data	No data

expectations; and finally, project scale. While differences arising from the additional labour input used in community schemes has little impact on overall project net present value (NPV) or the lifetime discounted cost of energy (LCOE), the main source of variation in the viability of commercial as compared to community projects is the higher risk faced by community groups, particularly during early phases of a project. The results of the sensitivity analysis in Article IV suggest that the financial viability of community projects remains most vulnerable to legislation that directly or indirectly influences access to low-cost capital.

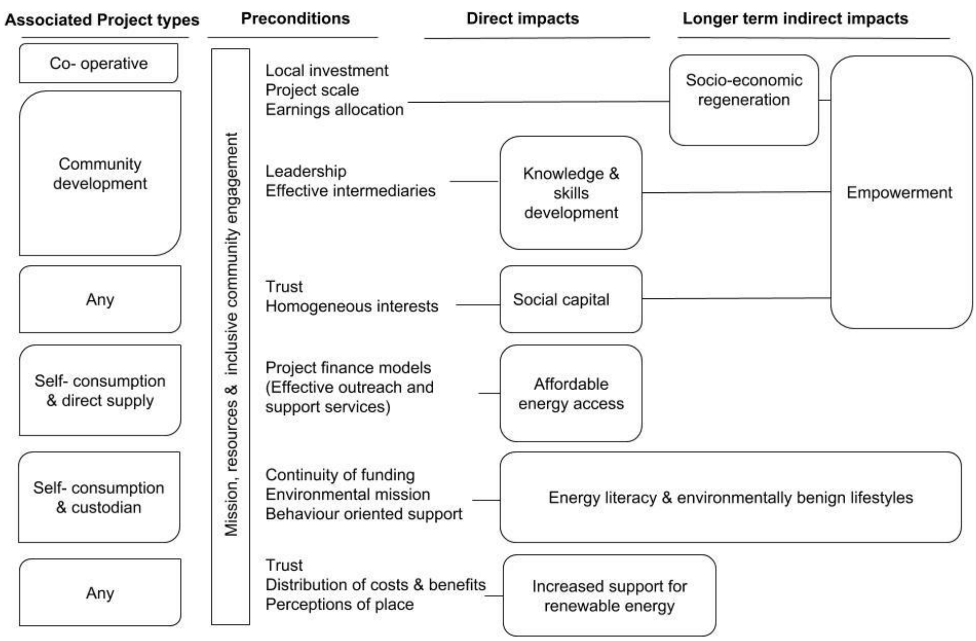

Figure 1: Summary of direct impacts from project development and longer term indirect impacts, showing preconditions and indicative associated project types (Source: Article II).

DISCUSSION & CONCLUSIONS

Through synthesis of existing literature, by addressing Quality of Evidence problems, and by firmly placing community renewable energy in context of both project economics and impact assessment literatures, this dissertation provides a basis for further research on community renewable energy, and perhaps for the study of communitarian approaches to sustainable development more broadly. The following synthesizes the key findings from the results of Articles I-IV. Building on the results, this section then reflects on the institutional requirements for community energy and asks whether community energy ownership models represent a feasible and effective means to operationalising a more ‘sustainable development’ in the renewable energy sector and beyond. The final paragraphs outline the limitations of this work and set out lines of further inquiry.

Key findings

- Ownership patterns in the energy sector are precarious and subject to changing ideology and narratives that emerge in response to exogenous shocks and domestic socio-economic and political dilemma's, as well as emerging economic concepts and schools of thought.
- All of the local impacts identified are to some degree dependent on inclusively managed project processes.
- The most substantial local impacts of community renewable energy are likely to be associated with indirect project outcomes resulting from investment of project revenues in the local community, rather than direct impacts associated with project development processes. As such, collective funding pools and negotiation processes around their distribution towards private versus public goods play a crucial role in determining far-reaching transformative local impacts of CRE.
- In a competitive market setting and where community energy is implemented predominantly by newly-established grassroots organisations, community renewable energy projects face a range of risks that commercial projects do not, and that work to erode the financial viability of their projects. These include internal process costs arising from the need to manage their activities to the satisfaction of all members, transaction costs as a result of a lack of in house skills or knowledge and the need to outsource to external contractors, a lack of legitimacy which affects their ability to access finance, and a lack of internal economies of scale.
- The development and expansion of community renewable energy as a substantial proportion of the energy sector requires policy makers to assign it special status and provide policy support on the basis of its local social, economic and environmental benefits. As such, policy support for community renewable energy requires a willingness to integrate energy and social policy domains; domains that have historically been governed by independent institutions.
- Policy support for community energy should be targeted at addressing specific costs and risk factors, including those that build local capacity for community energy projects (ranging 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 active promotion of community organisations as legitimate players in the energy market.

Institutional requirements

The findings of Articles I and III demonstrate that community organisations do not typically exist on a level playing field with incumbent actors, emerging only where policy frameworks have been established to address these challenges. Drawing on Articles I and IV as well as further literature, distinct layers of policy support can be identified (Figure 2). Layer (1) represents *corporate legal frameworks that provide community organisations with suitable tradeable entities* through which they can raise capital, manage projects and carry out their activities to the satisfaction of their members or shareholders. For instance, co-operatives have variably been restricted in their rights to sell electricity directly to their members, or by high fees for investments (Farrell 2008). Layer (2) is legislation enabling *market access for independent power producers or service companies* and has become standard where generation has been unbundled and fully privatised. This includes power purchase guarantees, net metering, priority dispatch, grid connection guarantees as well as grid upgrade and congestion management systems, and the ability to obtain supply licences - or indeed any other low risk market integration mechanisms for electricity. Where these provisions do not exist, community energy development is by and large limited to energy efficiency or self-consumption projects. Beyond microgeneration projects, the requirements to balance supply and demand internally makes self-consumption projects both more complex and capital intensive and viable only in contexts where energy access is problematic and cost of energy alternatives are high, such as remote islands.

Layer (3) sets out *medium-term demand guarantees and market-based investment incentives* for renewable electricity, heat or energy efficiency. These include mandatory renewable energy portfolios for electricity suppliers, purchase obligations, renewable energy mandates or quota systems and associated green credits, export and generation tariffs for heat and electricity, tax credits or environmental premiums – typically embedded in national renewable energy targets and commitments under international climate agreements. Across Europe and North America, these support mechanisms have allowed standalone heat and power generation projects to become financially viable and bankable even where the levelised cost was higher than the price of purchasing heat from fossil fuel alternatives or power from the electricity grid. Layers (2) and (3) both address the financial viability of projects and are congruous with the interests of the commercial renewable energy industry and characteristic of privatisation reforms and renewable energy support policies in many countries across the world (Hess 2015). However, owing to the unique nature of community projects, the specific design parameters of support instruments have been observed to carry substantial consequences for risk exposure and viability of small-scale or community-based generation projects (Schreuer 2010; Cumbers 2012; Strachan *et al.* 2015, Nolden 2013). For instance, auction-based support mechanisms that force technologies at different levels of maturity to compete, that do not remove short-term power price or imbalance risks, or that require large sunk investment and hedging across multiple projects are more likely to drive out small-scale or community-based projects (Toke 2000; Mitchell 2004). As such, the jury is still out as to whether community-based generation projects can thrive in a context in which low- risk price-based incentives such as Feed-in-Tariffs have been phased out in favour of

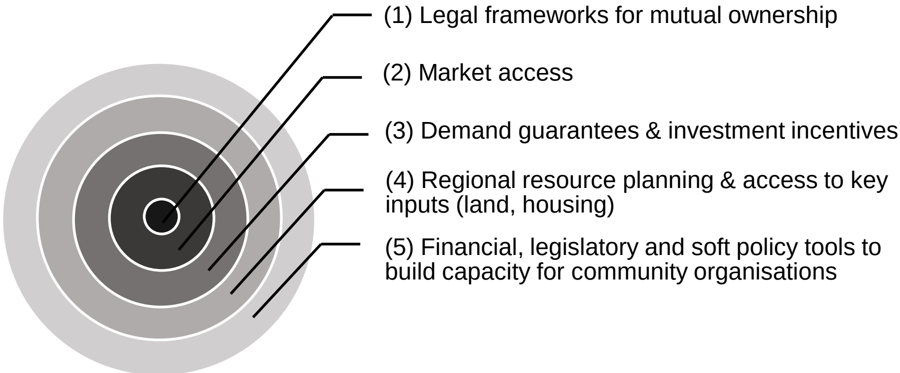

Figure 2*:* Layers of access to community energy as defined by broad categories of formal institutions (Source: original work)

more competitive auction mechanisms, as is increasingly the case internationally (REN 2016). In general, given adequate market access legislation, market-based investment incentives are likely to become less pertinent to the growth and diffusion of community energy over time as renewable energy technologies approach grid parity. However, as global policy trends shift from 'feed-and-forget' policy frameworks to frameworks that require generators to internalise whole system costs of renewable energy integration, the development of inclusive grid flexibility incentives is likely to determine whether community-based generation projects will continue to be able to play a role in renewable energy deployment.

A fourth and fifth layer of access relate to alleviating constraints that are specific to community-based projects or leveraging its specific qualities, enabling further replication and growth of the community sector where market access and support systems are adequate. Layer (4) consists of *land ownership and land use planning or resource consent processes that enable or restrict access to local renewable energy resources and sites for development*. In many countries, land use planning is devolved to regional authorities and characterised by some form of public engagement that has been thought to give locally owned projects an advantage over commercial projects. However, there is wide variation in the extent of local land rights and ownership, with landless community organisations struggling to negotiate access to suitable sites for development (Strachan *et al*. 2015). There is also wide variation in how effectively planning processes provide opportunities for genuine discourse around desirable strategies for regional development and the role that renewable energy may have (Cowell 2016).

The fifth and final 'layer of access' exists around financial, legislatory and soft policy frameworks *enabling third-party involvement in renewable energy deployment*. These comprise of a wide diversity of policy frameworks designed specifically to incentivise and build organisational capacity and human resources for community energy initiatives, or to remove some of the unique constraints faced by less established community organisations. These range from (revolving) seed capital loans or grants, fixed premiums for electricity generated from community or small to medium-scale projects, tax privileged investment structures for social enterprise, or knowledge platforms disseminating essential technical, financial, legal, project management information and facilitating subcontraction of services. It might also include legislation on local ownership that makes shared or local ownership voluntary or compulsory (Mendonca 2009). Policy instruments in this category are variably embedded in broader policy agendas around rural development and income diversification, cultural landscape protection, 'Third Sector' approaches to social policy, as well as regional or national climate, renewable energy or energy poverty strategies. Regional authorities have either had to transpose national legislation or utilised what powers of discretion they have to legitimise, prioritise and support community energy projects (Bulkeley 2016; Spath 2010; Toke 2005; Oteman *et al* 2014). Policies have ranged from adopting regional targets for renewable energy development, formally or informally including local ownership criteria in planning consent, developing and disseminating regionalised development zones or pre-feasibility studies to relevant organisations, or making public land available for renewable energy development (Li *et al*. 2013; Strachan *et al.* 2015).

Where policy objectives and legislation are less tightly aligned across different levels of government, regional powers of discretion have also resulted in inconsistent, opaque and highly political treatment of renewable energy projects within the planning process (Toke 2005; Nolden 2013). More generally, community energy has reached highest levels of penetration in countries where layers of access (2)-(5), including the design of market support mechanisms, were devolved to regional authorities, yet embedded and streamlined with national level targets (Strachan *et al*. 2015; Oteman *et al*. 2014). This observation has considerable empirical and theoretical support in climate change mitigation and natural resource management more broadly (Andersson 2008; Lutsey 2008). Local authorities are better able to identify the unique constraints and opportunities of any given region or community project (Moss 2014; Wirth 2014), facilitate it's route to market by matching local resources and interest groups (Hall *et al*. 2015; Hoppe *et al*. 2015; Peters *et al*. 2010) as well as experiment with, learn from and lobby for necessary central policy change (Lutsey & Sperling 2008) - in particular in absence of other handholding intermediaries. Not only are local authorities better positioned to facilitate community energy, but also face stronger incentives to do so since they benefit from the direct and ancillary benefits generated by community energy projects (Kelly & Pollitt 2011).

Community energy and sustainable energy development

This dissertation shows that while community energy through grass- roots organisations can potentially generate a wide range of socio-economic and environmental benefits, it is also costlier than equivalent commercial development, because of higher risk, lack of economies of scale and higher transaction costs. However, recent evidence has shown that the cost of community energy has fallen in the last decade as a result of policy innovations and learning by doing, in addition to an increase in average project scale (Roberts *et al*. 2015). This suggests that these cost discrepancies may at least partially disappear upon the establishment of skilled local energy enterprises and intermediaries.

Together this dissertation suggest that community energy can potentially contribute to demand-side energy savings and, through facilitating support and investment into renewable energy, contribute to replacing fossil fuels (Lund 2007). As long as community renewable energy projects remain capital constrained, they are unlikely to contribute to efficiency improvements in energy production (Lund 2007). However, the results also demonstrate that community renewable energy can potentially catalyse a range of socio-economic and environmental impacts that extend beyond energy into other domains of production and consumption. Exact impacts are highly dependent on organisation mission, managerial choices and continued success, and, confirming the findings of others elsewhere (Hess 2008), community energy organisations do not necessarily generate far-reaching environmental impacts. Nevertheless, community energy projects in the UK are, by virtue of being risky and labour-intensive, often motivated by specific and urgent needs around local public good provision, and 13% of organisations have an explicit environmental mission statement (Article II). With the possible exception of co-operative projects, community energy projects are not an obvious road to private gains, and it follows that they may be immune to exploitation.

Limitations and lines of further inquiry

This dissertation saw several shortcomings. The impacts review (Article II) was limited by the lack of explicit impact assessments for community energy in the available literature. In addition, methods and language to assess less tangible social impacts such as empowerment and social capital in particular are poorly developed and there may be bias towards impacts that can be more readily assessed, such as economic impacts. Given the varied distribution of evidence for impacts across project types, a systematic comparison of medium- to long-term impacts across different types of community energy organisations in which earnings are allocated to a variety of private and public goods would shed light on the conditions under which specific impacts are generated. This would enable a discussion around how to encourage desirable impacts, for instance by making policy support dependent on inclusive community development plans.

The analysis in Article III was constrained by a small project cost data set (n=51) developed between 2003-2014, each with different development timescales and expenditure profiles. Given the downward trend of project costs over time (see Roberts *et al*. 2015) an extended analysis with a representative sample size for several time periods and with more detailed breakdown of project cost data would complement the analysis by being able to confirm the nature of cost trends as well as their origin. Furthermore, the analysis would be improved with empirical data to substitute initial base transition probabilities based on expert opinion, and empirical data for project hurdle rates.

The findings of this dissertation and its ability to shed light on whether community energy can contribute to sustainable development outcomes are limited by its scope of analysis, which does not extend beyond project level costs and impacts. For instance, a number of studies suggest that broad distribution of co-benefits of climate mitigation strategies to actors beyond professional energy companies can work to change narratives regionally and nationally, gradually generating support for more ambitious and accelerated climate and energy policy (Meckling *et al*. 2015). Furthermore, it is quite possible that engaging community organisations in climate mitigation and adaptation as well as other pertinent policy challenges that simultaneously address local needs can counter populist sentiments resulting from socio-economic marginalization and lack of control over the political system, restoring civic engagement and effective democratic processes. Other authors have highlighted concerns around civic energy pathways, including the unequal capability of communities to partake and benefit, the notion that distributed generation may undermine universal access to energy (Johnson & Hall 2014) and the notion that community energy as part of the UK's progressive localism agenda is fulfilling roles that should in fact be provided equally across communities by the government (Catney *et al*. 2014; Williams, Goodwin & Cloke 2014). In addition, across Europe there is a resurgence of concerns around the macro-level costs of distributed generation at the energy system level, in the form of curtailment costs, transmission network upgrades, increased reserve requirements and efficiency losses from de-charging conventional power stations (SWECO 2016).

Table 2 summarizes the potential advantages and disadvantages of community renewable energy based on the discussion so far. A full analysis of all the advantages and disadvantages of widespread local community engagement in the energy transition at both local and energy systems level is beyond the scope of this dissertation. However, taken together the findings presented do demonstrate that governance attributes, including innovations in energy market reform, policy and support mechanisms, heavily influence the nature of the advantages and disadvantages of community renewable energy, influencing aspects ranging from legal incorporation and investment strategies (Article I), to local impacts (Article II), to risk exposure and project costs (Article III). In addition, Articles II and III show that choices and strategies around the role of civic engagement in climate and energy strategies can be based on informed analysis of both tangible and less tangible impacts beyond mere analysis of the consumer costs of policy support.

Finally, the definition of community energy adopted in this dissertation is based on the nature of projects in the UK. It remains to be seen whether the findings discussed here are applicable to citizen collective projects elsewhere, such as Denmark, Austria or Germany, where citizen and municipal engagement in renewable energy was much more central to energy policy strategies from the outset. Given the dependence on domestic policy and the variance in the emergence and character of civic and community energy internationally, a clear understanding of what factors enable the sequential and sustained implementation of policy frameworks that are critical to its development would necessitate country comparative analysis. We may find for instance that prevailing actors, institutional rules and arrangements in some countries have enabled a more adaptive and inclusive energy governance than in other countries. In addition, studies outside of the UK contrasting community energy models in relation to impacts would also help to confirm the causal processes and preconditions for local impacts identified in this dissertation.

Table 2: Summary of potential advantages and disadvantages of community renewable energy

ADVANTAGES	DISADVANTAGES
Increased acceptance for renewable energy	Diseconomies of scale
Increased social capital	Unequal access and regional inequality
Socio-economic regeneration / economic regional development	Whole system costs of DG
Energy literacy and environmental lifestyle changes	
Empowerment	
Access to affordable energy	
Knowledge and skills development	
Support for ambitious climate and energy policy	
Energy supply resilience	

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