Moving towards whole settlement energy self-sufficiency in rural communities

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Abstract

Energy has become an important issue for governments, communities and individuals, as concerns about energy prices, security of supply and climate change increase. Community scale low carbon energy systems could play an important role in future energy systems, but until recently UK government policy focussed on centralised energy systems. A number of rural communities elsewhere in Europe have made transformational whole settlement transitions from fossil fuel dependent towards renewable powered energy systems; however, the number of these in the UK is limited.

Using a case study approach of European and UK cases, this research examines: reasons why rural communities embark on journeys towards whole place energy self-sufficiency; what capacities are present and contributions of these on outcomes achieved; whether there are similarities or differences between Europe and the UK and whether these are generalisable. European cases are examined using secondary and UK cases mainly primary data sources.

Cases had varying rationales for embarking on whole settlement approaches to energy self-sufficiency. Whilst these don't appear to determine the degree of energy self-sufficiency achieved, a whole settlement approach was considered important. No cases achieved energy self-sufficiency, but most made significant progress towards this and the idea did function as a boundary object. A number of capacities were present across all the cases such as public funding for energy system delivery, some capacities were present in the majority of cases and there were differences in capacities between the European and UK cases including leadership by local government. If the UK is serious about whole place energy self-sufficiency there needs to be; a commitment to public funding and resolving whether local authorities at their current scale and resourcing can provide leadership, or if alternative forms of local governance need to be found.

Dedication

To my husband Paul, who has selflessly supported me, emotionally throughout and financially when needed. His quiet grace and sense of humour has both grounded me and enabled me to breathe freely.

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List of Acronyms

AHGCN	Ashton Hayes Going Carbon Neutral
ATC	Alternative Technology Centre
BMVEL	Ministry of Consumer Protection, Food and Agriculture (Germany)
CCF	Climate Challenge Fund
CEFS	Calderdale Energy Future Strategy
CERT	Carbon Emission Reduction Target
CHP	Combined Heat and Power
CIC	Community Interest Company
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment Food and Rural Affairs
DNO	Distribution Network Organisation
DTI	Department of Trade and Industry
FIT	Feed In Tariff
FNR	Agency of Renewable Resources (Germany) IPCC Intergovernmental Panel on Climate Change
IEA	International Energy Agency
IEHT	Isle of Eigg Heritage Trust
IPCC	Intergovernmental Panel on Climate Change
IZNE	Interdisciplinary Centre for Sustainable Development, Göttingen and Kassel University
LEADER	Liaison Entre Actions de Développement de l'Economie Rurale
MEC	Mureck bioEnergy Cycle
NIReS	Newcastle institute for Research in Sustainability
PECAN	*El Plan Energetico de las Canarias*, produced by the Canarian Autonomous Government

PHS	Pumped Hydro Storage
REI	Renewable Energy Island
RES	Renewable Energy Supply
RHI	Renewable Heat Incentive
SEEG	South Styrian Energy and Protein Production Co-operative
SSSI	Sites of Special Scientific Interest
SWT	Scottish Wildlife Trust
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WSESS	Whole Settlement Energy Self-Sufficiency

Chapter 1. The Research, Context, Aims and Methodology

1.1 Introduction

The global climate is changing. There is little doubt that human activity is contributing to the rate of climate change (IPCC, 2014a, p.5) and if communities across the globe are going to survive, they will need to change the way they do things in order to both mitigate against and adapt to climate change. Energy is an important consideration in this, as a quarter of all greenhouse gas emissions globally come from the generation of power and heat (IPCC, 2014a, p.47). In addition, concerns over security of energy supplies and until recently a general trend, of rising global oil prices (IEA, 2013) has focussed political, communities' and individuals' attention on alternative energy supplies and sources.

The International Energy Agency (IEA) projects that Global energy demand will continue to increase to 2035, but the share of fossil fuels in meeting demand in 2035 is expected to fall from 82% in 2011 to 76% in 2035 (IEA, 2013). There will be growth in all types of energy, with the low carbon energy sector (renewables and nuclear) projected to meet 40% of the increased demand to 2035 (ibid.).

As we approach (or have possibly passed) Peak Oil (Murphy and Hall, 2011), even companies whose current business is dependent upon the market in fossil fuels believe that by 2015 growth in production of easily accessible oil and gas will not keep pace with the demand, (Shell, 2008).

1.2 UK Energy Policy

Over the last thirty years the UK has seen a major transformation of its energy industry from a state owned monopoly to a number of private utility production and supply companies (Houghton, 2001, p.190). There have been also changes in energy policy at an EU level through treaties, such as the Lisbon Treaty (European Commission, 2007), which give the EU a new role in energy markets including security of supply, energy efficiency and supporting development of renewable and other new energy technologies. These changes have resulted in a reduced role for the UK Government in directing change in the energy markets (Skea, Ekins and Winskel, 2011, pp.2-3). During this same thirty year period, the UK has gone from being mainly self-reliant in energy to becoming a net energy importer and so needs to address issues of energy security that haven' been faced before (ibid. p.45). This combined with commitments by the UK Government to reduce the UK's greenhouse gas emissions by 80% compared with 1990 levels by 2050 (Great Britain. Climate Change Act 2008) means that even with a reduced role in directing the energy markets the UK Government nevertheless still has an important role to play in addressing significant energy challenges the UK is facing (Skea, Ekins and Winskel, 2011, pp.2-3).

To that end over the last fifteen years there have been a myriad of government papers and legislation produced at a UK level to address these issues, the legislation includes:

Act	**Description**
Utilities Act 2000 (Department of Trade and Industry, *2000*)	set out to modify previous legislation on the gas and electricity markets
Sustainable Energy Act 2003 (Department of Trade and Industry, *2003)*	amended the Utilities Act 2000 to make provision to develop sustainable energy policy
The Energy Act 2004 (DTI, *2004)*	set out a range of provisions for the nuclear power industry, encouragement of renewable energy and regulation of the gas and electricity industries
Climate Change and Sustainable Energy Act 2006 (Department of Trade and Industry, *2006)*	made provisions for reducing greenhouse gases from energy, reducing fuel poverty and encouraging production of energy from renewable sources
Energy Act 2008 (Department of Energy and Climate Change, *2008)*	made provisions to deliver the energy policies identified in the Energy White Papers (DTI, 2007) to reduce greenhouse gas emissions and ensure affordable energy supplies
Climate Change Act (2008) (Department of Energy and Climate Change, *2008)*	set a target for reduction of greenhouse gas emissions by 2020 and 2050 and made provision for carbon budgets to be established
Energy Act (2010) (Department of Energy and Climate Change, 2010)	made provision for development of carbon capture and storage
Energy Act 2013 (Department of Energy and Climate Change, 2013)	had a range of provisions for the energy industry, but did not include any targets for production of energy from renewable sources

Table 1. UK energy legislation

It should also be noted that there are differences between the nation states that comprise the United Kingdom in areas of energy and climate policy. Of particular interest for this research is legislation passed by the Scottish Government:

- The Climate Change (Scotland) Act (2009), which included a statutory obligation to reduce all greenhouse gas emissions by 42% by 2020 and 80% by 2050, a two percent higher interim target than the UK Climate Act (2008).

Following this, the Scottish Government produced the 'The Routemap for Renewable Energy in Scotland' (Scottish Government, 2011), which set out a target for the equivalent of 100% of Scottish electricity demand to be met from renewable sources by 2020, with an interim target of 31% by 2011. This was updated in 2013 with an interim target of 50% of electricity demand being met from renewable sources (Scottish Government, 2013). Whilst not embedded in legislation, this shows a clear difference in ambition between the UK and Scottish Governments, as there were no such targets in the UK Energy Act 2013 (DECC, 2013).

Whilst the opening up of the energy markets has provided opportunities for a range of utility companies to establish, in reality the UK market is dominated by a small number of large firms who supply energy using mainly centralised technologies and large scale distribution systems (Foxon, 2013; Ekins, Skea and Winskel, 2011, pp.42-43). UK energy systems have been described as being in 'lock-in'; where radical change is inhibited due to the vested interests of mainstream actors, whereby they seek incremental change to existing energy systems rather than looking at system innovation (Hawkes et al, 2011, p.243).

In recent years, however, the UK Government has recognised the contribution that more decentralised, distributed energy systems can have in the UK's future energy systems and the important role that communities can play in this. As well as involvement in local energy generation and in reducing CO_2 emissions, communities can also help reduce energy demand and there is a real appetite from communities to do this, evidenced by an increase in community interest and involvement in energy projects (Bomberg and McEwen, 2012; Seyfang et al, 2014). In response to this, the UK Government launched the Community Energy Strategy in January 2014 (DECC, 2014a). Whilst the definition of community energy in this strategy is not limited to production of renewable energy and reducing energy consumption by communities, these are identified as two key priority areas for action. It identifies a number of key interventions to help communities develop energy schemes and to secure greater benefits from commercial operators of energy schemes in their area.

1.3 The Need for Low Carbon Energy Futures

The IPCC Fifth Assessment Synthesis Report confirms that the evidence for anthropogenic impacts on climate change is overwhelming:

> ‘The evidence for human influence on the climate system has grown since AR4. Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, and in global mean sea-level rise; and it is extremely likely to have been the dominant cause of the observed warming since the mid-20th century.’
>
> IPCC (2014a, p.5)

There is a high degree of confidence that ‘About half of the cumulative anthropogenic CO_2 emissions between 1750 and 2011 have occurred in the last 40 years’ (IPCC, 2014a).

However, it is possible to meet the entire world’s power demand from water, wind and solar power by 2050 (Delucchi and Jacobson, 2011) and a resilient, low carbon energy system in the UK is also possible by 2050 (Ekins, Winskel & Skea, 2011, p.360). There are significant challenges that will need to be overcome in achieving this including political, policy and societal responses, not least infrastructural challenges as acknowledged in the IPCC 4th Assessment Report:

> ‘Renewable energy sources (with the exception of large hydro) are widely dispersed compared with fossil fuels, which are concentrated at individual locations and require distribution. Hence, renewable energy must either be used in a distributed manner or concentrated to meet the higher energy demands of cities and industries.’
>
> (IPCC, 2007, p.253).

However, failure to deal with challenges such as this and move towards the goal of low carbon energy systems presents serious risks for the economy and way of life in the UK (Ekins, Winskel & Skea, 2011, pp.364-365).

In its first report looking at different scenarios to meet the UK's Climate Change target of an 80% reduction in greenhouse gas emissions (Great Britain. Climate Change Act 2008), the UK Committee on Climate Change suggested that the reductions in emissions to 2022 will 'primarily' be achieved through deployment of renewable energy (Committee on Climate Change, 2008, p.173)

It is suggested that many communities fail to meet energy reduction/climate change targets as their focus is on short term, incremental approaches, rather than tackling the more challenging transition to 'renewable energy communities' (Carlisle and Bush, 2009, p.263). Whilst such incremental changes in areas such as energy efficiency are important, they should be seen only as steps in a more comprehensive approach to moves towards meeting all a community's energy requirements from renewable resources.

1.4 Rural Areas and Energy

54% of the global population live in cities (United Nations, DESA, Population Division, 2014, p.1). As a result, globally urban activity is a 'major contributor' to emission of greenhouse gases, because the emissions are as a result of human behaviour and features of urban landscapes (IPCC, 2014b, p.538; Rydin, 2010, p.12). However, this also offers opportunities for adaptation and mitigation activities in terms of low carbon energy generation and more energy efficient systems, such as transport. Despite the concentration of emissions from urban centres, invariably emissions per capita in urban centres are lower than those in rural areas in the same countries (ibid.; Satterthwaite and Dodson, 2012, p.75).

For the first time the IPCC in its Fifth Assessment Report included chapters on both urban and rural areas. In the rural chapter (IPCC, 2014c, pp.629-630) there was recognition that whilst there are some challenges associated with development of renewable energy systems in rural areas, such as competition for scarce land resource and perceived impacts of wind energy systems in the UK in particular, it also identified that this can have benefits for rural areas, notably increasing employment and that 'Steps towards energy self-sufficiency can reinforce rural autonomy in isolated rural communities'. The report also observed that the governance arrangements for distribution of renewable energy were an important consideration.

In 2011 in England, 17.6% of the population lived in rural areas (DEFRA, 2014), the majority of these in small towns. In Scotland 30.8% of the population lived in rural areas, which includes small towns (Scotland, National Records Office, 2014). As described above, people who live and work in rural areas make a higher per capita contribution to the UK's CO_2 emissions and therefore have the potential to make a more significant contribution per capita to the target of an 80% cut in greenhouse gas emissions below 1990 levels by 2050, as set out in the Climate Change Act 2008 (Great Britain. Climate Change Act 2008).

One of the key findings in the International Energy Agency report (IEA, 2009) was that it is easier for small rural towns to achieve a high contribution of renewable energy to the local mix than for larger urban settlements. They are smaller in scale and in closer proximity to many of the resources that can be used as part of a renewable energy mix than their larger, urban counterparts. Just because they are smaller in scale than other communities, energy projects based there should not be viewed as less important than larger scale schemes, as described by Mulugetta, Jackson & Van der Horst, (2010): 'community scale initiatives in the current climate debate should not be seen as marginal, or as a distraction from the 'real' priorities of climate change mitigation'. There have also been compelling cases made that smaller and rural communities can make significant contributions to low carbon energy systems (Kellett, 2007; Walker and Devine-Wright, 2008; Trutnevyte et al, 2011).

However the UK has been lagging behind other European states, such as Denmark and Germany in the deployment of community scale renewable energy. There are a number of factors contributing to this around differences in local ownership and benefits pertaining to the different approaches to local and regional strategies, which in the European states deliver local jobs, taxes and co-operative models of ownership (Cass, Walker and Devine-Wright, 2010; CSE, 2005).

1.5 Capacities for Rural Communities to Develop Their Own Low Carbon Energy Systems

A community's ability to establish and sustain itself in working towards an energy goal is dependent upon the resources and skills it has to do this (Bomberg and McEwen, 2012, Dalton 1994, p.6). In this research, I use the term capacities to refer to these resources and skills (Middlemiss and Parrish, 2010) and these are described in more detail in chapter 2.

Whilst the focus of some research into low carbon community energy has been on different aspects of developing individual community renewable energy projects (Walker et al, 2010), or where community scale energy projects are referred to, such as a district heating systems, only making mention of linking different buildings and organisations in a community, rather than delivering a system for the whole community (Walker et al, 2007); there is, however an emerging interest in community scale approaches to low carbon energy systems (Hauber & Ruppert-Winkel, 2010; Hoffman & High-Pippert, 2010; Mulugetta, Jackson & Van der Horst, 2010). This research sets out to build on this to investigate what capacities are present in communities that have taken whole settlement approaches to energy self-sufficiency, what the energy self-sufficiency outcomes are in those communities, what individual lesson can be learned and whether the approaches adopted can be generalised. This forms the main analytical focus of my research and my contribution to academic literature.

1.6 Introducing the Research

This is an applied piece of research, examining the rationales and presence and role of capacities in rural communities that have adopted whole settlement approaches to energy self-sufficiency. In the following section I outline the aims of the research, the research questions and how the research is presented in the following chapters.

There are a number of rural communities that have made a successful transition from mainly fossil fuel to mainly renewable powered energy systems, with some claiming to have achieved energy self-sufficiency. This research sets out to understand the reasons for the transition; what capacities were present in those communities as they made these changes and whether there are lessons that can be learned from these to inform development of energy self-sufficiency schemes in rural communities in the UK in the future.

My research questions are:

1. Why do rural communities embark on approaches to whole settlement energy self-sufficiency (WSESS)?
2. In rural settlements that develop a whole settlement approach to energy self-sufficiency, what capacities are present and how do these capacities contribute to the development and delivery of this?
3. Do whole settlement approaches to energy self-sufficiency function as a boundary object?
4. Does the rationale for a rural community starting its journey towards energy self-sufficiency make a difference to its progress in achieving this and was a whole community approach to energy self-sufficiency present at the start? Was there was a relationship between these and the energy self-sufficiency outcomes achieved?

1.7 Methodology

In understanding the presence, role and impact of capacities in rural communities that have achieved, or are working towards energy independence, my research takes a case study approach. Firstly a cross case analysis is undertaken of a number of European rural cases that have made significant progress towards energy independence in order to understand what the capacities might be in those communities; this part of the research is based mainly on secondary data sources. In addition to contributing to the research findings, this also informs the selection of four UK rural settlement cases. For both the European and UK cases, a 'most different systems' approach was taken to their selection (Przeworski and Teune, 1970, pp.34-39).

In order to understand what decisions were made, who the key actors were and the processes in making these in moving towns towards energy independence, in depth interviews were undertaken as the principle research method with key actors in each of the UK case study settlements. This is recognised to be a most useful research method for comprehending more fully the reasons behind how decisions were reached (Chong, 1993, p.868) and was supplemented by documentary analysis, case study visits and ethnographic observations.

A further opportunity arose during the course of my research to gather wider views on the approaches in some of the case communities and examination of some of the issues considered here. I had a proposal for a community renewable workshop accepted by the Newcastle Institute for Research in Sustainability (NIReS). This was held in October 2013 at Newcastle University and had two parts; presentations from inspirational individuals I had met from some of my case communities during the course of my research, followed by a series of workshops to enable delegates to learn more from both the presenters and each other about different aspects whole place energy transitions.

1.8 Summary

Energy has become a progressively more important issue for governments, communities and individuals, as energy prices increase, concerns continue about security of supply and the challenge of addressing climate change becomes more acute.

A number of rural communities in Europe have made transformational whole settlement transitions from fossil fuel dependent to renewable powered energy systems. However, the number of these communities in the UK is limited. This research seeks to understand what the rationales are behind communities' decisions to start on a journey towards energy self-sufficiency, what capacities are present in those communities and how they contribute to the development and delivery of this approach.

1.9 Thesis Structure

This first chapter forms the introduction to the research. **Chapter 2** provides an overview of the literature on whole rural settlement approaches to energy self-sufficiency. It includes a critical review of literature on energy self-sufficiency, renewable energy and community capacity. I reflect on how these can inform the research and present a conceptual framework to provide a focus for the key elements that are built into the data collection process.

In **Chapter 3** I describe the methodology adopted in my research to answer the research questions. I consider the best methods for obtaining the richest sources of data and describe the three main methods adopted; cross case analysis, case studies and a conference. I present the cases selected, the reasons for their selection and discuss the techniques used in the data collection and analysis.

Chapter 4 illustrates the European cases, without presenting any analysis of the data. The data is collected from secondary sources and is presented using the framework of problem formulation, mobilisation and communication to provide a structure (Mårtensson and Westerberg, 2007). It describes the process of each case's move towards energy self-sufficiency and the capacities present.

Chapter 5 describes the UK cases, using the same framework as for the European cases for presenting the data. The data is collected mainly from primary sources describing each case as it attempts to move towards energy self-sufficiency and the capacities present. I use the conceptual framework described in **Chapter 2** to present the capacities identified in each of the cases.

In **Chapter 6** I describe the cross case analysis of both European and UK cases, an analysis of the UK cases and identify where the contributions from the community renewables workshop I organised with NIReS support, or depart from these. I discuss the capacities and combinations of capacities present in each case and whether these are replicated in other cases and draw key themes that have emerged from these. I revisit the research questions and use the themes that have emerged to present my findings to answer these.

In **Chapter 7** I consider how the findings from the research can inform future approaches to energy self-sufficiency in rural communities in the UK and make some concluding remarks on the study and its wider implications for future policy and research.

Chapter 2. The Challenge of Whole Settlement Approaches to Energy Self-sufficiency

> 'Many of those that need to change, however, have not yet accepted the reality of the threat and their need to act locally in a different manner'
>
> (Ostrom, 2009, p.4).

2.1 Introduction

The first chapter introduced the research, the background to this and provided an overview of the research process. The aim of this chapter is to set the context from the literature and present the key issues surrounding a whole settlement approach to energy self-sufficiency for rural communities and the capacities needed to do this. First I examine what an energy self-sufficient community is, examining the term energy self-sufficiency and its use and drawing on other terms in use across Europe.

Next the matter of how this issue can be considered is investigated, introducing a conceptual framework to do this. Using the conceptual framework as a guide and drawing from the literature I go on to consider four different types of capacities and the potential role they may play in a rural community on a journey to energy self-sufficiency. These capacities are Individual, Structural, Infrastructural and Cultural and together encompass issues such as: the role of place as a motivating factor; the motivations and reasons that communities might have for starting a journey towards energy self-sufficiency, individual leadership, the concepts, systems and structures of governance that communities might consider/adopt in doing this, whether the idea of WSESS can be considered a boundary object, the role and types of community renewable energy in a UK context, the role of policy, visions and strategies.

Having considered the roles and forms of capacities communities may need, the next section investigates the process for a community in initiating this journey, using the framework identified by Mårtensson and Westerberg, (2007) of problem formulation, mobilisation and communication and the chapter ends with the conclusions to inform the research methods, data collection and analysis.

2.2 What is an Energy Self-sufficient Rural Community?

There are a number of terms in use in research and public policy that variously describe approaches, development and use of low carbon and renewable energy systems and technologies by communities. These will be examined here in the context of their relevance to whole rural settlement approaches.

One term that is gaining currency is energy independence. It was first used in the United States of America (U.S.) following the 1973 Arab oil embargo and since then has been used in the U.S. by politicians of all persuasions. It was used to describe a long term goal for the U.S. to provide all of its own sources energy, the primary reason for this being to provide a stable supply of energy that is not dependent upon foreign suppliers (Brown, Sovacool and Hirsh, 2006). Although a shift in U.S. policy referring to energy independence has occurred since the 1970s to also include energy efficiency and development of U.S. renewable energy sources *(United States Energy Independence* and Security Act of 2007), this is a long way from a working definition that is helpful for this research.

However, elsewhere, there is a growing use of the term energy independence, particularly in countries such as Germany, Austria and Switzerland to describe local renewable energy production to meet local energy demands. For example, in their research into developing ambitious energy goals in a rural Swiss community, Trutnevyte and Stauffacher (2012, p.7887) use the term energy independence for a scenario where; ‘Urnäsch utilizes its own energy sources for electricity and heat production and, on a yearly basis, does not import electricity or fuels’. Interestingly, this term was selected rather than one referring to mitigating climate change, although if delivered it would have this impact. The steering group felt that it was a helpful description, as it had more resonance with other community development aspirations, such as economic independence, and when asked about this at a conference one of the authors observed, “the Swiss people like anything that describes them as being independent.” Similarly a desire to achieve energy independence is given as one of the reasons the community of Jühnde embraced a project to transform the energy supply for their village from mainly fossil fuel sources to local renewable sources of heat and power (Raven et al, 2008).

Li et al (2013) use a number of terms; ‘sustainable energy community’, ‘self-sustaining energy management community’ and ‘community-owned renewable energy’ in describing community scale development of renewable energy to deliver a 100% renewable energy target. However the discussion revolves around a case that produces more than 100% of local demand only for power, but not for heat, so the terms are not useful for this research.

Spath and Rohracher (2010) use the term ‘energy autonomous’ to describe an objective for heat and electricity to be in a ‘positive balance for renewables in primary energy flows’, as part of an Energy Vision for Murau, a rural area of Austria. However, whilst this description does encompass both heat and power, it does not have a spatial dimension nor does it deal with any other aspects of energy management.

Research undertaken to inform the development of the UK Government’s Community Energy Strategy defined the term Community Energy as; ‘any UK energy project …that was led by a community group for the benefit of their community’ (DECC, 2013, p.15). Whilst the report goes on to recognise that much of community interest is around renewable energy systems and energy efficiency measures, the definition used includes any form of energy production for and by a community. The definition of community used here is also not place based, setting no geographical limitations, so whilst acknowledging the findings of the report, the definition and findings are of only limited interest for this research into whole settlement approaches to energy self-sufficiency.

There are elements of all of these definitions that are helpful in framing this research, but none completely describes a place based community managing a transition to low carbon energy through managing both demand and production. Of more relevance, perhaps is, Hauber and Ruppert-Winkle’s (2012) discussion in their paper investigating transitions to energy systems based on renewable energy sources about the concept of ‘energy self-sufficiency based on renewable resources’, which describes local production of renewable energy sources to meet local energy demands.

Another interesting concept, 'energy autarky' is used by Muller et al (2011) to describe transforming energy systems as a means of moving to sustainable regional development. Within this, they surmise that the energy used locally is from local renewable sources and supports the local economy and services. Whilst this concept is approaching a useful one for this research, the scale is of a region, rather than at the community or settlement level that this research will focus on.

A closer working definition is provided by Carlisle and Bush (2009) for a '100% renewable community':

> 'one that uses renewable energy generated on-site or from a resource owned by the community off-site or meets 100 per cent of the 'direct uses' of energy within the boundary of the community for all buildings, community infrastructure (energy for water, waste, light etc.) and transportation systems.'
>
> Carlisle and Bush (2009, p.264).

However, this definition does not capture communities that own or produce renewable energy that is not used on site, but instead use income generated from selling the power to a national grid to improve energy efficiency of properties and for other low carbon/renewable energy developments in the community (FDT, 2014). Whilst such communities are not self-sufficient in energy in the truest sense of the word, as they are dependent upon external factors, i.e. the National Grid for connectivity; and the power produced is not consumed locally, arguably these communities can still be described as working towards becoming energy self-sufficient, being producers/exporters of renewable energy and using the income to further their goals of becoming carbon neutral settlements.

Inclusion of transport within the definition of energy self-sufficiency has also been problematic, as whilst most places acknowledge that transport is a significant factor of a community's energy consumption, it is difficult to attribute proportions of journeys to a given settlement. There are a few exceptions to this, such as Freiberg, Germany, which uses electricity from renewable sources to power the city's trams, with 80% of this from local hydropower plants and good cycle ways and access to public transport enabling 35% of residents not to own a car (IEA, 2009, p.139). However, most settlements, in setting goals to meet their energy needs through energy efficiency measures, behaviour change and local renewable energy sources have focussed their efforts on power and heat supply/demand within the settlement e.g. Güssing, El Hierro, Samsø, although they all have developed or have plans to develop some aspects of low carbon transport (ibid., pp.166-167, 159, 162).

Arguably the terms energy self-sufficiency and energy independence are interchangeable. However, energy self-sufficiency is the term that will be used for this research, acknowledging the work by Hauber and Ruppert-Winkle (2012) mentioned above. The working definition, therefore for energy self-sufficient rural communities used in this research has been adapted from Carlisle and Bush, (2009, p.264) to address these issues as follows:

A community that uses renewable energy generated on-site or from a resource owned by the community off-site, providing 100 per cent of the direct or indirect uses of energy within the boundary of the community for all buildings and community infrastructure (energy for water, waste, light etc.).

2.3 Developing a Conceptual Framework

In order to provide a context as to how to approach the research I find it helpful to bring the different elements together in a conceptual framework. The following section examines the context for such a framework.

2.3.1 *Capacities for whole settlement energy self-sufficiency*

This section examines what capacities are needed to both develop an idea of energy self-sufficiency and translate this into action.

Whilst there may be sustainable development benefits to rural communities by the development of renewable energy systems, such as the emergence of 'green' economies and the recirculation of money within the local economy (New Economics Foundation, 2002); this is dependent upon the capacities of rural communities to engage with complexities of renewable energy development and harness the benefits for their communities (Munday, Bristow and Cowell, 2011). If a community is to embark on a process of whole settlement/community transition to energy self-sufficiency, it is therefore necessary to understand what such capacities may be in order to gather support and momentum in the early stages of development. In her work examining collective action for governing 'common-pool resources', Ostrom (1990 pp.88-89; 1996) showed that regular interaction and communication in small communities in a local area can build productive social networks, through information flows and the development of relationships and trust. Such capacities, variously described as 'capitals' or 'resources' (Flora & Flora, 2004 pp.9-10; Magis, 2010) have been positively associated with a programme's success (Brown & Ashman, 1996; Rydin and Pennington, 2000).

Indeed, in his report for The Carnegie Trust Shucksmith describes the concept of networked development for rural areas; a combination of top down and bottom up influences as:

> 'Critical to the socioeconomic development process are those institutions, actors and networks that have the capacity to link businesses, communities and institutions involved in governance at a variety of scales. Networked development therefore also advocates an emphasis on local capacity-building. From this perspective, development should be reoriented so as to use local territorial assets (physical or human, tangible or intangible, within or outside) with the objective of retaining as much as possible of the resultant benefit within the area concerned'.
>
> (Shuckmith, 2012, p.12)

The concept of assets in rural community development is also is described by The Carnegie Trust (2007, p.20) in their definition of 'Asset based rural community development' as taking 'its starting point the existing assets, particularly the strengths inherent in community associations and social networks, and mobilises these, alongside tangible assets such as land and buildings, to create new economic and social opportunities' and identifies social and community 'assets' as fundamental to the achievement of sustainable rural communities. The description of these assets for rural communities is arguably interchangeable with the term capacities examined here, as to their types, presence and use in rural communities working towards energy self-sufficiency.

Communities generally embark upon action on energy goals in the form of an organisation, which could be as a loose collection of individuals or as a more formalised body. However, their ability to establish and sustain themselves in working towards their energy goals is dependent upon the resources and skills they have to do this (Bomberg and McEwen, 2012; Dalton 1994, p.6). Different capacities necessary for communities in working towards becoming energy self-sufficient/low carbon communities are discussed in more detail below and develop a little explored area of practice theory in relation to this.

Working towards a whole settlement approach to energy self-sufficiency is one aspect of sustainable community development and to develop initiatives to achieve this can require social, economic and human capital, as well as working within ecological imperatives (Dale and Newman, 2010).

In identifying what capacities should be used for this research as the independent variables, the conceptual framework described later has been drawn from earlier work investigating what resources are needed for actors to mobilise and sustain action on aspects of sustainable development; including communities working on low carbon energy (Porritt, 2007; Middlemiss and Parrish, 2010; Dale and Newman, 2010; Bomberg and McEwen, 2012; Seyfang et al, 2014).

Porritt (2007) developed a capitals model for sustainability, primarily for businesses to consider how sustainability could be built into their business practises, but it is equally applicable for a broad range of organisations or communities. Initially based on five capitals, but later developed into six described here:

Natural Capital. The natural resources and processes needed to make products or deliver services.

Manufactured Capital. The material goods and infrastructure owned, leased or controlled by an organisation that contribute to production or service provision, but do not become part of its output.

Human Capital. An individual's resources, including knowledge, skills, health, motivation, intellect, emotions and capacity to develop relationships.

Social Capital. Value added to the activities and outputs of an organisation by human relationships, partnerships and co-operation.

Financial Capital. The assets of an organisation in a form of currency that can be owned or traded, including (but not limited to) shares, bonds and banknotes. Financial capital (shares, bonds, notes and coin) can reflect the productive power of the other types of capital.

Cultural Capital was not defined in Porritt's original model, but added to later, described perhaps better by Daniel Lousier (2010, p.4) as:

> 'reflecting a society's basic patterns of thought and behavior [sic.], which are shaped by customs and experience. Thus, the culture and customs of any society can be affected or managed only by the people themselves. Stocks of social capital accumulate through the processes and diversity of human cultures, which result in the learning, knowledge, customs, and heritage we have to pass on to the generation.'

The use of the term capital and the different forms described above reflects an economic focus, unsurprising as Porritt's original target audience was the private sector. However, in considering rural communities' approaches to energy self-sufficiency, use of a more nuanced term may be more appropriate.

In considering this, Bomberg and McEwen (2012) derive their assessment of what is needed for community mobilisation on energy schemes from resource mobilisation frameworks to arrive at the term 'structural resources'. That is the features and opportunities presented by a political system including materials, as well as the ability to influence policy. However, they adapt the framework to also include non-material aspects, describing these as 'symbolic resources', which are the less tangible elements such as identity, legitimacy and the quest for autonomy.

The independent variables identified here are the different forms of capacities it is proposed that communities may need in order to develop whole settlement approaches to energy self-sufficiency. I have selected the term capacities, being the abilities that a community has to draw on resources (ibid.) to make the changes to develop an approach for WSESS, (Middlemiss and Parrish, 2010). This encompasses; appropriate forms and structures of governance, renewable energy sources, infrastructure, key willing and able individuals, trust etc. that are needed for communities to identify the problem, formulate solutions, mobilise actors and communicate the strategy to move towards energy self-sufficiency (Mårtensson and Westerberg, 2007).

Drawing on the earlier work by Porritt (2007), Seyfang et al (2014), Bomberg and McEwen (2012) and Middlemiss and Parrish (2010), I have arrived at the following descriptions of four capacities that will be used to develop a conceptual framework to guide my research:

2.3.2 *Individual Capacity*

Individual Capacity is identified as the resources that participating individuals in the community have, including values, skills and knowledge of issues relating to energy self-sufficiency that they draw on to act. This encompasses elements of Middlemiss and Parrish's personal capacity, Porritt's human and social capital and Bomberg and McEwen's structural and symbolic resources. In investigating Individual Capacities, the research will also examine the presence and impact of technical and political 'pioneers' (Hauber and Ruppert-Winkle, 2012) or 'citizen entrepreneurs' (Foxon et al, 2009) in the case study communities who have the ideas and play a role in their delivery. The relationship between the 'pioneers' or 'citizen entrepreneurs' including what role trust and knowledge play in changing the behaviour of the other individuals that comprise the rural communities in order to more towards energy self-sufficiency, will also be examined through the detailed case studies in the context of Individual Capacities.

2.3.3 *Structural Capacity*

Structural Capacity describes the organisations in the community or in the sphere of influence of the community or the organisations that the community is in the sphere of influence of, such as political systems or state support (Bomberg and McEwen, 2012). It also includes whether the principles of these organisations/structures are/can be aligned to a goal of energy self-sufficiency and what resource and support they can contribute to deliver this and will it encompass the governance arrangements for communities in moving towards energy self-sufficiency. The presence and role of politicians and the decisions they make will be explored here and whether they are the ‘courageous’ politicians that Van Staden (2010, p.23) says are necessary. The suggestion by Evans et al (2005, p.111) that the greater achievements in sustainable development have been described as being almost always part of a higher level of dialogue between local authorities and civil society will also be examined. Structural Capacities will encompass finance; the funds and sources of these to facilitate the energy schemes and as such this includes Porritt’s (2007) descriptions of both social and financial capital. It will also include the development, presence and role of visions or strategies for whole place energy self-sufficiency.

Within Structural Capacities I will also consider the role of boundary organisations. There are a number of possible ways to manage conflicting views in relation to a boundary object, discussed in detail in 2.6.7 and it is inevitable, given the issues identified there, that conflicting views will arise in a community context. Approaches include: finding a ‘lowest common denominator that is acceptable to all actors, or reconfiguring the object to fit the circumstances’ (Star and Griesemer, 1989). However, a lowest common denominator approach rarely satisfies any stakeholders, often resulting in frustration. This leads on to the idea of boundary organisations; what kind of space is needed for the drawing together of actors for/around a boundary object, and managing these tensions and conflicts? White et al (2010) describe the function of boundary organisations as to 'internalize [sic.] the differences of actors and institutions on both sides of the boundary, negotiate across them to develop decision-making options, and produce boundary objects applicable to either side’. They create a space for the development and use of boundary objects and for involvement of actors from both sides of the boundary, where the sides are defined as ‘political’ and ‘scientific’ – ‘labels for distinct forms of life in modern society’ (Miller 2001, p.482). Do such boundary organisations exist in places that have embarked upon whole settlement approaches to energy self-sufficiency and if so, what contribution have they made and are their roles generalisable?

2.3.4 *Cultural Capacity*

Cultural Capacity is whether a goal of energy self-sufficiency can sit comfortably with a community’s history and ideals, including legitimacy, integrity and pursuit of autonomy (Bomberg and McEwen, 2012). Cultural Capacities will also include the development role and impact of trust in working towards energy self-sufficiency, although there is likely to be some cross over in examining this with individual capacities, described above. In addition, Hauber and Ruppert-Winkel's (2012) suggestion that there is an 'advantage of proximity' that may provide the communities with a common sense of place; will be examined in this context.

2.3.5 *Infrastructural Capacity*

Infrastructural Capacity encompasses the systems, physical resources and infrastructure that exist in a place that can provide the potential for it to become energy self-sufficient. This will also include what Porritt (2007) defines as both manufactured and natural capitals. As described earlier, Hauber and Ruppert-Winkel (2012) suggest that rural communities have the 'advantage of proximity' (ibid.) – citizens sharing the same setting and infrastructure (Heiskanen et al, 2010). In the context of energy self-sufficiency, can this be the basis for a new actor network to both initiate and take action towards energy self-sufficiency? This will be explored within this capacity later through the detailed case studies.

2.4 Conceptual Framework

The conceptual framework below draws together the idea and goal of a whole settlement approach to energy self-sufficiency. WSESS as an idea is a boundary object - a cultural capacity, but as a goal it is the variable dependent upon the presence and application of the four different types of capacities identified above. It provides the framework for how the research questions will be addressed in this research, thus informing the methodology described and explained in the following chapter.

Figure 1. Conceptual Framework, adapted from Middlemiss and Parrish (2010).

In addition to examining the presence, role and impact of each of these defined capacities individually on rural communities' in working towards energy self-sufficiency, it is also important to note that these capacities can impact on and shape one another (Middlemiss and Parrish, 2010). Ostrom (1990 p.88; 1996) notes how socially cohesive groups or individuals in seeking to maintain their social standing can become more aware of issues of others within the community and facilitate co-operation. This position is developed by Brown & Ashman (1996, p.1477), who argue that social capital can play a role in tackling future problems and developing more social capital. For the purposes of this research, such social capital in relation to the capacities model here has elements that would fall within both structural and individual capacities; organisations and networks, and relationships and cross sector contacts respectively. These will also be explored through the research, depicted by the arrows in the diagram.

Communities, in this case rural communities, are not homogenous; comprising individuals and organisations with different backgrounds, values and resources. There can be many communities of interest, even within very small communities, so how can a potentially new idea, such as WSESS be considered and developed? Using the conceptual framework as a guide, I now consider the capacities that a rural community may require to both develop the idea and to work towards the goal of a whole rural settlement approach to energy self-sufficiency.

2.5 How to Consider Capacities for Whole Settlement Approaches to Energy Self-sufficiency?

The research will examine the presence and role of each of the capacities described above, but how can the process of this transition be considered? In essence, how can the collective agency (Flora & Flora, 2004, p.327) of a community be assessed in moving towards energy self-sufficiency? Mårtensson and Westerberg (2007) describe problem formulation, mobilisation and communication as sub processes in developing strategies for transforming energy systems. That is; how the problem and potential solutions and how they interact are understood by local actors, how these actors and resources are mobilized and how the transformation process is organised and communicated. Whilst mobilisation in some community energy literature does refer to the galvanising activity of a community as a precursor to energy action (Bomberg and McEwen, 2012), in this research, it will also encompass the action itself. These processes are used here and throughout the chapters to provide a structure for describing and understanding the capacities present and the contribution they make in whole rural settlements as they move towards energy self-sufficiency. However, I recognise that this is an heuristic device and in reality distinctions between the three processes are blurred. Initially this will be through a cross case analysis of five European case settlements based on secondary data sources and then four detailed UK case studies using primary data sources, supported by secondary data sources to understand what contribution different capacities have had on the development and delivery of a whole settlement approach to energy self-sufficiency in these places. Also examined will be whether the development of energy self-sufficiency, here identified as the dependent variable creates further capacity within the community, thus creating a mutually sustaining system.

Drawing from the literature, I now consider the capacities that will form the focus of the research using the structure described above.

2.6 Problem Formulation

> 'the causes of climate change are the actions undertaken by individuals, families, firms, and actors at a much smaller scale…To solve climate change in the long run, the day-to-day activities of individuals, families, firms, communities, and governments at multiple levels—particularly those in the more developed world—will need to change substantially'
>
> (Ostrom, 2009, p.4).

Whilst the rationale for a settlement's transition to energy self-sufficiency may not primarily be climate change, through taking action on energy self-sufficiency at a local level, communities are helping to adapt to and mitigate against climate change.

2.6.1 *Cultural & Structural Capacity: Rationales for whole settlement energy self-sufficiency*

A review of settlements that have made significant steps towards achieving energy self-sufficiency is discussed in more detail in the case studies in chapters four and five. Communities that develop low carbon approaches to energy in their settlements can have very different rationales for doing this (Seyfang et al, 2014), this could be economic, environmental or perhaps a completely different reason, although the UK Government's review of evidence to support the development of its Community Energy Strategy found that the reasons communities engage in community energy projects are principally economic or environmental (DECC, 2013). It is unclear whether the rationale for a community starting a process towards energy self-sufficiency has any impact on its progress in achieving this. What is clear, however is that one of the first steps for communities that embark on this process to energy self-sufficiency is deployment of energy efficiency measures, (Carlisle and Bush, 2009, p.264), so that the demand for energy is reduced and less energy needs to be produced to meet their demand.

2.6.2 *Cultural capacity: The importance of place for energy self-sufficiency*

What role can place play in a rural, whole settlement move towards energy self-sufficiency?

As described in section 2.4, communities are not uniform. A definitive description of what comprises a community has been eluding academics, practitioners and policy makers for decades. In academia it is both a widely used, but contested term; meaning different things within and between different disciplines. For example for sociologists, historically it has been used to describe a form of social organisation, such as a small town, whereas anthropologists tend to use the term to describe culturally defined groups, such as minorities (Delanty, 2010, pp.x-xi), so communities can be of place or interest. Walker and Devine-Wright (2008, p.498) identified the difficulties in defining what a community is in their research into what community renewable energy should mean, with one interviewee describing that they were 'making it up as we went along' rather than defining the meaning of community at the outset. Historically communities have had three components; location, social system and community identity. However as transport and communication systems have developed, the social systems that support individuals and the communities they identify with may not be in the place where they live (Flora and Flora, 2004, pp.8-9). In this research I will be using the term community primarily to describe a community of place. Edwards, Goodwin and Woods (2003, p.183) identified that at the scale of small rural towns, the terms 'town' and 'community' can be used interchangeably with no loss of meaning. In this research on rural places, I acknowledge the difficulties in defining what a community is and will be using both community and terms referring to rural settlements interchangeably throughout. Through the research of Capacities I will also be examining other aspects of community, such as a sense of place, described later.

In examining what a sense of community is in psychological terms, Sarason sets the scene as a support network in which people can trust (Sarason, 1974, p.157) and through developing a physical form and definition of a community; such as a town or village, community cohesion, a sense of place and empowerment may arise which can lead to increased participation (Pol, 2002; Pol and Castrechini, 2002; Garcia, Giuliani, and Wiesenfeld, 1994, p.78). Interestingly in their research on identity in small rural towns in Cape Cod, Cuba & Hummon (1993) found that involvement in social aspects of a community were critical for community identity. It appears, therefore that a sense of place or place identity can both develop as a result of participation in community activity, or lead to increased participation in community activity.

Both the natural and built environments contribute to developing a place identity, with the scale, diversity and quality of the natural environment determining the strength or speed of development of this identity (Dale, Ling and Newman, 2008). Therefore, the influence of the geographical and spatial setting of a community on identity and sense of place should not be underestimated. Following on from this, in considering how place can contribute to the development by a community of self-sufficient energy goals and systems, it is interesting to note that the City-Identity-Sustainability Network assumes that sustainability cannot be achieved without a high degree of social cohesion and identity in a place (Pol, 2002); with the potential for such sustainable decision making being enhanced by a sense of place (Uzzell, Pol and Badenas, 2002). Hanna, Dale and Ling (2009) identify links between how people view their community and actions they take in/for their communities: 'Perceptions of place shape individual and collective action and provide the locales for connections between people and community' (ibid.). It is also thought that if individuals in a community participate in a shared event, then this can strengthen the sense of community, particularly if the shared event was in response to a crisis (McMillan and Chavis, 1986).

For governments and movements who wish to harness support for transformational policy agendas, a population that has a strong, distinctive sense of shared identity and the mutual trust and solidarity developed through this can also be viewed as an important resource (McEwen and Bomberg, 2014).

In researching links between a sense of place and appetite for sustainable development in rural settlements in Canada, Dale, Ling and Newman (2008) found that high levels of sense of place in a community could lead to increased sustainable community development and initiatives; however it could also present a barrier to acceptance of new ideas and people. It also showed that a 'one-size fits all' approach to sustainable community development may not work, as each place and importantly its sense of place is different, or as Raven et al (2008, p.475) in their analysis of energy projects in Europe observe; 'Ready-made solutions cannot be dropped into a context without local negotiations', which presents a real challenge to policy makers in working out how best to support communities in their transitions to energy self-sufficiency.

As mentioned earlier, rural communities in particular have what is described as the advantage of proximity – citizens sharing the same setting, providing them with a common sense of place (Hauber & Ruppert-Winkel, 2012) and infrastructure (Heiskanen et al, 2010) and this sense of place can benefit a community both economically and socially (Mesch & Manor, 1998; Dale, Ling and Newman, 2008). If a community is to be truly sustainable, then development of the built environment needs to recognise and deliver balanced economic, social and ecological obligations (Dale, Ling and Newman, 2008).

The research described above shows that the physical characteristics of a place can inform and shape a sense of place. This place identity is important for communities in participating in sustainable community development activities and decision making and this participation continues to reinforce place identity in a mutually supportive way. Place, therefore, can play an important role in whether and how a community moves towards WSESS and this will be examined through the research. In terms of local energy projects, rural communities can deliver greater local participation and ownership of energy projects than more urban communities and may also provide greater support for these, as a result of there being fewer economic opportunities available locally (Raven et al, 2008). A view supported by the IEA (2009a, p.16) who observes that it is easier for small rural towns to achieve a high contribution of renewable energy to the local energy mix than for larger urban settlements. They are smaller in scale and in closer proximity to many of the resources that can be used as part of a renewable energy mix than their larger, urban counterparts.
Given the importance of sense of place and place identity on communities' abilities to act described above, I would argue that sense of place is a cultural capacity in my research. In his seminal book, Sarason sums up why cultural capacities are an important factor when considering how a community may function, in this case in deciding to adopt and in working towards a whole settlement approach to energy self-sufficiency;

> ‘a community has a distinctive history that, although it may not seem relevant in a psychological sense, is crucial to understanding some of its present qualities and social, political, religious, or economic characteristics’
> (Sarason, 1974, p131).

The literature suggests that the presence of a sense of place and place identity by a community is likely to make a significant contribution to its ability to identify a ‘problem’. This identification of a problem that can be addressed locally is the first step for a community in its journey towards energy self-sufficiency (Mårtensson and Westerberg, 2007). It might be a problem that has emerged due to short term changes in policy, funding or services provided, or it could be a result of a much longer term process, such as climate change.

2.6.3 *Individual Capacity: Skills*

Closely linked to sense of place, considered as a Cultural Capacity above in the problem formulation phase are the skills of key individuals during this phase. There are some critical skills that individuals need both during the problem formulation and mobilisation phases, to both develop and sustain community engagement and support. These include: confidence, emotional stamina, social skills, ability to: adapt models to a local context, understand and apply unfamiliar structures, financial models and decision making processes (Seyfang et al, 2014). The presence of or means to develop or source individuals with these skills and the contribution these make to the energy goals will be examined in the research.

2.6.4 *Structural Capacity: Vision & Strategy*

In developing governance strategies for regime transitions, such as a move to become energy self-sufficient; ‘Guiding Visions’ are seen as key to move towards the desired goals (Spath and Rohracher, 2010). Indeed, setting a ‘bold goal’ at the highest level may be a good first step for a community in its transition towards energy self-sufficiency (Carlisle and Bush, 2009, p.281).

Hajer describes the move to more collaborative forms of governance as an ‘Energetic society’, to overcome three deficits: legitimacy; implementation and learning to develop participatory governance with active, engaged citizens helping to shape policy and delivery, rather than having decisions made for them and things done to them (PBL, 2011). If this 'Energetic society' is one to strive for in this transformation of local energy systems, then it follows that development of a rationale and local strategy to support this is also likely to be a process of negotiation and compromise between local actors, moving from an initial 'planned' strategy through a series of iterations as different actors and issues become involved to a 'realized' strategy (Mintzberg, 1988, pp.82-88). Dialogue with different actors in the community will help clarify shared values in the community (Carlisle and Bush, 2009, p.281) and inform the development of an agreed strategy; it may be that a range of visions need to be developed, involving academics and practitioners in addition to community stakeholders. Whilst the 'realized' strategy may be very different from the initial one, the shared understanding and interpretation in its development legitimises it. It also needs to be recognised that more radical visions may lead to problems in implementation, as it reduces flexibility to manage competing perspectives from stakeholders and potential consequences of delivery (Trutnevyte and Stauffacher, 2012).

Developing qualitative, whole settlement visions of future energy systems for a small rural settlement has been shown to make a positive contribution in planning energy transitions. In research of UK community energy case studies, all cases were found to have clear visions, with about half of these being maintained over time (Seyfang et al, 2014). Trutnevyte, Stauffacher and Scholz (2011) suggest that visions must also be supported by quantitative analysis of the technologies to implement these and stakeholder based multi criteria assessment of the consequences of implementation in order to develop informed, deliverable preferences for the settlements future energy systems. Such shared visions for sustainable energy systems can be powerful, emerging from shared goals or problems and can lead to co-operation on the issue through the bringing together of local stakeholders (Mårtensson and Westerberg, 2007). However, these shared visions should not just be developed by a few key stakeholders, but by all relevant actors, otherwise this can lead to resistance and problems in the implementation stage (Trutnevyte & Stauffacher, 2012). This then provides the platform for how boundary objects can work in practice with sustainable energy providing the framework around which multiple actors can coalesce, each bringing their own perspective to the common issue (Hajer, 1995, pp 58-68). The role of visions and the process of their development will be explored in the case studies.

2.6.5 *Structural Capacity: Government and Governance*

Existing forms of statutory local government may have a role to play in the governance of initiating whole place approaches to energy self-sufficiency. With respect to community renewable energy, ICLEI (2007) suggest there are a number of reasons why local authorities would do this:

- Promoting sustainable and local resources;
- Enhancing security of energy supply, using diversified and decentralised local energy provision;
- Reducing the cost of energy transmission and distribution (and associated waste);
- Moving away from finite sources of fossil fuel and reducing CO_2 emissions;
- Strengthening the local economy, considering new development opportunities that improve local employment options, in particular for growth of Small and Medium-sized Enterprises (SMEs);
- Using the expertise and development from local universities, researchers and NGOs;
- Promoting innovate schemes for municipal funding working with the private sector (ESCOs).

ICLEI (2007)

Governance at a community level has two aspects, structure and process, where structure focusses on the organisational and institutional arrangements of state and non-state actors and process focusses on the dynamic two way interaction of both (O'Toole and Burdess, 2004). In terms of structure and process spatially delimited, defined, local forms of governance have been identified as most helpful in developing social capital in local communities for tackling certain environmental issues, but may not be appropriate in all situations (Rydin and Pennington, 2000). Research has shown that many rural partnerships cover a town area; the reason for this is thought to be that it coincides with the jurisdictional area for Town or Community Councils who act as the representatives of the community on the partnerships (Edwards et al, 2001) and the community has an association with the Town or Community Councils as the closest level of government to their communities. The role and scale of government and forms of governance in problem formulation of whole place energy self-sufficiency will be examined.

2.6.6 *Infrastructural Capacity: Energy Infrastructure & renewable resources*

Assessing the local renewable energy resource is crucial before developing any plans for their deployment (IEA, 2009, p.65). Communities therefore need to examine the presence, availability, understanding of and access to the renewable energy resource. Consideration should also be given to these aspects of the existing energy infrastructure when embarking on transitions to low carbon community energy futures. What role this plays in the cases considered will be examined in the problem formulation phase of whole settlement approaches to energy self-sufficiency and how this relates to the development and delivery of community energy systems in the mobilisation phase.

2.6.7 *Cultural Capacity: Whole place energy self-sufficiency as a boundary object*

Rural communities as with most other communities are not homogenous entities defined only by their place; although this can be very important in developing a sense of place and engagement in community activity, which will be discussed later. They comprise many different communities of interest, sometimes with conflicting interests, views, politics and in some situations personalities. So given this, how can a new idea, such as a whole settlement approach to energy self-sufficiency be developed by a community?

In his work exploring governance for sustainable community development, Roseland (2000) describes a collaborative process whereby different perspectives find common ground and agree recommendations on difficult issues, without necessarily coming to full agreement, but have no 'substantial disagreement'. This leads me to the concept of 'boundary objects', which emerged from experience of cross disciplinary scientific research and other case studies where co-operation had been achieved without consensus and seeking an explanation for this (Star 2010; Star and Griesemer, 1989). It had regard to problems identified earlier where groups of actors coming together from different backgrounds around an issue and having to simultaneously translate concerns to each other (Callon, 1985, pp.196-230; Latour, 1988). Whilst Callon and Latour's models funnelled information into narrower 'passage points' generally through a 'managerial' gatekeeper; in developing the concept of boundary objects Star and Griesemer (1989) presented an alternative, whereby views were translated without presupposing primacy of any one viewpoint and at the same time ensuring the integrity of the interests from all actors.

This approach thus enables negotiation and exchange of knowledge and action from different world views (White et al, 2010), a position supported by Allmendinger and Haughton (2012), who identify that there are the risks associated with recent consensus based approaches to planning in that they have replaced wider debate and potentially conflicting and competing views. Boundary objects offer arenas where such debates can be had around particular issues, without settling for lowest common denominator outcomes.

There are a number of other concepts that have been developed to address the challenge of cross disciplinary, multi-perspective partnership working. These include trading zones, an idea developed by Peter Galison (1997) to resolve the problem of incommensurability between paradigms. In investigating how collaboration works in trading zones, Collins, Evans and Gorman (2007) identify four types of trading zones. One of these is 'Fractionated' trading zones, which has two types, one being boundary object trading zones. This leads me back to consider boundary objects as being the most useful concept in considering how communities co-operate around the idea of whole place energy self-sufficiency.

In sustainability literature, the malleability of the term boundary object can be an advantage to its acceptability, particularly in political arenas. For example, sustainability when viewed as a boundary object has provided common ground for ecologists and economists to engage on the needs of future generations, when traditionally they have been viewed as having opposing views. However critics of boundary objects view this flexibility as vagueness, or as being inherently ambivalent, which may dilute meaning and understanding, or provide an arena for justifying a particular interest (Brand and Jax, 2007). I suggest that this 'vagueness' is fundamental to engaging disparate groups and individuals with varying viewpoints on a particular issue, as it enables interpretive flexibility of the subject without these actors losing autonomy, as Brand and Jax (2007) found in their examination of the role of boundary objects and resilience; 'Boundary objects are able to coordinate different groups without a consensus about their aims and interests'.

As mentioned above, boundary objects were first described in scientific terms as shared spaces of action that people can move with and towards, whilst having different reasons for doing this. Importantly they must be flexible to adapt to local needs of the actors involved, but be robust enough to retain a common identity. Such 'boundary work' has been recognised as very important in the context of effective scientific advising at the interface of communities of experts and communities of decision makers (Cash et al, 2003). Of relevance for this research of whole settlement approaches to energy self-sufficiency, is that boundary objects are viewed as being strongly structured in individual site use (Star and Griesemer, 1989); this could for example be a rural community.

These provide an argument for viewing the idea of a whole settlement approach to energy self-sufficiency as a 'boundary object'. This enables actors from different arenas in a community; the experts and decision makers, to co-operate at the boundaries of the idea without having to reach a consensus about their individual aims and interests (Hauber and Ruppert-Winkel, 2012; Brand and Jax, 2007). Literature suggests that for effective boundary work it is essential to develop procedures or organisations that span the boundaries (Cash et al, 2003) and also that the scale that boundary objects are best suited to is at the organisational level (Star, 2010). This is also helpful in considering the structures and agency of development and delivery bodies for energy self-sufficiency in a community. Using the concept of a boundary object in this situation, it also enables communities and individuals and organisations involved in those communities to engage in the process without losing their autonomy.

Four different types of boundary object were described in the Star and Griesemer's early work; repositories, ideal types, coincident boundaries and standardized form (Star and Griesemer, 1989). However, this was based upon one case and was clearly not identified as an exhaustive list, so whilst none of these types of boundary object describes the idea of a whole place approach to energy self-sufficiency, this in itself is not a problem. Given this and the diverse spectrum of personalities, politics and interests in and serving small rural communities, considering a practical, but flexible issue such as WSESS as a boundary object is a helpful concept in understanding how resources are marshalled in its development and delivery (Walker and Cass, 2007) and will be considered in developing the research methodology. In addition, boundary objects were originally seen to sit between two different social worlds, such as science and non-science (Guston, 2001). Whilst not disagreeing with this high level distinction, I would suggest that it is too broad and that a boundary object can be further refined so as to sit between multiple worlds; for example, the public sector, communities and higher education institutions. In this research, a local authority might engage in a whole place approach to energy self-sufficiency, because it will help it meet its targets for reducing CO_2 emissions, whereas a local community may engage, because it wants a sustainable low cost energy supply, or a university may engage because it offers the opportunity for field scale trials of new renewable energy technologies. They can work together around the boundary of the idea of WSESS bringing with them different capacities to do this, but have very diverse aims and reasons for engaging.

In the conceptual framework, the idea of a whole settlement approach to energy self-sufficiency is at the centre of the diagram, forming both the boundary object around which the diverse interests in a rural community can coalesce even though they may have very different interests in it (Hauber and Ruppert-Winkel, 2012), but also the dependent variable, being the outcome or goal of the action of the capacities examined later.

Whether the idea of moving towards whole place energy self-sufficiency is a boundary object in the case studies is an important consideration and as such forms one of the four research questions. It does comprise one of the Cultural Capacities examined, but will be considered separately in the analysis chapter in response to its significance as a research question.

2.7 Mobilisation

Resource mobilisation literature shows how individuals and entrepreneurs can play a vital role in marshalling resources and initiating projects. With respect to why and how communities start a journey towards energy self-sufficiency, this mobilisation of a community has been described as; 'galvanising communities to support and actively take part in initiatives linked to energy reduction or producing energy from renewable or low carbon sources.' (Bomberg & McEwen, 2012, p.436). Bomberg and McEwen go on to suggest that community mobilisation is shaped by access to two types of capacities: structural and symbolic, where structural refers to the broad political context (including policy, funding, in kind support), described as structural capacities in this research and symbolic refers to the less tangible aspects of community identity and the search for autonomy and sustainability (ibid.), described as cultural capacities in this research. In addition to these two, I will also consider the contribution of infrastructural and individual capacities to mobilisation for whole place energy self-sufficiency.

It is recognised that time and again, a community's ability to harness these resources to progress their move towards energy independence depends upon individual actors' abilities to navigate a path through these. Often communities can feel excluded from these structural resources. Whilst this can dis-incentivise some communities in taking action for local energy, it has also been shown to have the opposite effect in certain cases, with this 'outsider' status actually incentivising them to take positive action for community energy (ibid.). In considering this, to maximise the resources available to them, communities need to have regard to the way that structural capacities are allocated is influenced by the wider political landscape within which the policies, financial and in kind support are developed and implemented (Mulugetta, Jackson & Van der Horst, 2010).

Transitions literature recognises that new practices arise in niches that are in part protected from pressures of the existing regime (Foxon et al, 2009). These 'niches' could be rural settlements in the UK and the reference to 'protection' could include exclusion from the current 'regime', when the 'regime' may include such things as proximity to centres of power and access to services; in this case affordable energy services. One possible transition pathway to low carbon energy systems in the UK is bottom-up, local led community energy solutions, to develop such things as micro-grids and local energy companies, terming this a 'Thousand Flowers' (Seyfang, Park and Smith, 2013). This diverse range of local schemes can then start to challenge the dominance of the major energy companies (ibid.).

The UK Government has for a long time recognised the important role that communities can play in shifting to lower carbon energy generation and consumption and reducing CO_2 emissions and that government has a role in enabling this;

> 'The role of the Government should be to create an environment where the innovation and ideas of communities can flourish, and people feel supported in making informed choices, so that living greener lives can become easy and the norm'
>
> (DECC, 2009 p.92).

However, even for a local authority that has made significant efforts to engage its constituency in changing to more low carbon lifestyles and behaviours, it still has a major challenge to engage with the wider community that is necessary for the greater transitions to be realised (Peters and Pierre, 2001; Peters, Fudge and Sinclair, 2010). Whether government at any level has supported the case study communities to develop their low carbon innovations and ideas will be explored in more detail in later chapters. Mulugetta, Jackson & Van der Horst (2010) suggest that the right mix of strategy and policy is crucial in determining the organisation of community carbon reduction measures and the role of government in this will be examined.

Autonomy is identified as a potential rationale for galvanising communities to action on developing their own energy projects, both to gain more control over energy supply and costs, but also to have more control over shaping the community (Bomberg & McEwen, 2012) and will be examined through the case studies in Chapters 4 and 5 and analysed in Chapter 6. Other aspects of mobilisation are considered here:

2.7.1 *Individual Capacity: The role of the individual in moving towards whole settlement energy self-sufficiency*

In addition to institutional involvement in governance arrangements, the power of the individual should not be underestimated. Change happens because of the actions of individuals, described by Sztompka (1993, p.200) as the "agential power of human individuals' social collectivities". The final evaluation report of the Big Green Challenge (Brook Lyndhurst, 2010) found that leadership by certain 'entrepreneurial' individuals in the community was essential in the development and delivery of the supported projects; a view supported by Hauber and Ruppert-Winkel (2012), that engagement of these 'pioneers' has been shown to be key from the early stages in the transition to new self-sufficient renewable energy systems. These pioneers can be split into two groups; technological and political. Both types have been found to form new networks which became the core of energy transitions, although the importance of the networks reduces over time.

Indeed, as Foxon et al (2009) suggest if citizens, in this case of a rural community, develop their own capacity in terms of power and influence, more so than actors in the energy markets in that place, then these 'citizen entrepreneurs' can emerge and become much more active in generating and exporting their own energy, thus developing potential for community ownership models of energy self-sufficiency.

Behaviour change is necessary for a community to move towards energy self-sufficiency, whether this is for energy efficiency, financial or other reasons. These changes in behaviour have to be made by individuals and sustained over time if the goal of becoming energy self-sufficient is to be realised. Trust, together with knowledge are recognised as crucial elements for social diffusion to effect such behaviour change within a community (Walker and Cass, 2007; Peters, Fudge and Sinclair, 2010). Indeed, trust has been identified as one of the necessary conditions that can help community renewable energy projects be taken forward. (Walker et al, 2010)

2.7.2 *Structural Capacities: Government and Governance*

> 'the right of participation in decision-making in social, economic, cultural and political life should be included in the nexus of basic human rights….Citizenship as participation can be seen as representing an expression of human agency in the political arena, broadly defined; Citizenship as rights enables people to act as agents'
>
> (Lister, 1998: p.228).

Given the inability of governments on the international stage to reach agreements on carbon reduction measures, this has conveyed increased legitimacy and urgency to local level solutions. In fact, the UK Government's Low Carbon Transition's Plan (DECC, 2009a) identifies the major role that communities will have in developing low carbon futures systems (Mulugetta, Jackson & Van der Horst, 2010). But how do communities organise themselves to develop low carbon futures, in this case a move towards energy self-sufficiency and what are the governance arrangements in place, or adopted to support them in doing this?

In considering this, first I will examine, what is governance? The definition of governance has evolved. For a long time it was recognised as the process of governing by government. However, this has shifted in more recent times, from being described as 'government without statehood' (Weale et al, 2000. p.1) to describing a process of governing that involves both state and non-state actors in the development and implementation of public policy (Mayntz, 2003), whereas government can be defined as the actions of formal government systems within a prescribed administrative boundary (Murray 2000, p 178). In the context of researching a whole settlement approach to energy self-sufficiency Folke et al, (2011) suggest that there is a misfit between governance systems and eco systems and that this makes it very difficult for changes to more sustainable practices, echoed by Hardin's pessimistic view of people's inability to manage the commons (Hardin, 1968).

However, how governments govern has been in a state of flux in the western world for some time, moving from a 'command and control' form of governing to a more enabling role, where the focus has been more on securing resources from a wide range of sources to deliver against defined objective (Peters and Pierre, 2001). The emergence of a new form of governance, where actors operating at different geographical levels govern through negotiated, non-hierarchical exchanges has been described as multi-level governance, the genesis of the term being in policy analysis at an EU level (ibid.). As well as describing relationships between different government levels of institutions, it also recognises more informal governance model relationships. One vision for governance that supports this is the disappearance of dominance or hierarchy between state, sub state and non-state actors, with actors collaborating or competing in shifting coalitions (Hooghe and Marks, 2001). It is helpful to recognise this in investigating WSESS, as government institutions that can facilitate the transition may operate on different geographical levels and have both formal legislative requirements that dictate certain behaviours, but also capacity to respond to wishes from a community level. There is an opportunity for government institutions to embrace new forms of governance and to be open to more relaxed relationships in order to achieve this (Peters and Pierre, 2001).

What types of governance arrangements can support a whole place approach towards energy self-sufficiency? There is a parallel between governance; describing the processes, policy and conventions around which interested actors can gather (Bulmer, 1993) and boundary objects, where multiple actors can coalesce around a common issue, bringing their various perspectives to find a way forward. Important in this context is that boundary objects, as with discourse coalitions do not necessarily seek to get agreement on objectives or values, but differences are acknowledged and discourse is conducted on key subjects, enabling an open arena to explore commonalities on these (Hajer, 1995, pp58-68). In recent years when describing processes for sustainable rural development, the term governance has been used, reflecting recognition of the changing role of the state at every level and the greater tendency for public, private and voluntary sectors to work together in less formally prescribed ways (Shucksmith, 2009). These concepts may be helpful for a community to consider in the early stages of a whole settlement transition to energy self-sufficiency in translating a vision or idea into a process of delivery that is supported by the community.

If formal structures of government are to play a role in tackling energy self-sufficiency, as with climate change, this will require political leaders to be courageous, because the process is a long term one where most likely the benefits of decisions made by elected leaders will only be evident long after their political tenure (Van Staden, 2010, p.23), and so supporting such action could be viewed as high risk, politically. This may contribute to the reason behind the findings of Dietz, Ostrom and Stern (2003) that new ways of governing need to be found, as early centralised systems of governance in managing resources have failed.

In support of this, there is a recognition that new forms of governance must be found in order to collectivise individual actions into low carbon communities (Mulugetta, Jackson & van der Horst, 2010), as a move to an 'Energetic society with more collaborative forms of governance (PBL, 2011). Such collaborative, participative democracy is seen as fundamental to achieving long term sustainable change in communities, such as a move towards energy self-sufficiency (Rydin, 2010, p.139; Ostrom, 2009; Haughton, 2000, p 198). As described earlier, small local communities have capacities that enable them to develop their governance procedures and institutions for managing the commons (Rydin and Pennington, 2000; Ostrom, 1996; Ostrom, 1990, pp.61-102). Rydin and Pennington (2000) also attribute Ostrom's work (Ostrom 1996; 1990 pp.61-102) with demonstrating how, through regular communication and interaction in a local setting, small communities 'can build rich social networks in order to overcome collective action problems' and the importance of information sharing and the development of relationships and trust in the success of these. The role of these will be examined in the European and UK cases in this research.

It is suggested that the greater achievements in sustainable development are almost always part of a higher level of dialogue between local authorities and civil society (Evans et al, 2005, p.111). However, in developing this as a multi-level governance approach, using boundary objects to develop an 'energetic society' also has risks. This more fluid, non -hierarchical approach as well as offering opportunities to groups can also be a threat, dependent upon their capacity to adapt and secure resources (other capacities) (O'Riordan and Church, 2001, p.22). Therefore, rural communities with aspirations to become energy self-sufficient may embrace new forms of governance and a more participative, local form of democracy, but their success in achieving their goal will depend upon the capacities the community has as individuals and collectively to secure the necessary resources to do this, which will be explored in more detail later.

2.7.3 *Structural Capacity: External expertise*

Given the potential roles described above that individuals can have in mobilising and sustaining communities into action for whole place energy self-sufficiency, I now consider whether all the skills reside in communities, or whether they will need to access external expertise. Research of UK community energy cases finds that access to skills of intermediaries for development of both technical and 'soft' skills is an important factor in their success. Often these are dedicated energy organisations, which may be different levels of government, from the private sector, or NGOs which tend to be grant funded by the public sector (Seyfang et al, 2014; Hargreaves et al, 2013).

2.7.4 *Structural Capacity: Funding*

Funding is essential for development and deployment of renewable energy systems. There is recognition that funding from the public sector is often necessary to develop and sustain such systems and these can be in a variety of forms, including: capital grants and rebates, operating grants (e.g. Feed In Tariffs), private investment (e.g. in a renewable energy company), soft loans and guarantees (e.g. the Green Deal), tax credits, reductions and exemptions. Through investment in renewable energy companies, the public sector can also provide investment opportunities for its citizens. Through ownership of energy companies the public sector can provide sustained benefits for its citizens, through influencing regulations and encouraging renewable power uptake (IEA, 2009, pp.178-179).

In general, the largest renewable energy systems are developed by the private sector with a range of finance mechanisms in place to support this. Whilst there may be many reasons why the private sector invests in renewable energy systems, because they are the private sector they expect to generate a financial return for their investment. Historically in the UK, the support that a private sector renewable energy developer provides to a community is in the form of community funds given to 'affected communities' which is often seen as a means of mitigating environmental impacts of a development (Bristow, Cowell & Munday, 2012). Given the definition of energy self-sufficient rural communities that is being used for this research, is it possible for a private sector renewable energy developer to play a part in working towards this goal?

2.7.5 *Infrastructural Capacities: Community energy systems*

Since the 2003 Energy White Paper there has been a shift in perception that the involvement of communities in the UK in the delivery of renewable energy is important (Bulkeley and Newell, 2010, p78). There are real opportunities for district energy systems in the UK to make a significant contribution to a decarbonised lower carbon future (Roberts, 2008). In his guide for the UK TCPA & CHPA , Dodd goes much further, suggesting that 'Decentralised, community energy is the new paradigm and it will need to be developed within our lifetimes if we are to create a path to a sustainable and low carbon future' (Dodd, 2008, p.8).

Whilst community energy is now recognised as making an important contribution to energy supplies, there has been little co-ordination across government departments in providing resources to support communities, resulting in a plethora of initiatives that use the words' community' and 'renewables', with little understanding of what 'community' means. It is suggested that there are two dimensions to community as regards renewable energy systems. The first is process; who initiates and runs the project and the second is outcome; who are the beneficiaries (Walker and Devine-Wright, 2008). It is a mixed picture as to whether the flexibility in terms of the use of the word 'community' in developing renewable energy systems has been helpful. However, there have been many successful renewable energy projects delivered through these schemes. There are four main reasons for this:

- That developing community renewable energy would assist in overcoming opposition to renewable energy schemes per se
- Developing a community focus on renewable energy systems enabled central government to stimulate the market for renewable energy, which was thought key to attaining carbon emission targets

- Many of the renewable energy projects have been located in rural communities, and it was thought this would stimulate economic development in these areas, which were perceived to be in decline
- It was thought that involvement of communities in development of renewable energy schemes was a democratic means of enabling them to be involved in decisions about future energy

(Walker et al, 2007)

It should be noted, however that some of the community renewable energy schemes have become locally divisive and controversial, when expectations as regards division of benefits from the system have not been realised (Walker and Devine-Wright, 2008). Also the evaluation of these has varied hugely, so it is difficult to determine what the successful elements have been (Walker and Cass, 2007).

Nevertheless there can be many benefits of moving towards energy self-sufficiency, including 'enhanced local value creation by decentralizing energy supply systems via regional and local self-governance processes' (Hauber and Ruppert-Winkle, 2012, p.492). Rural communities have what is described as the advantage of proximity – citizens sharing the same setting, providing them with a common sense of place (ibid.) and infrastructure (Heiskanen et al 2010). In the context of energy self-sufficiency, can this be the basis for a new actor network to both initiate and take action towards becoming energy self-sufficient?

2.8 Communication

Communication covers the transfer of information at every stage in the process of a community's move towards energy self-sufficiency, including the content, method, agent, medium and audience in doing this, (Mårtensson and Westerberg, 2007). In order for the goal of a transition to renewable energies for the whole community to be adopted and ultimately taken forward by the community, this must be effectively communicated (Carlisle and Bush, 2009, p.281). Indeed regular communication and information sharing can be crucial components for development of successful networks and trust in small communities when addressing challenges of managing the commons (Rydin and Pennington, 2000; Ostrom, 1990 pp.61-102; 1996). As renewable energy systems are dependent upon the commons for their energy sources, wind, sun etc., this is important to note.

2.8.1 *Individual and Cultural Capacities: The role of trust and the individual*

Having someone local and known explain what a whole place energy transition to become self-sufficient means and give a personal invitation to become involved in such energy transitions increases the likelihood that an individual will become engaged (Hoffman and High-Pippert, 2010). This is because of increased trust in and knowledge of the values of those known individuals rather than of unknown persons and as described earlier, trust is essential in order for community renewable energy projects to be progressed (Walker et al, 2010).

The role of the political and technical pioneers can be important in the early stages, in promoting and translating the idea of transitions to renewable energy systems, to show they are realisable to gain acceptance and support for their proposals. This may take a variety of forms, from study tours, conferences and case studies. Through the presentation of successful examples, this can gain legitimacy of and engagement with the proposition (Hauber and Rupert-Winkel, 2012). However, this is only possible where examples already exist. If the proposal is to do something truly innovative; that is untried and untested in a community context, then the skills of the political and technical pioneers must be truly exceptional to convince their community to support the idea.

2.8.2 *Structural capacities: strategy and policy*

It is suggested that the right mix of strategy and policy is crucial in determining the organisation of community carbon reduction measures such as energy self-sufficiency (Mulugetta, Jackson & van der Horst, 2010). However can the 'right mix' include a lack of local strategy and policy from formal government bodies, with the gap filled by strategy and policy development at the community organisation level? In either case, for both the development and translation of local strategies and policy to support moves towards whole place energy self-sufficiency, it is important how this is communicated to get support from the community. Many projects seeking to support a transition to low carbon communities have used a range of techniques and opportunities to communicate messages and information, including workshops, training events forums and community events (Moloney, Horne and Fien, 2010). All of the elements of communication; content, method, agent and medium and audience, including how decisions about these were made and what the impact of these all had on the move to energy self-sufficiency will be examined in the case studies.

2.8.3 *Structural Capacity: Sharing learning*

Research on grassroots sustainable energy niches showed that most of the case communities investigated demonstrated a willingness to share the learning from their energy projects, either directly with other similar community energy groups or with intermediaries who would share information with other communities for example in the form of case studies as a source of inspiration (Seyfang et al, 2014). Whether this happens in the WSESS approaches, the reason for this, in what form and by whom will be examined in this research.

2.9 Conclusions

Interventions can have different effects dependent upon the actors involved and alternatives available to them, (Pawson and Tilley 1997; Middlemiss, 2008). There may be many actors necessary for a whole settlement approach to energy self-sufficiency to be developed successfully and their involvement and the contribution they make to these needs to be marshalled effectively. The actors may have conflicting aims or views, but a means of engaging them in the idea of a whole settlement approach to energy self-sufficiency has to be found that that provides them with interpretive flexibility around the subject, without necessarily reaching consensus (Hauber and Ruppert-Winkel, 2012; Brand & Jax, 2007). For this research, I will use the concept that the idea of a whole settlement approach to energy self-sufficiency is a boundary object around which disparate interests can gather without losing autonomy.

The resources identified here that contribute to the adoption and development of whole settlement approaches to energy self-sufficiency for this research are described as capacities, that is 'the ability of the community in question and its members to make changes by drawing on the resources available to them individually and collectively.' (Middlemiss and Parrish, 2010, p.7561). Based on the key areas and gaps in knowledge identified from the existing literature described above, the key areas to be examined are:

2.9.1 *Problem Formulation*

How are initial ideas for a whole settlement approach to energy self-sufficiency generated, who generates the idea and how does this get support from the community?

2.9.2 *Mobilisation*

Once formulated, how is the approach developed? What existing government and governance arrangements are used and are new forms of governance developed?

Is a higher level of dialogue between local authorities and civil society necessary in working towards and achievement of goals in energy self-sufficiency as Evans et al, (2005, p.111) suggest?

Do individual politicians have a role to play in facilitating a community's move toward energy self-sufficiency and are they courageous in taking those decisions as described by Van Staden, (2010, p.23) if the impacts of their decisions will not be seen until after their political tenure?

Does the 'outsider' status conferred upon a community that feels excluded from structural resources (policy, funding, in kind support) actually incentivise them to take action as Bomberg & McEwen (2012) suggest?

What governance arrangements are in place or developed?

How does the presence or absence of energy sources, systems and other infrastructure influence the generation of ideas about WSESS and subsequent implementation?

Is there any difference in the level of achievement of energy self-sufficiency by communities with different rationales for doing this?

2.9.3 *Communication*

How is information communicated at the different stages of the energy transition, by whom and who is the audience for this?

These are encapsulated in the four research questions set out in Chapter 1. Using the answers to these questions I will conclude my research by considering the implications of this on the following area relating to whole rural place energy self-sufficiency:

How can the UK do better?

Chapter 3. Developing a Research Design

> ‘Building capacity…….is about providing and enhancing local resources for low-carbon communities, and enabling grassroots initiatives to draw on and remodel such community capacity to create low-carbon change.’
>
> (Middlemiss and Parrish, 2010, p.7566).

3.1 Introduction

In the previous chapters I examined the context for a whole settlement approach to energy self-sufficiency for rural communities, identifying gaps in the literature and focussing on the key areas to examine in addressing my research questions; those being the capacities required by communities to motivate, mobilise and deliver on these energy goals. The conceptual framework set out in the previous chapter illustrates how these capacities may influence the development and delivery of whole settlement approaches to energy self-sufficiency. Building on these, this chapter will consider the most appropriate research methods to address my key research questions into how rural settlements can work towards energy self-sufficiency.

As Nelson, Treichler and Grossberg (1992, p.2) recognise the “choice of research practices depends upon the questions that are asked”. Examination of literature and research on communities working on whole place approaches to energy self-sufficiency, variously described in terms including energy self-sufficiency, community renewable energy, low carbon community energy and the emerging term, energy independence, has largely had a base in qualitative research, allowing theoretical ideas to emerge from the data (Bryman, 2008, p.541).

Quantitative research is focussed on the study of causative associations between variables (Denzin and Lincoln, 2008, p.14). I recognise that quantitative research in this area is important, however often the information research is trying to elicit are empirical views and perceptions of actors and to understand the actions taken as a result of this. Therefore, in attempting to identify and understand complex situations, relations and interactions and the consequences of these, qualitative methods and analysis are more appropriate approaches for field research, including my own.

There are, however, criticisms of qualitative research; itself being described as criticism, rather than science or theory and with researchers using qualitative methods sometimes being described as 'soft scientists'. Much of this it appears is due to the interpretative nature of qualitative research, that there it is no one definitive 'truth' and that findings cannot be verified (ibid., 2008, pp.10-11). This highlights the challenges that I need to address in undertaking qualitative research including; how reliable is the data and analysis and how can these be demonstrated to be valid (Bryman, 2008, p.376), or as Guba and Lincoln (1994, p.114) describe these, how trustworthy and credible are the data and findings?

In considering the most appropriate methodologies to identify the mobilisation of, and the presence and roles of capacities in communities in moving towards energy self-sufficiency, described above; a phronetic approach is an important consideration in understanding values (Flyvbjerg, 2001); and of particular relevance here, that it focuses on the variable and on specific cases (ibid. p.57). This 'organisational field of interest' can be at the level of a community and is interested in examining 'who does what to whom' (Flyvbjerg, 2008, pp.153-154). I have, therefore, chosen a comparative qualitative approach to enable me to do this. Whilst recognising the potential impact my own biases may have on my role as researcher, as set out in my personal reflexivity section later, I will undertake to follow systematic procedures, record all stages and data collected throughout my research and verify data collected with participants in an attempt to address the concerns identified above re reliability and verification of the data.

3.2 Case Studies as a Research Method

Often research in this field uses a case study approach, (Bomberg and McEwen, 2012; Hauber and Ruppert-Winkel, 2012; Heiskanen et al, 2010; Hoffman and High-Pippert, 2010; Mårtensson and Westerberg, 2007; Middlemiss and Parrish, 2010; Peters, Fudge and Sinclair, 2010; Trutnevyte, Stauffacher and Scholz, 2011; Walker et al, 2010; Warren and McFadyen, 2010), or a review of research that has a basis that includes case study approaches (Carlisle and Bush, 2009; Foxon et al, 2009; Moloney, Horne and Fien, 2010: Walker and Devine-Wright, 2008). It is likely that one of the main reasons for such widespread use of case studies as a research method in this field is that many of the research arenas in this area are contemporary and complex and case studies can be useful in helping to understand such 'complex social phenomena' through in depth, real life studies where divisions between context and phenomena are unclear (Yin, 2009 pp.4-18).

Yin (2009, pp.27-35), proposes there are five elements of research design relevant for when using/considering case studies as a research method set out below with my reflections as to how these will be addressed in my research:

1. The study's questions. Are case studies an appropriate tool for addressing the research questions? In this study, the questions do lend themselves to the use of case studies, as they are in the main how and why questions.
2. The research propositions. As outlined in the previous chapter and described in more detail later in this chapter, the research propositions this study is examining are: to identify what capacities exist in places that have set out to move towards energy self-sufficiency, to understand what role they play in contributing to this and are there any wider benefits from this. Therefore the propositions will also seek to compare these places.
3. The study's units of analysis. In this study the unit is the communities that form case study settlement(s). These will be within a specific geographic area, satisfying Gerring's (2007, p.94) criteria that 'a case may be created out of any phenomenon so long as it has identifiable boundaries and comprises the primary object of an inference.'
4. Logic linking the data to the propositions. Through the data analysis stage of the research, the data collected will be coded in a way that has cognisance to the propositions.
5. Criteria for interpreting the findings. A system of coding will be undertaken of the detailed case studies. This will not be done by data analysis software. Such tools are dependent upon identification of codes/words and are more appropriate when there is likely to be a reasonable frequency of such codes and words. As set out in the section later on case selection, there may be significant variation in terms used, particularly in data collected through

interviews, due to the different geographies and types of case study settlements and approaches taken to energy self-sufficiency.

There are also likely to be significant nuances in some forms of the data collected that will have an impact on how the data is analysed and there will be different forms of data collected, some of which will not lend themselves to data software analysis. However, as mentioned above, coding of the data that has cognisance to the research questions and propositions will form an important analytical tool and will be undertaken manually.

In addition, it is proposed that some of the data collected in the European case communities, which is mainly from secondary data sources, may best be analysed by forming a matrix of categories populated by evidence in order to illuminate areas of interest and inform the more detailed UK case selection (Miles & Huberman, 1994, p.101; Yin, 2009, p.129).

Given that a case study approach would satisfy the criteria as outlined above, I will use comparative case studies as an appropriate method for investigating the complex, contemporary situations over which I as the researcher have no control in seeking to understand the rationales and the presence and contribution capacities in rural communities make as they move towards a goal of energy self-sufficiency.

As with all qualitative research methods, the use of case studies has its critics, such as concerns of robustness where only one case study example is used (Walker, 2004, p.301). This is overcome here by using multiple cases; see later in this chapter. In addition to the concerns of researcher bias and lack of rigor that are levelled at case studies, as with other qualitative research methods mentioned above, there is concern that findings are not generalisable (Bryman 2008, p.57). However, Yin (2009, p.15) suggests that case studies are generalisable, but to theoretical propositions only, not to wider populations, whilst Flyvbjerg (2001, p.77) suggests that even single cases can be generalisable. There is also a concern that case studies cannot definitively ascertain causal relationships (ibid.), this is disputed by Gerring (2007), George & Bennett (2005) and Tilly (2001) who suggest that identification of a ‘causal pathway’ is considered integral to causal analysis and identifies case studies as a means for undertaking such causal investigation. The focus, therefore, in using this as one of the main research methods is to facilitate the emergence of theory and causal pathways through analysis of the case study data collected.

In order to compare the cases, the multiple-case design used here enables compilation of a more convincing evidence base resulting in a more robust study and this forms a significant element of my research methods. Yin (2009, pp.6-9; 2003 p.11) suggests that there are three types of case study: exploratory which aims to develop hypotheses for further study and consists mainly of 'what' questions; descriptive, which seeks to illuminate situations in detail with a focus on context and history (when, why) and explanatory, which seeks to identify and explain causal links (how and why). Given the research questions identified here, the case studies will be a combination of all three, but with a focus more on explanatory, or hypothesis testing aspects, as described by Flyvbjerg (2001, p.77): 'the case study is useful for both generating and testing of hypotheses but is not limited to these research activities alone'.

Having identified that my principal research method would be case studies, I considered how to undertake these studies and settled on an approach that took three forms:

- Firstly for researching the five European cases, I adopted a case study approach using secondary data sources. I carried out a cross case analysis of the data to identify what capacities were present in each case at it moved towards energy self-sufficiency, using Truth tables (Georges & Romme, 1995) and Boolean equations (Ragin, 1989) to ascertain combinations of capacities present and the energy self-sufficiency outcomes achieved in each of these. The findings from this informed the selection of UK cases for the second part of the data research.
- Secondly in my case study research of four UK cases, the main data source was primary data collected through interviews, using secondary sources to supplement and triangulate this data as appropriate. Truth tables (Georges & Romme, 1995) and Boolean equations (Ragin, 1989) were used as for the

European cases to identify capacities and combinations of capacities present and the energy self-sufficiency outcomes achieved for each case.

- Lastly I used data collected through a workshop I organised at Newcastle University in October 2013 with the aim of testing some of the findings from the case studies.

Each of these research methods is described in detail below:

3.3 European Cases

In selecting the detailed European cases for research, there were a number of considerations:

In order to be able to make a comparative assessment of the approaches and outcomes achieved, there needed to be similar systemic factors: the first was that all cases needed to have followed a whole settlement or area based approach to moving towards energy self-sufficiency. The second was that the settlements and communities were to be rural in type. I also considered data availability; what information was available, in what form and how reliable was it. This was particularly important, as the first research method was to use secondary data sources to examine whole settlement approaches to energy self-sufficiency in a number of European cases.

Through examination of the literature, it was apparent that there are a number of examples of rural settlements across Europe that have made significant progress towards achieving energy self-sufficiency. Using the 'most different' approach (Przeworski and Teune, 1970 pp.34-39), five rural communities were selected that had adopted different rationales and/or means of doing this.

3.3.1 *Rationales*

Two cases were selected that primarily had economic rationales for embarking on their energy transformation journeys, although they followed different approaches to achieving this. These were:

Güssing, Austria, a small rural town in Burgenland, Austria with a population of approximately 4,000. The population of the wider district is 27,000. Its transition to energy self-sufficiency is perhaps the best documented of the settlements considered here. In the late 1980s and early 1990s the town was in decline and led by Peter Vadasz, Mayor of Güssing and the Municipal Council Güssing developed a goal to transform the economy by providing energy for the district from regionally sourced renewable energy (Marcelja, 2010, p.221). In 2001 a target of providing 100% self-sufficiency through renewable energy was introduced (IEA, 2009, p.167).

Mureck, a rural municipality in Radkersburg, southern Austria with a population of 1,700, covering an area of 5km^2, by the mid-1980s was also experiencing economic challenges particularly in the agriculture sector due to surpluses in crop production (McCormick and Kåberger, 2007). Karl Totter, a local farmer in Mureck started the process of moving to biodiesel production in Mureck and the original aim was "to become more self-reliant, more independent, to farm according to natural cycles and for the well-being of everybody within the region." (Tomescu, 2005, p.12).

Island communities. Two of the European cases are island communities. Due to their geographic isolation and often limited availability of resources locally, island communities have to import many necessities, including food, fuel and other consumables. In addition, island communities can be particularly susceptible to the effects of climate change. Taken together, these can provide incentives for island communities to explore opportunities to be more self-sufficient in energy and the most abundant local sources of energy are often renewable which means , as Hallam et al (2012, p.2958) say 'Islands are excellent sites to examine the implications and issues surrounding the creation of a low carbon, renewable energy future'. The two island communities considered here have different rationales for embarking on their energy transitions:

El Hierro had an Environmental rationale for its energy transition. It is one of the Canary Islands, with a population of 10,600 covering an area of 276km^2. In the early 1980s, the local council, the Cabildo de El Hierro, wanted to develop a sustainable development model for the island that respected the island's natural and cultural heritage and developed its infrastructure, but not using the property based mass tourism model that seemed to predominate elsewhere in the Canary Islands. In 2000, when the island was granted UNESCO World Biosphere Reserve status, the government seized the opportunity to pass its new Island Planning Regulations and launch its sustainable development plan, entitled 'El Hierro 100% Renewable Energies' project', (Droege 2009, p.94).

Samsø had an Opportunistic rationale for its energy transition in response to a competition. It is an island off the Jutland peninsula, Denmark with a population of 4,000 and covering 1,400 ha. In 1997 the Danish ministry of Environment & Energy launched a competition for communities to move from fossil fuel dependency to renewable energy. Samsø won with a plan to become entirely self-sufficient in energy from renewable sources within 10 years (IEA, 2009, p.161).

The last European case community considered here, **Jühnde** took a different approach to a transition towards energy self-sufficiency with an Opportunistic, research led approach. The initial idea was generated outside of the community and led by a local university. Jühnde is a small rural settlement in Lower Saxony, Germany with a population of 800, in an area including 1300ha. farmland, 800 ha. forest. In 1998 a project was launched by Göttingen and Kassel University through the Interdisciplinary Centre for Sustainable Development (IZNE). It was called the Bioenergy village and the rationale was to identify and support regions with the biggest potential for biomass fuelled energy systems. A survey of 3,000 households from 17 villages was conducted. This led to a short list of four villages. Detailed technical and economic feasibility studies were undertaken on these four, which resulted in Jühnde being selected for the Bioenergy village pilot in 2001 (Brohmann et al, 2006).

3.4 Cross-case Analysis

A cross case analysis was undertaken, firstly of the European settlements that set out on a whole settlement approach to move towards energy self-sufficiency, using the matrix category approach described earlier. Rural European settlements were selected for this, rather than settlements from other places around the world, as they most closely resemble the UK situation in terms of governance systems (including the European Union), climate and other factors, such as demographics. Whilst the analysis of European cases was undertaken on a more superficial level using secondary data sources than the detailed UK case studies; described in detail in Chapter 6, it provides an understanding of cross-case characteristics and patterns which both inform a better selection of cases and provide a baseline for comparison with the detailed UK cases; the second form of case study. The Boolean analysis (Ragin, 1989, pp.85-87), described below was also undertaken as one part of the analysis of the data from the UK cases, described in Chapter 6 in order to undertake between case comparison with the European cases.

The cross case analysis was undertaken using Charles Ragin's (1989, pp.85-101) Qualitative Comparative Analysis (QCA) techniques. There are a number of reasons for using this. It allows an holistic examination of cases where different combinations of factors and casual pathways have led to the same outcome, based on Boolean algebra (Caren & Panofsky, 2005). Ragin notes that: 'The holistic character of the Boolean approach is consistent with the orientation of qualitative scholars in comparative social science who examine different causes in context.' (Ragin, 1989, p.93). It is also a useful tool for analysis of data in case studies, as it helps to understand the contribution a number of variables might have on an outcome, thus bridging the gap between a case study and 'variable-based' approach, attempting to overcome the criticism of the terminal uniqueness and lack of generalisation of the case study approach (Ragin, 1999; Caren and Panofsky, 2005).

There are some criticisms of Ragin's approach: Caren & Panofsky (2005) raise concerns that QCA does not take into account temporal order of attributes and that the order in which these attributes occur may affect outcomes. Whilst the main focus of this research is the capacities present in case communities as they move towards energy self-sufficiency, I will have regard to the issue of the temporal order with which these are applied. It has been suggested that Boolean analysis is normally one of the last steps in a research methodology (Georges and Romme, 1995) and there is also concern that Ragin's approach may be too rigid (Pickvance, 2001). However, as it is most helpful in structuring large amounts of qualitative data, usually from case studies and also for assisting interpretive analysis (Georges & Romme, 1995), its application here in conducting a preliminary assessment of characteristics and capacities in the European cases and as one element of analysis in the UK cases was appropriate.

Another important consideration was the interrelationship of causes, (Lazarsfeld, 1955), as there may be challenges through the research in isolating individual causal variables and direct pathways to the achievement of the energy self-sufficient outcome (ibid). This was addressed where possible through objective multiple secondary data source collection and subsequent analysis of this data, as this was critical for assessing the transferability/generalisibility of factors relating to energy self-sufficiency from/between case study settlements.

For the European cases, the sources of data for the cross-case analysis were documentation in various forms, including websites, presentations, books, reports and journal articles. The data for the Boolean analysis for both European and UK cases was presented in a Truth table format, (Ragin, 1989, pp.87-89) described in more detail in Chapter 4. The Truth table represents two possible states to any given variable; presence/truth or absence/false. Ragin used a binary system in his Truth tables, with 1 denoting presence and 0 denoting absence (Ragin, 1989, p.86), assigned to a variable and then the variable was represented by a letter. In order to simplify this, in the Truth tables used in this research, rather than using binary notation; for each variable for each case an upper case letter represents presence and a lower case letter absence (Ragin, 1989; p.89; Georges and Romme 1995). This makes it easier to trace the variables from the Truth tables to the Boolean equations.

3.5 Detailed UK Case Studies

The second part of my research design is to undertake detailed case study research of UK case communities, using research techniques for data collection described below including primary data through interviews and direct observations and secondary data collection from documentary sources.

The selection of the UK cases was informed by findings from the cross-case analysis of the European cases and the 'most different' system of comparative research design, as used in the cross case analysis process described above (Ragin, 1989 pp.85-101;

Przeworski and Teune, 1970, p.34-39). So whilst there will be similarities in case settlements in terms of population, geography, function etc., these will be considered to be 'systemic factors' and as such will not determine the observed outcome of impact upon energy self-sufficiency (ibid.). The differences are the approaches they have adopted in moving towards energy self-sufficiency; that is the capacities available to and harnessed by the communities, which will be examined as the independent variables and the outcome in terms of energy self-sufficiency as the dependent variable.

3.5.1 *UK case selection*

The research was undertaken through multiple case studies, rather than just using a single case, as this enabled comparative analysis of the variables. In this research these variables are the capacities, described in the conceptual framework section earlier. One of the strengths of the case study method is the opportunity to use multiple sources of information, as this enables triangulation of information to corroborate facts of the case study (Yin, 2009, p.116). The sources that were used here include semi-structured interviews with key actors, a review of available documentation and direct observation through field visits to each of the case settlements/communities, described in more detail later in this chapter.

As for the European case selection, in selecting the detailed UK cases for research, there were similar considerations:

- All cases needed to have followed a whole settlement or area based approach to moving towards energy self-sufficiency.
- Settlements and communities were to be rural in type.
- Availability of data; what information was available, in what form and how reliable was it? However, this was of less importance than for the European cases and if there was little or poor quality of information, this did not mean that the case should not be studied, in fact it may provide a greater justification for a case study approach of that place – to produce some primary data.

In terms of following the 'most different' approach to comparative research design (Przeworski and Teune, 1970, p.34-39), using the analysis of the European cases as a starting point I then sought to find places with the similar characteristics identified above (systemic factors), but who had taken different approaches to achieve their energy goals. This would form the basis for my fieldwork, to identify what capacities were present in each case, how were these used in working towards their energy goals and what impact this had upon achieving their goals. I searched for books and journal articles using key word searches and on the internet using different search engines, including using some organisations websites that I had prior knowledge of, such as Transition Towns (Transitions Network, 2014). Through this I found a limited number of potential cases in the UK. Whilst there were many rural settlements that had delivered renewable energy projects, there were very few that had adopted a whole settlement approach to moving towards energy self-sufficiency. Four cases were identified that had different key characteristics; summarised below:

Case Characteristics	**Case one Eigg**	**Case two Ashton Hayes**	**Case three Fintry**	**Case four Hebden Bridge**
Typography	An island community	A rural, predominately commuter village	An isolated rural village	A semi-rural town with an industrial heritage
Rationale	To provide a reliable, sustainable electricity supply for the community to sustain and prosper	To become a carbon neutral community	To become a carbon neutral community	Economic, social and environmental resilience.
What progress has been made?	Developed a community owned renewable powered microgrid, innovative socio-technical aspects,	Carbon reductions achieved in the community in first 3 years mainly through behaviour change, with some renewable installations.	The community bought 1/15 of a commercial wind farm (equates to 1 1.5mW wind turbine) and receives payment for electricity it produces, which funds low carbon energy measures in the community.	The Council produced an Energy Future strategy for the district, launched in early 2012 with targets for CO_2 emission reduction: 40% by 2020 and 80% by 2050
Structure	Parent company is a charitable community	AHGCN is a sub group of the Parish Council. A	A Development Trust, registered as a charity	Principal Local Authority with an Energy Future

Case Characteristics	Case one Eigg	Case two Ashton Hayes	Case three Fintry	Case four Hebden Bridge
	company limited by guarantee which wholly owns an energy company that owns and operates the microgrid (Eigg Electric, 2014)	Community Energy Company set up to develop and deliver a community owned renewable powered microgrid,	manages the whole carbon neutral process, with a wholly owned subsidiary company owning and managing the wind turbine	panel of experts and interests to lead the implementation
Energy Outcomes	Renewable powered microgrid delivered for whole community, operating on average at 85% from renewable e power sources and up to 95% in some years (Eigg Electric, 2014)	23% carbon emissions reduction achieved in 2 years and plans for renewable powered installations for the village are being developed	The wind turbine produces on average 73.5% of the amount of electricity consumed by the community, which is fed into the National Grid (FDT, 2009).	Plans are at an early stage, so there is no information on progress yet.

Table 2. UK case selection

3.5.2 *Case one*

Eigg, an inner Hebridean island adopted a whole island approach to producing its own energy. The rationale here was predominantly economic and security of supply, as previously all power on the island was produced from diesel/oil generators, with all fuel having to be imported (Eigg Electric, 2014). Through the IEHT and Eigg Electric Ltd, the community developed and operates its own renewable powered microgrid for everyone on the island (Community Energy Scotland, 2009), achieving an average 85% energy self-sufficiency for power from renewable sources (Islands Going Green, 2013).

3.5.3 *Case two*

Ashton Hayes is a village six miles from Chester in Cheshire, England. It has a population of 1,000. In 2005, Ashton Hayes Parish Council adopted a proposal put forward by local resident, Gary Charnock that the village should aim to become carbon neutral, (Ashton Hayes Going Carbon Neutral, 2014). The rationale for doing this was environmental. The project became Ashton Hayes Going Carbon Neutral (AHGCN), a sub group of the Parish Council, with the aim of Ashton Hayes becoming the first carbon neutral community in England and was launched in January 2006. It is very much a community led initiative. Whilst the overarching aim is not specifically energy self-sufficiency, in order to become carbon neutral, this inevitably must form one element of its achievement and energy use and renewable energy production has been the key focus in the early years.

3.5.4 *Case three*

Fintry, a small rural community in Stirlingshire, Scotland, with a population of approximately 800 set a goal of becoming carbon neutral in 2003 when it established FREE, so again its goal was primarily environmental, but it also recognised that fuel poverty was a big issue in the community. On average it produces the equivalent of 73.5% of the electricity it consumes through its ownership of one fifteenth of a nearby wind farm (FDT, 2009). They have used the first income generated from the wind farm to fund a study of all buildings in the village to assess energy use and loss and have funded energy efficiency and insulation measures for all buildings that can benefit from this. The electricity produced by the wind farm is sold to the National Grid, not supplied directly to the village. Whilst there is no information available on the carbon reductions, residents have seen an average annual reduction in their household energy bills of 60% (FDT, 2014).

3.5.5 *Case four*

Hebden Bridge is a small town in the West Yorkshire Pennine valley of Calderdale, with a population of approx. 4,500. It is an old textile town in a steep sided valley, ideal for developing the water powered textile mills in the 18th and 19th centuries. In the 1970s and 80s the town was in steep decline, having lost most of its textile industry. A new wave of 'immigrants' moved to Hebden Bridge, attracted by the cheap property and many wanted to start more sustainable ways of living. In February 2012, Calderdale Council adopted a Future Energy Strategy for the district, (Calderdale Council, 2014) that sets out how it will work with partners to see an 80% reduction in CO_2 emissions by 2050 compared to a 2005 baseline. Whilst this is not specific to Hebden Bridge, the town will need to make a contribution towards this, so there is real potential for the community will to be translated into a move towards energy self-sufficiency.

3.6 Sources of UK Case Study Evidence: Primary Data Sources

3.6.1 *Interviews*.

In seeking to understand the presence and role of Capacities, the decisions made and processes adopted in working towards energy self-sufficiency in the case communities, in depth interviews with key actors, will be undertaken, as this is recognised as a useful research method to understand more fully how decisions were reached (Chong, 1993: p.868). It is suggested that it is likely most qualitative research is based on interviews (Peräkylä, 2008, p.351) and that the use of interviewing in general is so pervasive in general today, that we live in the 'interview society' (Silverman, 1993, p.19). Interviews can provide a rich source data through subjects' insights into events that is helpful for understanding complex, social phenomena, such as how communities develop approaches to WSESS and the capacities they use to do this. I have therefore used interviews as the principal methods of primary data collection in the detailed case studies, as the research is examining events and the contribution that individuals and organisations made to these and well-informed interviewees can provide valuable insights into these (Yin, 2009, p.108).

The semi-structured interview style formed the basis of my interview method. The term 'semi-structured' interview, describes an interview method where the interviewer has a list of questions, or 'interview guide'. The interviewer will usually ask all of these questions, but they may be asked in a different order and additional questions can be asked as relevant (Bryman, 2008, p.438). In such a way, the 'semi-structured' or 'responsive' interview can be more a fluid conversational exchange (Yin, 2009, p.107, Rubin and Rubin, 1995, pp 12-14).   I selected this, as it strikes a balance between covering the key topics I, as researcher wish to explore, but also offers the flexibility to follow up other relevant queries depending upon the interviewees responses. In addition, the more informal nature of semi-structured, as compared with structured interviews is more suited to my strengths in communication skills and aims to put the interviewees at ease, which hopefully elicits more considered responses. I also determined to visit each case to in order to more fully understand the place and the processes followed in their energy transition. This would also enable me to undertake direct observation as one of my case study tools and face to face contact made developing rapport with interviewees easier, resulting in more informative and effective interviews.

3.6.2 *Guiding principles*

There are guiding principles for interviewers to use in planning and conducting successful interviews. Of interest for me and my research are: gaining access to the setting, deciding how to present oneself, locating a potential informant, gaining trust, establishing rapport and collecting empirical material, (Fontana & Frey, 2008, pp.131-133). How I addressed each one of these for the detailed case studies is described below:

Gaining access to the setting. My starting point was reviewing available documentation, much of this, described later, was via the internet. Three of the four case study communities had websites, or pages on web sites specifically for aspects of the energy projects they had been working on. For the fourth case, the council website was a useful starting point. The key actors identified through the cross-case analysis of European settlements formed the initial list of potential interview categories for my UK case study interviews. These were: local authority members, local authority officers, individual/community representatives who had taken a leading role in the energy schemes, delivery bodies and other key partners. In addition, where possible I also wanted to gauge views of local residents and businesses, as potential actors and customers in the energy schemes. My starting point was to find contact details, or names of these actors available on the website. I initially contacted individuals who it appeared had been most closely involved in the energy schemes in each case. This was done via email where possible, which included a letter of introduction about my research and some background about me, or hard copy letter where no email contact was available - see Appendix one. In total I approached thirty one people to interview across the four cases - see Appendix two and received mainly positive responses, or a more appropriate alternative interviewee was suggested. This resulted in twenty two individuals agreeing to be interviewed.

Deciding how to present oneself. As a mature postgraduate researcher, with more than 20 years professional experience in the fields of sustainable development and regeneration, within my introductory email/letter I provided a pen portrait of my experience and in exchange for giving me their time to be interviewed offered to share my experiences with individuals and organisations if they thought it might be helpful. I was clear that I was undertaking my research as a postgraduate researcher. At this point I also asked whether there were other key actors involved in the energy schemes that I might contact, thus using these contacts as potential gatekeepers.

Locating a potential informant. As mentioned above, through information on the cases' websites, initially I identified individuals who had been involved in the energy schemes and contacted them as described. Some of these became informants; others were 'gatekeepers' who were able to provide details of potential informants, who I then contacted in the same way.

Gaining Trust. In order to gain trust of prospective informants and respondents, in addition to clearly setting out my intentions in the initial emails and letters, I then sent each individual a 'Use of Information' letter – see Appendix three. This described how I would use information collected through interviews in the research and outlined that interviews would be transcribed and the transcription would be sent to each interviewee, so they would have the opportunity to amend these if the transcription did not accurately reflect the real situation. This process also helped in terms of verification of the data. Whilst the sources of quotes used in chapter five have been identified by a unique reference to provide a more detailed understanding of which interviewee had said what, the anonymity of interviewees has been maintained by not relating these to descriptors in Appendix two. This was important for ethical reasons as I had given an undertaking in the 'Use of Information' letter – see Appendix three that anonymity of interviewees would be preserved, which assisted in the interviews being open and honest.

Establishing rapport. This was important, in order to encourage fuller more detailed responses from the interviewees and would build upon the earlier point of gaining respondents' trust. The process started with my initial email and follow up correspondence and continued in the interviews themselves. I was fortunate that a number of respondents invited me into their homes and provided me with meals and refreshments, which meant the setting was comfortable and relaxed. For other respondents I met them in locations where they would feel comfortable, which varied from work environments to meetings in local pubs. More challenging in terms of building a rapport were the two interviews that had to be undertaken over the telephone, as I was unable to meet the individuals in person. However, for these and all other interviews, before starting the recorded parts of the interview I chatted with respondents, restating the purpose of the interview, how information would be recorded and then transcribed, and the transcription would then be sent to them for verification. This also provided an opportunity to discuss other issues and if any of these was relevant to the research we would return to them during the interview, but just as important, these off-record discussions put both myself and respondents at ease.

I anticipated that some of the interviewees may fulfil the role of ‘informants’ (Fontana & Frey, 2008, p.132: Yin, 2009, p.107) through more in depth open ended interviews; providing detailed insights into the processes and events and so fulfilling the role of guide in researching how the communities move towards energy self-sufficiency. They may also suggest other individuals to interview, thus acting as gatekeepers as well.

Collecting empirical material in interviews. Most interviews were conducted face to face and were digitally recorded using a hand held device. Each interview was then transcribed in full in order to accurately represent an account of the full interview. Two of the interviews had to be conducted via the telephone and I got agreement in advance from the both respondents that the interview could be recorded using a mobile phone application, Ipadio, which produced a digital recording of the interview that was then transcribed in the same way as those of the face to face interviews.

The intention of conducting interviews was to contribute data for analysis in answering my research questions about reasons for a whole place approach to energy self-sufficiency and capacities harnessed that enabled them to do this. Given this I chose to transcribe the interviews verbatim, in order to record a ‘full and faithful transcription’, but ‘denaturalised’, that is not reflecting such things as accents or non-verbal contributions, as it was the meanings and perceptions I was interested in capturing from the interviews, rather than the mechanics of the interview itself (Oliver, Serovich and Mason 2005).

I transcribed about half of the interviews and had the remaining interviews transcribed professionally. For the professionally transcribed interviews I checked each of these thoroughly against the recorded interviews to ensure accuracy of the transcriptions and consistency of style of transcription with my own. Full transcriptions of interviews were sent to all respondents for verification and a few respondents requested minor amendments be made to the transcription. In one instance, there was an error in the digital file, which resulted in notes of the interview being written from handwritten notes taken during the interview and from memory and these notes were sent to the respondents for verification, rather than a full transcription. Most often respondents had no changes they wanted made to the transcriptions. I chose that the interviewees would remain anonymous in this research, in order to encourage more full and frank exchanges through the interviews, which may have been an issue for some respondents, particularly the 'elites'. However, in the 'Use of Information' letter sent to all interviewees, (see Appendix three), I did set out that should it be helpful to attribute quotes to an interviewee, I would seek their agreement for this, which I did for a few quotes.

3.6.3 *Direct Observation*

In developing my case study design, I selected to visit each of the UK cases to gain a better understanding of the context, process, community and projects with respect to their moves towards energy self-sufficiency. In addition to conducting more effective interviews as described earlier, this also enabled me to make direct observations of aspects of the cases. These included, walking around the settlements, visiting individual energy projects, walking between settlements and renewable energy systems where appropriate, taking photographs of the settlements, geographical settings, renewable energy systems, actors and publicly available information on energy systems.

3.7 Secondary Data Sources

3.*7.1 Documentation*

The primary role of documentation as a data source in case study research is to verify and supplement the evidence from other sources, in this case the interviews and direct observations, (Yin, 2009, p.103). Documentation can take many forms, such as meeting minutes, media articles, project reports, evaluation reports. I used documentation as my starting point in each of the UK case studies to help inform both my selection of cases and detail on each case, but also revisited this throughout the data gathering and analysis to check whether it was corroborating or contradicting the other evidence collected. Many items were available on the internet, from self-published information on the individual cases websites, or through linked organisations and some documentation was provided during the interview process. However, in doing this, I recognised that some of the information I found was the 'public face' of the case community and as such could be subject to bias, no matter how inadvertently. Triangulation of all of my data would assist in the verification process of information collected from such documentation.

3.8 Community Renewables Workshop

The third part of my research methodology was not part of my original plan; however an opportunity presented itself when the Newcastle Institute for Research on Sustainability put out an invitation for members of their theme groups to suggest ideas for events on research for sustainability. I am on both the energy and rural and urban theme groups and proposed an event based on my research, which became known as a community renewable energy workshop. My reasons for proposing this were twofold: firstly I had met a number of truly inspirational individuals through my research, who had played a role in significant energy transformations within their communities and I thought it would be helpful to share their stories with a wider audience which might result in further action on community renewable/lower carbon energy systems. Secondly, I was keen to understand more about wider views on whole settlement approaches to energy self-sufficiency from a diverse audience that might assist in my research and this event could provide a rich source of data to test some of the case study findings.

The proposed audience for the event was to be cross sectoral as early indications from my research was that a range of organisations from different sectors had a role to play in WSESS, and event flyers were circulated to: departments across the university, contacts at Northumbria, Durham, Leeds and Sheffield Universities, University of East Anglia and to the organisation of North East Councils, the Energy Savings Trust, Community Energy Scotland, Small Towns for Tomorrow Forum and Rural Community Council in the north of England. In addition, information about the event was circulated via the NIRES website, Northern Rural Network and the Action for Market Towns website. The event was fully booked – see Appendix Four

I put forward a proposal for the event to NIReS staff which included presentations by a number of interviewees/key actors from my case study communities. This became the programme for the day - see Appendix Five, which included presentations in the morning by Peter Vadasz, former mayor of Güssing, Austria, John Booth and John Hutchison from the Isle of Eigg and Garry Charnock of Ashton Hayes, with a panel Q&A session. The afternoon was for workshops to enable delegates to discuss issues either raised during the morning sessions, or relating to community renewable energy in general. The four workshop sessions were:

- Galvanising your community & sustaining interest
- Establishing organisations to deliver and manage community renewable energy schemes
- Why getting political support in community renewable energy schemes is important & how to get it
- Planning & delivering community renewable energy schemes

In preparation for the event, I drafted briefing papers for the workshop facilitators and also for potential cartoonists, together with a recruitment flyer for cartoonists (Appendix Six). I commissioned two cartoonists, who would produce cartoons of issues raised during the afternoon workshops. The aim of this was to avoid boring workshop feedback sessions, by allowing delegates to view the cartoons during the afternoon coffee break (Appendix Seven). In addition I also prepared a policy briefing for the Centre for Rural Economy at Newcastle University, which was circulated to a wider audience through the Northern Rural Network (Appendix Eight)

In order for the event to provide useful data for my research, it was essential that the workshop was documented or recorded. As the workshop was another form of qualitative research, documentation would help triangulate the data from my case study research and address issues of reliability, validity, trustworthiness and credibility of the data and my findings (Bryman, 2008, p.376; Guba and Lincoln 1994, p.114).

The workshop was documented as follows: The morning presentations were all filmed (NIReS, 2013); notes were taken of the panel Q&A session and of three of the four workshop sessions. Regrettably the recording failed of workshop three: Why getting political support in community renewable energy schemes is important & how to get it. Copies were taken of the cartoons drawn during the workshop sessions (Appendix Seven).

The data from the event supplemented the data from my case studies and enabled me to further verify, or challenge some of my initial findings; this is explored in Chapter 6.

3.9 Analysing the Data

3.9.1 *Analysis of semi-structured Interviews*

The questions asked during the interviews were designed to elicit responses from interviewees that would address the research questions, with flexibility through its semi-structured format to enable additional questions to be asked where relevant. As already described, interviews were recorded and transcribed in full, with verification by the interviewees, with one exception where notes were prepared and sent to the respondent for verification.

The approach I took to analysing the interview data was thematic analysis. This is an emerging and growing approach to analysing qualitative data and as such, there is some concern that it is not an identifiable approach; for example there is disagreement in some areas whether thematic analysis and coding are the same thing and there is very little guidance about how to conduct such an analysis (Bryman, 2008, pp.554-555). However, the National Centre for Social Research in the UK produced a framework for thematic qualitative data analysis (ibid., p.554; Ritchie, Spencer and O'Conner, 2003, p.220), which provided a structure for doing this. I used this as a guide for organising the analysis of my interview data. Through thematic colour coding of my interview responses, this enabled me to identify key themes and to compare similarities and differences across all the cases and to consider these in relation to the conceptual framework presented earlier.

3.9.2 *Analysis of documentary data sources*

Documentary evidence served two roles in my research, that of providing information for other parts of my research, such as contact information for potential interviewees and to assist in triangulating data from the interviews to corroborate this, or not. In analysing documentation for this secondary purpose, I recognised that documents may not provide a window onto reality (Bryman, 2008, p.526), but should be viewed in terms of the context within which they were produced and their potential readership (Atkinson and Coffey, 2004, p.77). They assisted in directing me to other documented data sources, supporting findings from my other data sources and also in guiding my interview questions and direct observations. In this way not only did they provide 'intertextuality' (Atkinson and Coffey, 2004, p.86), but also interconnectedness to my other evidence. Such data was identified in my case study notes.

In presenting the data for the UK cases using Mårtensson and Westerberg's (2007) structure, the data is presented as the stories of the journeys the case communities have followed in working towards energy self-sufficiency, providing 'thick descriptions' (Geertz, 1973, pp.5-10), which capture the nuances of each case.

3.10 My Role as Researcher

In seeking to understand the capacities that are present in places that have made significant progress towards energy self-sufficiency, my role as a qualitative researcher can be described as a 'bricoleur', a term first coined by Lévi-Strauss (1966, pp.16-24), to describe a way of using whatever methods are available to make sense of a situation, as an attempt to offer an alternative to precise, 'engineered' methods. My approach is part interpretive – piecing 'together a set of representations that is fitted to the specifics of a situation' and part methodological 'performing a number of diverse tasks, ranging from interviewing to intensive self-reflection and introspection' (Denzin and Lincoln, 2008, pp.5-8), which together will enable me to connect all the parts to a whole that elucidates what capacities are, where they are present and what role they play in settlements that move towards energy self-sufficiency.

As described earlier, I will be using the conceptual framework as the basis for my research, which will be observation based and any findings or theories that emerge will have their basis in these observations. In doing this, I acknowledge it is not possible for the fieldwork and findings to be value free, as researchers bring their own value systems to the analysis of the observations. I am no exception to this and need to recognise that I am a product of all my experiences and therefore my position as researcher cannot be entirely neutral, bringing with me my own biases (Scheurich, 1995). However in acknowledging these, set out in the personal reflexivity section below, this enables me to understand the lens through which I view the world, how this might impact on the design, fieldwork and analysis of my research and enable me to critically review my position and assessments throughout and minimise any bias these might have.

3.10.1 ***Biographical reflexivity***

For almost 25 years I have worked in the public, private and charity sectors in the fields of sustainable development, regeneration and community development. Whilst having commissioned a lot of research in my role immediately prior to starting my PhD research, some of these involving academic institutions, I had not been involved in undertaking any academic research of my own for about 20 years. I viewed starting my research like moving to a new sector for a job and recognised that I would be on a very steep learning curve to familiarise myself with all aspects of academic research and a detailed understanding of the bodies of academic work more closely related to my area of research. This was a real challenge, as with all new fields there was a new language to learn.

My professional work has required me to work across many disciplines, shaping teams, research and work to facilitate policy formulation and programme and project delivery. This has given me an appreciation of the value of multi, cross disciplinary work, where contributions from diverse subjects and professions have resulted in delivery of more than the sum of the parts. I have brought this approach to my research, not confining myself to one subject area, but using knowledge from a wide range of sources to provide me with the best understanding of whole rural community approaches to energy self-sufficiency and the capacities used to achieve this.

What I take from this reflection is that I can bring my awareness, experiences and skills learned in the other areas I have worked in to my research to have a more cross-cutting approach. The potential risk of this is that I could follow a broader approach in less depth, but in recognising this and using the academic skills and knowledge I have acquired over the last four years, together with the guidance I have received from my supervisors, I hope that this research provides a focussed in depth study to doctoral standards.

3.11 Conclusions

In this chapter I have examined appropriate research designs that will help me to address the research questions using the conceptual framework described in the previous chapter to help provide a focus and guidance throughout the research. In order to collect the level of detailed data necessary to elicit robust, evidence based findings, I have chosen three main qualitative research methods for my research:

- A cross case analysis of five European cases using mainly secondary data sources.
- A case study approach of four UK cases, using mainly primary data collected through interviews, supplemented by case study visits, observations and documentary analysis.
- A community renewables workshop of multi-disciplinary stakeholders to help triangulate the data and test the findings from my case study research.

This framework and research design helped me in examining rural communities that are working towards energy self-sufficiency: why they embark upon a journey towards energy self-sufficiency; what capacities are present and how have they been used to support these goals; does the idea of whole place energy self-sufficiency function as a boundary object; does the rationale make a difference to the progress in achieving the goal; whether a whole place approach was present at the start and was there a relationship between this and the energy self-sufficiency outcomes achieved?

In the following two chapters I will present the process of collecting data and the data itself on rural whole place energy self-sufficiency, firstly through the cross-case analysis of European settlements and secondly from the detailed UK cases.

Chapter 4: European Cases

4.1 Introduction

In the previous chapter, I examined the best way of conducting my research into capacities for whole rural settlement approaches to energy self-sufficiency and identified the methodologies that I would adopt. This chapter sets out the process undertaken and data collected from the five European cases. These cases were selected for three reasons;

- their size, i.e. small towns or functional groups of rural settlements
- they have made significant progress in moves towards energy self-sufficiency
- they have adopted different rationales and/or different ways of delivery towards energy self-sufficiency

I then go on to undertake a cross case analysis of the capacities present in these cases using the Qualitative Comparative Analysis (QCA) and Boolean analysis techniques described in the previous chapter. The findings of this cross case analysis are set out and how these are used to inform the selection of the UK cases for more detailed research; described in more detail in the following chapter.

As outlined in Chapter 3, the European case settlements considered here are; Güssing, Mureck, Jühnde, Samsø and El Hierro. I have used Mårtensson and Westerberg's (2007) structure of problem formulation, mobilisation and communication as the framework for examining the data sources for the cases to identify what capacities were present and engaged in their energy transformations. In addition to these, I have added outcomes, as progress made towards the energy goals is a key consideration in assessing the relative importance of the presence and application of different capacities in achieving this. The issues considered in this section have been identified in Chapter 2 as key capacities that warrant further examination to assess their contribution to the settlements achievement of/working towards energy self-sufficiency and are described below.

I then undertake a cross-case analysis of the cases, described in Chapter 3, which provides an understanding of cross-case characteristics and also patterns of potential causes. Boolean equations are then applied to the cross case analysis (Ragin, 1989 pp. 85-89) in order to explore where different combinations of factors have led to similar outcomes. This will help in determining the potential contributions that the presence and application of different capacities, in effect causal effects and pathways, make in rural places working towards energy self-sufficiency. Of particular interest will be to understand what combinations of these are present in places that have made significant progress towards energy self-sufficiency. This will provide a baseline of capacities from the European cases that will enable a better selection of UK cases for primary research and also for comparative analysis with these.

Data for the cross-case analysis are secondary sources, including journal articles, websites, reports, books, but for one case, that of Güssing, Austria, which is supported by data from personal interactions.

The rationale for the move to energy self-sufficiency is explored; what the rationale was, whether this was explicit at the outset and whether this was a whole settlement approach. This is linked to examining whether a strategy was developed, if so, who developed this, was it iterative and inclusive, or imposed. This will help in assessing whether and which of these are important in the move to/achievement WSESS. Table 3 summarises the capacities that will be examined.

Capacity	**Scope**
Individual	Individuals' skills, knowledge, values, leadership and trust
Structural	Role of government, governance, organisations and funding
Infrastructural	Energy sources, infrastructure and ownership
Cultural	History, values, importance of place

Table 3. Summary of capacities to be examined

As mentioned above, also examined here are the outcomes; how far the settlements have gone in achieving energy self-sufficiency. This has been divided into electricity, heat and transport, as the literature clearly distinguishes between the three elements.

Transport is the biggest challenge and arguably none of the cases considered here have made much progress in tackling this. It is intrinsically difficult to identify what proportion of transport fuel should be assigned to a community for them to produce from renewable sources in order to make them energy independent in transport. This is what led to the consumption models used for assessing ecological foot printing – that resources used should be assigned to wherever and whoever consumes them. As described in my introduction, the transport element of energy self-sufficiency in small settlements is not addressed in detail in this study, but could form the basis of future research. It is, however, acknowledged that transport and the fuel used in this is a fundamental component of energy use in these communities, so an attempt is made to understand how low carbon sources of fuel for transport systems locally is being addressed.

Sources of information for this review of European case communities are secondary. Where possible academic papers, books and conference papers have been used, however for some of the cases the availability of academic data is limited, so additional sources of information have also been used such as project/partner websites and presentations in order to expand and verify information through triangulation. Using the structure and capacities outlined above I consider each case in turn:

4.2 Güssing

4.2.1 *Problem Formulation*

Cultural & Structural Capacity: Rationales WSESS. Güssing is a small rural town in Bergenland, Austria with a population of 3,800, covering an area 49.31km^2 (Vadasz, 2013); 46% of the area is forest and 40% is used for agriculture (Muller et al, 2011). The population of the wider district is 27,000 (Vadasz, 2013).

In the late 1980s and early 1990s the town was in decline. As much of its hinterland bordered Hungary, then part of the Eastern Bloc, there was no trade across the border, up to 70% of the working age population commuted to Vienna and elsewhere for employment, and the Local Council was struggling to meet its payments, the largest of which was the energy bills (Marcelja, 2010, p.219). GDP per capita in Bergenland at that time was the lowest in Austria and was 72% of the EU average (Wagner, Schrefel and Roediger-Schluga, 2000).

As the town faced significant economic challenges, the rationale for the energy transition was economic. As a means of changing the economic fortunes of the town, the municipal council set about producing energy from local renewable sources. In Güssing the goal was to transform the economy by moving to a fossil fuel free town through providing energy for the district from regional renewable sources (Marcelja, 2010, p.221). Reinhardt Koch, an electrical engineer produced a report showing that in 1988 the town of Güssing spent €6.2 million buying energy from external suppliers This led to the 1990 resolution by the municipal council that all public buildings would change to renewable powered heating systems and become fossil fuel free. Energy efficiency measures were also taken in all public buildings and for public lighting and within two years, the energy consumption on these was reduced by 50% (Austria. Austrian Federal Ministry for Transport, Technology and innovation, 2007; Douthwaite, 2006). Peter Vadasz was elected mayor of Güssing in 1992, prior to this, he had already been working with Reinhard Koch and Herbert Sattler, head of the local timber growers association to undertake an assessment of how to transform the economy of the town by producing energy from local renewable fuel sources (ibid.). In 2001 a target of providing 100% self-sufficiency through renewable energy was introduced, (IEA, 2009a, p.167). The process was driven by the municipal council and Peter Vadasz, as Mayor.

Cultural Capacity: The importance of place for energy self-sufficiency. There was little evidence, documentary or otherwise, of the importance of place in Güssing's decision to embark upon a transition to energy self-sufficiency.

Individual Capacity: Skills. As described above, two individuals played a key leadership role in different stages of the initiation and development of the energy transition. Peter Vadasz, provided the political leadership, supported by the technical expertise of Reinhard Koch, the town's engineer in initiating the energy transformation of the town from fossil fuel to renewable energy based. The combination of the skills of the two; consummate political leadership and detailed technical expertise of energy systems facilitated the development of wider community support for the proposals (Douthwaite, 2006).

Structural Capacity: Visions and Strategy. As noted in the Rationale section above, in 1990 the municipal council agreed a resolution that all public buildings would change their heating systems to become renewable powered and fossil fuel free (Douthwaite, 2006). This led to the development of the first district heating system for the town. In 2001 the goal of becoming 100% self-sufficient through renewable energy was introduced for the whole community (IEA, 2009a).

Structural Capacity: Government and Governance. The forms of governance, defined as the processes, policy and conventions around which interested actors can gather (Bulmer, 1993), for the initiation of energy transitions in the case communities are examined in this section for each case, including leadership roles.

The role of the local government was fundamental in leading the whole settlement approach to energy independence from the start. Following the presentation of Reinhard Koch's report in 1990 and the council's resolution to initially put their own house in order through energy efficiency measures and renewable energy systems in public buildings (Austria. Austrian Federal Ministry for Transport, Technology and innovation, 2007; Douthwaite, 2006), the council passed the following resolution:

- Resolution of the local council of 13 July 1993:
  Drafting an energy study on the future energy supply
  (European Centre for Renewable Energy Ltd., 2011).

The resulting study laid the foundations for the transition of the town from fossil fuel to local renewable energy systems described in section 4.2.2:

Infrastructural Capacity: Renewable Energy Resources. Following the resolution above, initial feasibility assessments were undertaken on energy demand and which renewable fuel sources could meet this demand. Wood and rapeseed were identified as the most appropriate and abundant local fuel sources for any energy systems (Juza and Marhold, 2011).

Cultural Capacity: Boundary objects in the European cases. As described in Chapter 2, the conceptual framework for the research sets out that the idea of a whole settlement approach to energy self-sufficiency would be both a boundary object around which diverse actors could co-operate without losing their autonomy, as well as being the dependent variable upon the actions of the capacities identified. This section for each of the cases explores whether the idea did function as a boundary object, a Cultural Capacity.

The original idea was for the municipal council to source all the energy for its public buildings and services from local renewable sources. The idea then developed to transform the economy of the town and its hinterland by producing all its energy needs from local renewable sources. This idea acted as a boundary object, drawing together the municipal authority, which wanted to ensure it could pay its own energy bill, but also wanted to support the development of a prosperous local economy, the local forestry businesses who wanted to develop sustainable, profitable markets for their timber and local residents and businesses who wanted a low cost energy supply. As the idea moved into delivery, other actors became involved including a university that wanted an opportunity to do a field scale trial of a new fluidised bed steam gasification system and residents who wanted a low cost sustainable energy supply.

4.2.2 *Mobilisation*

Individual Capacity: The role of the individual in moving towards WSESS. As in the Problem Formulation phase, Peter Vadasz as mayor of Güssing from 1992 to 2012 and, supported by the technical expertise of Reinhard Koch, the town's engineer are widely regarded to be responsible in a large part for the success of the delivery of the renewable energy systems and the associated transformation of the local economy (Douthwaite, 2006); in a case of "the right persons met at the right time" (European Centre for Renewable Energy Ltd., 2011).

Structural Capacity: Government and Governance. Following the measures taken by the municipal council detailed in the Problem Formulation: Government and

Governance section above; the council continued to lead the way in the delivery phase, passing a further two resolutions:

- Resolution of the local council of 24 November 1994:
  Participation of the municipality of Güssing in the Güssinger Fernwärme GmbH (Güssing District Heating Ltd.)
- Resolution of the local council of 19 March 1996:
  The municipality provides a special plot of land for the construction of the district heating

(ibid.).

These enabled the council to start a second phase of works to develop a larger scale renewable heat and power plants in 1996, described in more detail below.

Structural Capacity: External expertise. This chapter demonstrates that many of the Capacities needed for the whole place energy transitions in the case communities have been found within the communities. This section for each of the cases examines whether any external expertise was needed in the case communities to help them work towards their goals.

The first renewable energy project delivered in Güssing was a biodiesel plant, by a private sector partner (Juza & Marhold, 2010), described later and they provided all the expertise needed to do this. As a tried and tested technology, the district heating system was developed by the municipal council and local forest growers association (Douthwaite, 2006). It was only when considering how to develop a local renewable powered electricity that Peter Vadasz and Reinhard Koch sought external expertise. They started working with Professor Herman Hofbauer and his team at Vienna Technical University who was developing a fluidised bed steam gasification system to overcome problems with production of tar in other gasification systems (Douthwaite, 2006; Juza & Marhold, 2010). There was recognition that this was still very much an experimental technology and so was a real risk for them to progress this to a full scale operational system in Güssing.

Structural Capacity: Funding. The cost of installing the biomass district heating system in Güssing in 1996 was €8m. As Austria had joined the EU in 1995 and Bergenland had been designated an Objective 1 area, this meant that Güssing was eligible for EU funding towards the capital costs of the district heating system. Of this €2.64m was provided by public grants from the EU, the national and regional governments, €2.64m was funded from connection fees and €2.72m was funded through a bank loan through the municipal council (Douthwaite, 2006; Vadasz, 2013). Costs for installing the fluidised bed steam gasification system to produce electricity were €13.5m (Vadasz, 2013). It took four years to raise the funds and get all the permissions for what was described as a pilot project, but as such it could be entirely funded by the EU and national and state governments (Douthwaite, 2006).

Infrastructural Capacity: Community energy systems. This section for each case describes the implementation of the community energy systems and includes the issue of ownership of the energy infrastructure. I use the definition of community ownership used by Binns et al (2007) in examining distributed generation (DG) energy systems here as 'DG projects owned by an individual or groups of individuals who live in the area where the DG technology is deployed and who are not affiliated with the traditional energy sector'. By definition, anything outside of this is not considered to be in community ownership.

The first project to be delivered in Güssing was a biodiesel plant delivered by company Burgenländische Alternativ-, Treib- und Heizstofferzeugung in 1991, processing rape seed to produce biodiesel, with an annual capacity of biodiesel producing 80m MWh energy (Juza & Marhold, 2010).

The next project was led by the municipal council, with the local timber growers association. Two small scale biomass district heating systems had already been successfully delivered in the local area, so as a tried and tested technology a 3MW biomass district heating system was installed, fuelled by wood from the local forests (Douthwaite, 2006; Vadasz, 2013). The plant started operation in 1996 and as the system was in local ownership, the council could negotiate long term rates with consumers. This local ownership was important as Vadasz states: "It was unthinkable that the majority of the shares should be in private hands" (Douthwaite, 2006). Key to getting local residents and businesses to sign up at the start was the agreement that the fees would be no more than for existing oil fired heating systems (ibid.). By 2013, the fees were up to 30% cheaper than similar oil heating systems (Vadasz, 2013).

The scheme proved very popular and within 2 years an additional 5MW capacity had to be added. By 2013, this had been expanded to 50MW, with a network of 36km pipelines (ibid.), see figure 2.

Figure 2. District heating system being installed at Güssing. Photo courtesy of Peter Vadasz

Having made good progress on developing a local renewable district heating system Reinhard Koch and Peter Vadasz turned their attention to how electricity could be produced from a local renewable source. The experimental fluidised bed steam gasification system was developed (Douthwaite, 2006; Juza & Marhold, 2010). In addition to producing electricity through burning of the gas produced, it also provides heat to the district heating system, so operates as a combined heat and power plant (CHP), operating at overall efficiency of 80-85%, with a capacity of 2MW for power and 4.5MW for heat (Douthwaite, 2006; Juza & Marhold, 2010). When the CHP plant was completed in 2001, it was estimated that through the biodiesel, district heating and CHP plants, with contributions from a photovoltaic and solar heating plant, whilst not completely self-sufficient in heating, Güssing became self –sufficient over all in energy terms (Austria. Austrian Federal Ministry for Transport, Technology and Innovation, 2007), as shown in Table 4:

	Fuel	**Heat**	**Electricity**	**Total**
Energy Demand (MWh)	30,251,000	50,470,000	29,984,000	105,705,000
Energy production from renewable sources(MWh)	80,000,000	47,520,000	31,500,000	159,020,000
% self sufficiency	264.45%	94.15%	126.08%	150.44%

Table 4. Degree of self-sufficiency in the town of Güssing (2005). Source: Koch et al, 2006; Juza & Marhold, 2010

However, in 2008, the model described above encountered a major problem. The biodiesel plant was a small one, supplying the local area. In 2005, a regulation introduced by the Austrian government to add biodiesel to fuels led to larger plants importing cheaper oils. This meant that smaller plants like the one at Güssing could not compete on price using local, more expensive rapeseed and the plant went bankrupt, closing in 2008. The effect on the energy self-sufficiency of Güssing was drastic, reducing to 51% (Juza & Marhold, 2010).

Since 2008, new renewable energy plants have been installed that are moving the town back towards energy self-sufficiency. These include a Fischer-Tropsch plant for producing biodiesel and gasoline and a methanisation plant which opened in 2009 (ibid.; Vadasz, 2013).

In Güssing, the district heating system is part owned by the town council and part owned by the local timber growers association (Douthwaite, 2006). The town council also owns the Fischer-Tropsch, methanisation and solar plants. Peter Vadasz, former mayor of Güssing credits the ownership of the district heating infrastructure and hence their ability to set long term rates for heating with much of the economic transformation of the town. It was able to attract/establish fifty businesses and create over 1,000 new jobs (IEA, 2009, p.165; Vadasz, 2013), in part because the municipal council controls the district heating system and can negotiate long term rates for businesses, dependent in part upon how much a business will contribute to the economy of the town. However, the council does not own the electricity grid and this is limiting the town's ability to extend the economic benefits even further, (Droege, 2009), as they are not able to set their own electricity tariffs. The town council received 15c /kWh for the electricity produced by the CHP plant, which is much lower than the 25c kWh paid by consumers. Peter Vadasz is quoted as saying "At present I can come to an arrangement with newcomers on the price they will pay for their water, sewage and heat. I'd like to be able to do a deal on the electricity as well" (Douthwaite, 2006).

4.2.3 *Communication*

As described in chapter 2, regular interaction and communication in small communities in a local area can build productive social networks, through information flows and the development of relationships and trust (Ostrom, 1996; 1990 pp.88-89). The presence, type and contribution such communication had in the case communities are described in this section for each case:

Individual and Cultural Capacities: The role of trust and the individual. Peter Vadasz and Reinhardt Koch were the key proponents of the energy transition in Güssing. Koch, as an engineer had the technical knowledge, which enabled his first report to the municipal council on energy use in public buildings, how this could be reduced and changed to renewable energy to be endorsed by the council (Douthwaite, 2006). His technical expertise was critical at every stage in communicating the new energy systems to different audiences throughout. Peter Vadasz provided the political leadership throughout and persuaded the council, citizens, investors and businesses to support the development of the Güssing energy model. He did this and gained the trust of the population by, for example, promising that the cost of the new district heating system would be no more than the existing oil systems (ibid.; Vadasz, 2013), which proved to be the case. He was mayor for a total of 20 years, demonstrating the trust of the community as he gained re-election four times.

Structural capacities: strategy and policy. The municipal council in Güssing recognised that they would have to get support from the community before they could embark on the delivery of any of the large renewable energy schemes, in particular those that would have a direct impact on residents and businesses, such as the district heating system. It was also necessary of course for residents and businesses to be persuaded of the benefits of such a system, so that they would agree to sign up to the scheme, as it would not be viable without enough people agreeing to this. A large number of town hall meetings and evening events were held to assist in this and they were successful in convincing much of the community of the benefits of such a scheme (European Centre for Renewable Energy Ltd., 2011). Key to winning the argument was an undertaking that the rates charged to consumers of the district heating system would be no more than the existing price of fossil fuel heating systems (Douthwaite, 2006). In reality, by 2009, the prices of the district heating system were approximately 30% less than the cost of oil, as shown in figure 3 (Vadasz, 2013).

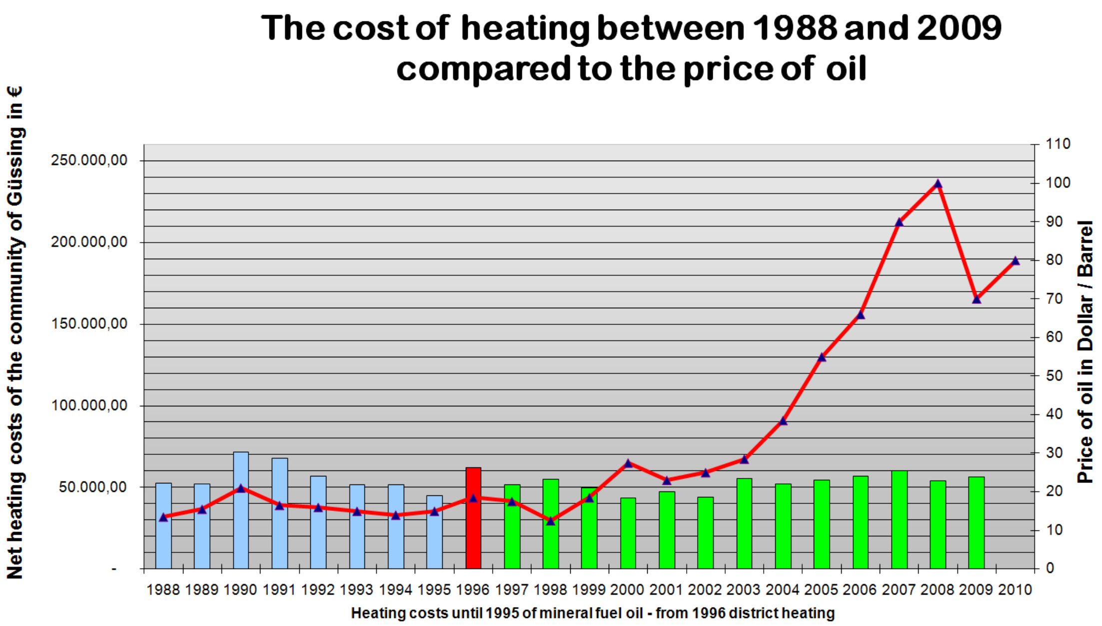

Figure 3. Cost of heating compared to price of oil 1988-2009 Source: (Vadasz, 2013).

Structural Capacity: Sharing learning. Since the early days, the sharing of information wider than the community has been a central part of Güssing's energy transition process, not least because it attracts 'eco-tourists' to the town. Given the economic rationale for starting the energy transition, it is important in learning about the process the visitors are also contributing the local economy. The European Centre for

Renewable Energy (EEE), was established, described as the umbrella organization for all energy-related activities in Güssing (Juza and Marhold, 2010), including undertaking research and dissemination of information through events and publications. The centre also hosts a website to provide information to a wider audience (EEE, 2014). Between 15,000- 20,000 people visit the town each year from across the world to learn about the energy transformation, which meant a new hotel had to be built to cope with the demand (Juza and Marhold, 2010).

In addition, Peter Vadasz and others involved in the energy project attend events around the world to share their experiences, including the Community Energy Workshop I organised at Newcastle University in October 2013 (NIReS, 2013).

A business has also been established, Güssing Renewable Energy which, provides paid for services to develop energy systems for communities and provides franchise and licensing agreements for this and has done this for communities across the world (GREG, 2014).

4.2.4 *Outcomes*

In order to analyse the contributions that the different capacities made to the energy self-sufficiency processes in the case communities, it is necessary to understand the level of energy self-sufficiency and related outcomes achieved, described in this section for each case:

Güssing achieved overall energy self-sufficiency in 2001 with the opening of the CHP plant, as shown in Table 4. Whilst not achieving energy self-sufficiency in heat at that time, the production of electricity and fuel exceeded demand in the town significantly.

The closure of the biodiesel plant in 2008 reduced the overall energy self-sufficiency significantly, but this has increased again with contributions of methane gas from the methanisation plant and synthetic gas and fuels from the Fischer-Tropsch plant.

Table 5 provides a breakdown of local power and heat demand and production of power and heat from local renewable sources in Güssing in 2010:

	Demand	Supply
Heat	60GWh (30GWh of this by households)	56GWh – from 4 biomass-district heating plants & 3 CHPs
Electricity	50.3GWh (8GWh households, 36,4GWh industry, 7,5GWh others)	22.2GWh – from 3 CHP plants
Fuels	29GWh (17,5GWh households)	Since 2009 Methanisation (Prod. synth. natural gas) projected
Degree of self-sufficiency heat and electricity: regarding private households, public buildings and industries 71% (2010)		

Table 5. Breakdown of local power and heat demand and production in Güssing (2010). (Keglovits, 2013)

Between 1996 and 2009, as a result of the shift from a fossil fuel based to a renewable fuel based energy system, the CO_2 emissions in Güssing have fallen from 37,000 tons per annum to 22,500 tons per annum, a reduction of 39.1% (Keglovits, 2013). In addition, over 50 businesses have set up or relocated to Güssing because of the long term heat energy tariffs and renewable energy, creating over 1,000 jobs, netting over €9m per year, (Vadasz, 2013). One of the successes for Güssing was the relocation of solar cell/energy companies, Blue Chip Energy and Solon AG, who relocated to Güssing in order to power their businesses wholly from renewable sources. The town also attracts over 400 eco-tourists per week interested in the energy systems Güssing has introduced, (Droege, 2009).

The European Centre for Renewable Energy (EEE) was established in Güssing as a result of the work being done there. It is a centre of excellence for research and training in renewable energy (Austria. Austrian Federal Ministry for Transport, Technology and innovation, 2007)

4.3 Mureck

4.3.1 Problem Formulation

Cultural & Structural Capacity: Rationale for WSESS . Mureck is a rural municipality in Radkersburg, southern Austria with a population of 1,700, covering an area of 5km^2

(Tomescu, 2005, p.10). By the mid-1980s Mureck was experiencing economic challenges particularly in the agriculture sector due to surpluses in crop production. This led local farmer, Karl Totter, to explore whether local farmers could use their crops to produce biodiesel, thereby getting an income in kind and reducing their overheads (McCormick and Kåberger, 2007) and became the starting point for the development of the Mureck bioEnergy Cycle (MEC). As with Güssing, the rationale for the energy transition therefore was an economic one. In 1985 Totter started the process of moving to biodiesel production in Mureck with the original aim: "to become more self-reliant, more independent, to farm according to natural cycles and for the well-being of everybody within the region."(Tomescu, 2005, p.12).

Cultural Capacity: The importance of place for energy self-sufficiency. Mureck is the one European case where there is documentary evidence of the importance of place in the decision to embark upon a transition to energy self-sufficiency. In his 2005 study of Mureck, Tomescu (2005, pp.53-54) examines what he describes as 'social-connectedness'. He suggests that in Radkersburg, the district where Mureck is located, 'the degree of social connectedness is very high', particularly among the farming community and that this is the reason why farmers became involved in the Mureck Energy Cycle projects.

Individual Capacity: Skills. Karl Totter is widely acknowledged to be the driving force behind the development of the Mureck Bio Energy project. He was respected amongst fellow pig farmers prior to this, which was why farmers in particular listened to him when he put the initial idea of developing biodiesel to them, as one farmer said, "That's why we followed him in the cooperative. He is a fighter. Otherwise he would not have made it so far!" (ibid., p.11). As a local farmer, Totters knowledge of local farming and the economics of this were critical in gaining support from the local farming community for the proposal, together with his leadership skills. He also became chairman of SEEG.

Structural Capacity: Visions and Strategy. In this respect, Mureck was also different to the other European cases. At the start its goal was not specifically to achieve energy independence, but to transform the agricultural economy of the area through development of biomass energy systems – initially biodiesel from oil seed rape and then heat and electricity from biomass and biogas.   However, since developing the MEC, Mureck has joined the Climate Alliance (Tomescu, 2005, p.44) and there is now an ambition to meet all energy needs of the town from renewable energy sources (McCormick & Kåberger, 2007).

Structural Capacity: Government and Governance. At the start of the process in Mureck the organisations providing governance were the Institute of Organic Chemistry, University of Graz in partnership with Weinbauschule, Silberberg, the region's technical college for viticulture and winegrowing. They got approval from the Styrian provincial government in 1986 to undertake a field scale trial to produce biodiesel from rapeseed (Tomescu, 2005, p.12). A meeting was held with local farmers to invite them to be part of this. One of these was Karl Totter and following the success of the trial in 1987, he decided to set up a farmers' co-operative in Mureck to produce biodiesel from crops. As was the case in Jühnde described later, the local council did not initiate the energy transition in Mureck.

Infrastructural Capacity: Renewable Energy Resources. Following the successful field scale trials by the University of Graz, Karl Totter was keen to develop this technology in Mureck. Rapeseed was seen by Totter as a welcome addition to the local crop rotation, with the benefits of the biodiesel produced being used to power farmers' tractors and the by-product of the process, rapeseed cake, being used as a protein feed for their livestock.   As the MEC was developed, other renewable fuel sources were identified and used in the energy plants, including woodchips, used cooking oil, liquid manure and maize (Bioenergie Mureck, 2014; Tomescu, 2005, p.21).

Cultural Capacity: Boundary objects in the European cases. The initial idea of transforming the local agricultural economy through producing biodiesel from oil seed rape in itself could be classed as a boundary object. The key partners in this were the University of Graz, who wanted to undertake field scale trials of a new production process, together with Weinbauschule, Silberberg, the region's technical college for viticulture and winegrowing (Tomescu, 2005, p.12). The other partners that came together around this boundary object were a business, Vogel and Noot who were interested in developing and patenting the technology and local farmers, led by Karl Totter. Each had a different reason for becoming involved; research in developing and testing new technology, developing a commercial model and developing a sustainable income stream; but all played a part in translating the idea into delivery of SEEG, the first energy plant in Mureck. This included the establishment of a farmers, co-operative to own and operate the plant.

The idea and development of the following two energy plants; Nahwärme and Ökostrom also acted as individual boundary objects, engaging other partners, such as the local authority and local residents as potential customers and local and regional sawmills as potential suppliers in the development of Nahwärme. For Ökostrom, the actors involved were Nahwärme as an established company and seven farmers. It wasn't until the three energy plants were developed and Mureck became part of the Climate Alliance (Tomescu, 2005) that it adopted an ambition to meet all energy needs of the town from renewable energy sources (McCormick & Kåberger, 2007). There were, therefore, a number of boundary objects in Mureck's case; each one the idea of developing a renewable powered heat of power plant, which then became the MEC. However, I suggest that the achievement of each of these was not dependent upon a whole settlement approach to energy self-sufficiency itself being a boundary object, as that idea and adoption of the MEC as a whole integrated system happened at a later point. Rather each of the ideas of the developing the individual renewable energy plants were boundary objects and the development of these was fundamental to the emergence of the WSESS goal.

4.3.2 *Mobilisation*

Individual Capacity: The role of the individual in moving towards WSESS. As described in the section 4.2.1, Karl Totter was the driving force behind the development of the transition in Mureck towards local renewable powered energy supplies. He also led the mobilisation to delivery, becoming chair of SEEG and the development and delivery of the other two energy systems that comprise the MEC (Tomescu, 2005).

Structural Capacity: Government and Governance. As described earlier, Karl Totter formed a farmers' co-operative in 1991, which constructed a plant to produce biodiesel from rapeseed supplied by its members. It was called Südsteirische Energie- und Eiweißerzeugungsgenossenschaft, which translates as The South Styrian Energy and Protein Production Co-operative, known as SEEG. Initially SEEG had 300 members (Tomescu, 2005). By 2006, due to changes to the plant to incorporate used cooking oil as a fuel source, membership of SEEG increased to 600 (Pahl, 2008, p.112; Bioenergie Mureck, 2014).

In 1995, the idea of developing a combined heat and power plant using locally produced biomass was developed, with Karl Totter, again the leading proponent of this. This led in 1998 to the construction of the Nahwärme Mureck plant. Nahwärme was set up as a limited company, comprising three members, one of these was SEEG and the other two partners were farmers (Tomescu, 2005; McCormick & Kåberger, 2007).

In 2004 Ökostrom, a biogas plant was constructed to produce electricity. Ökostrom was also set up as a limited company, this time with eight partners, one of these being Nahwärme; the others all farmers (Tomescu, 2005).

The three plants are collectively known as the Mureck bioEnergy Cycle (MEC) and are described in more detail in the Infrastructure section later. Interestingly, Tomescu (2005) notes that the development of the current form of the MEC would not have been possible without the support of local, regional and federal governments, who all provided financial support that will be discussed in the Funding section later.

Structural Capacity: External expertise. From the start of the energy transition in Mureck, there has been recognition of the contribution that external expertise can make. In the earliest stage of development, this was this was provided by the Institute of Organic Chemistry in partnership with Weinbauschule, Silberberg, the region’s technical college for viticulture and winegrowing (ibid.). They led the 1986 pilot field scale trial to produce biodiesel, the success of which was the catalyst for the development of SEEG.

Following this in 1992, the Institute of Organic Chemistry and the Technical University of Graz first produced biodiesel from used frying oil. The technology was then developed and patented by Vogel and Noot and led to SEEG becoming the first producer of biodiesel from used frying oil (Tomescu, 2005; Pahl, 2008 p.112). Vogel and Noot provided the expertise to alter and expand the SEEG plant to increase biodiesel production, using used frying oil as one of its fuel sources (Pahl, 2008 p.112).

Structural Capacity: Funding. Much of the initial capital funding for the three energy plants that comprise the MEC, was provided by the local, regional and national government, as set out in Table 6 below:

	SEEG	Nahwärme	Ökostrom
Legal form	Farmers' co-operative	Ltd. company	Ltd. company
Investment costs	€6.15m	€7.2m	€5.4
Direct aid	75%	48%	30%

Table 6. Capital funding of Mureck bio- Energy Cycle Source: (Tomescu, 2005, p.39)

Infrastructural Capacity: Community energy systems. The first rapeseed harvest of the trial led by the Institute of Organic Chemistry was in June 1987 and later in that year the first biodiesel was produced in what is believed to be the first plant in the world producing rapeseed methyl ester, constructed by the local blacksmith and farmer under direction of staff from Weinbauschule, Silberberg and the Institute for Organic Chemistry. However, despite the large number of farmers agreeing earlier to take part in the pilot project, many of them withdrew from the field tests due to fears that the biodiesel would damage their tractors, so in the end fewer than 20 farmers took part in the pilot (ibid.).

Despite this, the SEEG plant was constructed for conversion of rapeseed to biodiesel and this was completed in 1991. Given the concerns of some farmers in the initial pilot phase, the viability of SEEG was helped by a decision by some of the major tractor manufacturers in 1990 to encourage use of biodiesel by issuing engine warranties to cover its use. The initial membership of SEEG was 300 and between 1991 and 1994 500 tons of biodiesel were produced per annum entirely from rapeseed provided by its members. However, during this time the cost of rapeseed increased dramatically as a result of changes to EU agriculture policy and so alternative fuel sources were explored. (ibid.)

In 1994, using earlier work by the Institute of Organic Chemistry and the Technical University of Graz that produced biodiesel from used frying oil and technology developed and patented by Vogel and Noot (Tomescu, 2005; Pahl, 2008 p.112), the SEEG plant was altered and expanded to produce 3,000 tons of biodiesel per year, using used frying oil as one of its fuel sources (Pahl, 2008 p.112). A scheme was developed successfully to collect the used frying oil from households and restaurants and in 2006, the output from SEEG increased to 10,000 tons of biodiesel per year (ibid.). Membership of SEEG increased to around 600; 510 of these are farmers in the region, who provide rapeseed to the co-operative and receive biodiesel and rapeseed cake in return, approximately 380 litres biodiesel and 620kg rapeseed cake per 1,000kg rapeseed (ibid.; Bioenergie Mureck, 2014). As the system developed, animal fat was also included as a fuel source from the Styrian carcass processing plant located 15 km from Mureck, which gave a breakdown in fuels for SEEG of 15% rapeseed, 70% used frying oil and 15% animal fat (Tomescu, 2005, p.25).

The next project to be developed was Nahwärme, a combined heat and power plant using locally produced biomass, with Karl Totter again leading this. He gained support for the scheme from all the groups in the local council and also secured a contract to supply heat to all the public buildings (ibid.; McCormick & Kåberger, 2007). It was constructed in 1998 and used woodchips as the fuel source, 25-30% provided by local farmers from their own land and the rest sourced from local and regional sawmills (ibid.). Initially Nahwärme produced heat only, with 50% of the local population connecting to the new district heating system, even though at the time the cost was 25% more than for oil fired heating. Nahwärme was set up as a limited company of three partners; SEEG owned 42%, with the remaining shares owned by the other two partners, see Table 7. By 2005, 80% of buildings in the town were connected to the system. The plant comprised two 2 MW furnaces, with a network of 13km pipeline, providing heat to 200 facilities, (75%) in the town (Bioenergie Mureck, 2014). The reason the pipeline is so long is that the Nahwärme plant was collocated with SEEG, on a site outside the town, which reduces its efficiency slightly (Tomescu, 2005.p.20).

Nahwärme was originally intended to produce both heat and power and it was hoped that glycerine created as a by-product of the biodiesel production process could be used for this. However, trials by Nahwärme over two years using glycerine to produce electricity failed and so in 2000 it was decided that a separate biogas facility should be constructed to produce power for the town. Work on this plant, known as Ökostrom, was started in 2004 on the same site as SEEG and Nahwärme. Production started in 2005 with a 1 MW plant, generating 8,000MWh electricity per year using maize and other biomass from farmers within an 8km radius, liquid manure and glycerine from SEEG. As with Nahwärme, Ökostrom was set up as a limited company, this time with eight partners (ibid.). Table 7 provides a summary of the three systems comprising the Mureck bio Energy Cycle projects.

	SEEG	Nahwärme	Ökostrom
Founded	1989	1998	2003
Legal form	Farmers' co-operative	Ltd. company	Ltd. company
Partners	Farmers, communities, local authorities, manufacturing companies, waste disposal federations	SEEG, two Farmers	Nahwärme, seven farmers
Number of partners	580	3	8
Date of construction	1990	1998	2004
Commissioning date	1991	1998	2005
Production	Biodiesel	District Heating	Biogas, electricity, heat
Production capacity	7,000 tons (under expansion to 10,000)	7,500 MWh	2.2M m3 CH4, 1MWhel, 1.165MWht
Resources	Rapeseed, UFO, animal fat	Woodchips, glycerine	Liquid manure, renewable vegetable raw materials (Maize, glycerine)
Employees	14	1.5	1.5
Customers	Approx. 650	Approx. 250	Approx. 2250

Table 7. Overview of Mureck bioEnergy Cycle projects (Tomescu, 2005, p.21)

There are a number of advantages of having three separate systems, comprising the MEC working closely together. These are:

- As the capacity of SEEG increased, so did the amount of glycerine produced as a by-product. The biogas plant for Ökostrom was developed to use the glycerine produced by SEEG as a catalyst for the fermentation process, providing a guaranteed market for the glycerine (Tomescu, 2005).
- The three projects share resources, such as pool cars, offices, machinery and a call centre, thus reducing overheads. Nahwärme also has an emergency generator powered by SEEG biodiesel and this can be shared with SEEG and Ökostrom in emergencies
- Ökostrom has a CHP plant built into its system which provides heat to keep its hydrolysis process at a constant 40^{o}C. However if the CHP is off for any time heat is provided from the Nahwärme district heating system. As well as providing a back-up system to Ökostrom, this also has the benefit of increasing the efficiency of Nahwärme
- It is uneconomic for Nahwärme to operate during warmer summer months, so Ökostrom provides heat to the Nahwärme district heating system from its CHP plant to provide hot water to the town. This increases heat-use efficiency for Ökostrom to 85% and provides it with additional income. For Nahwärme the advantage is a cost saving on wood fuel and operation of the boilers (ibid.).

The only negative impact of the three plants and organisations working together is that their co-location on a site outside the town has led to additional length of the Nahwärme district heating system pipework and a consequent small reduction in efficiency of the system and a slight increase in costs of transportation of liquid manure and maize to Ökostrom (ibid.).

In Mureck, SEEG owns its own plant. Nahwärme owns the district heating system and is a company limited by guarantee, with three members; the farming co-operative SEEG and two other farmers. Ökostrom is another company limited by guarantee with eight members; Nahwärme and seven farmers and it owns its own plant and produces electricity which is sold to the grid. As a district heating provider, Nahwärme sets its own tariffs, which despite having been more expensive than the oil alternatives when installed, are estimated to save the average household in Mureck €450 per annum in 2004 (Tomescu, 2005). As described earlier, the three plants that comprise the MEC are very closely linked in their operation, however, public trust in the two privately owned companies is less than in the co-operative SEEG, so Nahwärme and Ökostrom work hard to ensure that they have a participatory approach to their development (ibid.).

4.3.3 *Communication*

Individual and Cultural Capacities: The role of trust and the individual. Karl Totter led the communication in the drive to get support for the three plants that form the MEC. In 1995 he promoted the idea of a combined heat and power plant from biomass through an information campaign in the area, using the strapline "A city meditates – a city rethinks!" As a respected local farmer, Totter ensured the discussions were open and involved all concerned parties (Tomescu, 2005). He is credited with single-handedly persuading local people to support the bioenergy projects and building trust within the community for the schemes, described as follows, but it should be noted that the quotes contained here are from interviews with Totters' son, so may be subject to some bias:

> 'the Mureck bio-Energy Cycle had to undergo the same laborious trust-building process: "my father […] has spent a long time with convincing [people] – be it private households, the township; [he has remained] many nights outdoors and has made calculations […] and practically this is how he has convinced all [residents] one by one", says Totter Junior (2005). Totter's success to develop a sense of community coherence in Mureck supports the interpretation that the region has a traditional culture for open communication, which is based on high interpersonal trust. Yet, it further implies that Totter, the main developer of the Mureck system, had the necessary social and entrepreneurial skills to form a trust-base relationship with the Mureck community, from which he ultimately gained direct support for the bioenergy projects.'
>
> (Tomescu, 2005, p.55)

Structural capacities: strategy and policy. Communication, both formal and informal were important in the development of the MEC and included meetings, information campaigns by the municipality, letters sent out by the MEC and importantly for the farmers - items on the agenda at meetings of the Styrian Chamber of Agriculture (Tomescu, 2005, p.30).

Continued communication with communities and stakeholders was as important for MEC in its ongoing operation as in its development. It is of particular importance for SEEG, as it relies upon businesses and communities for supplying the used cooking oil as its largest fuel source and also as customers for its biodiesel. MEC therefore has a joint marketing department that manages this ongoing information provision and dialogue.

Structural Capacity: Sharing learning. In addition to sharing information with key stakeholders, the three organisations that comprise the MEC also deliver regular information campaigns to local schools (Tomescu, 2005, pp.30-31), As with Güssing, Mureck receives a large number of visitors, around 6,000 visits per year, from individuals wishing to learn about the MEC. MEC staff provide information and tours to visitors and a website has been developed to provide information to a wider audience (Bioenergie Mureck, 2014).

4.3.4 *Outcomes*

Through the MEC, Mureck produces 10,000 tons biodiesel per year from SEEG, using rapeseed and used cooking oil as the fuels source, 8MWh electricity from Ökostrom using glycerine from SEEG and local woodchips as the fuel source and 7MW heat from Nahwärme using glycerine from SEEG, locally produced liquid manure and maize as a fuel source (Bioenergie Mureck, 2014). The MEC has reduced consumption of oil by 15m litres and CO_2 emissions by 45,000 tons per annum, which is a 70% reduction in the town (Bioenergie Mureck, 2014). The city of Graz operates 55 buses powered by biodiesel from SEEG (Tomescu, 2005 p.15 Pahl, 2008 p.114).

The district heating system is connected to 80% of the properties in the town (Tomescu, 2005) and in 2010 it supplied 85% of heat consumed in the area (Droege, 2009, p.121) from renewable source through the biogas and CHP plants and produces some electricity through the CHP plant also. It produces some biodiesel for local transport use. However, some of the used cooking oil used to produce the biodiesel has been imported a considerable distance, so arguably cannot legitimately be classed as a local source of renewable energy.

Bioenergy Mureck or the Mureck Energy Cycle (MEC) is credited with an increase in local jobs. 43-48 jobs have been created directly through the MEC (Bio-energy Cycle Mureck, 2005), plus jobs associated with the energy plants - electricians, machine fitters and joiners and in job retention in farming through production of biomass. Mureck also receives 6,000 visitors per year to learn about the energy systems, (Bioenergie Mureck, 2014). It provides guaranteed income to 23 local and regional forest owners and other forestry businesses who supply woodchips to the district heating system. In 2004, households connected to the Nahwärme district heating system saved €450 per year (Tomescu, 2005). The MEC has added almost €1m to the region per year. This was calculated as the difference between actual expenditure on goods & services that MEC provides and what would have been spent on these goods and services had MEC not existed (Bio-energy Cycle Mureck, 2005).

4.4 Jühnde

4.4.1 *Problem Formulation*

Cultural & Structural Capacity: Rationales for WSESS. Jühnde is a small rural settlement in Lower Saxony, Germany with a population of 800 in an area including 1300 ha farmland, 800 ha forest (IEA, 2009b). The rationale for its energy transition was opportunistic, research led. The project started in 1998 and was led by Göttingen and Kassel University through the Interdisciplinary Centre for Sustainable Development (IZNE) who were seeking to develop an energy strategy linked to economic and community welfare in rural areas (Brohmann et al, 2006). It was called the Bioenergy village and the rationale was to identify and support regions with the biggest potential for biomass fuelled energy systems. Initially a survey was undertaken of 3,000 households from 17 villages in order to assess which communities had the best potential for this. This led to a short list of four villages. Detailed technical and economic feasibility studies were then undertaken on these four, including surveys of the residents. In Jühnde 69% of residents indicated they would switch to a new heat supply system, 22% wished to actively support the project, i.e. through working groups and 35% of households wanted to invest in a co-operative if one were set up to manage any new energy systems in the village (ibid.). This resulted in Jühnde being selected for the pilot in 2001.

Cultural Capacity: The importance of place for energy self-sufficiency. As with Güssing, there was little evidence, documentary or otherwise, of the importance of place in the community's decision to embark upon a transition to energy self-sufficiency.

Individual Capacity: Skills. August Brandenburg was the mayor of Jühnde in 1998 when IZNE at Gottingen and Kassel University started their project to find a community that was willing and able to become their Bioenergy Village pilot. Whilst the university led in the development of the project, as a respected member and leader of the community, August Brandenburg played a critical role facilitating discussions at an early stage to gain local support (Koch, 2008).

Structural Capacity: Visions and Strategy. Initially Jühnde was part of a wider project developed by IZNE with a goal to 'convert biological material into electrical power and heat' (Bioenergiedorf, 2014). This led to the development of the Bioenergy Village project in Jühnde with an aim 'to shift from fossil energy sources for electricity and heat to a fully renewable base with active participation of the population' (Brohmann, Fristche and Hünecke, 2006). The community of Jühnde responded positively to this. These were high level strategic goals, and a further seven visions or objectives were set by (IZNE) for Jühnde at the start of the project. These were:

- protection of climate and resources
- soil and water protection
- plant diversity
- positive contribution to the regional business cycle and economy
- participation
- decentralization of energy supply,
- quality of life

(Raven et al, 2008; Brohmann, Fristche and Hünecke, 2006)

The goals and visions developed for Jühnde were whole settlement from the start, albeit the idea an initial impetus for this came from IZNE rather than from within the community.

Structural Capacity: Government and Governance. The governance and leadership at the start of the Bioenergy village project was provided by IZNE at Gottingen and Kassel University, which initiated the whole project and supported the development of the bio energy systems as part of a wider research project. The local council did not provide a form of governance or leadership at this stage, but was involved as a member of the central planning group (Brohmann, Fristche and Hünecke, 2006) described in 4.4.2.

Infrastructural Capacity: Renewable Energy Resources. The fuel sources used in Jühnde energy plants were locally produced biomass. Two local farmers were keen to transfer from traditional crops to providing biomass for the Bioenergy village project and part of the original vision was to provide more sustainable income streams for local farmers. Fuel sources identified were whole plant silage and grass, liquid animal manure and locally produced woodchip (IEA, 2009b; Brohmann, Fristche and Hünecke, 2006).

Cultural Capacity: Boundary objects in the European cases. As described above, the 'Bioenergy village' idea was put forward by Göttingen and Kassel University through IZNE. Their interest in doing this was to undertake research to identify and support regions with the greatest potential for biomass energy systems in order to develop an energy strategy for rural areas that was linked to both economic and social welfare in rural areas (Brohmann, Fristche and Hünecke, 2006). The aim of the Bioenergy village in Jühnde was: 'to shift from fossil energy sources for electricity and heat to a fully renewable base with active participation of the population' (ibid). This idea became a boundary object, gaining support and engagement from a number of actors each with a different reason for this: the local mayor provided local leadership and was instrumental in getting wider support for the scheme from the community, 70% of local residents and a number of local farmers became involved; the residents wanted local renewable energy supplies and the farmers wanted to either diversify into crops to provide biomass or to have a market for their manure. The local municipal authority also engaged in the scheme at an early stage, both in the planning and delivery of the renewable energy systems as a member of the central planning group.

4.4.2 *Mobilisation*

Individual Capacity: The role of the individual in moving WSESS. Mayor of Jühnde, August Brandenburg continued to provide local leadership as the early ideas developed by IZNE at Gottingen and Kassel University were translated to delivery. He again facilitated discussions to gain local support for the biomass scheme, as he explained; "People have always got to feel that they have a say. We didn't do anything without consensus." (Koch, 2008, pp.22-23). This role was also important in persuading enough residents – 70% in the end to agree to be part of its development and crucially in persuading them to sign up and pay to be connected to the new district heating system (Brohmann, Fristche and Hünecke, 2006).

Structural Capacity: Government and Governance. Following initiation of the BioEnergy village project in Jühnde by IZNE and the early development work, which included gaining support from the local community using techniques described in section 4.4.3, the project moved into the delivery stage. A local energy co-operative was established in in May 2002, with 70% of the residents as members. This led to the delivery of the district heating system. The cost of membership was €1,500 and this would also cover the cost of connection to the new heating system (Raven et al, 2008; Brohmann, Fristche and Hünecke, 2006; IEA, 2009b). The local council was involved in planning and delivery of the renewable energy systems as a member of the central planning group.

Structural Capacity: External expertise. As described above, external expertise was provided by Göttingen and Kassel University through IZNE. They undertook preliminary surveys to assess potential, followed by detailed technical and economic feasibility studies and resident surveys to support project development and delivery (Brohmann, Fristche and Hünecke, 2006).

Structural Capacity: Funding. In Jühnde, funding for the research and early development work of the project linked to the research was provided by the Agency of

Renewable Resources (FNR), through the Ministry of Consumer Protection, Food and Agriculture (BMVEL) (IZNE, 2005). Funding for capital works was provided by both regional and central government (Brohmann et al, 2006), specifically from FNR through BMVEL, the county of Göttingen, the State of Lower Saxony and European LEADER+ funding (IZNE, 2005). Total project costs were €5m, and the funding split for the capital costs was 54% from the Federal Government, 26% from state and municipal governments and subsidy from FNR and 20% was from private equity (Binns et al, 2007).

Infrastructural Capacity: Community energy systems. In Jühnde a local co-operative was formed and developed the district heating system, which is 5,500m in length and heats water to 85^{0}C (IEA, 2009b). Heat is provided from a biogas facility, using locally produced liquid manure and silage plant material as fuel sources. Combustion of the biogas is in a combined heat and power plant (CHP) provides heat for households in the village and all of their electricity demands. A small amount of heat is also used for the digestion facility to produce the biogas. In winter months the heat produced by the CHP is not sufficient to meet the demand of the community, so an additional heat plant was installed, using locally produced woodchip as the fuel source to meet this demand (Brohmann, Fristche and Hünecke, 2006).

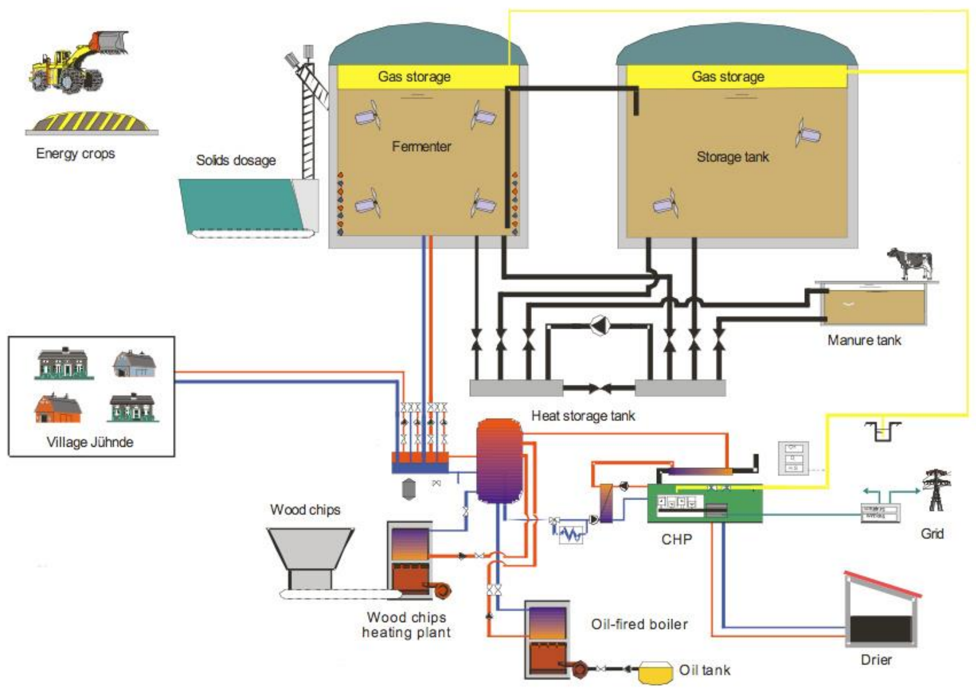

Figure 4. Diagram of Jühnde Bioenergy system (IEA, 2009b)

5,000MWh of electricity is produced each year by the CHP, which is double the demand in the village. 6,500MWhth heat is produced: 85% by the CHP and 15% by the wood chip fired heating plant. Of this, 3,200MWhth is sold to the community, which is approximately 99% of the community's heat demand. Figure 4 shows the whole Jühnde Bioenergy system. Heat loss in the district heating system is 22%, the plant has been located as close as possible to the village to minimise this (IEA, 2009b). Only 10% of heat produced is required to heat the biogas facility, as the anaerobic process of producing the biogas is itself heat producing. If excess heat is produced in the summer months, this is used to dry the woodchips, thereby increasing their calorific value (ibid.). Excess electricity is fed into the grid and the co-operative receives income for this via a Feed in Tariff, at a guaranteed rate for 20 years, which it uses to pay off loans for the system construction costs (Koch, 2008).

Each year, 15,000 tons of whole plant silage and grass, plus 6,000 m^3 of liquid animal manure from six local cow and pig farms are produced to power the CHP plant. 350 tons of locally produced woodchip are used fuel the heating plant (IEA, 2009b).

The co-operative established in Jühnde owns and operates the Bioenergy systems. One of the biggest problems in developing a viable economic model for the system is the wide variation in heat demand in the community throughout the year. The income from supplying electricity is significantly higher than from heat, which means the CHP unit cannot be modified just around the heat demand. The optimum levels for electricity and heat production is therefore a balance between economic operation and minimising environmental impacts of the system. The downside of this is that even with using excess heat production to dry the woodchips for the heating plant during the summer months, only 70% of the heat produced is used across the year (IEA, 2009b).

4.4.3 *Communication*

Individual and Cultural Capacities: The role of trust and the individual. As described in 4.4.1 and 4.4.2, the individual that played a key communication role in the BioEnergy village project was August Brandenburg, mayor of Jühnde, both at the start of the project in 1998 and in the development of community owned renewable energy systems. His leadership and the trust from the community was essential in persuading enough people to sign up and pay to join the energy co-operative that developed, owns and operates the biomass district heating system (Brohmann et al, 2006). Not always an easy task, as he admits; "Some convincing was necessary." (Koch, 2008, p.23).

Structural capacities: strategy and policy. In Jühnde, communication was seen as important by IZNE from the pre-selection process in order to engage with the 17 volunteer communities as effectively as possible. The communication strategy by IZNE in each of the communities included:

'• Information flyer and brochure
• Press and media work
• Public presentations (external experts, visualizations)
• Consulting
• Door-to-door information
• Visiting demonstration projects (best practice).'

(Brohmann, Fristche and Hünecke, 2006)

Once Jühnde had been selected to become the bioenergy village, IZNE also organised the communication during the project, initially engaging in a top-down approach by meeting with the mayor and an engineering firm and this was followed by a range of participatory planning sessions with local residents. Eight working groups were established covering a range of issues. Table 8 illustrates the number and range of participation and communication techniques and platforms that were used in the early development stages of the Bioenergy project:

Type	Organiser	Involvement	Purpose
Village meeting	IZNE, municipality	Residents, university members	Information, discussion, transparency, participation, support the 'we-feeling'
Planning workshop	IZNE	Speaker of the working groups, mayor, two local council members, members of local associations, members of Samtgemeinde, university members,	Decision in the name of the community. Public discourse, announced by public displays
Eight working groups	IZNE	Residents, university members	Development of planning decisions, based on the 'Grounded theory'
Round tables/open meetings (target specific)		Different participants	Discussion of technical problems
Meeting of co-ordinators			Information transfer between working groups and external stakeholders
Round table	Communities	Several communities in southern, Lower Saxony	Gaining and transfer of information
Festivals	Associations, 'clubs', local authority, IZNE		Support emotions and motivation, transfer technical aspects into a positive context
Painting & jogging contest	IZNE	Children	Support emotions and motivation
Website, internet presentation		Public in general	

Table 8. Communication techniques and platforms used in the development stages of the Jühnde Bioenergy project. Adapted from Brohmann, Fristche and Hünecke (2006).

The intense levels of communication, led mainly by IZNE ended after two years due to lack of research funding. Whilst the overall cross disciplinary approach taken by the university was seen as generally positive by the community in Jühnde, there were concerns over lack of face to face and expert technical meetings, and the control of information flow by the university led to some misunderstandings (ibid.).

Structural Capacity: Sharing learning. One of the key elements of the BioEnergy Village project was the sharing information with external audiences. Roundtable meetings were held for other communities in Southern Lower Saxony to share and exchange information and this worked well, with 12 communities interested in following the Jühnde model (Raven et al, 2008; Brohmann, Fristche and Hünecke, 2006). A website provides information to a wider audience (Bioenergiedorf Jühnde, 2014) and the village also has many visitors who come to learn about the BioEnergy village.

4.4.4 *Outcomes*

Jühnde produces more than twice the electricity used by the community and 99% of the heat demand. Through its shift to bioenergy, the village produces 3,300 fewer tons CO_2 emissions (IEA, 2009b; IZNE, 2005) and uses 400,000 fewer litres of oil for its heat and power. The Bioenergy village project also created two new jobs to operate and administer the system and the co-operative that owns it (IEA, 2009).

4.5 Samsø

4.5.1 *Problem Formulation*

Cultural & Structural Capacity: Rationales for WSESS. Samsø is an island off the Jutland peninsula, Denmark with a population of 3,765, 26km long by 7km wide at its maximum, covering 114km^2 (PlanEnergi, 2007; Danish Energy Agency, 2014). The rationale for starting its energy transition was opportunistic, in response to a national competition. In 1997 the Danish Ministry of Environment & Energy launched a competition for communities to move from fossil fuel dependency to 100% renewable energy. There were a number of criteria against which submitted master plans would be judged, including:

- Reduction of energy consumption including heating, electricity and transport
- Degree of local support and participation across all sectors

- As well as describing how existing technologies would be used, it was expected that the master plan would include new ways of delivering renewable energy projects.
- How the winner would promote itself and Danish renewable energy technologies to the world (PlanEnergi, 2007)

Samsø was one of five communities who entered the competition and won with a plan to become entirely self-sufficient in energy from renewable sources within 10 years (Danish Energy Agency, 2014; PlanEnergi, 2007; IEA, 2009a, p.161).

Cultural Capacity: The importance of place for energy self-sufficiency. As with Güssing, and Jühnde there was little evidence, documentary or otherwise, of the importance of place in case communities decisions to embark upon a transition to energy self-sufficiency.

Individual Capacity: Skills. The inception of the idea for Samsø to become a renewable energy island was led by the municipal island authority and no individuals have been identified in the literature as key to this. However, one individual has been identified as critical for the translation of the plan to delivery and gaining support from the community for this (Droege, 2009, pp.102-103). This will be discussed in more detail in Individual Capacities in section 4.5.2.

Structural Capacity: Visions and Strategy. In 1997, in response to the national competition the Samsø Municipal Authority developed it's Renewable Energy Island Plan (REI Plan) to become completely self-sufficient in energy from renewable sources within 10 years (Danish Energy Agency, 2014; IEA, 2009a, p.161; PlanEnergi, 2007). The Danish Energy Authority provided the funding for the development of detailed plans for this (PlanEnergi, 2007). In 2011 Samsø decided on a new goal to become fossil fuel free by 2013 and produced an Island Sustainable Energy Action Plan: Island Of Samsø that set out the objectives and actions as to how this would be achieved (Samsø Energy Academy, 2011). Both plans were whole island approaches from the start.

Structural Capacity: Government and Governance. In Samsø, the municipal authority also led the energy transition, firstly in the development and submission of the 1997 competition master plan to become a 100% renewable energy island in 10 years and the project became known as Samsø Renewable Energy Island (REI) (Danish Energy Agency, 2014). The authority set up Samsø Energy and Environment office in 1997 to provide advice and information to islanders to deliver their own renewable energy projects.

Infrastructural Capacity: Renewable Energy Resources. In 1997, the Samsø Municipal Authority developed its REI Plan to become completely self-sufficient in energy from renewable sources within 10 years (Danish Energy Agency, 2014; IEA, 2009a; PlanEnergi, 2007). Work had been undertaken to investigate the most appropriate renewable fuel sources and energy systems; identifying wind power and a variety of other fuels sources: woodchip, straw, solar heating, excess heat from ferries and biogas produced from organic waste and woodchip to be used in district heating systems as the best due to availability and efficiency (PlanEnergi, 2007).

Cultural Capacity: Boundary objects in the European cases. As described above, the municipal council in Samsø led in the initiation and development of Samsø Renewable Energy Island (REI) project (Danish Energy Agency, 2014). A number of meetings and events were held by the council to get support for the REI. However, popular support for the plan did not start until local teacher Soren Hermansen started actively engaging with local people as a volunteer in support of the plan. This was the point at which the REI became a boundary object, gaining the support of local residents, a utility company, local businesses, Århus County office and local farmers. Each actor or group of actors had a different reason for engaging from wanting a cheaper, sustainable energy supply to wanting to invest in, develop and generate income from renewable energy systems. Each played a crucial role in the delivery of the REI plan.

4.5.2 *Mobilisation*

Individual Capacity: As described above, , Soren Hermansen a local environmental studies teacher is attributed as being the key to getting wider community support for the REI Plan (Droege, 2009). At first Hermansen was a passionate volunteer supporter of the project, attending as many project events and meetings as he could to promote the project amongst his fellow islanders. He then was then employed as a project officer for Samsø Energy and Environment office and then became director of Samsø's Energy Academy (ManagEnergy, 2012) and through these roles he has provided the leadership for the island's energy transition.

Structural Capacity: Government and Governance. Following the success in winning the competition to become the Samsø Renewable Energy Island (Danish Energy Agency, 2014), the municipal authority set up Samsø Energy and Environment office in 1997 to provide advice and information to islanders to deliver their own renewable energy projects. They also set up the Samsø Energy Company in 1998, whose remit was to deliver the larger renewable energy systems contained in the master plan, such as district heating systems and wind turbines (PlanEnergi, 2007). With other partners, the municipal authority led in the development of some of the renewable energy schemes, including the following:

- As one of the partners comprising the Samsø Offshore Wind company it provided support in the development and financing of the off shore wind turbines, owning five of the ten turbines.
- Facilitating other renewable energy systems, by changing policy, such as increasing the allowable height of on shore wind turbines
- Developing an ownership model to encourage support for the Energy Island project by enabling local residents to own a share of some of the on shore wind turbines.
- Providing guarantees for mortgage loan finance for the new biomass district heating systems
- Approving the heating prices for the district heating systems

(PlanEnergi, 2007)

Structural Capacity: External expertise. In order to enter the 1997 national competition, a plan had to be produced and submitted to the Danish Ministry of Environment & Energy. It was produced by engineer, Ole Johnsson from Aarhus on the mainland (Fauziah, 2010). The Danish Energy Authority provided the funding for the development of a detailed master plan (PlanEnergi, 2007) which was led by the Samsø

Municipal Authority, but developed by PlanEnergi, an independent consultancy firm specializing in renewable energy and sustainable development (Fauziah, 2010). This is what is known as the Renewable Energy Island Plan (REI Plan).

Structural Capacity: Funding. In Samsø, renewable energy schemes had predated the island achieving REI status, such as the Tranebjerg district heating system, opening three years prior to this in 1994 and at that time no public funding was available to subsidise the project. Installation costs for the system were 26.3m DKK (approximately €3.4m) (PlanEnergi, 2007).

Upon becoming the REI, whilst there was no funding attached to winning the 1997 competition to become the REI, a significant amount of public funding was made available for a number of the renewable energy projects. The financing is as follows:

The first of the three new district heating systems developed as part of the REI scheme was in Nordby-Mårup was launched in 2002. Owned by energy company NRGi, the capital costs were 20.5m DKK (€2.7m) and the Danish Energy Authority provided a grant of 9m DKK (€1.2m).

The second REI district heating system to be delivered was in Onsbjerg in 2003. Owned by local firm, Kremmer Jensen ApS, capital costs were 8.5m DKK (€1.1m) and the scheme received a grant of 3m DKK (€0.4m) from the Danish Energy Authority.

The last of the three REI district heating plants to be delivered was in Ballen-Brundby. It is customer owned through a limited company and launched in 2004. Capitals costs were 16.2m DKK (€2.1m) and the scheme received the last grant to be given to such schemes by the Danish Energy Authority of 2.5m DKK (€0.3m) (ibid).

11 land based wind turbines were installed as part of the REI project. These are owned and financed by 430 local shareholders. Each turbine cost 6mDKK (€.8m) including site preparation and grid connection. Whilst not receiving any subsidy for the capital installation cost, the shareholders will receive guaranteed prices for the electricity produced for the first ten years.

In 2002 10 2.3MW wind turbines were installed off shore. The Samsø off shore Wind Company was formed by Samsø municipal authority, Samsø Commercial Council, Samsø Farmers Association, and Samsø Energy and Environment office in order for Samsø to own the concessions. The funding for the initial sea floor and environmental studies was provided by the Danish Energy Authority. The capital costs of installing the 10 off shore turbines was 239.2m DKK (€32.2m). Five of the turbines were funded by the Samsø Municipal authority, three are owned by commercial investors and two are owned by 1500 smaller shareholders through two separate companies (ibid.).

In addition to providing direct funding for projects, the municipal authority provided important financial services to enable other renewable energy projects to be delivered, including providing the guarantee for mortgage loans for the district heating systems, enabling the owners to secure the finance to deliver these (PlanEnergi, 2007).

The Danish Energy Authority (now Agency) also provided funding to the REI project for consultants in both 1999 and 2000 to give advice and undertake free energy appraisals for private homeowners living outside the areas proposed for district heating systems (ibid.)

Infrastructural Capacity: Community energy systems. In the Samsø 1997 REI Plan there were plans for four new district heating systems. The municipal authority established that connection to new systems by residents should be on a purely voluntary basis and the registration fee for signing up to this prior to construction was only 80 DKK (€10). NRGi, a regional co-operatively owned utility company had developed this model for a district heating system they had installed in Tranebjerg, Samsø in 1994, predating the REI competition win. Using this model of significantly lower registration fees means that higher prices are charged for the unit heating costs in order to recoup the initial set up costs. However, the heating costs through the new district heating systems would still be lower than the existing alternatives of oil or electric heating (PlanEnergi, 2007).

Only three of the four new district heating systems were developed, one for each of; Nordby-Mårup, Onsbjerg and Ballen-Brundby. The first to be developed was in Nordby-Mårup. It was fuelled 80% by woodchip and 20% from a solar heating system and was opened in 2002 and is owned by energy company NRGi. The second plant to open was in Onsbjerg in 2003, fuelled by straw provided by owner and local firm Kremmer Jensen ApS. The original plan in the REI Masterplan was for Onsbjerg to be one of seven villages described a string of pearls that would have one district heating system with 37% of the heat demand supplied by excess heat from ferries at the docks to the west of the island and the rest from biogas produced from organic waste and woodchip. However, this plan was abandoned in 2000, because the 52m DKK (€6.8m) capital funds could not be raised. The Onsbjerg district heating system cost only 16% of the proposals for the larger scheme. The last of the three district heating systems to be developed was in Ballen-Brundby, opening in 2005 and is fuelled by burning straw. It operates, based on a co-operative model, owned by the users through a limited company, the Brundby-Ballen District Heating Co-operative following rejection of a number of proposals by energy company NRGi to develop a scheme (ibid; Danish Energy Agency, 2014).

The last of the four district heating systems contained in the REI masterplan was for the villages of Besser, Langemark, Torup and Østerby. This was not taken forward for a number or reasons; there was a lack of interest by some residents, others had recently invested in private renewable energy systems and the distribution pipe to one of the villages would have been very long (PlanEnergi, 2007).

The REI Plan recognised that for areas where no district heating systems were planned, residents would need access to a range of advice and support if they were to be persuaded to install their own renewable energy system. This became increasingly important when grants for private individual renewable heating systems ended in 2001/2. Support that was offered included:

- Training by the Danish Technological Institute to give a certification for local trades in blacksmithing, plumbing and heating services, which allowed them to install government approved solar heating systems. Prior to 2001/2, installing these systems enabled customers to a grant of 30% of the set up costs.
- An energy exhibition was held in 1998, with 1,600 delegates attending
- Two energy campaigns through which 74 homes were visited, with approximately 25% of these installing solar heating systems in the two years

following this. Overall 59 solar heating systems were installed between 1998-2000.

- Energy appraisals were offered between 2003-5 in Besser, Østerby, Pillemark/Hårdmark and in other places not connected to district heating systems in order to encourage energy efficiency measures for heating and where there was interest, alternative renewable heating systems were discussed. 29 energy appraisals were undertaken (ibid).

The REI 1997 Masterplan estimated annual consumption of electricity on Samsø to be 29,000MWh. The plan proposed that 15 750kW onshore wind turbines could meet this demand.

In 1998 work began on selecting sites for onshore wind turbines and assessing interest in investing in these. The municipal authority and Århus County office undertook the area zone planning for the wind turbine sites, based on over 40 applications they had received, which led to 10 sites being designated suitable for wind turbines. The high level of interest was greatly assisted by a proposal in the REI Masterplan, supported by the Wind Turbine Association for an ownership scheme that would provide opportunities for all islanders to invest in and own shares in the proposed wind turbines. This was approach was adopted for future renewable energy schemes on the island (ibid, Samsø Energy Academy, 2014).

For Samsø to become self-sufficient in electricity it was necessary for wind turbines with total capacity of 11MW to be installed and so the municipal authority gave special authorisation for the maximum height of onshore wind turbines to be increased from 70m to 77m.   11 1 MW wind turbines were installed, starting in 2000. Through a pre-sales share offer managed by Samsø Wind Energy, working with Samsø Energy and Environment office, two sites were reserved for 430 shareholders (PlanEnergi, 2007).

In 2002-3 10 2.3MW off shore wind turbines were installed. In the 1997 REI Masterplan there was recognition that at the time there was no workable solution for renewable energy to fuel the islands transport sector, so the Masterplan included a proposal for off shore wind turbines to be installed in order to offset the CO_2 emissions from the transport sector. The Samsø off shore Wind Company was formed by Samsø municipal authority, Samsø Commercial Council, Samsø Farmers Association, and Samsø Energy and Environment office in order for Samsø to own the concessions (Samsø Energy Academy, 2014; Danish Energy Agency, 2014; PlanEnergi, 2007).

In Samsø it was recognised in the original 1997 REI Masterplan that local ownership of some of the renewable energy systems would be an important factor in getting local support for the REI project and this has proved to be the case. From 1997-2012 €60m was invested in renewable energy systems on Samsø and 70% of this was provided by the islanders themselves (ManagEnergy, 2012). Ownership of the renewable energy systems is as follows:

Of the 11 on shore wind turbines, nine are owned by individual or groups of farmers and the other two by co-operatives, which enabled 430 small shareholders to invest in these (PlanEnergi, 2007; Samsø Energy Academy, 2014).

Three of the ten off shore wind turbines are privately owned, mainly by local farmers who have joined forces to buy the turbines, two are owned by a large number of small shareholders through co-operatives; one organised by local organisation Paludan Flak I/S and the other by professional investment firm Difko I/S. The remaining five turbines are owned by the Samsø municipal authority, which reinvests profits into other renewable energy schemes, as they cannot by statute earn money through energy generation (Energiplan, 2007; Samsø Energy Academy, 2014).

Two of the four district heating systems on the island; Tranebjerg and Nordby-Mårup are owned and operated by co-operatively owned regional utility company NRGi on normal commercial terms. The plant at Onsbjerg is owned by local firm Kremmer Jensen ApS, with customer and council representation on the committee. The last system at Ballen-Brundby is customer owned and is operated by a locally elected committee, which is the governing body for the scheme (PlanEnergi, 2007; Samsø Energy Academy, 2014).

4.5.3 *Communication*

Individual and Cultural Capacities: The role of trust and the individual. One of the most important communication tools for Samsø's energy transition appears to have been a personal one in the shape of Soren Hermansen. Not much was being achieved until he was appointed to a federally funded position. His enthusiasm, attending almost every meeting on the REI project persuaded many islanders to get involved in the REI project (Droege, 2009, pp.102-3).

Structural capacities: strategy and policy. Communication was a key part of the REI Masterplan, which identified a range of methods for informing residents and businesses to change behaviour to save energy and also to enable them to make decisions to invest in or join new renewable energy schemes, or install systems in their own house. These included five energy saving campaigns launched by the Samsø Energy Company and Samsø Energy and Environment office:

- A pensioner campaign on energy saving measures and grants.
- A campaign focussed in Ballen-Brundby and Onsbjerg offering visits by an energy adviser to all households and to inform and assess interest in a potential district heating system.
- A campaign focussed on energy efficiency and renewable energy in the countryside.
- A campaign demonstrating alternative insulation materials ran from 2001-2.
- A campaign focussed in areas not connected to district heating systems

(PlanEnergi, 2007)

Structural Capacity: Sharing learning. Education and sharing of information has also been a central tenet of the Samsø REI concept. Since the island won the national competition, people have visited the island from across the world to learn about their energy transition. The REI team have always provided information and education activities, such as seminars, courses and exhibitions. Since the opening of the Energy Academy on the island, the demand for these has increased significantly, with 30-50 visitors per day taking part in tours and schools regularly visiting the academy for full day visits. University students also spend time on the island undertaking energy research projects (PlanEnergi, 2007) and a website is provided by the Energy Academy on all aspects of the energy project (Samsø Energy Academy, 2014).

4.5.4 *Outcomes*

The 1997 Samsø REI Masterplan set out a vision to achieve 100% of its energy demand from renewable sources within ten years. By 2005, Samsø has achieved 99.6% of energy demand being met from renewable sources, from a starting point of 13% in 1997 (EnergiPlan 2007). By 2014 more than 100% of electricity demand was being supplied from renewable sources and 70% of heat demand (Samsø Energy Academy, 2014). Despite the focus on energy efficiency measures, heat consumption on the island actually increased between 1997 and 2005 by 10%. This continued increase in heat demand is one of the reasons it has not been possible for 100% of heating to be provided from renewable sources to date. During the same period electricity consumption remained largely unchanged (PlanEnergi, 2007).

As the off shore wind turbines produce more energy than is used on the island for transport (the emissions of which they were developed to offset), Samsø actually has a negative figure for CO_2 emissions at -3.7 tonnes per annum (ManagEnergy, 2012).

The REI plan set a target for 60% of islanders to be connected to a district heating system and for the remaining 40% to have individual renewable energy heating systems within ten years (Samsø Energy Academy, 2014). By 2005, 43% of heat demand on the island was being supplied by the district heating systems (EnergiPlan, 2007). An estimated 300 houses not connected to the district heating system have installed renewable fuelled heating systems (Danish Energy Agency, 2014), which is approximately 25% of the total number of houses.

In 2007, the Samsø Energy Academy was opened as a centre for education, advice, exhibitions, research and conferences on renewable energy, using lessons learned from Samsø REI project (Samsø Energy Academy, 2014; Danish Energy Agency, 2014). The Samsø municipal authority provided a subsidy of 5m DKK to the Academy from income from the off shore wind turbines (Danish Energy Agency, 2014). The Academy’s director is Soren Hermansen, the man widely acknowledged to have been the driving force behind the island’s acceptance and enthusiasm for its transition to a renewable energy island.

4.6 El Hierro

4.6.1 *Problem Formulation*

Cultural & Structural Capacity: Rationales for WSESS. For El Hierro, the smallest of the Canary Islands, with a population of 10,890 covering an area of 278km^2, (Gorona del Viento, El Hierro,2014) the rationale for its energy transition was environmental and security of supply (Suárez, 2013; Hallam et al, 2012). In the early 1980s, the local council, the Cabildo de El Hierro, wanted to develop a sustainable development model for the island that respected the island's natural and cultural heritage and developed its infrastructure, but was not based on the property based mass tourism model that seemed to predominate elsewhere in the Canary Islands. There was also recognition that its dependency upon imported fossil fuels for its power and heat reduced the resilience of the island to external shocks. For example 96% of the island's power demand was met by a 13.3MW diesel powered power plant at Llanos Blancos on the west of the island (Hallam et al, 2012). In 1997, it produced a Sustainable Development Plan which identified four key priorities, one of these being to maximise use of the island's renewable energy sources. This lead to the island being granted UNESCO World Biosphere Reserve status in 2000 and the launch of 'El Hierro 100% Renewable Energies' project by the council (Droege, 2009, p.94).

Cultural Capacity: The importance of place for energy self-sufficiency. As with the other European cases, with the exception of Mureck, there was little evidence, documentary or otherwise, of the importance of place in case communities decisions to embark upon a transition to energy self-sufficiency.

Individual Capacity: Skills. There were no individuals documented in the literature as having a leading role in the initiation of the energy transitions in El Hierro. Leadership for development and delivery was provided by the local council, the Cabildo El Hierro.

Structural Capacity: Visions and Strategy. In 1997, the Cabildo El Hierro produced a Sustainable Development Plan which identified four key priorities, one of these for a sustainable energy supply:

- Sustainable commercial development, including agriculture and tourism

- Develop an island waste management system to reduce resource use and impact on the environment.
- Develop an education system to support long term success of the sustainable development goals
- Create an energy plan to maximise use of the island's renewable energy resources to make the island one of the first 100% renewable energy sourced islands

(ITC, 2011; Hallam et al, 2012).

This paved the way for the island being granted UNESCO World Biosphere Reserve status in 2000. The council seized the opportunity to pass its new Island Planning Regulations and launch its sustainable development plan, entitled 'El Hierro 100% Renewable Energies' project' (Droege, 2009, p.94) to set out how the island could meet all of its energy demand from local renewable energy sources. This was a whole island approach from the start.

Structural Capacity: Government and Governance. The leadership role for governance in the early stages of the energy transition in Güssing was mirrored in El Hierro by the island council, the Cabildo El Hierro who in producing the 1997 Sustainable Development Plan, identified the need for future development to be sensitive to the islands unique landscape in order to sustain tourism, the main contribution to the islands economy (Hallam et al, 2012). The Cabildo El Hierro then set out the ambition for the island to become self-sufficient in energy in the El Hierro Management Island Plan, approved on the 17th of June, 2002 (Gorona del Viento, El Hierro, 2014). This was followed in 2006, by *El Plan Energetico de las Canarias*, produced by the Canarian Autonomous Government, which has become known as PECAN. PECAN set out a strategic vision for affordable power supplies maximising the use of renewable energy combined with energy efficiency measures and established a target of 30% electricity generation to be from renewable energy sources by 2015 (ibid.) The Cabildo El Hierro then devised an ambition to derive all the islands energy needs from renewable sources on the island in their 2007 100% Renewable Energy Supply (RES) project.

Infrastructural Capacity: Renewable Energy Resources. In El Hierro the first stage of developing ideas to harness the abundant source of wind power on the island was to undertake a technical feasibility study in 2007 on a potential wind-hydro system. This assessed the optimal mix of wind and water turbines and pumping equipment to generate enough electricity to meet projected demand on the island in 2030. The idea behind this was that there is a significant wind source on the island, but that it does not blow all the time, so would need to be combined with some form of storage system. Water supplies on El Hierro are a scarce and valuable resource, with 50% of electricity consumption being used to produce water for domestic and agricultural uses (Hallam et al, 2012). The study examined opportunities to enable a wind-Pumped Hydro Storage system (PHS), using water produced from a desalination plant, which would form part of a closed loop system. Given that the three key element required for such as system are a good wind supply, a sufficient gradient and a sustainable water supply, this was a key consideration (Gorona del Viento, El Hierro, 2014).

Cultural Capacity: Boundary objects in the European cases. As described in the Structural Capacities; Vision and Strategy and Government and Governance sections above, The local council, the Cabildo El Hierro led the development of plans for the island to become one of the first 100% renewable energy sourced islands (ITC, 2011; Hallam et al, 2012). However, if it was to be delivered, the council needed the support and involvement of a range of actors. The council led an information and awareness campaign to get support for the plan from local residents and businesses (ITC, 2011) and also gained support from other actors crucial to the successful development and delivery of the plan, including: Endesa (the largest electric utility company in Spain) and the Technological Institute of the Canary Islands, who have a 30% and 10% share respectively in the Gorona del Viento El Hierro, SA company , which developed, constructed and operates the PHS (Gorona del Viento, El Hierro, 2014). Other businesses have become involved in different aspects of delivery of the plan. It is correct to determine that whilst the development of the idea of El Hierro becoming a 100% renewable energy island was not itself a boundary object, once the plan was developed, it did become a boundary object around which these various actors could coalesce in order to effect its delivery.

4.6.2 Mobilisation

Individual Capacity: The role of the individual in moving towards WSESS. As in the problem formulation phase, there were no individuals documented in the literature as having a leading role in the development or delivery of the energy schemes in El Hierro. The leadership of the Mobilisation phase was provided by the Cabildo El Hierro.

Structural Capacity: Government and Governance. Similar to Güssing, following the adoption in 2007 of the 100% Renewable Energy Supply (RES) project, the mobilisation process was led by the Cabildo El Hierro. It led the information campaign to inform and involve islanders to ensure there was support for the scheme through workshops and awareness raising campaigns (ITC, 2011) and they then went on to play a leading role in delivery:

As described above, they set up Gorona del Viento El Hierro, SA, retaining a 60% share in this, with Endesa and the Technological Institute of the Canary Islands the other shareholders to develop, construct and operate the PHS (Gorona del Viento, El Hierro, 2014), described in the Infrastructure section later. They also led the zero waste project that formed part of the 100% RES plan using sewage sludge and animal waste as biomass for a biogas plant.

Whilst there was a lot of support for the proposals from islanders and the international community, it should be noted that there was not universal support for the energy proposals, particularly the PHS. Ossinassa, a local cultural and ecological organisation objected to the scheme for a number of reasons including: the scheme using unproven technology and systems, the development being in a protected area and the diesel generator still needing to be used, as the PHS scheme would not produce all the islands electricity (Global Islands Network, 2014).

Structural Capacity: External expertise. The idea of developing the PHS using a volcano crater as a storage facility had been untested, so in 2007 technical feasibility study on the potential of this was undertaken by the Canary Islands Technological Institute (I.T.C.) (Hallam et al, 2011) and Endesa, a subsidiary of Enel, one of Spain's big five electricity companies (Energy Storage Report, 2014). In addition, expertise from Spanish grid operator Red Eléctrica de España has been necessary for the connection of the electricity supply to the grid, increasing the contribution by 100kW increments and testing the system at each stage (ibid.)

Structural Capacity: Funding. An agreement was signed in March 2007 in El Hierro by the General Director of the Institute for Diversification Energy Saving (IDAE) and the President of the Cabildo El Hierro representing the project developer, Gorona del Viento, which set out the mechanism for the project to receive public funds to deliver the PHS. The costs of delivering the hydro-wind powered system were €64.7m and of this €35m of funding for this was provided by the Spanish government between 2007-2011. The justifications for this public investment were economic, environmental and transferability of new technologies, (Gorona del Viento, El Hierro, 2014). I have been unable to determine the other sources of capital finance for the scheme, despite having requested the information from Gorona del Viento. It is likely that some of the funding was provided in part by the Cabildo El Hierro and the other partners comprising Gorona del Viento, but this is unconfirmed.

Revenue generated through the scheme will be invested in other projects on the island that will move it towards its 100% RES goal, such as replacing petrol and diesel vehicles with electric vehicles and installing solar panels to provide heating (EUSEW, 2014)

Infrastructural Capacity: Community energy systems. Following the 2007 technical feasibility study on a potential wind-hydro system the PHS, as shown in figure 5 was designed to comprise:

- A wind farm to be developed on a site near the existing diesel generator on the north east coast of the island, as average annual wind speeds there are 9-9.5 m/s and average wind densities are 600-700W/m^2, well above the minimum requirements of 7m/s and 300W/m^2 needed for deliver a viable scheme (Hallam et al, 2012). The wind farm would have 5 2.3MW Enercon E-70 turbines giving a total capacity of 11.5 MW.

The rest of the system would be:

- An upper reservoir, with a capacity to hold 500,00m^3 of water was to be located in an the crater of 'La Caldera' volcano, some 683m above a lower reservoir located near CT White Plain, with a 150,00m3 capacity .
- Penstocks, comprising two airtubes, a drive pipe, two driving turbines and a suction tube.
- A central pump with a 6MW capacity with 1500/500kw inverters.
- Central turbine stations comprising four groups of 2,830k Pelton wheels with a total capacity of 11.32MW. Maximum flow is 2m^3/s with a 655m head.
- The electrical substation that provides the connection between the wind farm, the pumping station and the hydro plant is located in the White Plain area.

(Hallam et al, 2012; Gorona del Viento, El Hierro, 2014).

- An existing desalination plant, which would use excess power from the system at times of low demand or high winds to produce water that could be used to top up the two reservoirs due to losses from evaporation (Hallam et al, 2012).
- The existing diesel generation system is also connected to the system to provide partial power supply to supplement the PHS as necessary and to provide back up during periods of maintenance (ibid.).

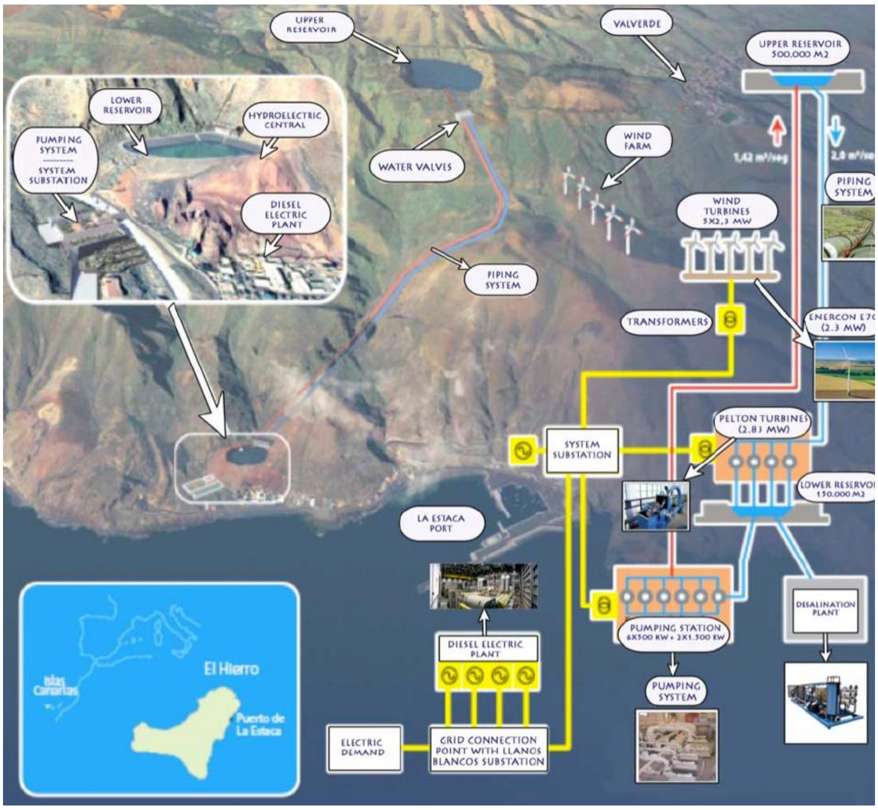

Figure 5. El Hierro Wind-Hydro system. Source: Hallam et al (2012, p.2965)

As Gonzalo Piernavieja, R&D Director at ITC describes, "The capacity of the upper reservoir, half a million cubic metres, is sufficient to meet the energy demand of the island during five consecutive days without wind. It is rare, though, on this island to go more than two days without adequate winds" (Global Islands Network, 2014).

It is expected that the power from the PHS will generate 40,360MWh of power, which is approximately 70% of the island's electricity demand (Hallam et al, 2012).

There have been some other renewable energy developments in addition to the PHS as the island moves towards its goal of achieving 100% of its energy from renewable sources. The first of these emerged from an ITC scheme and was a called '10 PV roofs', whereby in 2005 a local company was formed and installed 10 5kW systems with the priority being given to public buildings (ITC, 2011).

A second solar heating scheme was launched, called PROCASOL to install solar heating panels. It provided funding towards the investment and loans at 0% interest rate to encourage uptake of the scheme. Another local firm was set up to install the systems (ibid.)

It was recognised that there were a couple of things that were crucial for the successful uptake and development of both of these schemes:

- Guarantees were provided for the installation, solar collectors and maintenance of the systems.
- To deliver on the last of these guarantees, it was essential that there were local trades people with the necessary skills to maintain these systems, so a number of training sessions were held early on for trades, such as plumbers and electricians (ibid.)

Another renewable energy system that was trialled in El Hierro was biogas production from waste biomass materials on the island, such as sewage sludge, animal waste and municipal solid waste under the 'El Hierro – zero waste' banner. A pilot plant was developed, but closed after only six months, with the reason given being the end of European grants for the scheme (Global Islands Network, 2014). It is hoped that a further scheme can be developed that will use recycled oils or energy crops as biomass to produce biofuels, which ultimately could be used to fuel island transport systems (ITC, 2011).

A local transport co-operative is developing a number of schemes, these include: operation of a hybrid bus between the airport and the capital Valverde, using either hydrogen or biogas as the fuel source, operation of a battery powered minibus in the El Golfo area mainly for tourist's use and development of a ticketing system to optimise collective use of vehicles in scattered areas, including the ability for private vehicles to be used as public transport (Global Islands Network, 2014).

The PHS on El Hierro is owned and operated by Gorona del Viento, with the majority shares owned by the Cabildo El Hierro, (Hallam et al. 2012; Gorona del Viento, El Hierro, 2014), so the majority is community owned and the Cabildo El Hierro plan is for islanders and island businesses to have the opportunity to buy some of their shares (ITC, 2011).

4.6.3 *Communication*

Individual and Cultural Capacities: The role of trust and the individual. As described 4.6.1 and 4.6.2, there are no individuals credited with a leadership role in the El Hierro energy transitions and this is the same in the communication of the issues surrounding this.

Structural capacities: strategy and policy. The Cabildo El Hierro recognised the importance of getting support for the development of the island's 100% RES plans and led the provision of information through awareness raising campaigns and workshops (ITC, 2011). As mentioned in 4.6.2; whilst there was a lot of support for the proposals, there was some opposition, but this did not ultimately affect the development of the PHS and development of other renewable energy systems.

Structural Capacity: Sharing learning. In addition to the initial promotional campaigns on El Hierro to gain support from islanders, one of the founding principles of developing the PHS and other renewable energy systems on the island was its replicability for other island communities and a range of methods have been developed to disseminate information, including the project website (Gorona del Viento, El Hierro, 2014), leaflets, seminars, conferences and exhibitions (ITC, 2011).

4.6.4 *Outcomes*

Although a review by the Instituto Tecnologico de Canarias (ITC) in 2010 showed that implementation of El Plan Energetico de las Canarias across the Canary Islands as a whole had failed to meet the targets, El Hierro was an exception to this, with its 100% Renewable Energy supply project. It was believed that the PHS would provide most (80%) of the island's electricity supply and is the first to be used for such a purpose, using a pumped hydro system harnessing wind power as its primary energy source.

The PHS itself was launched on 27th June 2014, following many years of development and construction, so the outputs have yet to be realised. However, it is now expected to meet 70% of the island's electricity demand (Hallam et al, 2012). If it does, it will have provided a solution to the problem of intermittent wind power by effectively 'de-coupling' wind generation from customer demand through providing a significant amount of latent or stored energy in the upper reservoir, using power produced when generation exceeds demand (ibid.). It is also expected to reduce consumption of 6,000 tons, or 40,000 barrels of diesel oil per year, equivalent to a cost saving of €1.8m per annum and reducing CO_2 emissions by 17,800 tons per year. It is also estimated that there will be reductions in emissions of sulphur dioxide and nitrogen oxides of 100 and 400 tons per year respectively (Gorona del Viento, El Hierro, 2014).

The PHS is the largest scheme to be developed on the island in its plan to provide 100% of its energy from renewable sources. Other schemes, such as the individual PV and solar thermal installations have continued to deliver, but will make a significantly smaller contribution to the island's target. The pilot biogas facility from waste did not continue beyond the first six months, so cannot be deemed a success and the transport co-operative is developing small scale pilot schemes for more sustainable transport systems across the island (Global Islands Network, 2014).

4.7 Energy Self Sufficiency Outcomes of European Cases

Community	Energy Goal	Achieved
Güssing	To become a fossil fuel free town (Economic rationale)	In 2010 overall the degree of energy self-sufficiency in heat and electricity was 71% Keglovits (2013) 93.3% in heat and 44.1% in heat (Güssing had achieved energy self-sufficiency in 2001, but due to bankruptcy of local biodiesel business , this has reduced)
Jühnde	Support regions with the biggest potential for biomass fuelled energy systems (Opportunistic - research led) rationale)	Double the amount of electricity is produced than is consumed in Jühnde and 99% of the heat demand is supplied from biomass (IEA, 2009; IZNE, 2005)
Mureck	To become more self-reliant, more independent, to farm according to natural cycles and for the well-being of everybody within the region (Economic rationale)	85% of heat consumed in the area from renewable source through the biogas and CHP plants and produces some electricity through the CHP plant and some biodiesel for local transport use (Droege, 2009, p.121).
Samsø	To move from fossil fuel dependency to 100% renewable energy (Opportunistic rationale – response to a national competition with a strong environmental justification)	Samsø achieved 99.6% of energy demand being met from renewable sources, from a starting point of 13% in 1997 (EnergiPlan 2007). By 2014 more than 100% of electricity demand was being supplied from renewable sources and 70% of heat demand (Samsø Energy Academy, 2014)
El Hierro	maximise use of the island's renewable energy resources to make the island one of the first 100% renewable energy sourced islands (Environmental rationale)	The PHS is expected to meet 70% of the islands electricity demand (Hallam et al, 2012), but as it was launched in June 2014, it is too early for monitoring information to be available.

Table 9: Energy self-sufficiency outcomes in European cases

4.8 Qualitative Comparative Analysis of European Cases

As explained in Chapter 3, for the first part of data analysis I am using Qualitative Comparative Analysis to examine the capacities present in the European cases described above as they undertook their energy transitions, using Mårtensson and Westerberg's (2007) structure of problem formulation, mobilisation and communication as the framework and the energy self-sufficiency outcomes achieved. Of course, as discussed in Chapter 3, it is difficult to attribute a direct causal impact of the relationship between the capacities or independent variables and the energy self-sufficiency outcome or dependent variable. However, it is recognised that there is a relationship between the presence and application of the capacities and the degree to which WSESS has been achieved.

4.8.1 *Truth tables*

The capacities described above have been allocated as sub headings in the Truth tables below (Georges & Romme, 1995). If they are present in a given place as it moves towards energy self-sufficiency, this is represented by letters in upper case. If they are absent, this is represented by letters in lower case. Where there is insufficient evidence to determine presence of any given capacity, then this is represented by a question mark. Similarly the energy self-sufficiency outcomes in each case are represented by upper case letters when they are present and lower case when they are not.

Following this, the Boolean algebraic model applied uses only the capacities that are present in the cases as they develop energy self-sufficiency. This is represented by capacity A plus capacity B etc. = energy self-sufficiency outcome (Ragin, 1989 p.89). In this way it attributes which combinations of capacities or causal factors have contributed to developing energy self-sufficiency outcomes in each of the cases. It should be noted that the energy self-sufficiency outcomes have been used in the equation even if these have not been achieved (represented by lower case letters), as three of the European and none of the UK cases have achieved any of these completely which would render the equations with no solution; this has been used rather than using the empty set symbol of {}, which is used for this purpose in mathematics.

The Boolean algebraic analysis was applied to the findings of the secondary data collected from the European cases in order to investigate whether there is a pattern of combinations of capacities that these cases demonstrate that have led to their moves towards energy self-sufficiency and that could have the potential to be replicated elsewhere and inform the selection of UK cases for more detailed research.

Using this, it is then possible to see whether there are any individual capacities that are evident in all or some of the cases, or whether there is a combination of casual factors in all or some of the cases that have led to the development of energy self-sufficiency. Equally it will show whether there are any patterns in absent factors in the cases that have contributed to the development of energy self-sufficiency. This was then used to guide what information should be collected in the detailed UK case studies, i.e. does the presence or absence of a capacity/combination of capacities have an impact on the achievement of whole settlement approaches to energy self-sufficiency. The Truth tables and Boolean equations are presented below, followed by the description of findings from these.

Table 10. European Cases Truth Table

Variable/ Town	Problem Formulation														Mobilisation						Communication			Outcomes			Comments
Capacity	Cultural/Structural Capacity: Rationale	Cultural/Structural Capacity: Whole place Energy self sufficiency aim at start	Cultural Capacity: Importance of place	Individual Capacity: Skills	Structural Capacity: Vision & Strategy	Structural Capacity: Government and Governance	Cultural Capacity: Boundary object	Infrastructural Capacity: Energy Infrastructure & renewable resources							Individual Capacity: The role of the individual	Structural Capacity: Government & Governance	Structural Capacity: External expertise	Structural Capacity: Funding			Individual/Cultural Capacity: Individual & Trust	Structural Capacity: strategy & policy	Structural Capacity: Sharing learning	Energy self-sufficiency achieved			
								Fuel Source				Community ownership						Public	Private Fun	Individual				Heat	Electricity	Transport fuels	
								Wind	Biomass	Hydro	Solar/PV	Heat	Electricity	Transport fuels													
Güssing	ER	pw	place	PIS	pv	PGOV	BO	w	B	h	S/PV	COH	COE	COT	MI	MGOV	MEE	MPUBF	MPRIVF	MIF	CI/T	CSTRAT	CSL	esh	ese	est	Overall 71% energy self sufficiency achieved in 2010 (Keglovits, 2013)
Mureck	ER	pw	PLACE	PIS	pv	PO	BO	w	B	h	s/pv	COH	COE	COT	MI	MO	MEE	MPUBF	MPRIVF	MIF	CI/T	CSTRAT	CSL	esh	ese	est	Mureck produces 12% (Stadtgemeinde Mureck, 2014) of local heat demand and some electrcity and biodiesel
Jühnde	OR/R	PW	place	PIS	PV	PO	BO	w	B	h	s/pv	COH	COE	cot	MI	MO	MEE	MPUBF	MPRIVF	MIF	CI/T	CSTRAT	CSL	esh	ESE	est	Produces more than twice the electricity consumed and 99% of the heat (IEA, 2009; IZNE, 2005)
Samsø	OR/C	PW	place	is	PV	PGOV	BO	W	B	h	S/PV	COH	COE	cot	MI	MGOV	MEE	MPUBF	MPRIVF	MIF	CI/T	CSTRAT	CSL	esh	ESE	est	By 2014 more than 100% of electricity demand was being supplied from renewable sources and 70% of heat demand (Samsø Energy Academy, 2014).
El Hierro	ENVR	PW	place	is	PV	PGOV	BO	W	b	H	S/PV	coh	COE	cot	mi	MGOV	MEE	MPUBF	MPRIVF	MIF	ci/t	CSTRAT	CSL	ese	esh	est	The PHS switched on in June 2014 is expected to meet 70% of the islands electricity demand (Hallam et al, 2012).

Key: ER – Economic Rationale. OR/R - Opportunistic Rationale/Research led. OR/C - Opportunistic Rationale/Competition. ENVR – Environmental Rationale PW – whole place approach at start. pw not whole place approach at start, PLACE – sense of place was important for approach. place - sense of place was not important for approach. PIS – Individuals with key skills played leadership role at start, pis - Individuals with key skills did not play a leadership role at start. PV – there was a vision/strategy at the start. pv – there was no vision/strategy at the start. PGOV – local government played a leadership role at the start. PO – other organisations played a leadership role at the start. BO – the idea of whole place energy self-sufficiency was a boundary object. W – wind was a fuel source. w – wind was not a fuel source, B – biomass was a fuel source. b – biomass was not a fuel source. H – hydro was a fuel source. h – hydro was not a fuel source. S/PV – solar/photovoltaics were a fuel source.

s/pv - solar/photovoltaics were not a fuel source; COH – community ownership of heating infrastructure. coh – no community ownership of heating infrastructure. COE – community ownership of electricity infrastructure; coe – no community ownership of electricity infrastructure; COT - community ownership of transport fuels infrastructure; cot – no community ownership of transport fuels infrastructure. MI – no leadership role of individuals in mobilisation; mi - leadership role of individuals in mobilisation; MGOV - leadership role of local government in mobilisation; mgov – no leadership role of local government in mobilisation; MEE – use of external expertise; MBUBF – public funding used for capital works; MPRIV – private funding used for capital works; IF – individuals' funding used for capital works; CI/T – contribution of individual & trust in communication; ci/t – no contribution of individual & trust in communication; CSTRAT – communication of strategy, CSL – sharing learning & experiences; ESH – energy self-sufficient in heat; esh - not energy self-sufficient in heat; ESE - energy self-sufficient in electricity; ese – not energy self-sufficient in electricity; est – not energy self-sufficient in transport fuels

4.8.2 *Boolean analysis*

Boolean algebraic analysis was applied to the findings of the desk based study, see Table 11, in order to investigate whether there is a pattern of combinations of capacities or causal factors present in these cases and what are WSESS outcomes that have been achieved. This was then used to inform the selection of UK cases for more detailed research.

Case community	Equation
Güssing	ER+PIS+PGOV+BO+B+S/PV+COH+COE+COT+MI+MGOV+MEE+MPUBF+MPRIVF+MIF+CI/T+CSTRAT+CSL=esh+ese+est
Mureck	ER+PLACE+PIS+PO+BO+B+COE+COH+COT+MI+MO+MEE+ MPUBF+MPRIVF+MIF+CI/T+CSTRAT+CSL=esh+ese+est
Jühnde	OR/R+PW+PV+PO+BO+B+COH+COE+MI+MO+MEE+MPUBF+MPRIVF+MIF+CI/T+CSTRAT+CSL =esh+ESE+est
Samsø	OR/C+PW+PV+PGOV+BO+W+B+S/PV+COH+COE+MI+MGOV+MEE+MPUBF+MPRIVF+MIF+CI/T+CSRAT+CSL=esh+ESE+est
El Hierro	ENVR+PW+PV+PGOV+BO+W+H+S/PV+COE+MGOV+MEE+MPUBF+MPRIVF+MIF+SSTRAT+CSL =esh+ese+est

Table 11. Boolean equations of European cases

4.9 Discussion of Capacities Present

From the Boolean analysis, there were no instances where combinations of Capacities present were identical. There were, however, eight Capacities in the above comparison that are attributed to all five cases, six of these are Structural Capacities, one is a Cultural Capacity and one is an Infrastructural Capacity:

- The first common capacity is that the idea of whole place energy self-sufficiency in its different forms did function as a boundary object in all cases. In one case, Jühnde, this was at the start and in the other cases, this developed at a later point as the schemes moved through mobilisation.
- Three of the common capacities are the sources of capital funding used to deliver the energy schemes in each place; public, private and individual funding

contributed to the capital works of implementing the systems towards energy self-sufficiency in all cases. This varied from delivering energy efficiency measures (Güssing) to large scale capital works in all cases. It also shows that more than one source of funding was required to deliver the capital works and from more than one sector. In some cases, there were multiple sources of funding, such as Samsø, where funders included the Danish Energy Agency, the municipal authority, the local co-operatively owned utility company, local farmers and individual shareholders. This is not unusual, as public funding streams usually have very specific criteria, so will only fund one specific type of activity to deliver specific outcomes, but does highlight the complexity of putting a viable funding proposal together.

- The fifth common capacity was use of external expertise, for example the universities in the cases of Güssing, Mureck and Jühnde.
- The sixth common capacity was communication of the energy approach to the community to gain support. Regular communication occurred in all of the cases here, albeit in different ways and made a significant contribution to the early engagement of actors within the communities and to sustaining their interest as the projects developed.
- The seventh common capacity was sharing the learning and experiences, which was important and encouraged interest and visits to the case communities.
- The last common capacity is the Infrastructural Capacity and is community ownership of at least some of the electricity infrastructure. As described in chapter 2, this was considered to play an important role in community energy in the UK (DECC, 2013) and will be interesting to see whether this is a common factor in the UK cases in Chapter 5.

In three of the five cases, the idea of moving towards energy self-sufficiency was a whole settlement/community approach from the start; these were El Hierro, Samsø and Jühnde. Of the remaining two cases, this whole settlement approach was developed following the successful delivery of earlier low carbon energy schemes. In Güssing initially the goal was for public buildings and facilities to move to fossil fuel free energy sources and then in 2001 the approach for the whole community town to become 100% self-sufficiency through renewable energy was introduced (IEA, 2009). The other case was Mureck, which initially set out to transform the agricultural economy of the area through development of biomass energy systems to produce biodiesel from oil seed rape and then heat and electricity from biomass and biogas. However, since then Mureck has joined the Climate Alliance (Tomescu, 2005) and set a goal to meet all energy needs of the town from renewable energy sources (McCormick and Kåberger, 2007).

Leadership by individuals in the energy transitions played a key role in four of the five cases, with individuals in two of the cases being involved from the start in the problem formulation stage (Güssing and Mureck) and in the other two, the individuals became involved at a slightly later point in the Mobilisation stage, but were crucial for getting the community wide support that enabled the energy transitions to develop (Jühnde and Samsø).

The leadership role of local government was important in three of the five cases in both the problem formulation and mobilisation stages (Güssing, El Hierro and Samsø) and whilst the local government did not play a leadership role in Mureck and Jühnde, they were key partners in supporting the delivery of new renewable energy systems. In the case of Mureck, it was recognised that the development of the Mureck Bio Energy Cycle (MEC) would not have been possible without the support of the local government, as well as the regional and federal governments (Tomescu, 2005).

Of the renewable energy sources harnessed, biomass was used in four of the five cases, solar technologies in three and wind was used in two. Hydro was used in only one, El Hierro in the form of wind pumped hydro storage. As indicated earlier, these are the sources that are most abundant or accessible in the given location.

In terms of the energy self-sufficiency outcomes, Jühnde and Samsø had achieved self-sufficiency in electricity, (this means they produced more than was consumed locally, although lack of local ownership of the grid systems meant that the electricity was fed into the grid and local consumers had to purchase their electricity individually). None of the cases had achieved energy self-sufficiency in heat, although Jühnde was very close to this, producing 99% of local heat consumed. None of the cases had made much progress in becoming self-sufficient in transport fuels, although Samsø had taken the approach to offset CO_2 emissions from transport and both Güssing and Mureck are producing some fuel for transport.

Arguably the two European cases that set out a strategy to improve the economy of the area by a transition to local renewable energy sources; Güssing and Mureck have achieved their aim. They have both increased the number of jobs locally, new businesses have been created and more income has been generated locally for public services through increased taxes. Güssing has achieved 71% energy self-sufficiency, but only owns the energy infrastructure for its heating system, not for the electricity produced (Droege, 2009). Mureck is a good way towards meeting its heat demand, estimated at 85% from biogas and CHP plants (Bioenergie Mureck, 2014) and in producing biodiesel from local crops and recycled cooking oil. However, the used cooking oil is collected from over 100 businesses and communities (Bioenergie Mureck, 2014), in some cases, this is imported from regions over 200km from the town including a tank imported from Luxembourg once a month (Tomescu, 2005, p.25). Interestingly, as both Tomescu (2005, p.37) and Simms (2000, p.17) note sustainable local or 'county' level production, distribution and services should be provided within a 20 mile radius. This and the definition of energy self-sufficiency being used for this research raises the question as to whether the production of biodiesel by SEEG can legitimately make a contribution to energy independence. Nevertheless, in both of these cases the transformational benefits to the economy have been achieved through working towards energy self-sufficiency.

The Boolean comparison did not provide an instance where a combination of capacities or causal factors was identical in any of the cases, but there were eight capacities that were attributable to all of the cases. All of the cases considered had made significant progress towards energy self-sufficiency goals for heat, electricity or a combination of both. This suggests a number of considerations for undertaking the case research of the UK cases:

- There is no one combination of capacities or casual factors that is essential for small towns or collections of rural settlements in moving towards energy self-sufficiency, however, access to capacities is vital.

- There was only one capacity that was identified in only one of the cases, described below, therefore all the capacities described in the European cases merit examination in the UK cases in the following chapter as to their contribution to energy self-sufficiency outcomes achieved

- Importance of place was only identified as an important contributing capacity to the adoption and delivery of energy self-sufficiency approach in one case, Mureck. Given the importance placed on this for community energy self-sufficiency in the literature examined in chapter 2, and also given that the European cases examined here are based mainly on secondary data sources this could be that this area has not been the focus of previous research. I will therefore examine this in the UK cases in the next chapter and it will be interesting to see whether this is identified in the primary data collected.

These support the earlier proposal that it is likely that this research will be hypothesis generating and it will be interesting to review this in the detailed case studies.

4.10 Conclusions

In this chapter I set out the stories of the five European case communities with respect to energy self-sufficiency. In doing this, I identified the capacities that were present in each of the cases and by representing these in the Truth Table and using Boolean analysis (Ragin, 1989 pp.87-88; Georges & Romme, 1995) have determined that there were no cases that had identical combinations of Capacities present, but there were eight capacities that were present in all cases:

- Six of these are Structural Capacities; public, private and individual capital funding, use of external expertise, communication of the approach within the community and sharing the learning and experiences with a wider audience
- One is a Cultural Capacity; the idea was a boundary object,
- One is an Infrastructural Capacity; community ownership of electricity generation plants.

A detailed analysis of the data from these European cases is described in Chapter 6. However, the starting point for this part of the research was to examine what capacities might be present in a number of European rural case communities that have achieved or have made significant progress in working towards energy self-sufficiency. This is to help inform selection of the UK cases for more detailed study, give an indication of the capacities to examine in and provide a baseline for comparison with the UK cases. All of the capacities considered here will be examined in the UK cases.

Given the findings from the analysis of the European cases here, described in more detail in Chapter 6, I propose to select UK rural cases for detailed research using the following selection criteria:

- Rationale. Cases with different rationales for moving towards energy self-sufficiency
- Local Authority led. Cases where local authorities have played a leadership role and where they have not
- Public funding. Cases where public funds have been used in the development and delivery of renewable energy systems and cases where there have not
- Private funding. Cases where private funds have been used in the development and delivery of renewable energy systems and cases where there have not
- Individual funding. Cases where individuals have made financial contributions to the development and delivery of renewable energy systems and cases where there have not
- Renewable energy sources. Cases that have used different sources of renewable energy or different systems to harness these
- Ownership models. Cases that have different ownership models of renewable energy plants and infrastructure
- Importance of place. Using geographic or economic isolation as an initial indication of this, including some cases where this is not present.

Chapter 5: UK Cases

5.1 Introduction

In Chapter 4 I presented the data and cross case analysis of the five European cases considered in this research. This analysis identified what capacities were present in each of the cases and the outcomes achieved and this was used to help inform the selection of the four UK cases and the capacities to examine. The primary and secondary evidence collected from the UK cases is described in detail in this chapter.

As in the previous chapter of European cases, the data is presented using Mårtensson and Westerberg's, (2007) structure of Problem formulation, Mobilisation and Communication and I have again added another section entitled Outcomes. Mårtensson and Westerberg's structure is concerned with understanding the process of energy transformations in communities, whereas in addition, this research is seeking to understand what capacities are present and have been engaged by rural case communities and what the outcomes are in energy self-sufficiency terms have been for those communities. The data is presented as described in interviews, papers, reports etc. and checked using triangulation methods where possible as described in Chapter 3. Following presentation of the data, I identify the capacities present as defined in my conceptual framework and assessment as to whether the idea of WSESS functioned as a boundary object. My detailed analysis and interpretation of the data, from both the UK and European cases is then presented in the following chapter using Capacities as defined in my conceptual framework in Chapter 2.

5.2 UK Policy Context

In considering the UK case communities, it is helpful to understand the UK policy context for whole rural settlement approaches to energy self-sufficiency.

At the 1992 United Nations 'Rio Earth Summit', the United Nations Framework Convention on Climate Change was adopted and came into force in March 1994, with 186 nation-state signatories. Its prime objective was to stabilise atmospheric greenhouse gas concentrations in order to prevent climate change (United Nations, 1992). Following this in 1997, the Kyoto Protocol was adopted (United Nations, 1997). The UK Government was a signatory to both. The Kyoto Protocol committed the UK Government to a binding target of 12.5% greenhouse gas emission reductions 2008-12 from a 1990 baseline position. Government provisional figures report that in 2012, the UK figures for greenhouse gas emissions (including emissions trading) was 22.5% lower than the baseline. The figure excluding emissions trading was a reduction of 23.4% (DECC, 2014b), substantially exceeding the targets.

As described in Chapter 1, there have been a number of policies and schemes introduced by UK Governments to reduce CO_2 emissions from energy through energy efficiency measures and encouraging development of low carbon and renewable energy systems. In 2002, the UK Labour government introduced the Renewable Obligation for electricity suppliers to source a proportion of their power from renewable sources. Generators of renewable energy receive Renewable Obligations Certificates (ROCs) for the renewable electricity they produce, which they then sell on to electricity suppliers. The suppliers must be able to produce ROCs for the total amount of renewable electricity they are obliged to supply. If they fail to do this a penalty is payable which is then redistributed to all the suppliers who did provide all the ROCs required. As this penalty directly benefits competitors, it is an additional incentive to ensure all ROCs are provided.

In the UK, since the 2003 Energy White Paper (DTI, 2003) there has been a shift in perception that the involvement of communities in the delivery of renewable energy is important (Bulkeley and Newell, 2010 p.78; Walker et al, 2010), not least because it has been recognised as a means of helping reach government targets on renewable energy production and reducing carbon emissions.

Through the Climate Change Act 2008 (Great Britain, 2008) the UK Government committed the UK to achieve a legally binding target of at least an 80% reduction in carbon emissions by 2050 compared to the 1990 baseline through setting 5 yearly carbon budgets. The 2008-12 target was set at a reduction of 22% in carbon emissions and as shown above this was exceeded (DECC, 2014b).

In 2009, the UK Government published two papers: The UK Low Carbon Transition Plan white paper (DECC, 2009a) and The UK Renewable Energy Strategy (DECC, 2009b). The former set out how an 18% reduction in CO_2 emissions could be achieved by 2020 from a 2008 baseline and for a target of 30% of electricity to be produced from renewable energy by 2020. It laid out plans to introduce Feed In Tariffs (FIT) and Renewable Heat Incentive (RHI) schemes for small scale electricity generation and heat production respectively, both from renewable sources as a means of encouraging more renewable supplies of power and heat. It also identified a role for communities in reducing CO_2 emission through a pilot for 15 'Green villages, towns and cities' and a 'how to' guide for community scale renewable or low carbon energy system installations. The UK Renewable Energy Strategy (ibid.) set out the detail of what government would be doing to both directly support and encourage others to meet the 2020 CO_2 emission target through renewable energy deployment. This included: producing a developer toolkit to show how development of renewable energy systems could deliver benefits to communities, introducing new financial packages to encourage renewable energy system deployment and supporting local authorities to lead by example and develop their own renewable energy systems (ibid.).

Community interest and involvement in energy projects in the UK has been gaining support over recent years and the UK Government has recognised this is a growth area by launching a Community Energy Strategy in January 2014 (DECC, 2014a). Whilst the definition of community energy in this strategy is not limited to production of renewable energy and reducing energy consumption by communities, these are identified as two key priority areas for action. The strategy recognises that community energy can assist in addressing security of supply and mitigating against climate change and that communities may be better positioned to capitalise on the benefits that particular renewable energy systems can bring, as well as reaping wider economic and social gains (ibid.). A report commissioned by DECC to inform the strategy using models of onshore wind, hydro and photovoltaic technologies installed by community energy organisations to 2020 identified that combined community and community/commercial ownership models of energy systems could generate more than 12 times the local economic benefits than 100% purely commercial owned models, estimated to value £1.3bn to 2040. The model also suggests that community ownership of these systems could produce up to 3GW of electricity by 2020, which would meet 1.4% of total consumption (DECC, 2014b; DECC, 2014c).

There are a number of elements contained within the strategy aimed at helping communities to become involved in local renewable energy projects. These include:

- Developing an onshore wind Community Benefits Register for England, which will record the benefits communities have received from wind farm developers (Scotland has had a register in place since 2012). This aim of this is to enable communities to be better informed when discussing community benefits with potential developers.
- Introducing a government funded peer to peer mentoring service to enable new community energy groups to be supported by more experienced groups.
- Consultation on increasing the FIT ceiling for community energy projects from 5MW to 10MW
- A ‘License Lite’ pilot by the Greater London Authority (GLA) to see how locally produced electricity can be sold on the national grid system (at the moment this is restricted to private wire systems)

(DECC, 2014a)

5.3 UK Case Studies

5.3.1 *Background*

There are two significant differences between the European cases, investigated in the previous chapter and the UK cases considered here. The first is that the data for the European cases was primarily from secondary sources; reports, websites, press articles etc., whereas the sources for the UK cases are mainly primary in the form of interviews, supported by data from some secondary sources. The other important difference between the European and UK cases examined here is the spatial scale of primary local government. In the majority of the European cases, the local authorities, or municipal councils had responsibility for a much smaller area than the UK cases, often at a town or island level, whereas in the UK cases, the local authority has responsibility for much larger areas, comprising many settlements. Given this, it will be interesting to investigate whether, as research suggests that having institutional arrangements at too high a jurisdictional level is a major cause of policy failure (Ostrom, 1996).

5.3.2 *UK Case Selection*

The findings of the cross-case analysis of the capacities present in European case communities, presented in the previous chapter are used to inform the selection of and show which capacities warrant examination in the UK cases:

Using documentary evidence, I examined a number of potential rural UK cases initial research indicated had taken whole place approaches to energy self-sufficiency. These included: Longtown, Newstead, the Dearne Valley, the Centre for Alternative Technology, Findhorn and Totnes. These were not selected as case studies for this research for the following reasons:

Longtown is a small market town of c 3,000 population, lying three miles to the east of Gretna on the England/Scotland border. The Market Town Initiative (MTI) healthcheck identified the lack of access to a mainline gas supply as a key issue for the town, with 72% of respondents to the healthcheck consultation not having mains gas supply (Countryside Agency, 2005). The MTI Action Plan identified exploring alternative forms of energy and demonstrating the benefits of renewable energy as a priority. In 2003, the Longtown Energy Partnership was set up by the MTI Partnership and Longtown and District Enterprise Trust to:

- Investigate the potential for renewable energy
- Energy efficiency
- Reducing and recycling domestic and business waste

The partnership commissioned a study by Dulas' consultancy services to examine the potential in Longtown for all forms of renewable energy. The following projects were identified to be delivered:

1. A waste wood fuelled community heating scheme
2. An anaerobic digestion plant using locally sourced green wastes to supply heat and electricity through a CHP plant.

3. Solar water heating on a community/leisure centre (Dulas, 2005).

Through this work, Longtown became one of the first market towns in the UK to have established a community-led renewable energy project. However, since 2005, there is no information available about whether these schemes have been taken forward and as availability of data is a foundation to a case study, it was not possible for Longtown to be taken forward as a case study for this research.

Whilst three of the Barnsley Dearne Valley settlements had taken part in Yorkshire Forward's Rural Capitals programme, the Dearne Valley Eco Vision, developed in 2008 to transform the area to into a low carbon community was for a much larger area, covering 13 settlements, with a population of approximately 80,000 (Urbed, 2008). As the study area was much bigger, crossing three local authority boundaries, this was not included as the scale was too large for transferability of lessons to other rural settlements.

Both Findhorn and the Centre for Alternative Technology are small rural settlements. Both were planned sustainable communities, established by like-minded individuals in the 1960s and 70s to develop as alternative sustainable communities (Findhorn Foundation, 2014; Centre for Alternative Technology, 2014). Whilst valuable lessons can be learned from both in terms of innovation and the development of the communities, they are not typical of rural communities in UK and so transferability of lessons learned would be limited.

Totnes was the first Transition Town and developed an Energy Descent Action Plan in 2010 (Transition Town Totnes, 2014). This was a real contender to be one of the case studies, particularly because it was unclear whether this grassroots approach had actually led to any significant change in energy use/production, as one reviewer quotes*:* 'as impressive a document as Transition in Action is, it falls short of being an Energy Descent Action Plan. Instead, it seems to be more of a vision – a remarkably explicit, exciting and community-based vision that tells us exactly what is to come about, but not how or by whom.' (Transition Culture, 2014a). However, the Transition Towns approach has been the subject of much study already, including a PhD thesis by its founder, Rob Hopkins (Transition Culture, 2014b), so I judged that there may be more new information to be gained in using a different place as a case community.

The UK cases selected for this research using the categorisation in the table are shown in Table 12:

	Eigg	Ashton Hayes	Fintry	Hebden Bridge
Rationale	Sustainability and viability of community (economic, social & environmental)	Environmental	Environmental	Economic, social and environmental
Local Government led	No	Parish Council	No	Calderdale Council
Individual leaders	Yes	Yes	Yes	No
Public funding	Yes	Yes	No	Yes in development, not yet in delivery
Private funding	Yes	Yes	Yes	Yes
Individual Funding	Yes	Yes	Yes	Unknown
Approach to energy self-sufficiency/Renewable energy sources	Solar, hydro & wind powered community owned microgrid with electricity all being used by residents & businesses on the island. In addition, energy efficiency measures & heating pilots	Energy efficiency, behaviour change, small scale solar in first instance	Used commercial mortgage to buy 1/15 of a wind farm. All electricity fed into national grid and community receives income from this. Uses money to develop low carbon energy in the village	Council launched an Energy Future Strategy in 2012 setting ambitious targets for carbon emission reductions through energy. An Energy Future panel has been set up to manage this
Ownership of energy systems	Microgrid owned by the Isle of Eigg Heritage Trust (IEHT)	Community ownership through Parish Council and aspirations for community ownership through community energy company,	Community ownership through Fintry Renewable Energy Enterprise (FREE), as part of privately owned wind farm.	One community owned wind turbine so far

	Eigg	Ashton Hayes	Fintry	Hebden Bridge
		public ownership through primary school		
Geographically or economically isolated as an indication of importance of place	Yes – an island community with a declining population at the start	No, is predominantly a commuter village close to Chester with a low Index of Multiple Deprivation (IMD)	Yes, is a rural village in Stirlingshire, central Scotland	No, is close to Halifax

Table 12. Capacities used for UK case selection

It should be noted that the biggest challenge was in selecting a UK rural case community that had been led by the local authority. As mentioned in 5.3.1, the areas covered by an individual local authority in the UK can be much larger than in other European states, where it is common for local government to be organised around an individual settlement, or municipality even if it is small, as in the case of Güssing, Austria. There are many instances of UK local authorities facilitating the development of renewable energy projects or even whole settlement transitions to low carbon energy for rural communities, such as Cornwall Council providing support to Polperro United Renewable Energy (PURE, 2014) and other community groups who are working to reduce energy consumption and develop renewable energy projects, as part of their Green Cornwall Strategy (Cornwall Council, 2014). There are also examples of local authorities in partnership with other organisations leading whole city approaches to low carbon energy, such as Sheffield City Council (2014). However, when embarking on this research I did not find a single case of a rural settlement in the UK where the local authority led a whole settlement approach just for that settlement. If councils took a leadership role, it has been a whole council area based approach. Therefore the settlement selected as the one led by the local authority is part of a whole district approach to low carbon energy and so by default it does encompass the whole settlement of Hebden Bridge. It will be interesting to observe the differences between this case and the European local authority led cases.

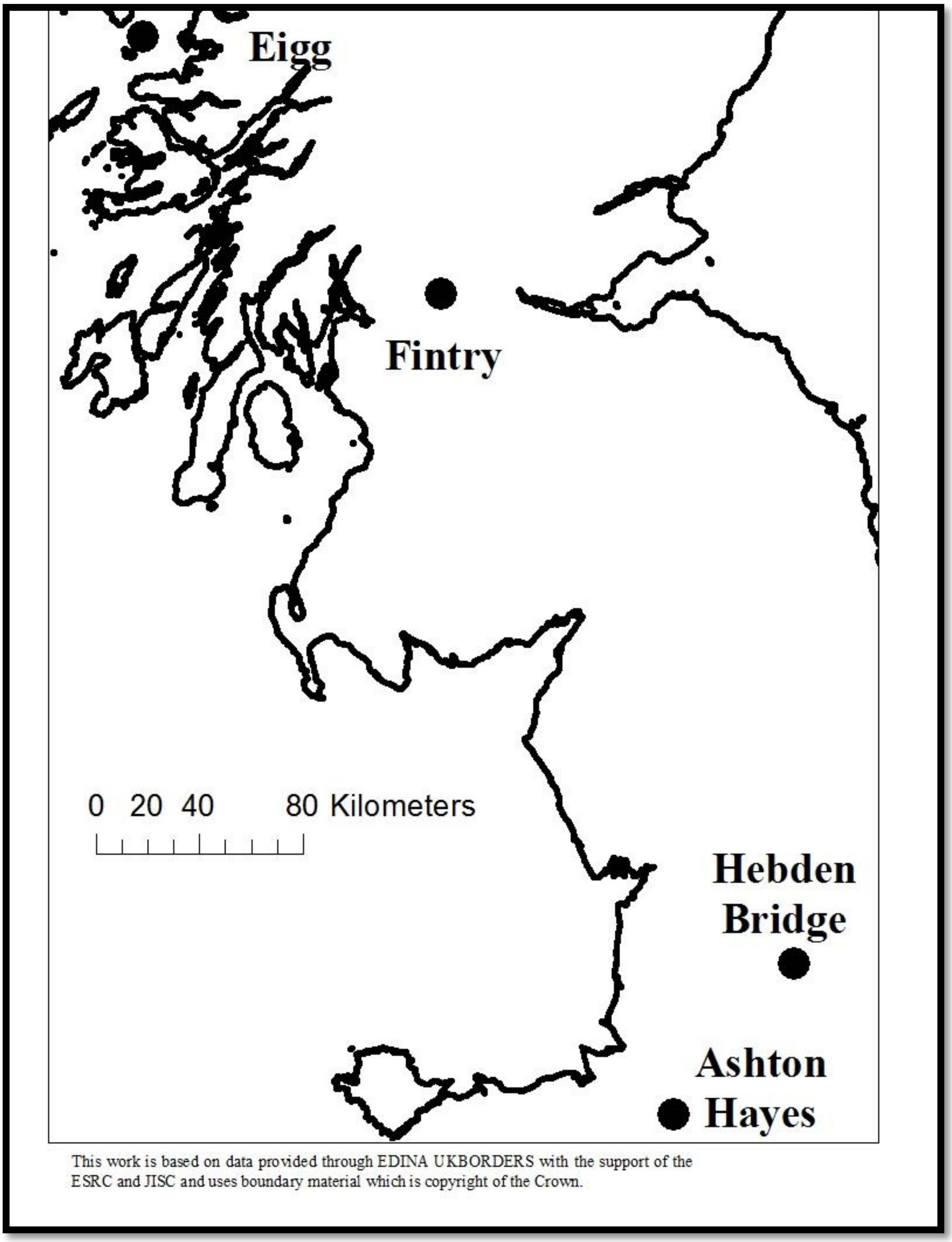

Figure 6. Location of UK case settlements

5.4 Eigg

Following the methodology detailed in the previous chapter, data on the development of the Isle of Eigg microgrid was obtained through documentation, direct observation and seven interviews. Interviews were undertaken with representatives of the following groups: Board members of the IEHT and Eigg Electric Ltd, residents, businesses, Big Green Challenge members and officers from the local authority and Scottish Wildlife Trust (SWT).

Figure 7. Welcome sign at Eigg pier

5.4.1 *Background*

The Isle of Eigg is one of the Small Isles of the Inner Hebrides off the northwest coast of Scotland. It lies to the north of the Ardnamurchan peninsula and to the south of the Isle of Skye and is nine kilometres long by five kilometres wide, with a total land area of 30.49 square kilometres and a population of 90, with 30% under 30 years of age, (Cifal Scotland, 2012). It is a 12 mile ferry journey from Mallaig on the Scottish mainland.

In December 1996 the IEHT was established 'to provide and create opportunity for economic development, housing and infrastructure, whilst conserving our natural and cultural heritage to ensure that development takes place in a sustainable way' (Isle of Eigg, 2014). It is a company registered by guarantee and a registered Scottish charity and has three Member organisations; the Highland Council, the SWT and the Eigg Residents Association, with the Residents Association in the majority to comply with the Land Reform (Scotland) Act (2003), plus an independent Chair. All residents on the island can be members of the Residents Association, but they have to be resident on the island for at least half of the year in order to be able to vote.

On 12th June 1997 the Trust bought the island, funded mainly by donations from ten thousand members of the public and brought an end to years of neglect and instability as a result of unsupportive absentee landlords.

5.4.2 *Problem Formulation*

Cultural & Structural capacities: Rationales for WSESS. At its lowest point, the population of Eigg had fallen to 63, raising real concerns about the viability of the island facilities and its community. By 2005/6, one of the biggest barriers to development on the island had been identified as noted by interviewee E1:

> "Round about 2005/6 or before that we realised that one of huge vulnerabilities, one of the barriers to economic development on the island was stability of electricity."

Cultural capacity: The importance of place for energy self-sufficiency. It is widely acknowledged on Eigg that it would have been impossible for any island wide electricity scheme to have been developed before the community buy-out of the island, as interviewee E1 went on to describe:

> "there would have to have been a motivating force to achieve that – the community resilience was just pretty well nil at that time. There wasn't a body that could have driven it forward and the landowner wasn't interested; who would that body have been to take it forward?"

This supports earlier research that land buy-out groups have been 'in the vanguard' of community energy projects (Bomberg and McEwen, 2012, p.442) It was recognised that significant investment would be needed to develop the microgrid and the component renewable energy systems and the Trust deemed it unfair if only a proportion of the island community were connected to this. It was a fundamental foundation to the development of a community microgrid that it had to be a whole island system, supplying every property, as interviewee E1 explained:

> "It was developed as a whole island scheme. There were a number of pre-requisites really. One is that everyone had to agree to draw their electricity from the scheme – there was no point in providing a scheme that 1/3 of the island supported and 2/3 didn't or whatever proportion and those parties paid the initial costs of installing and another one piggy backed on that, so that wouldn't have been fair."

There is an independence of spirit in the isle of Eigg, which may in part be due to the island community's geographic and economic isolation and also because prior to the community buy out there had been a history of landlords unsympathetic to community needs.
The community buy out has given a lot of confidence to the community that they can achieve things by working together. There is a willingness to share responsibility to enable the microgrid to work, such as agreeing the cap on usage and getting all wiring checked by one contractor.

Individual Capacity: Skills. There are three individuals on Eigg who were essential to the successful development and delivery of the microgrid and who undertook most of the work to develop it and two of them have an on-going role in its operation, described by interviewee E2:

> "it wouldn't have happened without the three of us"

The first is John Booth, a retired incomer to the Isle. At a Trust meeting discussing the proposed electricity grid, he volunteered to project manage the design, development and operation of the scheme. The second key individual is Maggie Fyffe, secretary to the IEHT who played a key role in the design and development phase of the microgrid. The third key individual was Ian Leaver previously employed by the Trust as a development officer until the funding ran out. He was then employed as renewables development officer for six months and during that time wrote a number of applications for funds to develop the microgrid and secured funding from a number of sources, including ERDF, Community Energy Scotland and the Highland Council.

As interviewee E3 said:

> "Without a champion for each of these things, then it's not likely to happen."

The three together, supported by the Chair of the IEHT acted as political and technical pioneers (Hauber and Ruppert-Winkle, 2012) and 'citizen entrepreneurs' (Foxon et al, 2009).

Structural Capacity: Vision & Strategy. As the IEHT wanted to develop a reliable, whole island electricity system, a local renewable energy specialist from Scoraig suggested that the Trust contact a company Econnect and so the IEHT commissioned a feasibility study to look at what forms and how much electricity the island could produce as a whole island scheme.

Structural Capacity: Government & Governance. The IEHT led the initiation of the development of the island microgrid. The Highland Council is one of the three member organisations that comprise the IEHT. However, it had a purely facilitative role in the development and delivery of the Eigg electric microgrid system; providing the policy framework for the grid through its Highland Renewable Energy strategy, which acts as planning guidance when planning applications for renewable energy systems are being considered.

There is a feeling from some islanders and IEHT members that the Council has not played much of a role in the energy transition on Eigg, in fact some feel it has been nil. Others feel that the island has achieved its development of the microgrid because it knows it cannot rely on the council to do it for them, as described by interviewee E4:

> "And what we are saying is that…islands in particular have the potential to be leaders in innovation because of our specific geographical situation. We are having to find innovative solutions otherwise…we can't rely necessarily on the councils to do things for us, we have to basically do it ourselves and that's how we can come up with these initiatives"

This supports other research findings that such outsider status can act as a stimulus to mobilisation (Bomberg & McEwen, 2012).

The islanders and the IEHT do not believe that the development of the microgrid could have happened without the community buy out. The last landlord was not interested in doing this and in order to install all the cabling, way leaves would have had to be granted across the landlord's land and multiple individual crofts and land holdings and it is unlikely that everyone would have agreed to these. As mentioned above, communities that have been involved in land buy outs are more inclined to become involved in community energy projects as they are already organised and have skills to negotiate with key stakeholders (Bomberg and McEwen, 2010).

Infrastructural Capacity: Energy Infrastructure & renewable resources. There are no mains electricity or gas connections to the island. Up to this point, electricity on the island was mainly provided by individual diesel generators for each property, with diesel having to be brought from the mainland; a dirty and time consuming task. In addition to the generators, a number of micro hydro schemes had been developed by individual residents across the island, supported by a specialist in developing and installing small hydro and wind power systems who lived on the Scoraig peninsula. There was interest from islanders in developing further small renewable schemes across the island. However, this would have meant that some people would miss out, if they weren't in a place appropriate for any renewable energy systems. As with the community buyout of Eigg, any energy system developed had to be whole island and community owned. The feasibility study assessed the capacity of renewable electricity sources on the island, together with the likely number of consumers and showed the optimum mix of hydro, solar and wind power would be; 6 x 15kW wind turbines, 30kW photovoltaics array and a small hydro system

The study also showed what the maximum amount of electricity each household and business could have at any given time and an innovative sociotechnical approach was developed to manage demand. At the very start of the design phase everyone on the island agreed to a cap of 5kW electricity at any one time for each house and 10kw per business. The adoption of this solution to manage demand is recognised as being the true innovation in the development of the microgrid on Eigg as interviewee E1 acknowledged:

> "the big story is really getting the community to agree to signing up to capping their use"

Cultural Capacity: Boundary objects. The community had come together in the late 1990s with the establishment of the IEHT to undertake the community buy out of the island. This in itself could be considered a boundary object, with residents, the council and the SWT, all with different interests and areas of responsibility coming together to enable the community buyout to happen. Having already got such a momentous achievement under their belts, a similar approach was taken to develop the microgrid; bringing together the IEHT members, plus additional internal and external support in the form of John Booth, Community Energy Scotland, professional contractors and interest from a large number of funding organisations to support the idea and its delivery. The idea of the development of the microgrid as a boundary object brought these disparate groups together, albeit with different reasons for being involved.

5.4.3 *Mobilisation*

Individual Capacity: The role of the individual in moving towards WSESS. John Booth, see figure 8, worked full time on a purely volunteer basis for three years to project manage the development and delivery of the microgrid. This included agreeing the system designs, siting of the individual renewable systems, routes for the cabling, access for installation, contracting and management of contractors, training for staff to manage the system, getting agreement from islanders for the checking and work on their electric systems and programming connections of all premises to the grid.

Subsequently as the Chair of Eigg Electric Ltd, he has also managed the commissioning and installation of the additional photovoltaic array. He had delegated authority from the Trust to make decisions about the system, which meant he had full authority in meetings to make key decisions in order to improve the system or to manage the costs. There have been significant benefits to his involvement being purely on a voluntary basis, with the authority to make decisions. In addition to saving the Trust three years of salary costs, this enabled him to make decisions and to find ways of getting agreement from all islanders to the routing of the grid and sequence of connections. At times, he has had to take a firm line with individuals and he feels if he was paid to do the work, he would not have been able to achieve this, as interviewee E2 explained:

> "You'll always get some people who'll angle for a bit more. But the great thing about doing it for nothing is you can give them a good row. Whereas, if you're being paid… I suppose if you were an employee of a company, they would then make a complaint about your foul and abusive language in their company"

Figure 8. John Booth at the windfarm

John's role was also valued by the contractors, as one director of Synergie Scotland Ltd. said:

> "The scheme was managed in such a way that we had a single point of contact in John Booth. He was able to make decisions on behalf of the board of Eigg Electric. This was hugely important because it kept things moving. Delays would have meant a rise in costs and our aim was to ensure getting the maximum energy out of the system while remaining on budget."
>
> HI energy (2008).

Maggie Fyffe continues to have an on-going role in the operation of the scheme. She managed all of the finances to deliver the system, paying invoices, balancing budgets, managing an overdraft facility to assist with cash flow and converting this to a loan. She also manages the Eigg Electric company accounts and issues the customer prepayment cards for the electricity supply.

Ian Leaver continued to work with Maggie Fyffe, the Trust secretary, during the delivery phase on submitting funding claims as the scheme was delivered and in negotiating the loan by the IEHT.

Structural Capacity: Government & Governance. The IEHT set up Eigg Electric Limited, one of its three wholly owned subsidiary companies, to develop, build and manage the micro grid system. SWT is one of the three member organisations of the IEHT and the SWT warden on Eigg worked closely with the project manager and the contractors to agree a site for and access to the windfarm, see figure 9 and the access to the proposed site of the hydro scheme, both of these are in SSSIs, so getting appropriate approved routes was essential.

Figure 9. Access route through the SSSI to the windfarm

Any decisions that need to be made about the microgrid, such as increasing the unit price are first suggested by the Eigg Electric company directors. These then have to go to the Residents Association for a vote, which meets every month. The decision by the Residents Association then goes to the next Trust meeting. In reality as the Residents Association is in the majority on the Board, any decisions they have made are carried by the Trust. Any profits generated are passed to the Trust to spend on projects that will benefit the island and island community.

As in all communities within its areas, the Highland Council has a number of areas of responsibility on the island, such as provision of the school, highways etc. Whilst it is one of the three partner organisations that comprise the IEHT, it does not appear to have been actively involved in the development of the microgrid and Eigg Electric Ltd, as interviewee E1 commented:

> "It will be interesting to see if anyone claims to have had any involvement, cos' the answer is no"

However, as the local planning authority, the Highland Council does have a role in governance terms in making decisions on planning applications for renewable energy systems installations. This is guided by the Highland Renewable Energy Strategy (2006), which has the status of planning guidance and subsequent renewable energy policies incorporated into the Highland Wide Local Development Plan (2012) and Interim Supplementary Guidance: On shore wind energy (2012). The planning applications for the Eigg microgrid system and its constituent parts were approved with no problems.

In some situations there is a feeling is that the council has been actively working against the islanders in managing the grid system, such as a decision to install a ground source heat pump in the school, which uses more electricity than the grid can provide, as interviewee E4 commented:

> "Our school is a perfect example of totally stupid policies that mean the Highland Council does not understand at all our situation, and has devised what they think is an example of good carbon reduction measures when in fact, what they have created is actually a total headache for our grid…connection. Because they have put a ground source heat pump which they show to other schools as a model of carbon reduction. It is not appropriate for our technology so we've been trying to tell them but they don't listen, so that's a source of frustration for us…they don't seem to be able to listen or to take in what we are telling them."

Once the microgrid system was completed the IEHT continued to encounter problems with the council, as described by interviewee E5:

> "We got a small amount of funding from them. And then we had huge battles with them after completion, because they were trying to charge us huge amounts of rates, which we fought tooth and nail until we got it revalued. And then a year ago, the government announced the renewable rates relief, so we now don't pay anything, which is great."

Structural Capacity: External expertise. The IEHT commissioned a study by Econnect, which identified that a micro grid electricity system could be developed for the island, powered mainly from renewable sources.

Once most of the funding had been secured to design and deliver the microgrid, Synergy Scotland Ltd were commissioned to manage the tendering process and then to project manage the development and delivery phases. Scottish Hydro Contracting won the contract, with Econnect Ventures Ltd, Wind and Sun Ltd, Energy Renewed Ltd, G.G.

MacKenzie Contractors as subcontractors (Isle of Eigg, 2014). They first designed the system and then delivered it.

Community Energy Scotland (CES) is the only charity in Scotland providing dedicated support to communities to develop renewable energy projects, (Community Energy Scotland, 2014). They provided funding and practical advice and support throughout the development of the microgrid through their staff based in Fort William, which was greatly valued by the Trust.

Structural Capacity: Funding. The development of the microgrid system cost £1.6m, which was £100K more than the cost of purchasing the island through the community buyout. The costs of this were met through grants from ERDF, Highlands and Islands Community Energy Company, Scottish Community Household Renewables Initiative, Highland Council, Big Lottery, Highlands and Islands Enterprise, HIE Lochaber and the Energy Saving Trust, (Isle of Eigg, 2014). The IEHT arranged an overdraft to manage the cash flow during the delivery phase, as all grants were paid retrospectively. In the end the Trust converted this to a loan and whilst being a relatively small amount compared to the overall development costs, it is still a significant, but manageable amount for a small community.

Each household had to pay a £500 connection fee to the grid and each business paid £1,000 (Ashden Awards, 2010). There is also a daily standing charge payable, 12p for domestic users and 15p for business users and then the actual unit cost via prepayment cards that slot into the electricity metre in a property (ibid.). The unit cost, (originally 15p, but had to be increased to 20p following a hard winter) is the same for all users and is the same whether the system is running on renewable energy, or the diesel generators. There is some thinking on the island that if the unit cost was higher when the grid was running on the diesel generators, this might encourage even more behaviour change to reduce dependency on the generators.

Towards the end of the delivery phase, it became apparent that there would be a small (1.5%, £70,000) overspend if the system was to be delivered as per the design. This coincided with a visit to the island by Charles Kennedy, the then leader of the Liberal Democrat Party and the then Energy Minister. John Booth spoke to both about this potential funding gap. A week later, the Trust was contacted by the Highlands and Islands Enterprise Secretary to make a case for additional funding. They did this and secured an additional £95,000, which enabled delivery of the four wind turbines as planned.

Eigg Electric currently makes a small profit. As a social enterprise, this is not its prime reason for being; but any profits generated are passed to the Trust to be allocated to schemes for the benefit of the island community.

Infrastructural Capacity: Community energy systems. The IEHT decided that there should be a larger hydro scheme and smaller wind turbines than what was proposed in the original feasibility study.

The original plan for the mix of renewable energy sources for the microgrid was for six 15kW wind turbines, 30kW photovoltaics and a small hydro scheme. What was actually installed were four 6kW wind turbines, 10kW of photovoltaics, see figures 10 and 11 and a 100kW hydro system, plus two smaller hydro systems of 10kW and 9kW. As interviewee E1 described, these were important early decisions that had to be made:

> "We had a feasibility study done and we took some decisions……one was the mix between hydro, wind and photo voltaic cells and how that would actually all work and that was linked to the cost, but more importantly it was linked to what we felt was the stability of the system…..initially there was going to be a far larger emphasis on wind than there was eventually, so that was a very fundamental decision to change the mix."

The reasons for this were that there were some problems with the proposed 15kW wind turbines. There was also a point at which the wind element would have to be reduced to 1 turbine due to costs of the whole grid, but due to additional funds being secured from the Scottish government, this did not happen.

Subsequently an additional 20kW of photovoltaic panels have been installed in 2010/11 using funds from the Big Green Challenge, and a further 20kW was installed in 2013, making the total capacity of the microgrid 184kW. This makes a significant contribution to the electricity supply during the normally drier months of May, June and July when there are more visitors on the island.

In addition to the electricity cap agreed at the start of the process, the islanders also agreed to have the electric systems in their premises checked and certified to the Institute of Electrical Engineers Regulation 17 standard. This was done under one contract for the whole island to keep costs to a minimum, which worked out at a standard charge of £300 per property.   There were also wider advantages to getting agreement to the cap usage, as described by interviewee E2:

> “once the residents had agreed to that, that was great because we had a big saving of money. Because then it set an upper limit to the size of transformers you needed and an upper limit to the size of cables that you needed. That was great, that helped to save quite a bit of money.”

Figure 10. Wind farm and An Sgurr

Figure 11. Photovoltaic arrays

The grid is a high voltage distribution grid, with the entire 11km of cabling underground. There are three Sites of Special Scientific Interest (SSSIs) on Eigg and many visitors come to the island because of its unspoilt landscape. The cost of burying the cable across the whole island to each dispersed settlement and property was significantly higher than putting it over ground, but the islanders felt this was essential in order to preserve the biodiversity and landscape of the island and to sustain its visitor economy.

Figure 12. The grid system control centre on the left

When more electricity is being produced from the renewable systems than can be consumed, an array of batteries are charged at the grid system control centre, see figure 12, which provides a back-up system when less electricity is being produced than consumed. When the batteries are fully charged, there are number of heat ‘sinks’ that have been installed into the system to enable the wind turbines to continue to operate under load. These are in public buildings, such as the community hall, lobby and Trust office at the Pier house, in the churches and also at the wind turbine control centre. This is something that wasn’t in the original design.

When the charge in the batteries drops to 60%, the back-up diesel generator is switched on automatically and charges the batteries back up to 80%. The reason for this is that the diesel generators operate most efficiently when they are putting out their maximum current. Above 80% battery charge, the generators efficiency tails off, but uses the same amount of diesel, so setting the 80% battery charge as the upper limit for the diesel generators to reach ensures the diesel generators are used as efficiently as possible.

There are transformers arranged along the system near to houses. There is a twofold tripping system, so if there is a fault and the whole island is switched off, the doctor’s surgery, fridge and the lights in the control building remain on.

In terms of the operation of the microgrid, there are two elements to this; the grid maintenance and customer and demand management:

Grid maintenance. The grid is powered by three sources of renewable energy, four 6kW wind turbines, 30 kW photovoltaics (originally 10kW and soon to be 50kW) and a 100kW hydro scheme, plus two much smaller hydro schemes of 10kW and 9kW. There are six islanders employed to manage the operation of the grid, equivalent to one full time equivalent post. They each have to pass the Electrical Trades Association Safe Working in the Presence of High Voltage Electricity course to be part of the team. As part of their contract, everyone who installs a part of the electric microgrid system has to train the team on this. The system is checked twice a day and there is an on-going maintenance schedule that the team undertakes, see figure 13. The team are paid for the hours they work as self-employed individuals.

Figure 13. The hydro system being maintained by one of the team of six employees

Customer & demand management. Each house and business on the island has an OWL metre that monitors the electricity usage in the property at any given time. It has an alarm that can be set to alert the occupier when a selected amount of electricity is being used. If the consumption reaches the capped limit of electricity, then the supply is cut off and has to be reconnected by one of the trained members of Eigg Electric Ltd staff.

There are times during the year, particularly when there is little wind and no rainfall when the diesel back-up generators may have to be switched on. This is mainly during

May, June and July. The cost of running the diesel generators is approximately £1,000 per week at 2012 figures. In order to keep costs to a minimum, the islanders have introduced a traffic light system at the pier. When there are low renewable energy sources available and the frequency of cycles of electricity being produced drops below 50, this is a red light day; a red light goes on and emails and messages are sent around the island to let everyone know. The islanders can then change their pattern of electricity usage, which generally reduces consumption by around 20% and avoids or reduces the need for the diesel generators to be switched on.

The IEHT has also invested in energy efficiency measures in properties on Eigg, such as: installing insulation in all of its properties at no costs to the tenants (private owners have installed insulation in their properties at their own cost); offering grants from the Big Green Challenge award prize money of 50% of the costs of equipment to reduce carbon emissions up to a maximum of £300 (Ashden Awards, 2010). This includes bikes, secondary glazing and solar water heating.

Future energy plans on the island include:

The development of a wave powered system, being developed by students at Dundee University. It is intended that Eigg Electric Ltd would receive the electricity generated for free, whilst the university would receive any FIT.

Discussions are underway about developing renewable sourced heating systems on the island. Small pilots of solar water heating in three properties, funded with Big Green Challenge award grants, have reduced the cost of heating and hot water. Plans include looking at wood fuelled heating systems, and a feasibility study has been undertaken to assess the stock of wood as a fuel on the island. Whilst plans are at an early stage, wood already provides heating for some islanders and the school and it is recognised that there is real potential for providing more renewable powered heating systems from wood on the island as interviewee E6 commented:

> "The balance certainly long term would be to more or less develop woodland for wood fuel systems and to manage the woodlands for that in that way."

Due to the dispersed nature of the settlements on the island, it is thought unlikely that one district heating scheme could supply everyone on the island. It might be possible to have a number of smaller systems, but building on the feasibility study, more work is needed to look at how the scheme might work and how wood on the island could be harvested for this.

5.4.4 *Communication*

Individual and Cultural Capacities: The role of trust and the individual. One of the first things that had to be communicated and agreed was the approach for developing the microgrid, including getting agreement from all islanders to the 5kW and 10kW caps described earlier. This was done by consensus and was led by John Booth, described by interviewee E2:

> "we decided that we needed to cap the supply to people and so I did a pitch to the residents. I mean, we could have imposed it because the constitution of a company as such allows you to do that. But we didn't, we discussed it with them. And we proposed a cap to households of 5kw and businesses at 10kw, and everybody agreed to that, you know, like 100%."

A large amount of trust developed in the individuals leading the microgrid development, which evidenced itself with most islanders being happy for this to be taken forward by a core group, but to be kept informed and consulted on some of the broader issues, as noted by interviewee E5:

> "Folk in general were quite happy to let a group of people just take it forward. You know they weren't so much worried about the nitty gritty of it – it were more a sort of a broad discussion that they were having."

Structural capacities: strategy and policy. In the initial stages when the idea of developing an island wide microgrid was being considered, this was led by IEHT and ideas were discussed at every stage at Residents Association and Trust meetings, as interviewee E5 explained:

> "Obviously before we had the power system there were a lot of meetings where we discussed every aspect of the how the system – how folk wanted to see the system…it went right through the whole things to things like…we asked people what were the maximum they would pay for their electric, what kind of

range, what they would think were a reasonable unit charge and also things like the cap we've got".

During the development of the scheme and its ongoing operation, proposals were put forward by Eigg Electric Ltd to the Residents Association, which meets once a month and the Residents Association makes a decision whether to accept the proposal or not. Interviewee E5 described an example of this:

> "So, for instance, there was a proposal to put the unit charge up by a penny. So Eigg Electric Directors agreed that was a good thing and then that went to the Residents Association and everyone accepted that that were probably necessary and that's what we did."

Decisions by the Residents Association are then taken to the next Trust meeting and are adopted, as the Residents Association, in compliance with the Land Reform Act (Great Britain *Land Reform (Scotland) Act Elizabeth II*. (2003)) are in a majority on the Trust. This participatory approach to local governance of the microgrid is the kind of system that is considered essential for communities in moving towards long term sustainable change (Rydin, 2010 p58, pp.138-9; Ostrom, 2009; Barton, 2000 p.248)

On a day to day operational basis, the six part time employees of Eigg Electric communicate directly with each other. A rota is developed by the team leader, with two team members on duty at any one time and the sheets that are completed for the daily inspections and other routine tasks are collected and returned to the company secretary. If there is a major problem, then all members of the maintenance team meet at the electricity control centre to deal with the problem.

When the electricity from renewable energy sources is low, an email used to be sent round the island asking for people to be careful with their electricity use and data showed that consumption reduced by about 20% during those times. A young islander had the idea that this could be done in the form of a traffic light system, described by interviewee E2:

> "And now what we've got down at the pier, is we've got an actual traffic light and what we do is we have it connected in, so that when the frequency goes above 50.1 cycles the green light comes on, and when it drops to 50 cycles the

green light goes off and the red light comes on. Because when it's at 50 it means we're likely to run the generator."

A number of information boards have also been installed on the island to inform visitors about the microgrid, see figure 14.

Figure 14. Green Island and Eigg Electric Information Boards

Structural Capacity: Sharing learning. There is a large amount of information sharing undertaken by people who have been involved in the development of the Eigg microgrid system. One of the requirements of winning the Big Green Challenge was to have a website in order to share information and so Island Going Green website was set up (Island Going Green, 2014a). There is also an Isle of Eigg website (Isle of Eigg, 2014), which provides a range of information about the island including Eigg Electric and the Big Green Challenge.

Many people visit Eigg in order to learn about how the microgrid was developed and how it operates. This includes a visit each year by a group of international students on a Masters course at Dundee University. Whilst everyone is very welcoming, it does take up a lot of people's time and managing that is an issue that still needs to be resolved.

However, there is also a feeling on the island that they have been able to achieve so much as far as the microgrid is concerned, in part because of the support and expertise provided by others, so the help they are providing to others is a continuation of this, as interviewee E5 commented:

> "I think we all feel that we got such a lot of help over the years from other groups that had done things before we had and random people round the edges that helped along the way, that you feel like it's part of the thing, that you share information with people"

In terms of networks, The IEHT is a member of the Scottish Islands Federation and the European Small Isles Network and islanders attend conferences and events to exchange information on a range of issues including their microgrid. They have been instrumental in gaining interest through these bodies in the possibilities of renewable energy for island communities, which includes a conference held in September 2012.

As a condition of funding, regular monitoring reports on the development and operation of the microgrid are provided to funding bodies each September by Eigg Electric Ltd. This includes information downloaded from the microgrid computer, including how much electricity of produced from renewable source s during the year. Information is available on the websites about the microgrid and The Big Green Challenge, but there does not appear to be any formal evaluation of the microgrid system of its impacts.

5.4.5 *Outcomes*

The biggest achievement has been the successful development and operation of a reliable microgrid for the whole island community of Eigg, powered mainly from renewable energy sources. The grid was switched on on 1st February 2008 and has averaged 85% of its electricity produced from renewable sources to 2012 as follows:

Year 1 95%

Year 2. 75%

Year 3. 85%

Year 4 83%

Island Going Green (2014b).

Diesel generators at each property are now a thing of the past, along with the associated noise and emissions and has done away with the need for expensive, time consuming and labour intensive transport of diesel from the mainland for individuals.

In January 2010, the community also won the National Endowment for Science Technology and the Arts (NESTA) Big Green Challenge, sharing the £1m prize money with 3 other winners. It had been the only Scottish finalist of the ten communities who were set the challenge to see how far they could reduce their CO_2 emissions in 12 months   A Green Group was formed as a sub group of IEHT and with 75% participation by the community, got agreement that Eigg would make the best use of its natural assets and to be less dependent on fossil fuel. They won a £300,000 share of the prize money.   It has used this money for a variety of things to reduce carbon emissions on the island, one of which is described by interviewee E4:

> "the first thing that we did when we won the grant, the money, is to spend half, a third of it on doubling our photovoltaic array, so that we could reduce further our dependency on diesel generators when there is no wind or sun, or both, which does happen sometimes."

A further 20kW was added to the photovoltaic array in 2013 funded by Big Green Challenge.

There are a number of benefits that the mainly renewable powered microgrid has brought to the island. The main one of course is a reliable, continuous supply of electricity for all properties on the island, which is cheaper than the previous system of individual diesel powered generators, as acknowledged by interviewee E3:

> "I can state categorically it's been cheaper than trying to run generators and more reliable. In fact it's been environmentally beneficial."

Another significant benefit has been a reliable high speed, broadband system. This has been a great help for existing businesses, as described by interviewee E3 said:

> "I pretty much rely on it for almost everything, from the banking to enquiries and the website and everything like that"

It has also enabled people to return to and set up businesses on the island, with much of their trade generated through access to the internet as interviewee E3 noted:

> "one of the things that that does is enable people to do work here and that's maybe bringing money in from outside. Whereas before it all had to be generated from here, so that's quite good and bringing business."

However, the broadband system is not completely independent of the national grid, as it relies upon a transmitter at Arisaig on the mainland, so when there is a power cut at Arisaig the broadband on Eigg doesn't work.

Another benefit is the strong belief that the development of the microgrid has brought stronger community cohesiveness to the island. Development of the microgrid gave confidence to the islanders that they had a real chance of winning the Big Green Challenge, which they went on to do and the prize monies enabled the island to undertake further works to reduce carbon emission on the island.

It is also thought that having a reliable electricity supply may have contributed to the population increase on the island, up from a low of 63 to 91 in 2012. Some of this increase is as a result of new comers to the island, but a significant number are people, returning to the island, who had left to follow careers. In part, this is a consequence of more opportunities to run a business as a result of the microgrid enabled broadband system. It has also enabled the shop to stock a much wider range of products, as it is able to run fridges and freezers.

On a macro scale, the shift to a mainly renewable powered electricity microgrid away from individual diesel generator electricity systems in each house and business premises has significantly reduced CO_2 emissions on the island. There has been a 47% reduction in household CO_2 emissions from 8.4 to 4.45 tons per year, making household CO_2 emissions 20% below the UK average and with the 5kw and 10kw cap applied, household electricity usage is 50% of the UK average (Ashden Awards, 2010).

Islanders feel that living with the electricity cap is perfectly achievable, as described by interviewee E4:

> "We can demonstrate to the rest of the country that you can live perfectly comfortably within that 5-kw allowance and that you don't really need more than that. It's a question of managing your energy needs"

Figure 15. Summary of capacities and outcomes on Eigg in the delivery of the renewable powered microgrid

5.5 Ashton Hayes

Data on the development of AHGCN was obtained through documentation, direct observation and six interviews. Interviews were undertaken with representatives of the following groups: AHGCN, University of Chester, Local authority officer and member, the electricity DNO industry, the primary school.

Figure 16. Ashton Hayes road sign

5.5.1 *Background*

Ashton Hayes is a village approximately eight miles west of Chester with a population of around 1,000 and approximately 350 dwellings (Edwards, 2007; Ashton Hayes, 2011). It falls within the local authority boundary of Cheshire West and Chester and is in the county of Cheshire.

5.5.2 *Problem Formulation*

Cultural & Structural capacities: Rationales WSESS. The idea for AHGCN came from long term Ashton Hayes resident Garry Charnock. By 2005 Garry had lived and run a publishing business in the village for over 20 years. He took a year's sabbatical and attended a debate organised by Greenpeace at the Hay-on-Wye book festival between the Government Chief Scientist, Sir David King and the then Chair of Shell, Lord Oxburgh. The focus of the debate was what the Government and private sector companies like Shell were doing to tackle climate change and its impacts. At the end of the debate, they received a standing ovation and Sir David King challenged everyone in the audience to think about what they could do to reduce their own impacts on climate change.

Garry continued to think about this and he had an idea whether a community could become carbon neutral and that Ashton Hayes could be an ideal 'petri dish' to try this out. He felt if it couldn't be made to work in what was considered to be a very nice community, then it would be much more difficult in places facing other challenges.

Following the initial meeting described in the Structural Capacity: Vision & Strategy section below, there was overwhelming support from the community to start AHGCN and the rationale for doing this was environmental; a concern about climate change.

Cultural capacity: The importance of place for energy self-sufficiency. Tukker et al (2008) show that feedback on the collective impact in reducing carbon emissions is a significant element in empowering people in changing to more carbon reducing behaviours in a community. AHGCN members also feel that the whole village approach has been key to this, as interviewee AH1 described:

> "I think by making it a whole village thing, it never became a kind of exclusive group of middle-class do-gooders who thought that they knew best and were going to tell everybody else what to do. It was, each person in the village could draw from it what they wanted, whether it was just, "I'm going to change my light bulbs," or, "I'm going to recycle more," or, "I'm going to get rid of my second car," or, "I'm going to put solar panels on the roof." It was a massive, because we offered everything, then people just took out of it what they could or would. And as people were successful with the smaller things, they themselves began to look at, "Oh, that worked, what could I do next?" and saying to people, "If you only do one thing, that's better than not having done it at all."

Individual Capacity: Skills. Having a wealth of experience in the print media, including working as a journalist for national newspapers, Garry understood the value of media interest and chose a title for the project; for Ashton Hayes to aim become the first carbon neutral village in England. He then decided he needed to test his idea out, so met some friends in the pub and asked them what they thought. They were all supportive, including Roy Alexander, a professor at the University of Chester and an Ashton Hayes resident, who offered support from the university.

Garry contacted the Energy Savings Trust to see whether any other communities had already adopted this idea. He was told that Fintry, a village in Scotland had already set an aim to become a carbon neutral community, but nowhere else in England had.

Structural Capacity: Vision & Strategy. The public meeting was held on 26th January 2006 at the primary school, see figure 17. English champagne was served and the WI served homemade apple pie and cream. On what was a bitterly cold evening, over 400 people attended the event, more than 75% of the adult population of the village. There were so many people that they couldn't all fit in the hall at one time, so groups were rotated around classrooms and the presentations in the main hall were given a number of times.

Figure 17. Ashton Hayes public meeting in January 2006, (attended by 75% of the adult population and recorded and transmitted by the BBC World Service) photo courtesy of Aston Hayes Going Carbon Neutral

There were a number of presentations by the Energy Savings Trust and the County and City Councils among others and a very short one by the embryonic AHGCN team outlining what was being proposed; that the University of Chester would support the project for five years, doing survey work to monitoring carbon emissions by the village community and that advice and support would be provided for people to help make behaviour changes to reduce their carbon emissions, as interviewee AH2 commented, the audience were told:

> "We don't want you to spend any money; we want to see how we can reduce our carbon footprint by just behaviour change. And we'll give you advice on, the university will give you advice, we'll all give you advice on what you can attempt to do and we'll just measure it."

Having a high level, long term vision was considered very important in terms of motivating people to change behaviour, as also noted by interviewee AH2:

> “if we’d said, “Let’s save 10% carbon footprint,” then we’d have done it…..long ago. So having a long-term vision is what will get people engaged. If you don’t have something that’s big then it’s harder to get people incentivised I think. So that’s very important.”

This supports earlier research findings that having such shared visions can be very powerful, and can lead to co-operation on the issue through the bringing together of local stakeholders (Mårtensson and Westerberg, 2007).

The approach in Ashton Hayes is quite different to that of Eigg, with the initial focus on supporting people in the community to reduce their CO_2 emissions through changing their behaviour, rather than installing renewable energy systems straight away. To that end a survey was developed by Professor Roy Alexander and students at University of Chester, with support from the University of East Anglia’s Carbon Reduction (CRed) team and using a range of web sources, such as The Energy Saving’s Trust and DEFRA (Alexander, Hope and Degg, 2007), as Professor Alexander explained:

> “the first thing we are going to do is find out where we are starting from, so hence, we did a baseline carbon footprint survey. And that was developed to look at three things: home energy use, car travel and other travel including flights.”

In May 2006, Six level five undergraduate students from the University of Chester undertook the survey work in the village as part of a Work-Based learning Module, either face to face or via a questionnaire dropped through their letterbox. If people didn’t want to take part in the survey, they were provided with stickers to put in their windows saying ‘No thanks’ – see figure 18:

No Thanks!

Figure 18. NO thanks sign, Ashton Hayes. Image courtesy of AHGCN

This first survey resulted in 167 questionnaires being completed, approximately 45% of households in the village (Alexander et al, 2007). After about four weeks, everyone who had taken part got their own survey results, including a pathway of suggestions as to how they could reduce CO_2 emissions. This survey provided the baseline of carbon emissions by the community, focussing on home energy, home energy use, car and other travel including flights. The data was used, together with national average data to develop the carbon emission model for the village by Professor Roy Alexander and his students at Chester University.

During the first three years AHGCN held carbon clinics in the pub and joined existing events in the village to provide advice, support and signposting on ways people could cut their carbon emissions.

The survey was repeated the following three years. In the first year the carbon emissions of the village had reduced by 20%. The survey results from the second and third year showed that an additional 3% reduction had been achieved, so a total of 23% CO_2 emission reductions in the first three years, mainly from behaviour change.

At the third annual meeting of AHGCN, the audience said they didn't think they could achieve much more in the way of CO_2 emissions reductions from behaviour change and discussed what else could be done. The suggestion was made for AHGCN to look at developing renewable energy systems. A vote took place the decision was almost unanimous to look at developing renewable energy systems for the village, so this started the next phase of AHGCN to look at local production of renewable energy with a feasibility study on a microgrid for the village being undertaken.

Structural Capacity: Government & Governance. At the start, Garry was mindful that this was an idea from an individual, albeit now supported by a few individuals, and felt it was important to have get a democratic mandate for the idea, as he described:

> "Well look, I feel that this has to be democratic. You cannot suddenly, one person stand up and say, "I'm going to make this community carbon neutral." You have to get the community behind you with a governance process. So I decided that I would go to the parish council and ask for a ten-minute spot as a citizen at the parish council meeting."

At the Parish Council meeting on 14th December 2005, the University of Chester, the Energy Savings Trust and a number of others were in the audience whilst Garry presented his concerns about climate change; how Ashton Hayes could try this approach to become the first carbon neutral village in England and that he would like the Parish Council's support for this. He committed that if the Parish Council supported the idea it would never using any money from the Parish Council precept to fund it and he would run the project for five years.

The idea was supported by the Parish Council by a vote of three for to two against, with three conditions: that Garry would become a Parish Councillor, that he had to demonstrate that the majority of the community supported it through a public meeting to be held within a month and that lessons learned would be shared with other groups and communities.   The support from the Parish Council was important as it also provided legitimacy for the project with external bodies and the community.

Within 72 hours of the Parish Council meeting Garry had raised £3,600 plus pledges of staff and other support from local business to host the public meeting. The meeting described above was then arranged. He had contacted the local press and used some of the funds to have road signs made stating 'Ashton Hayes Going Carbon Neutral – Aiming to become England's first carbon neutral village', see figure 19.

Figure 19. Garry Charnock with the Ashton Hayes road signs

photo: courtesy of AHGCN

These were put up without any permission, with the aim of giving the press something to photograph, because as interviewee AH2 put it:

> "climate change is really difficult, because there's nothing to photograph"

Early on AHGCN adopted a number of 'Big Rules' that have guided the approach ever since. They are:

- 'Our project is owned by Ashton Hayes Parish Council
- Our aims are two-fold:
  To help Ashton Hayes become carbon neutral
  To share our experiences and inspire others
- This is a journey towards carbon neutrality. We do not know when we will get there
- It is a non-political 'grass roots' project
- We are a non-confrontational group
- We recognise human activity is contributing to major climate change but we do not apportion blame or point the finger at anyone
- We welcome everyone to join in and support our aims
- We do not focus on the threats of climate change, more on the benefits of taking action'

AHGCN (2014)

These Big rules have been described as the golden thread running through everything AHGCN does, but are not necessarily visible all the time. Two of these have been credited with the ability of AHGCN being able to maintain control over decision making; to be apolitical and to be non-confrontational (Hope & Alexander, 2008). To ensure AHGCN was apolitical the AHGCN team decided that they wouldn't allow politicians to present to them, but would be happy for politicians to attend the public meeting to listen.

Infrastructural Capacity: Energy Infrastructure & renewable resources. Following the decision by the community to investigate renewable energy systems in the village, a Feasibility study was then commissioned on developing a renewable powered microgrid for the village, funded by a grant of £86,558 from Carbon Connections UK, an investment body based at the University of East Anglia and undertaken by the University of Chester and EA Technology Ltd. This was in collaboration with Ashton Hayes Parish Council and a Memorandum of Understanding for the study was agreed by the council in April 2008 (AHGCN, 2014).

The aims of the feasibility study were that it:

- 'Finds a mix of generation that is likely to be generating at the same time as power is consumed.
- Provides an economic model for metering, billing and buying and selling any deficit or surplus in locally generated power with a licensed supplier.'

(Gillie, Carter and Alexander, 2009)

As the study progressed a number of additional requirements were made for a model for Ashton Hayes, to enable the community to control the microgrid and benefits to the community arising from it, but also to enable compliance as far as possible with the existing regulatory framework. These were:

- ‘The community or members of it should own the generation;
- Incentives should encourage as much as possible of the locally generated power to be used by the community;
- The community should be empowered to make decisions about how the energy it produces is shared between its ‘members’; and
- The model should be simple, workable, inclusive, replicable and sustainable.
- Generation equipment should be owned by the community as a whole, rather than by individuals within it;
- Households and businesses within the Microgrid area should be able to choose to ‘opt-in’ to buying their energy from the community or to maintain the existing arrangements with a licensed supplier, in order to preserve consumer choice; and
- A number of communities developing the model should be able to work together to use economies of scale to minimise their overheads and thereby produce energy at the lowest cost possible.’

(ibid.)

An area was identified for a potential microgrid trial along and around Church Road, incorporating a number of community and public buildings, (i.e. church and primary school) and some housing.

The approach adopted would need a significant amount of demand side management to match demand as closely as possible to supply available through a microgrid. Therefore the study looked at how generation (supply) and demand could be matched. Generation capacity was estimated from wind and solar energy sources; wind energy measurements were taken at two locations and solar energy at one near the proposed microgrid. Demand was measured by Scottish Power Energy Networks a local Distribution Network Operator (DNO) providing the load profile for one of the feeders in the village, together with individual residents using Wattson monitors to measure their consumption.

Cultural Capacity: Boundary objects. In Ashton Hayes, the original boundary object was the idea of becoming a carbon neutral settlement. At the start this drew together the initiators of the ideas, the local parish/community council, local residents and businesses. As the idea translated into delivery, more actors became engaged, but with more obviously different reasons for this. In Ashton Hayes, this involved a local university that wanted to develop an area of research, representatives from the electricity distribution network operation sector who wanted to better understand what developing a distributed electricity system would have on the distribution network and funders who each wanted to 'buy' carbon emission reductions with their funding.

5.5.3 *Mobilisation:*

Individual Capacity: The role of the individual in moving WSESS. AHGCN has a core of four people, plus 30-50 volunteers who get involved as and when needed.

Garry Charnock has been the driving force behind the AHGCN project since the start and was the originator of the idea. He has used his considerable skills and talents, described above to develop support within the village for the idea and it has resulted in a 23% reduction in CO_2 emissions in the first three years, primarily through behaviour change. He is also a member of the Community Energy Company.

Roy Alexander is a Professor of Environmental Sustainability at the University of Chester. From the start, he committed that the University of Chester would support AHGCN for five years and that his MSc students would undertake the surveys in the village. He has hosted a conference at the University of Chester on behalf of AHGCN and worked on different aspects of the microgrid development. He is also a member of the Community Energy Company.

Kate Harrison has been involved in AHGCN since the launch event in January 2006. She is a resident in the village and has provided support to all aspects of the development of AHGCN, including giving presentations and she is now also involved in running the community shop. She is also a member of the Community Energy Company

Mary Gillie got involved in AHGCN at an early stage through EA Technology and has provided much of the technical expertise looking at the impact of generation, how a community could really benefit from using their own generation and working with the local DNO to investigate its impact on the network and how that could be changed. She is also a member of the Community Energy Company.

Structural Capacity: Government & Governance. AHGCN has continued as a sub group of the Parish Council and all AHGCN funds go through the Parish Council accounts. It provides a level of, accountability and democracy for AHGCN, as interviewee AH1 described:

> "in order to keep … it as a village thing, if you like, and not someone's vanity project, then by doing it through the parish council, it gives legitimacy to us from the outside world, but also it gives legitimacy within the community as well."

There is a feeling that there have been benefits for the parish council of being involved in the AHGCN project, in that it has invigorated the parish council.

One of the actions identified in the microgrid feasibility study was to develop a community renewable energy company. This was launched in January 2012, called Ashton Hayes Community Energy Company, a Community Interest Company (CIC), with advice and support from Carbon Leapfrog to do this. It aims to manage renewable energy generation in the village, with any profits generated being ploughed back into projects that make the village more sustainable, (AHGCN, 2014). The company is in its early stages of operation.

Initially there were two tiers of local authority, Chester City Council and Cheshire County Council. Since 2009, the Council is now unitary - Cheshire West and Chester Council. The councils attended and presented at the launch meeting in January 2006. There are mixed views of how supportive the local authorities have been, from useful, but not critical, as the process has been very much bottom up, but it keeps AHGCN at the forefront of things, as interviewee A3 noted:

> "It was extremely helpful, just in terms of credibility at the simplest level."

A different view is that AHGCN has been 'doing the council a favour' (Hope & Alexander 2008). Yet another view is that they have contributed very little and then mainly in terms of staff resource, only contributing financially to projects when there is a potential threat of less favourable media coverage, such as the funding for the footpath to Mouldsworth train station. There is also some frustration as to the lack of understanding by the councils that everyone involved in AHGCN works as a volunteer on the project, so whereas council staff are paid for they work they do with AHGCN, each request they make of AHGCN has to be undertaken by a volunteer (Hope and Alexander, 2008). It could be argued that the councils (district, council and now unitary) have benefitted more from having AHGCN in their area than AHGCN has benefitted from the councils' involvement. The Councils have used AHGCN as a good example of what communities can achieve and have promoted this. There has also been representation by people involved in AHGCN on several of the councils' bodies from the Climate Change Ginger Group to the Sustainability and Carbon Reduction Commission. AHGCN also facilitated access by the council to the University of East Anglia's (UEAs) CRED package, an online carbon reduction pledging package. Due to close personal links UEA had already made this freely available to Ashton Hayes.

The apolitical Big Rule has also been viewed as of benefit by elected members, as interviewee AH4 commented when asked whether this had been a constraint:

> "I think it's probably had the opposite effect to be quite honest with you. It allows people to see me then as representative of Cheshire West and Chester rather than a member of the Going Carbon Neutral group. It splits the two quite nicely for me which I can work to good effect, and use to good effect. I think it………was the right decision for the project, the carbon neutral project, to make at the beginning. We refused offers, I say 'we', the village refused offers from MPs, 'cause this within eighteen months it was global news and we had TV crews everywhere. And you can imagine the number of requests we had from MPs saying; well, I wouldn't mind coming and having my photograph taken there. And they quite rightly resisted it."

Structural Capacity: External expertise. Scottish Power Energy Networks, the local DNO has effectively adopted Ashton Hayes and now monitors all of the energy consumed and patterns of consumption for the entire village. They are interested in learning what happens when the community starts generating its own electricity and how Demand Side Management (DSM) can be used alongside this to match generation and demand and what will the impacts of this be on the network.

As described earlier, the University of Chester has been involved in AHGCN from the start, providing staff and student resource to develop the carbon footprint model and undertake and analyse the carbon survey work. It has also provided venues for events and has been a partner in a number of the studies undertaken, such as the Microgrid Feasibility study and has provided credibility to AHGCN in academic circles.

EA Technology is a company working in the electricity distribution network. Historically the electricity distribution network in the UK has been just about managing generation and getting electricity along a system to the consumer. However there are increasingly lots of smaller electricity generators and EA technology were interested in looking at how to manage how people use electricity and how to balance generation and demand. EA Technology approached Ashton Hayes as they were interested in working with people to look at how a community could benefit from generating its own electricity, the impact of this on the distribution network and how it could be changed. They have invested a significant amount of time and resource into investigating these for the development of a microgrid. They have been working with a Distribution Network Organisation (DNO) on the trial microgrid area in Ashton Hayes, looking at profiles, integrating generation and new ways of managing their network.

The benefits for EA Technology of investing this time and resource on the projects in Ashton Hayes are: it is an area that now has considerable funding from the DNOs and they are ahead of the game in the industry, having gained a lot of experience in dealing with communities, they have also gained a lot of very positive PR.

Carbon Leapfrog has provided legal expertise to AHGCN on the structure and operation of the Community Energy Company.

Structural Capacity: Funding. The AHGCN approach was a low cost approach at the outset, when the focus was on reducing CO_2 emissions through behaviour change and energy efficiency measures. Villagers were mainly taking individual actions on this. However, there have been a number of elements that have been funded:

£3,600 was donated from local businesses for the launch event in January 2006.

£26,000 was given to AHGCN from DEFRA’s Climate Challenge fund to share their lesson learned with other communities and organisations. This funding was for travel expenses only.

£86,558 was given by Carbon Connections UK, an investment body based at the University of East Anglia, which funded the Microgrid Feasibility study.

£400,000 prize money was awarded to AHGCN from DECC's Low Carbon Communities Challenge and the plan was for this to be used to start the potential microgrid.

EA Technology and Scottish Power Energy Network have both committed a significant amount of resource to investigating how the electricity network can support development of distributed electricity systems, such as the proposed Ashton Hayes microgrid, but the financial value of this is unknown.

There will be future funding requirements as renewable energy generation and the development of the microgrid in Ashton Hayes progresses. The Community Energy Company will need to identify appropriate funding models for this.

Infrastructural Capacity: Community energy systems. In 2010, AHGCN were awarded £400,000 prize won from DECC's Low Carbon Communities Challenge and the plan was for this to be used to start the microgrid by funding a CHP unit, a seasonal heat store and photovoltaic panels at the school, plus wind turbines. Due to a Comprehensive Spending Review, resulting in delays to the grant being given, this did not allow enough time for the CHP unit to be delivered and installed by the 31st March 2011 deadline. However, AHGCN got approval from DECC to use the grant to build a new pavilion with photovoltaic panels, air source heat pump, high levels of insulation and a community electric car as an energy store, see figure 20.

The findings of the microgrid feasibility study were:

Technically it is possible to develop a microgrid for Ashton Hayes. However, the biggest obstacle was the existing Balancing and Settlement Code. In order for a microgrid in Ashton Hayes to work, there would need to be changes to this system to enable small generation networks to link to the national grid, so that they could draw power from it when there is not enough generated locally and feed power into the grid when more is being generated locally than consumed. This would involve half hourly metering and the setting up of a community energy company that had a relationship with a generator and licensed supplier. In order for this microgrid model to be developed, smart meters would need to be installed in all properties. This is planned to be rolled out nationally by 2020. The study also identified a number of actions that could be taken to progress a microgrid for Ashton Hayes (Gillie, Carter and Alexander, 2009).

The school could act as a hub for a microgrid, as it had a large roof surface area for photovoltaic panels, could use heat from a CHP unit and would be close to the location of any wind turbines. 15kW of photovoltaics were installed in the school, following a delay due to the roof being found to be structurally unsafe to have the panels installed. Cheshire West and Chester Council agreed to bring forward building an extension to the school in order to replace some mobile classrooms, which enabled the photovoltaic panels to be installed, see figure 20. However, the delays resulted in a deadline for FITs being missed due to changes with the FIT, but AHGCN had not been informed of these changes.

Figure 20. The carbon neutral pavilion, community electric car and photovoltaic panels installed at the school. photo courtesy of AHGCN

The result of the various delays meant that the microgrid as envisaged in the funding application didn't happen, the renewable installations at the pavilion and the school are stand alone. However, it is hoped that as the microgrid project develops that these systems can be integrated into the microgrid.

5.5.4 *Communication*

As with Eigg, communication on AHGCN has been twofold; with and between villagers and key stakeholders and the sharing information with external organisations and individuals. Exploiting the potential of the media was a high priority for AHGCN from the outset, due to Garry's knowledge and experience of the power of the media, as he explained:

> "I decided on that title [becoming the first carbon neutral village in England], because one of the things I knew was, if we were going to do this we needed free communication and having a title like that gets you free press. As a journalist I know."

As a consequence, media interest and coverage from the very start has been extremely high, although at times, the level of this has even surprised Garry. The coverage has in turn has led to political and wider public interest. As Garry went on to state:

> "The power of the media is fantastic, if you know how to use it."

Gaining good media interest has had three benefits; one has been to encourage local people to make and continue to make changes to behaviour in order to reduce their energy use and carbon emissions through realising that there is real interest in what they are doing, secondly it has worked as a tool for obtaining other support, such as funding from the council for the footpath to Mouldsworth train station and thirdly it has inspired and encouraged other communities to embark on projects to reduce their carbon emissions.

Individual and Cultural Capacities: The role of trust and the individual. As a former journalist, Garry Charnock understood the media industry and how to use it effectively, including how the threat of adverse media coverage can play a crucial role in decision-making, such as the decision to retrospectively grant planning consent for the pavilion and to get the funding approved for the new footpath to the station.

It is widely recognised that a lot of trust has been built within the village of AHGCN, not least because the leaders of this have kept all their promises. Interviewee AH5 commented on the importance of having this from within the community:

> "I think, you know, you do need at least something like a Garry or an Alex to get things going. I've seen in other places where maybe there aren't really those capabilities in the community, where other people from outside have, you know, gained the trust of the local people and provided that role but it takes quite a long time to build that up"

Such ‘pioneers’ are recognised as having a crucial role to play from the early stages of community energy transitions (Hauber and Ruppert-Winkel, 2012).

Under Garry’s guidance a film was also made at the start, showing the commitments that villagers made to reduce their carbon emissions. The film was shown to everyone in the village and has been a powerful tool in spurring people on to make the changes. One of the things that members of AHGCN believe has been key to its success has been the Big Rules.

The website described later was set up at an early stage (AHGCN, 2014) and has provided information to both local people and stakeholders and to external individuals and organisations.

Structural capacities: strategy and policy. From the start there was a huge amount of media interest in the story and vision of a small village trying to become the first carbon neutral village in England. Garry Charnock described how he went about getting this:

> “because we tried to call it, ‘attempting to be the first carbon neutral village’, I press-released that…and I also took out for lunch the editor of the Chester Chronicle newspaper and said, “Would you support this project?” And he said yes, he was interested, he’ll do regular features on it……I knew from my journalist experience that if you get a story in the Chester Chronicle, all the nationals, every week, scour the locals for stories and that they would pick it up. So, they did. So within a month, we started getting press enquiries and we had BBC Granada News and ITV News come with their satellite trucks in the village to interview people.”

Media coverage has included: Chester Chronicle, The BBC World service , articles in all national newspapers, BBC Radio 4 Today programme, The Big Issue, Television or newspaper coverage in Germany, Norway, Romania, Canada, Sweden, Brazil, New Zealand, Mauritius and France, BBC Radio 5 Live, ITV News, BBC Newsround and The Financial Times magazine.

Structural Capacity: Sharing learning. This has been another key element of the AHGCN approach from the outset. AHGCN set up a website (ibid.) very early on in the process and used it as a means to communicate both with the local community and a wider audience. Notes of all meetings are uploaded, a diary of all work and meetings that AHGCN is involved in since the outset, together with videos and reports produced, including the results of the annual surveys, information about upcoming events and activities, news and links to other sites/sources of information and media. It is kept up to date and receives thousands of hits per month.

In recognition of the work being done in Ashton Hayes, in 2007/8 AHGCN received £26,000 from DEFRA's Climate Challenge Fund in order for them to share their lessons learned with other communities and organisations. This funding was for travel expenses only. Since 2006, members of AHGCN have presented to over 150 different organisations.

Founder Garry Charnock has been a member of DECCs Community Energy Contact Group, which met monthly to provide informal advice to Ministers and DECC staff as they developed the Community Energy Strategy (DECC, 2014a).

AHGCN members have met and advised the Commission for Rural Communities, various Ministers and MPs, given evidence at the Parliamentary Select Committee on Environment Food and Rural Affairs (Hope & Alexander, 2008). They have also advised the Big Lottery Fund and AHGCN has developed strong links with the Norwegian island of Nøtterøy to advise them on using their carbon toolkit (Charnock and Alexander, 2007).

5.5.5 *Outcomes*. Arguably there have been a large number of achievements of the AHGCN approach:
Whilst local renewable energy generation so far has been relatively low, significant progress has been made reducing energy consumption and there is still a real appetite in the village to work towards becoming carbon neutral and to develop the microgrid for the village. The Community Energy Company has been set up and there are plans to develop wind power, whether through turbines or ridge blade systems, which could be installed on the roofs of houses.

AHGCN has directly involved 45% of the village, achieving a 23% reduction in CO_2 emissions in the first year three years of AHGCN through behaviour change, (reduced to 20% by year five, (Alexander et al, 2010); switching to more energy efficient equipment and through installation of renewable energy systems in some properties.

There were two rules that were put in place for anyone wanting to do an article or piece about AHGCN; that journalists/presenters had to speak to people/families in the village and they had to buy a meal in the village pub, the Golden Lion, so they were putting something back into the village.

A toolkit was developed in 2007 with the University of Chester, funded by DEFRA's Tomorrow's Climate, Today's Challenge initiative (Charnock and Alexander, 2007) so that other communities could learn how to follow the Ashton Hayes example of working towards becoming carbon neutral. This is freely available on the AHGCN website, with the only request that AHGCN is credited by users.

The involvement of private sector organisations that have worked with the community to progress the work on developing a microgrid system has been a great benefit. The business benefits by piloting work that will put them in a strong position as the interest grows in distributed energy systems and how these can connect to the national grid. The benefit to Ashton Hayes has been access to technical expertise in these areas.

AHGCN was awarded £26,000 DEFRA Climate Challenge funding for travel expenses to share their experiences.

The first Grassroots conference on carbon neutrality was held in April 2007, funded by DEFRA's Climate Challenge Fund.

In March 2008, the footpath linking Ashton Hayes to Mouldsworth train station was constructed, funded by the council to encourage more use of the train by residents of and visitors to Ashton Hayes.

The Carbon Leapfrog charity was launched on 24th September 2009, co-founded by AHGCN founder Garry Charnock. The charity supports communities and projects taking action to combat climate change with professional pro bono advice to overcome hurdles the community/project faces in progressing their goals. It has now merged with Pure the Clean Planet Trust to become Pure Leapfrog, a business led charity providing 'social investment and professional support to community energy projects in the UK' (Pure Leapfrog, 2014).

Ashton Hayes Community Energy Company, a CIC was formed in January 2012, to manage renewable energy generation in the village, with any profits generated being ploughed back into projects that make the village more sustainable (AHGCN, 2014).

A study by LSE and Universities of Leicester and Chester was undertaken in 2012/13 'Accounting for Communities' investigating the real value of the community working together.

A study was completed in March 2012 by the New Economic Foundation (New Economics Foundation, 2012), '*An evaluative framework for social, environmental and economic outcomes from community-based energy efficiency and renewable energy projects for Ashton Hayes, Cheshire' to provide a tool for assessing the outcomes from the energy projects in the village*

AHGCN has won the following awards:

- £400,000 prize won from DECC's Low Carbon Communities Challenge in 2010, which was used to fund the construction of a carbon neutral pavilion, purchase of an electric vehicle for the village and installation of photovoltaic panels on the roof of the school.
- International Visual Communications Award (IVCA) – Climate Change category in 2007 for the film made by Steve Holland from the start of the AHGCN project.
- The Energy Institute Community Initiative Award, November 2007
- The AHGCN film 'Our Footprint, our journey' won the Clarion Award, September 2007.
- Garry Charnock won the 2011 Climate Week Most Inspirational Leader for outstanding leadership for Ashton Hayes' work on combatting climate change.

There is a feeling in the local community that the AHGCN project has brought much greater confidence and cohesiveness to the community. It was recognised even in the early days of AHGCN that the project had empowered the community in its dealings with various external agencies (Alexander, Hope and Degg, 2007). In 2012, the Community Energy Company commissioned a study, 'An evaluative framework for social, environmental and economic outcomes from community-based energy efficiency and renewable energy projects for Ashton Hayes, Cheshire' by the new Economic Foundation, funded by DECC's Local Energy Assessment Fund (LEAF) grant. This demonstrated that there has been an increased sense of community cohesion, pride in what has been achieved and the sense that the community can tackle new projects and ideas. As interviewee AH2 commented:

> "the genius of the community comes out, when it has confidence."

A demonstration of this is the feeling that the progress made in AHGCN as a village helped galvanise the community to develop the community shop.

Installing the photovoltaic array at the school has been seen as being beneficial to the pupils, as well as the wider community, as interviewee AH6 described:

> "I think the fact that it does work and it is successful is a positive thing, and has given people confidence that we've got the capacity, I guess, to make good decisions and to make something that works. So that's been positive. Involving children has been a really positive thing, obviously, because it's on their school and they need to be part of that."

As cuts to the public and charity sectors have an impact on services being delivered in the village, there is an interest in looking at how installing new renewable energy systems such as wind turbines could provide income for the village to provide these services. AHGCN is also interested in exploring the possibility of buying into systems that are not located in the village, such as anaerobic digesters. In addition, AHGCN would like to see any new development in the village have a renewable energy element to it and encourages prospective developers to discuss plans with the Parish Council at an early stage.

Early on in the AHGCN journey, an article was produced that identified five things as being central to its success (Alexander, Hope and Degg, 2007). They were:

1. From the outset the project was led by the community and there has been continued high level of community involvement at every stage

2. A huge amount of effort was put in to maintain the momentum of the project, such as the media coverage and the website
3. There was a diverse, multi-agency partnership that drove the project, including villages, businesses, The University of Chester and Local Authorities.
4. Involvement of the local primary school engaged a large number of children and their families in the project.
5. The key role played by a small number of committed individuals.

The whole settlement approach and vision taken by AHGCN has been absolutely fundamental to its success. It has been inclusive, ambitious and long term and has incentivised the community. One of the key lessons from this has been to keep communicating at every level. The value of regular, good quality communication, both to the community and with external organisations and media is hugely valuable and has enabled AHGCN to achieve some things that it otherwise would not.

A study undertaken in 2007 (Edwards, 2007) assessed the motivators and barriers to successful public participation in community-based carbon reduction programmes, using Ashton Hayes as a case study. It found that almost all the village regularly undertook environmentally friendly behaviours (EFBs), including many who had not taken part in any AHGCN events or activities. Motivating factors for EFBs included: an interest in climate change, EFBs considered a moral responsibility, saving money, being part of a community initiative, support from friends and family and being proud of the village. Barriers to undertaking EFBs were: being too busy, not prioritising EFBs when considering time and cost for more expensive items. The research showed that retired people did more EFBs than younger employed people in the village and more EFBs were undertaken by people with higher education qualifications than those without. The study also found that AHGCN improved community cohesiveness and encourage more take up of EFBs.

The focus first on energy efficiency and behaviour change worked and the positive impact this had on reducing the carbon emissions of the village. This approach and success then enabled the village to tackle the next challenge of developing the microgrid and getting the pavilion and photovoltaics installed at the school. This incremental approach, with a whole settlement carbon neutral vision was felt to be very important.

EA Technology has learned lessons in its approach to support the development of a microgrid in Ashton Hayes. The trial area it was monitoring with the local DNO was only part of the village and they feel that with hindsight, monitoring the whole village from the outset might have been a better approach.

It has taken longer to do some things than expected, such as working through the levels of statutory regulation on everything from planning to grant funding and the electricity distribution network.

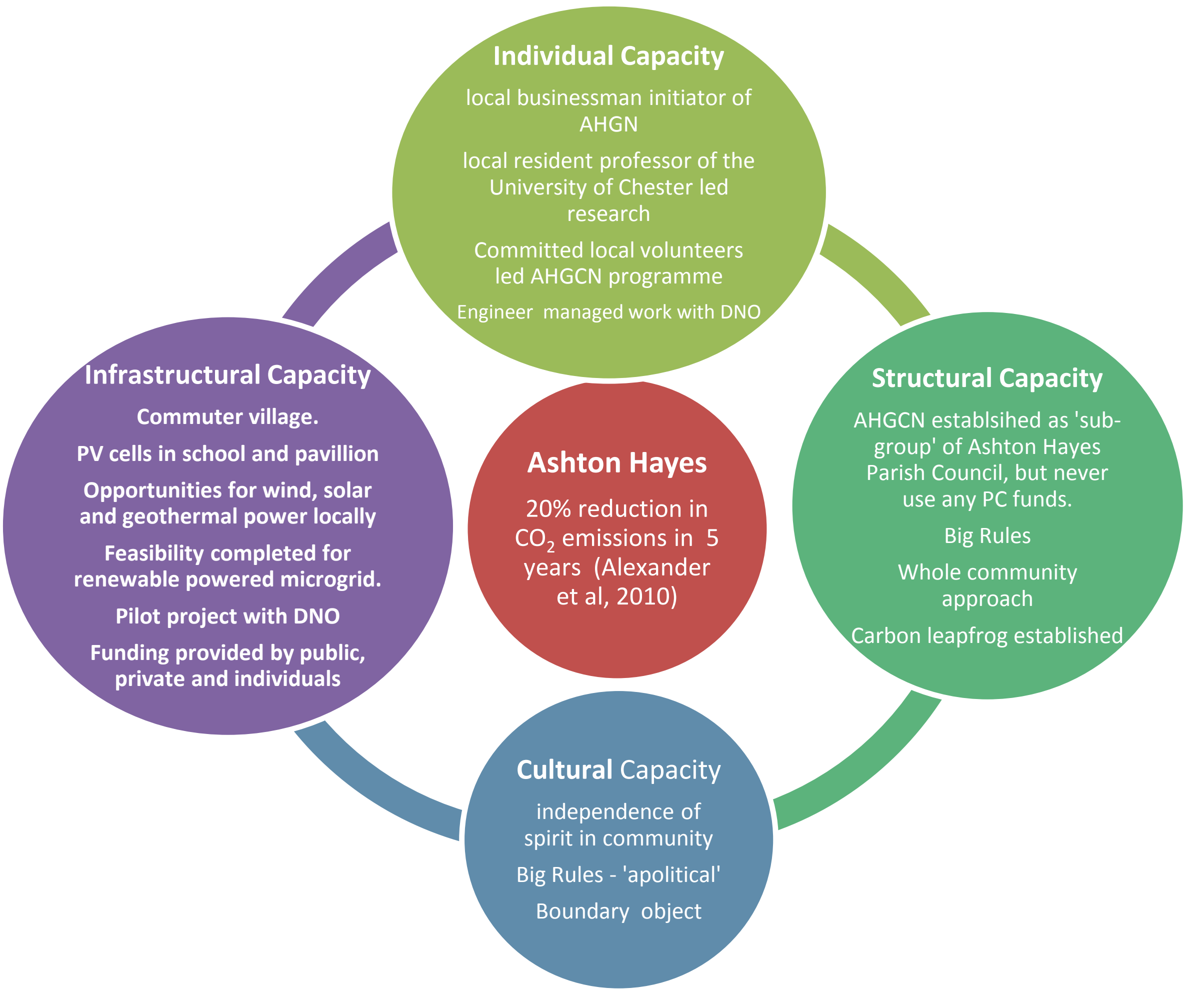

Figure 21. Summary of capacities in Ashton Hayes in the delivery of AHGCN

5.6 Fintry

Data on Fintry's energy project was obtained through documentation, direct observation and interviews with four individuals. Interviews were undertaken with representatives of the following groups: FDT and FREE, Local authority officer, private sector wind farm partner.

Figure 22. Fintry road sign

5.6.1 *Background*

Fintry is a village in Stirlingshire, central Scotland, 19 miles north of Glasgow. It has a population of approximately 800, with 333 dwellings. The village is not connected to mains gas supply (FDT, 2009).

5.6.2 *Problem Formulation*

Cultural & Structural capacities: Rationales for WSESS. Two Fintry residents, Martin Turner and Bill Acton were concerned about climate change and how the community of Fintry could do something to reduce its impact on climate change. To address this, in 2003 they started to look at the possibility of developing some kind of community based renewable energy system in the village.

Cultural capacity: The importance of place for energy self-sufficiency. As in Eigg, there is a real independence of spirit in Fintry. The Fintry Four did not wait for another organisation to deliver low carbon energy projects in the village, but set about doing this for themselves. As acknowledged by both officers at Stirling Council and FDT members, the council has had very little involvement in the work in Fintry, other than to provide support for specific initiatives, such as providing insulation in council owned houses in the village.

The Fintry community wanted a model of ownership of a wind turbine that would benefit the whole community, and did not want to accept an existing model that would only benefit those that could afford shares. This resulted in the Fintry Four negotiating a 'new' arrangement for ownership of 1/15 of the new Earlsburn wind farm, described in more detail below.

Individual Capacity: Skills. With support from Fintry Community Council, four local residents; Bill and Martin, plus Gordon Cowtan and David Howell took forward negotiations with a wind farm developer on community ownership of a wind turbine at the proposed Earlsburn wind farm, described later (Development Trusts Association Scotland, 2012). These four came to be known as the 'Fintry Four'. They acknowledge that their understanding of how the electricity industry operated was relatively low at the outset. As they learned more they realised they would need a different approach to their original idea of having a community owned turbine that supplied electricity directly to the village as described by interviewee F1:

> "because we kind of learnt about how the electricity industry works and how it's structured both in terms of regulation and in terms of the technical constraints, the notion of having the turbine on the hill and using the income that that generates for other energy-related projects in the village kind of emerged as being the way forward. So you kind of had, you know, the big thing on the hill funding little things in the village."

Structural Capacity: Vision & Strategy. Around the same time as Martin Turner and Bill Acton were considering developing some form of renewable energy in the village, a renewable energy developer, Falck Renewables approached Fintry Community Council about a 14 turbine wind farm they were proposing to build nearby (ibid.). The Community Council realised that there could be potential through this for the village to develop its own wind turbine. The preliminary discussions were with a company, West Coast Energy, who were working with wind farm developer, Falck Renewables and another company called RDC to develop the Earlsburn wind farm.

Following these initial discussions, Falck Renewables Ltd. proposed that the community ownership idea could be addressed though Energy4All, an organisation they work with where Energy4All set up a cooperative and raise a prospectus for people to invest in that cooperative (Energy4All, 2014). The cooperative invests in a particular wind farm and in return, they get a return from Falck Renewables on their investment. This is something that has worked successfully on four of Falck Renewables projects, with over £5m invested by 2,500 individuals. Falck Renewables are supportive of this approach, as they believe it has generated a lot of local support and interest in those schemes, helped people feel better connected with renewables and get a better understanding of how wind farms work. They were keen for this approach to be adopted for the Earlsburn wind farm.

A public meeting was held in the village and the Energy4All proposal put forward by Falck Renewables Ltd. was discussed. However, as described above, there was a strong feeling that any ownership of a wind farm should be on a whole community level, as interviewee F1 described:

> "The wind farm developer were very keen for us, as a community, to go down a different route which was, basically, for individuals in the community to invest money into the wind farm…….And there was a kind of public meeting……….where it was agreed that that wasn't the approach that, as a community, we wanted to take. Because it would be fine for people who've got money to invest, but many people didn't."

The approach became a whole community goal to become a carbon neutral community and the Energy4All proposal did not fit with this principle as interviewee F2 explained:

> "what's been the driving force, I think, is that everyone, this has been a totally inclusive thing. Because, I mean, the people you're referring to is the Baywind version of community involvement in turbines, which is, it's about how much you can afford to invest. And then it's no different from any other kind of investment. And what we've always wanted to do is try and tie the thing down to the environmental aspects of it. Which is why we have carbon neutrality as our main kind of goal. And involvement with the entire community."

This whole settlement approach was considered very important and influenced the decisions made to fund the Fintry share of the Earlsburn wind farm on a commercial basis, described in the Funding section later.

Rather than setting time driven targets, FREE developed a more organic approach and vision, as interviewee F1 commented:

> "it was quite an instinctive, organic sort of process that we went through, rather than saying, we've gone out, you know, in ten years' time we want to reduce carbon by such and such an amount. It was never that kind of process"

Setting such a headline vision is considered a good first step for a community in its transition towards energy self-sufficiency (Carlisle and Bush, 2009, p.281).

Structural Capacity: Government & Governance. In the initial negotiation stages with Falck Renewables about developing a community wind turbine at the Earlsburn wind farm, the Fintry Four who led the negotiations operated as a sub group to the Community Council. Community Councils in Scotland have a similar status to Parish and Town Councils in England and Wales, so are the level of government closest to the communities they serve. Although meetings were minuted, it is not clear whether the sub group was a formal part of the Community Council. However, the Fintry Four felt that this involvement of the Community Council was important as the contact point with the community, so it wasn't just the four of them taking this forward in isolation, as noted by interviewee F1:

> "It gave us a legitimacy, particularly in the very early days, there was just four of us and there was no formal structure at all. The fact that we have got their blessing for what we're doing gave it a legitimacy it wouldn't have had otherwise."

This was similar to Ashton Hayes who gained support from the Parish Council to give accountability and legitimacy for AHGCN.

In order to gauge whether there was wider community support to take forward the idea of a community owned wind turbine, the 'Fintry Four' took a stall at the Fintry Fling, the village fair and were overwhelmed by the positive support the idea received. They then formalised this with a questionnaire sent to everyone in the village and got an 80% response rate, with only one objection to the idea.

Following this positive community support, the 'Fintry Four' formed FREE in 2003 to take the wind turbine project forward, a company limited by guarantee, with the aim of Fintry becoming a carbon neutral sustainable community. In a document prepared at the time, FREE set out their aims and objectives for their involvement with the wind farm:

> 'Our ideal proposal was that the revenue from a community-owned wind turbine at the nearby windfarm would enable us to fund our own energy-reduction measures within the village.
> This proposal would directly involve most members of the community and increase awareness of energy utilization. We believe that to achieve both local and global benefits of reductions in fossil fuel use and thus lower CO2 emissions, local strategies to reduce energy use through the provision of more efficient heating and insulation are essential. We would look to link these improvements in efficiency to use of energy from renewable sources, either through green energy supply or the use of sustainable fuels such as wood chip etc.
> Ultimately, we believe that this proposal may pave the way for major changes in the use of energy by the public. Such a model would not be confined to communities close by renewable energy developments, but a direct linkage with a local source of energy generation is necessary for emotional resonance and identification with the project.'
>
> FDT (2014)

In the early stages, FREE tried to achieve charitable status, but the Inland Revenue did not deem FREE's aspirations to be charitable and had concerns about FREE's relationship with the Earlsburn wind farm (ibid).

Infrastructural Capacity: Energy Infrastructure & renewable resources. Following the response from the public meeting, the 'Fintry Four', now representing FREE contacted Falck Renewables Ltd to discuss the village owning a turbine at the proposed Earlsburn wind farm. Initially Falck Renewables appeared to be uncomfortable with the suggestion, as they had not had such a proposal from a community previously. FREE recognised that the greatest leverage that Fintry had with Falck Renewables was during the pre-planning stage of the Earlsburn wind farm development, as noted by interviewee F2:

> "we realised that post-planning, we're not that as important as we are pre-planning because, obviously, they needed us and the community acquiescence to say, "Okay, yeah, we're happy with this." And that was where our main kind of negotiation took place."

There has been a general agreement that increasing community benefits from the development of renewable energy systems will increase acceptance and acceptability of the same and accelerate planning approval (Cowell, Bristow, Munday, 2011; Cass, Walker and Devine-Wright, 2010). Indeed, when on shore wind farm approval rates fell in 2011, a renewable energy spokesman was quoted as saying the main reason for this was failure of advocates to 'adequately engage with local communities' (Shankleman, 2011; Bomberg and McEwen, 2012). However there is some debate as to whether community benefits do automatically lead to local support for wind farm developments (Cowell, Bristow and Munday, 2011).

When FREE presented their proposal, Falck Renewables agreed to work with the group on developing a community wind turbine as part of the Earlsburn wind farm and decided not to take the Energy4All scheme forward there, so as not to have two different community ownership models on one scheme, as interviewee F3 described:

> "they [FREE] suggested that there would be mutual benefits from us working with each other, and they said that they'd done quite a lot of work over a couple of years looking at how to develop a wind farm application themselves. But, the way it ended up working was that we helped them make a planning application for a single turbine located right next to a wind farm that we'd applied for planning permission on."

A Heads of terms document was then drawn up by FREE and Falck Renewables, outlining how the 2.5MW Fintry turbine would be developed as part of the Earlsburn wind farm and a separate planning application submitted for the proposed 15th wind turbine. Originally this was for a lower turbine than the other 14, which would have a separate grid connection and activity line that would probably be metre set.

The idea of the community owning a particular turbine and being able to point at it and say 'that one's ours' had become quite totemic in the community. However, Falck Renewables Ltd suggested it would be easier, less expensive and generate more money for the community if the community owned a share of the wind farm, rather than owning a particular turbine. Initially this was difficult for FREE to accept. However, they realised that the proposal made better business sense, for example if a wind turbine needed repairing, FREE could still receive income from the electricity generated by the other 14, whereas, if the turbine being repaired was the Fintry

Turbine, they would lose all income during the period of repair. Another potentially huge stumbling block was described by interviewee F3:

> “we had various discussions with them [FREE], and I think from the outset, they were keen to try and do a lot themselves, but when we talked it through, it became clear that the pragmatic way forward was for us to build and operate the project on their behalf. And the reason for that was, you know, a number of things. One, for instance, they didn’t have a grid connection for their turbine and we had a grid connection; it was quite a long connection that went through, all the way back to Bonnybridge, and so the pragmatic thing to do was to connect their turbine into our grid application…….We put in place an agreement that said that we would pay them revenues from that turbine, net of a share of the operating costs and the cost for us providing finance, and that was done like a mortgage where re pay debt over time and interest on that debt.”

Cultural Capacity: Boundary objects. In Fintry, the original boundary object was the idea of becoming a carbon neutral settlement. At the start this drew together the initiators of the ideas, the local community council, local residents and businesses. As with Ashton Hayes, as the idea translated into delivery, more actors became engaged, but with more obviously different reasons for this. This included a renewable energy developer who wanted to develop a wind farm nearby, funding bodies and the local authority, both as the local planning authority, but also facilitating areas of delivery such as providing insulation for council owned houses.

5.6.3 *Mobilisation:*

Individual Capacity: The role of the individual in moving towards WSESS. The ‘Fintry Four’ Fintry residents, Martin Turner, Bill Acton, Gordon Cowtan and David Howell, see figure 23, were the driving force on developing the Fintry Turbine project from the start.

Figure 23. The Fintry Four, photo courtesy of FDT

They led the negotiations with Falck Renewables over a long period of time, as described above. Developing the community owned share of the Earlsburn wind farm was a huge amount of work for the 'Fintry Four' and they encountered a number of challenges along the way. However, this only prepared to strengthen their resolve as interviewee F2 noted:

> "each time we solved one of these major issues, you…felt, "Great, look what we've done…we've achieved something." And that set us up for the next one, which is kind of how we just kept going, it carried its own momentum."

They do acknowledge, however, that they could possibly have negotiated a better deal for the community if they had taken a different approach as interviewee F2 noted:

> "I think from the point of view of dealing with developers…..I think a lot of it was quite naïve. We…thought, "We're being benign, I'm sure they'll be benign back to us." And yet, it's not necessarily them, it's the people who finance them, you know, the international banks….I think we said, "Well, they're just people,"….we could have done a better deal, but, you know, hindsight's a wonderful thing, isn't it? At the time…… the bids were going in…..there was a time pressure imperative there"

Structural Capacity: Government & Governance. The 'Fintry Four' had little experience of different types of community organisations and structures. Interviewee F1 described how the decision to become a Development Trust occurred:

> "when we were setting it up, none of the four of us had any backgrounds…in energy, we didn't have any background in ...using organisations for anything, So

> it was all new and….we got talking to somebody from the Development Trust Association of Scotland, who said, "I think what you ought to do is the Development Trust." We said, "Oh, well that sounds fine." And we did it. I think we couldn't see any downsides to it, financially"

It appears that no other types of organisational structure were considered and so in June 2007, FDT was formed and FREE became a trading arm of this, as interviewee F1 explained:

> "it's a wholly owned subsidiary. It really has no autonomy of its own. And the only reason that there's that split is so that we comply with charity regulations."

FDT has 150 members from an adult population of approximately 500. All profits generated by FREE fund projects that deliver the charitable aims and objectives of FDT. FDT has eight Board members; one of these is a co-opted member from the Community Council to ensure that the Community Council continues to be represented with full voting rights. FREE has five Directors on its Board.

The relationship between FDT/FREE and Stirling Council is described as a 'fine' one, although the involvement of Stirling Council in the development and operation of the Fintry wind turbine has been at a low level. They provided advice during the planning stages and contact is kept on an ad hoc basis, as interviewee F1 noted:

> "they were helpful in……initial stages of the planning application. And we kind of from time to time keep in touch with the rural development side of things. But apart from that, it's fairly minimal, actually."

As with Eigg, Fintry is more remote and this may have conferred an 'outsider' status on the community which has been instrumental in them developing their innovative approach to WSESS (Bomberg & McEwen, 2012)

In terms of ongoing operation of the wind turbine, the relationship between FREE/FDT and Falck Renewables is a business one with little contact between the two, as interviewee F3 described:

> "we get on perfectly well but we don't have that much contact. We make payments to them once every six months. There'll normally be a little bit of discussion around the calculations regarding that payment. Other than that, they do things to raise publicity, to raise awareness of what they're doing

> periodically, and they may contact us to get involved, when they want to take access to the wind farm, take people out there occasionally. But other than that, we don't have that much contact."

FREE and the FDT faced scepticism and other challenges, as interviewee F2 noted:

> "the biggest challenges have always been the bureaucracy that we've had to go through, and it's the developers' bureaucracy, the planners, the local authorities…we said, "We can do this," and they said, "But no-one's ever done this before." And our arguments were, "Well, that's no reason not to try it, is it, you know, because everything has always happened once, the first time, so let's try it." And we've managed to get that through."

Another challenge the FDT and FREE had to deal with was lack of co-ordination and communication by government bodies, or government funded agencies between themselves and with the community. An example of this was the Energy Savings Trust arriving in the village six months after FDT had funded and worked with other agencies to put insulation in people homes, offering to install free insulation. If there had been some co-ordination and communication, FDT could have used funds and resource on developing some other aspect of working towards becoming a carbon neutral community.

Structural Capacity: External expertise. Stirling Council assisted with analysis and insulation of council properties in Fintry as part of the Fintry Community Energy Project (FDT, 2009). However, other than undertaking its statutory responsibilities, such as determining the wind farm planning application, the involvement of the council in the wind turbine project and community goal to become carbon neutral has been fairly minimal.

Following initial discussions, Falck Renewables gave a lot of support in providing data for the Environmental Impact Assessment and Planning Application and submitting the Planning Application on FREE's behalf.

For the Fintry Community Energy project, work was undertaken by the Energy Agency, a charitable organisation that provides advice on energy efficiency, renewable energy and sustainability issues.

Structural Capacity: Funding. Negotiations were held between FREE and Falck Renewables as to how the Fintry turbine was to be funded and how the structure and operation of this would work. From the outset, it was agreed that FREE would have to raise the capital for the wind turbine themselves. FREE decided that the funds needed should be secured from commercial lenders, rather than through grants, as the process of securing grants could be very onerous. FREE were making good progress in securing offers of loans from lenders, such as Triodos and Co-operative Banks, when Falck Renewables offered to lend them the money in the form of a 15 years mortgage. There are thought to be a number of reasons that Falck Renewables made this offer:

- There were some technical difficulties with developing this smaller, separate wind turbine as part of the larger wind farm
- There was some concern from Falck Renewables about a third party lender having security on the wind farm as part of their loan agreement for the Fintry turbine, which might present problems if the wind farm was sold at some point in the future
- They may have thought that FREE would not be able to secure the financial and other backing for the Fintry wind turbine and if that was the case they would inherit an additional wind turbine. However, when it became apparent that FREE was going to secure the backing needed, it made better business sense for Falck Renewables to loan FREE the money and not have third party interest on the site

Falck Renewables offered FREE a 15 year £2.5m mortgage and also paid for the work in preparing and submitting the planning application for the fifteenth turbine. During these discussions and because of the concerns identified above, it was agreed that FREE would own one fifteenth of the wind farm of 2.5MW wind turbines, rather than any one particular wind turbine and that Falck Renewables would manage all the operation, maintenance and connections and connection to the National Grid of the additional turbine as with the rest of the wind farm. They deduct all charges and loan repayments and then make a payment to FREE on a six monthly basis for income generated from sale of electricity to the National Grid.

The income generated is quite variable, depending upon the wind conditions, but is approximately £50,000 per year whilst the mortgage is being paid off (15 years) and is estimated to be approximately £400,000 per year once the mortgage has been paid off for the rest of the term of the planning consent (10 years). The first cheque arrived in March/April 2008. More income was generated in the first two years of operation than the third and fourth. However, FREE and the FDT made a decision to hold some of the income in reserve, so cash flow has not been a problem. The profits received go to FDT to spend on items that will specifically move the community towards the goal of becoming carbon neutral. These decisions as to how the income should be spent were made by FDT members as interviewee F1 commented:

> "It was….about using the money for reducing carbon, for improving sustainability………I know quite a lot of organisations go out and do a whole community engagements and consultations and so on. We didn't do that. We said, "Well, we said, this is what it's for, that's it really." Which we felt perfectly entitled to do, because we'd done it."

Climate Challenge Funding (CCF) from Natural Scotland and CERT funding from Scottish Hydro Electric was given for the Fintry Community Energy Project (FDT, 2009).

Infrastructural Capacity: Community energy systems. The planning applications for the 14 wind turbines and then the additional 'Fintry' wind turbine were approved in 2004. As interviewee F3 described:

> "we had a lot of data that we'd used in preparing the EIA and the planning application for Earlsburn and so it was relatively easy for us to help them put together an application for an additional single turbine. And so that was done; the application was submitted in their name and it got approval pretty easily."

The fifteenth wind turbine was developed as part of the Earlsburn wind farm. The farm has planning consent for 25 years and was switched on in 2007, see figures 24 and 25.

Figure 24. The launch of the Earlsburn wind farm and FREE's ownership of a share of this. Photos courtesy of FDT

Figure 25. Earlsburn wind farm near Fintry

Alongside the development of the turbine, it was also felt important that in order to move towards becoming a carbon neutral community, the village could benefit from becoming more energy efficient. In 2008, FDT secured Climate Challenge Funding (CCF) from Natural Scotland and Carbon Emission Reduction Target funding from Scottish Hydro to undertake the Fintry Community Energy project. The work started with a thermal imaging assessment of heat loss from houses in the village and then surveying of individual households. Each household then received a report on their ecological footprint and energy rating. Free loft and cavity wall insulation was offered to households. 152 households received free insulation, which is 46% of households in the village. The CCF target was 170 households to receive free insulation. However, even though the target number of households receiving free insulation wasn't achieved, the estimated CO_2 emissions savings as a result of this were 464 tonnes per annum, compared to a CCF target of 272 tonnes (FDT, 2009).

In the first instance, most villagers' prime motivation for supporting the Fintry wind turbine and the aim for the village to become carbon neutral was concern about their impact on the environment and climate change. However, as fuel prices increased, financial concerns also became an important consideration and influenced the Trust's ongoing work to look at cost effective low carbon energy solutions for the village, as interviewee F1 noted:

> "certainly, when the heating oil price started going up significantly that became quite an issue for people… although, probably, the term fuel poverty didn't cross our lips in the early days, it became increasingly a significant part of what we were doing"

The audit undertaken by the Energy Agency showed that the amount of energy being used in the village was much higher than the Scottish average and this was thought mainly to be due to the village not being on mains gas.

One of the things that the FDT has done to address fuel poverty in the village is to operate a Warm Home Grant, which is targeted at households that spend more than 10% of household income on energy. The grant is for up to £1,000 to be spent on energy efficiency measures. FDT also offers two other grants to support the community in moving towards becoming carbon neutral; the Fintry Grant, a grant of up to £500 available for any home in the village to spend on energy efficiency measures and the Green Deal Assessment Grant, available to any households in the village who are not eligible for the Energy Saving Trust Green Homes Cashback scheme. This is for up to £150 per household to fund Green Deal Assessments for houses that cannot be improved using the Green Deal Cashback (FDT, 2014b).

As part of the commitment to move towards becoming a carbon neutral community, FDT employs two energy advisers using income from the wind turbine. The first was employed initially to deliver a one year scheme to provide support for installation of 20 low carbon energy systems in the village. This proved to be very successful, so the post was continued and another post created to support people in the village in making changes to their energy systems and consumption by providing advice and guidance on different low carbon energy systems and advise and assist on funding sources and grant applications. As of March 2014, through FDT's energy advice team 85 renewable energy systems have been installed in the village: 22 Solar Photovoltaics, 7 Solar Thermal, 25 Air Source Heat Pumps, 18 Ground Source Heat Pumps, 7 Biomass boilers, 4 wind systems and 2 heat recovery systems (FDT, 2014).

FDT also provide a range of other services for villagers to reduce carbon emissions, these include:

- a Wood Fuel Bulk Buy scheme, which enables access to lower cost fuel though the FDT buying in bulk at a lower cost and passing the savings on to villages
- Draught proofing workshops, with an online manual (FDT, 2014) and a draught proofing goody bag to take away
- Fintry Energy Efficient Transport (FEET) Car Club
- Fintry Car Share Club in partnership with Stirling Council
- Cycle Fintry, a bike club operating in a similar way to the car club
- Fintry's Community Orchard
- Fintry Community Garden

(FDT, 2014)

FDT employs two other members of staff, a project manager who leads the Trust's outreach work and a co-ordinator, responsible for administration of the Trust.

Plans are advancing to investigate the potential of a renewable powered CHP system for part of the village; quotes have been received for installing a system. The challenges perceived in developing this are social, rather than technical, although the Fintry Community Energy project showed that of the 260 households surveyed, 95% would be interested in micro renewable energy projects (FDT, 2009).

FDT has also considered other district heating systems. The biggest challenge they face with this, as most of the houses are owner occupied, is the installation costs.

The Earlsburn wind farm has planning consent for 25 years, so the FDT and FREE feel it is too early to consider what to do when this period ends, as technology will advance significantly before then.

Stirling Council is interested in looking at the best ways communities can be supported to become energy self-sufficient and one possible way to do this was described by interviewee F4:

> "one of the conversations I remember having a few years……..was, if we could get a real handle on what is the smallest economically viable turbine development. And you made the linkage between sustainable communities and that then, it might be preferable to have a small wind farm attached to each rural community, making that community self-sufficient but generating a surplus to the grid, but no more and no less than is required to be a viable development. You know, I think that would be quite an interesting way to go on, on some of this. Because the answer I got from that discussion was that somewhere between eight and ten turbines would be required for, say, a community of a few thousand of a population to be self-sufficient and for the surplus generated and sold to the network to make it worth the developer's and the investor's while"

Falck Renewables have planning consent for an extension to the Earlsburn wind farm, called North Earlsburn. Planning approval was given against officer advice, as interviewee F4 explained:

> "When we come to the extension, in 2010, the report was actually recommending refusal, so the planning officers are recommending refusal at that stage, but the committee actually granted….I think what you have there in the second application is a recognition on the part of the elected representatives who form the planning committee, that it was appropriate to override the planning officers' advice, which was this is an application in the planning officers' professional judgement shouldn't be granted, but the elected members did grant it. And I'm sure that had a lot to do with this active and

> vocal and influential community, by that stage there had been numerous articles in the national press about the success of the first."

In 2012, FDT undertook a further energy audit in the community. This time the response rate was somewhere between 50-80%, lower than the original survey, which had an 80% response rate. It is thought that the lower response rate was because when the original survey was being done, there was the offer of free insulation at the same time, which was not the case in the later survey, but the response rate is still considered good.

FDT and FREE did also consider setting up an energy supply company as a means to fund installation of household renewable energy systems. However, this was not taken forward for two reasons:

- The first was it was felt that that there were onerous restrictions on who could buy and supply wholesale energy and that tariffs for energy supplied would have to be made available to anyone.
- The second was that it was very difficult to find a model on a scale as small as Fintry that could provide everyone with the flexibility they required from an energy supply company

In 2009 FDT funded energy efficiency measures in the village sports club, which included low energy lights and sensors to switch lights off when not required. They also funded installation of radiant heaters in Menzies village hall. Whilst these were not considered energy efficient, the Trust decided to support this, so that energy wasn't being wasted using heating systems that didn't work properly (FDT, 2014).

In 2010, FDT received Climate Challenge Funding, which enabled them to employ the Energy Advisor and Project manager to provide advice to households on energy efficiency and appropriate renewable energy systems. 35 households were supported and 22 of these installed renewable energy systems. FDT also funded the development of an outdoor woodland classroom at Fintry Primary school (ibid.).

FDT, together with Community Energy Scotland and Fintry Sports Club members funded the installation of a biomass boiler system at the Sports Club, providing hot water and heat from wood chip. The club receives funds from the RHI scheme and pays a local company to manage the system on a payment per kWh contract (ibid.).

2012 saw FDT, together with Fintry Community Council, develop a Green Pages of local services and businesses to encourage local people to support them. The Trust also launched the Fintry Renewable Energy Show, which is planned to be a biennial event to showcase renewable energy and host events and discussions on a range of subjects related to reducing carbon emissions in the village (ibid.).

Through the Fintry Community Energy project, it was found that a number of houses in the village were hard to treat homes for insulation. These were post war prefabricated concrete clad houses that had poor thermal efficiency and consequently high energy bills. FDT has accessed, or facilitated funding from a number of sources, including the Scottish Government, Scottish and Southern Energy and CERT for external wall insulation on a number of these hard to treat houses (ibid.)

In 2012 FDT also had an electric Citroen zero car loaned to the car club for an eight week trial, which proved very popular (FDT, 2014). The success of this led to FDT securing a Nissan Leaf Electric car through the Scottish Governments Developing Car Clubs Scotland EV programme, which is available to members of the FEET car club (ibid.).

5.6.4 *Communication:*

Communication has been important for the FDT and FREE throughout the process of developing and, delivering the Fintry share of the wind farm, through what it has enabled them to fund and for their other activities.

Individual and Cultural Capacities: The role of trust and the individual. In the early stages, the 'Fintry Four' were just four residents who had an idea and were concerned about climate change. During this phase the support the Community Council provided, following presentation of ideas by the 'Fintry Four' gave them a form of legitimacy. The four of them also gained wider trust from the community through open engagement at the Fintry Fling and public meetings and took the decisions made at these events by the majority of people to guide the whole community approach and negotiations with Falk Renewables on a new approach to community ownership of part of a wind farm. Through delivering what they set out to do and having regular meetings to share information, the trust in the individuals leading the process has built and sustained over time.

Structural capacities: strategy and policy. At the start, before FREE and the FDT were set up, communication with and through Fintry Community Council was felt to be an essential link to the community, as interviewee F2 observed:

> "the Community Council….we were speaking to them all the way through the process of dealing with the developers. So that was the sort of contact point with the community, if you like. It wasn't just the four of us going up and doing things and then coming back and telling the community what we'd done, you know, it was very much a process where they were kept advised, there was lots happening and it was a very positive experience, I have to say."

As the wind turbine and other energy schemes were developed by FREE and the FDT, there have been regular meetings and events held that have been important in continuing to share information on the plans with the community and to sustain their support for these.

Structural Capacity: Sharing learning. As with its plans to become a carbon neutral community, FDT does not have a grand plan for communication and networking with a wider audience, it has developed its approach to this in an organic way. One of its key sources of information is its website that is regularly updated (FDT, 2014), providing information and advice on a range of issues relating to reducing the carbon emissions within the village. The Trust is also establishing, what is loosely termed a Centre of Low Carbon Excellence through which it aims to be more proactive about inviting groups to the village to see what they do and share lessons learned. They feel it is important for visitors to see that Fintry is an ordinary village and what can be achieved in such a place, as visitors are more likely to relate to the setting than a purpose built low carbon community.

5.6.5 *Outcomes*

Following the Fintry Community Energy project, it was estimated that the total village energy consumption was 10.2GWh per annum. The Fintry Turbine project generates approximately 7.5GWh per annum, so the community is 73.5% carbon neutral (FDT, 2009).

FREE own 1/15 of the Earlsburn wind farm. They have a 15 year £2.5m mortgage from Falck Renewables for this. Whilst the mortgage is being paid off, FREE receive in the region of £50,000 per year income from their 1/15 share, once all costs have been deducted and it is estimated that once the mortgage has been paid off FREE could receive around £400,00 income per year for the remaining 10 years under the existing planning consent.

Income from the wind farm provides funds to develop other measures in the village that will reduce CO_2 emissions, including offering the Fintry Grant, which provides grants to properties in the operation area (within Fintry Community Council Boundary), (FDT, 2014) for energy efficiency measures and renewable energy systems.

In 2008/9, The Fintry Community Energy project was undertaken as one of the steps to move towards becoming a carbon neutral settlement. This was funded by Climate Challenge Funding from Natural Scotland and CERT funding from Scottish Hydro. By using thermal imaging to identify heat loss, surveying of residents and follow up activities, the following was achieved:

- Energy advice to 330 households (100% of village households)
- Energy surveys to 260 households (75% of village households)
- Free insulation for 152 households (46% of village households), Fintry Community Energy Project (2009). This was estimated to reduce household energy consumption by 10.2 MWh per household per annum, save each household £600 per annum and reduce CO_2 emissions by 464 tonnes per annum.
- 13 households (25% of fuel poverty households at start of project) removed from fuel poverty

(FDT, 2009)

In addition to the core benefit of significant moves towards Fintry becoming carbon neutral village with 73.5% of the amount of electricity consumed in the village being produced by the wind turbine (FDT, 2009), the existence of FREE and the FDT with the vision of the community becoming carbon neutral has enabled the village to benefit from other funding, such as the Climate Challenge and CERT funding to provide free insulation for households. FDT had to react very quickly to submit an application for this funding, which has benefitted many people in the village.

There is now a car club operating in the village for car sharing, set up by the FDT to tackle carbon reduction in transport.

An extension to the Earlsburn wind farm received planning consent against officer recommendation in 2010. It is thought that the reasons behind this were:

- The success of the Earlsburn wind farm
- The developer had been proactive in engaging with the six local communities and had agreed that they would each get a share of income from the extension, so there was a good level of community support.
- The leading group at Stirling Council was then the Scottish National Party (SNP). It is thought that as the SNP had set ambitious national targets for renewable energy that the local group wanted to help achieve that.

The significance of support for the scheme from the Fintry community and the recognition of their work in securing a share of the first Earlsburn wind farm development in the decision to grant planning consent against officer recommendation should not be underestimated, as interviewee F4 commented:

> "I'm sure that had a lot to do with this active and vocal and influential community, by that stage there had been numerous articles in the national press about the success of the first."

There have been benefits to Falck Renewables of working with FREE to develop their community ownership model at Earlsburn windfarm. This means that they now have two different models of community ownership of wind farms that they can offer. Arguably, adopting this approach at Earlsburn helped them obtain planning consent and the success of this has provided confidence in the business and approach to the extent that it has also helped them to get member support to approve the planning application for the Earlsburn wind farm extension against officer advice. They used lessons learned from the community ownership model at Earlsburn to proactively offer an element of community ownership at the Earlsburn wind farm extension, which will benefit six local communities, including Fintry. Planning gain for the extension, based on the Fintry model, was that one turbine would be owned by the six communities closest to it, of which Fintry is one, and they would receive the income from the electricity generated by this. The planning application was supported by all six communities. This is thought to the most important reason why members, with one exception voted against officer recommendation and approved the application, as interviewee F4 acknowledged:

> "that's my sense of it, yes, 'following the success of the Fintry community turbine, the extension development would also have a community turbine with all the net financial benefits being shared amongst the six communities'…….there was a motion and an amendment so it was a divided decision. So there was six for the motion and one against"

In terms of formal evaluation, monitoring information was provided for the Fintry Community Energy project, which was undertaken in 2008, as a requirement of funding received by FDT from CCF and CERT. This included the results of the community energy audit and the free insulation provided to participating households. The CCF target was for free insulation to be provided for 170 households. Whilst the project delivered free insulation in fewer households (152, 46% of household in the village) than the target set, the estimated CO_2 savings achieved were much higher than the CCF target of 272 tonnes per annum at 464 tonnes per annum.

Given that FREE secured private sector funding through Falck Renewables for their share of the wind farm, and Falck Renewables Ltd has been responsible for delivery and ongoing operation of the wind farm, there has been no formal evaluation required for the funding of this.

It was felt that there was no grand plan as to how Fintry was going to achieve its ambition to become carbon neutral at the start and that was helpful, because it meant that FREE and the FDT were open to opportunities that presented themselves, such as discussions with Falck Renewables about having a community owned wind turbine, as interviewees F2 and F1 respectively commented:

> "I think it's right from a community point of view, because it has been kind of hand-stitched, you know, and I think that the beauty of that is it works because it's not something that's being dictatorial, it's reactive. It's the tree that bends to the wind rather than the one that doesn't and snaps."

> "I do genuinely think that taking the approach of not really having a plan is actually the right thing to do. Sounds very contrary, but."

For Falck Renewables, there was a lot of time and resource they had to commit to develop the community ownership model at the Earlsburn windfarm to get all the agreements in place. However, they have used this approach successfully for the Earlsburn wind farm extension. In terms of on-going involvement, there is a lot less time and resource needed from them for this model than for the Energy4All model of community ownership, as there are 2,500 investors to liaise with on an on-going basis, either directly or via Energy4All, for which there is a financial cost.

Falck Renewables believe that they have a unique offer in the wind farm industry of engaging communities in two different models of community ownership and that these approaches increase the likelihood that they will secure planning consents for the wind farms.

Stirling Council promotes the work of Fintry in working towards its goal of becoming a carbon neutral settlement and what it has achieved in developing the community ownership model of a share of the Earlsburn wind farm.

Since the development of the community ownership model at Fintry and the positive publicity that this has received, community ownership has been perceived as an important element of planning gain when planning applications are considered. There is a feeling that the Fintry approach has been a ‘sea change’ in how developers compensate communities when they want to develop a wind farm in their locality, as described by interviewee F2:

> “The Fintry model has become like a standard that people now look at and say, “Right, that’s the yardstick we need to use as a measure.””

It has been noted that the location of the Earlsburn wind farm may have been a contributing factor to the community’s support for the scheme, interviewee F2 acknowledged:

> “I think we’ve been very helped by the fact it’s four miles outside the village, so it’s not right in your face”

Figure 26. Summary of capacities in Fintry in the delivery of the wind turbine and carbon neutral project

5.7 Hebden Bridge

Data on Hebden Bridge's energy project was obtained through documentation, direct observation and five interviews with six individuals. Interviews were undertaken with representatives of the following groups: Local authority officer and member, Hebden Bridge ATC, the Power from the Landscape project, Hebden Royd Town Council.

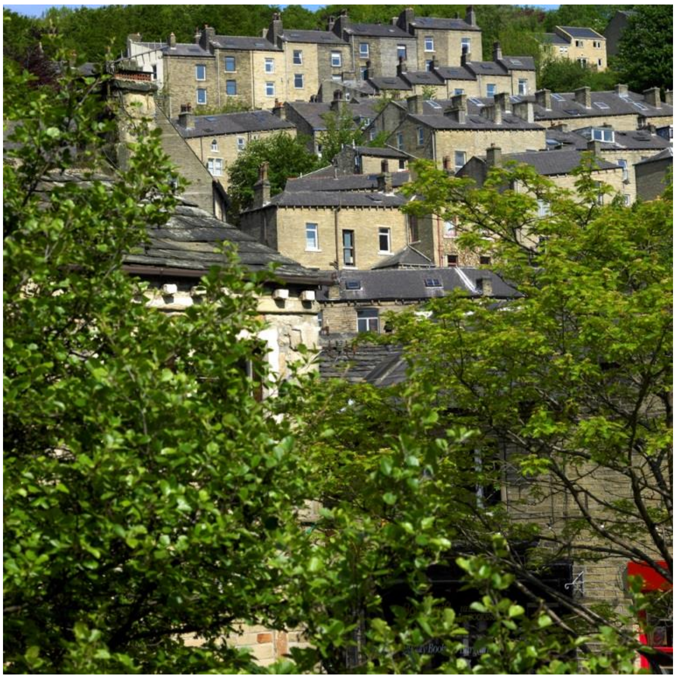

Figure 27. Hebden Bridge under and over dwellings

5.7.1 *Background*

Hebden Bridge is a small former textile mill town in Calderdale, West Yorkshire, lying eight miles west of Halifax. It has a population of approximately 4,500 and is built up around the confluence of the Calder river and Hebden water (Academy of Urbanism, 2011). It developed during the industrial revolution as a mill town, with cottage industry on the fell tops being replaced by larger textile mills in the valley bottoms powered by abundant water supplies. The textile industry declined in the 20th century and today, most of it has disappeared, but the canal and many of the mill buildings and the unusual under and over dwelling houses that were built to maximise the number of houses in the steep sided valley still exist. Over the last 40 years, the town has undergone a transformation from a failing town to a vibrant centre full of independent retailers and businesses (Upper Calder Valley Renaissance, 2003). It has long been a town where people are seeking to lead lives that have a lower impact on the environment.

5.7.2 *Problem Formulation*

Cultural & Structural capacities: Rationales for WSESS. In January 2012, Calderdale Council launched Calderdale's Energy Future Strategy (CEFS), (Calderdale Council, 2012), which sets out how the Council and its partners can achieve ambitious targets of a 40% reduction in carbon emissions by 2020 and an 80% reduction in carbon emissions by 2050 for the whole district. The strategy was developed by a council Labour-Liberal Democrat coalition.

The rationale for the CEFS approach was a mix of economic, environmental and social drivers. The economy of the district had been dominated by the financial, professional and manufacturing services sectors, which made up 60% of the economy. The economic downturn, started by the collapse of parts of the financial services sector in 2007 showed how vulnerable the local economy was, so developing a more diverse, resilient economy was a key driver for developing this approach. However, developing an economy that benefitted both the environment and the local communities was also key.

Cultural capacity: The importance of place for energy self-sufficiency. In developing the CEFS, Calderdale Council focussed on their entire geographic area of responsibility; the district of Calderdale. Whilst the actions necessary to achieve the strategy's targets will need to happen in all communities in the district, at that stage there was no attempt to engage in settlements at a sub district level, so the district was important, but not the towns or villages, including Hebden Bridge

Individual Capacity: Skills. As the Council led in the development of the CEFS, it was presented as a corporate approach, albeit with a strong emphasis that the targets could only be achieved through a partnership approach. The individuals associated with its development were therefore the council Member who's portfolio this was in and the Director with responsibility for this area, although they were not recognised as leading this by interviewees in Hebden Bridge.

Structural Capacity: Vision & Strategy. The CEFS sets out a vision for how the CO_2 emission reduction targets can be achieved based on two consultation events, regional, city regional and local reports and energy modelling. The idea behind developing this vision led approach with such ambitious targets for the whole district emerged for a few reasons. There was a perception that the council was 'behind the game' on this agenda and had no co-ordinated strategy on reducing its own energy use. It had to consider options for rationalising its own estate and assets and realising value from this and also discussions were being held other organisations about possible major renewable energy installations in the district. There was a feeling that the council might not get its own house in order on energy use and carbon reduction in isolation without such a vision and that the ambitious vision led approach was the right one for the council, as interviewee HB1 commented:

> "If the vision doesn't scare you, it's not big enough."

The high level vision contained within the strategy would link into all aspects of council services and the communities within the district, as interviewee HB1 went on to describe:

> "I see it links into flooding, it links into countryside management, it links into future education, it links into our school…..So it's a nice aspiration"

There was also some support by organisations within Hebden Bridge for such a high level vision, as interviewee HB2 noted:

> "It's great having this, it was a great moment when we got the carbon reduction targets approved by Cabinet. It's great when you go to scrutiny panels meetings and they're talking about renewable energy and how they can do it."

Some people view the Future Energy Strategy as crucial, as interviewee HB3 noted:

> "I personally think Energy Strategy is the most important government policy possible. You know, it's up there with human rights and tax. It's not more important than the rest. We use a vast amount of energy and having targets and a plan that will work is essential, but as with everything, it takes investment and there has to be a serious amount of investment and a bold approach. So it's very well producing a bold document, but a bold strategy has to be followed up by a bold implementation of that strategy, which inevitably will ruffle a few feathers someway along the line."

Development of this deadline vision supports earlier findings that 'Guiding Visions' are key in developing governance strategies for successful transitions, such as a moves towards energy self-sufficiency (Spath and Rohracher, 2010).

Structural Capacity: Government & Governance. In developing the CEFS, the council felt that it had a mandate to lead this, and be an honest broker and energiser. The council attempted to straddle the technical, academic and community hearts and minds positions set out in the two consultation events. It identified what the capacity of renewable energy generation was in the district and set out headline issues and priorities that needed to be taken forward. The Council then set up an Energy Future panel to drive the strategy forward. Members were recruited to the panel from a wide range of interests and backgrounds, with Joanne Pollard of CO_2 Sense (2012) as the Chair and Calderdale Council agreed to service this. This supports the council's approach that in the future, it will not be as much a direct deliverer of services, but have a facilitator role.

One of the first priorities for the Panel, as set out in the Strategy, was to agree an action plan that clearly identifies and prioritises the actions that need to happen to meet the carbon reduction targets. An initial Action Plan has been produced; work has started on developing this and the council has committed to moving resource to serve and support the development and delivery of the strategy, as detailed in the document. However, there is still a limited staff resource leading on this, and they have other responsibilities, which is not considered enough to drive the strategy forward. It will be extremely challenging for the Council to allocate more resource to this, even if there is significant pressure applied, as since 2010, it has to make cuts equivalent to almost one third of its budget, s, as interviewee HB1 acknowledged:

> "and politicians and…senior management, to say "We've got 83 million to find out of 225 million in the next two to three years. How are we going to do that when we've got 100 million pounds worth of staff costs?" You've got to have a reality here that actually means, if we're going to do this, we don't have that." You can't just be the funder of last resort. "Don't worry that the council will pick it up if we push hard enough". No we won't, we'll just have to walk away and say "OK, sorry, it's not our priority at the moment, because we've got 1500 kids in care that weren't budgeted for, so we can't spend any time on this. But we understand it's a really good idea, we really want to push it and we think it's something really of benefit to Calderdale. Can you convince people of that? Very difficult"

There is, however recognition that a time of such public sector budgets constraints, as a result of the economic downturn may be the best time to initiate the CEFS, as interviewee HB4 reflected:

> "In many ways, it's the worst time to be trying to push an agenda like this, but in another way, it's the very best time, because in a funny kind of way, the recession has actually given us a gain in terms of CO_2 emissions."

During the same time, there have been significant price increases in UK household energy bills by the six main energy suppliers, so this could also help get people's interest in changing their behaviour on energy consumption and possibly increase the possibility of alternative low carbon energy systems being installed.

The strategy sets out that communities, residents and businesses in the district will need to work together through energy improvements and behaviour change in order to achieve these targets (Calderdale Council, 2012). This case study approach is looking at whole settlement approaches towards energy independence. The CEFS is a whole district approach to reducing carbon emissions through changes in energy use and generation. However, it explicitly acknowledges that communities in the district will have to work together to achieve this, so this case study investigates how the strategy has involved the Hebden Bridge community in its development and what the strategy will mean for Hebden Bridge.

Infrastructural Capacity: Energy Infrastructure & renewable resources. A second district level consultation event was held, with a presentation by Andy Gouldson, a professor from Leeds University who had worked on the Leeds City Region mini Stern Review (Gouldson et al., 2012). He presented a document that showed how different interventions could achieve carbon reductions that could move towards the targets that were being discussed. Pam Warhurst, a high profile resident of Todmorden and co-founder of Incredible Edible Todmorden (2014) was very critical of this technical, academic approach, suggesting that in order to make significant progress on carbon reductions, work had to be done to win over the hearts and minds of people. This would involve engaging with local communities.

Cultural Capacity: Boundary objects. Hebden Bridge differs from the other three cases in that the idea for the CEFS and its development, which includes a transition to renewable energy was not developed by the community, but external to it by Calderdale Council. The CEFS is focussed not at a settlement level, but on a wider local authority area. However, I would argue that the CEFS as an idea has acted as a boundary object in its development at the district level, bringing together individuals and organisations with diverse interests, such as the council, businesses, a university and local environmental groups to support the production of the strategy and as representatives on the CEFS Panel to oversee delivery of the strategy. However, it has not been a boundary object at the Hebden Bridge level. It is too early to say whether it will remain a boundary object in its delivery at a district level, or whether it can become a boundary object at the Hebden Bridge level in its delivery.

5.7.3 *Mobilisation*

Individual Capacity: The role of the individual in moving towards WSESS. Other than the Council officer and member indicated in the problem formulation: individual skills section earlier, there have been no individuals identified as having a leading role in the mobilisation to deliver the CEFS.

Structural Capacity: Government & Governance. As in the Problem Formulation stage, Calderdale Council is leading the development of the CEFS by providing staff support to the CEFP. However, it recognises that it cannot achieve the ambitious carbon reduction targets set out in the strategy on its own and needs to engage with all sectors and communities across the district to do this. It has committed to providing the necessary staff and resource to support the delivery of the strategy, but over two years since the CEFS adoption the staff resource is still very small.
Whilst the development of the CEFS has been mainly driven by officers, involvement of key members has been important in this. In terms of political support, the CEFS has been developed and adopted by Calderdale Council under a Labour, Liberal Democrat coalition, so is supported by both political groups and some independent councillors have also been involved in its development. Cross party support will be key to the successful implementation of the strategy and achievement of targets in the medium to long term, so getting support for this from all parties is essential, so that it is not abandoned when there is a change of leading group at the council as interviewee HB4 noted:

> "broadly…speaking there's a lot of support for it and the council, at the moment, the administration's a coalition so we've got Labour and Liberal working together anyway and there's complete cohesion on that. So I'd hope for the foreseeable future we'd be able to carry this through. And frankly, if we didn't have long term political support, it would be completely tragic; given this is probably the biggest issue we face as a council. It doesn't seem like that at

> the moment, because we're drowned in demands for savings, which just diverts your attention and just stops you trying to think ambitiously."

The CEFP has agreed a methodology for recording and monitoring the progress against targets set in the CEFS (Calderdale Energy Future Panel, 2013). However, much of this is dependent upon data collected and released by DECC, which is released 2 years in arrears, so monitoring progress will always be 2 years behind actual delivery.

There is an aspiration, articulated by Calderdale Council that the CEFS is something that both they and Town and Parish Councils should support 'for the greater good' and get away from a more confrontational stance where they are in opposition, as interviewee HB1 noted:

> "we've got to work together with it and we've just got to use all our different powers as - and, you know, in the joint way of commissioning…….The fact is, you've got to make these decisions now, you can't hold it off, because the resource is either going to disappear, so you either go for it, or you don't and therefore if you're going to do for it, everybody's got to be in and accept sometimes you're only going to get 70% of what you want, but it's better than getting nothing."

However, the Council has not demonstrated the 'higher level of dialogue' it is suggested is required with civil society to make progress in sustainable development (Evans et al, 2005, p.111) and may have made its job more difficult than it needed to be in gaining whole hearted support at the Town Council level by not involving them in the development of the strategy itself. At Hebden Royd Town Council, the feeling is that they have not been involved in the development of the strategy. In fact the only involvement they have had is as a statutory consultee, with three communications from Calderdale Council on the draft and final strategy, which the Town Council noted. A view from a Town Councillor is that if the CEFS is such an important document, they should have had some form of education about it by Calderdale Council.

Since the lack of engagement with the Hebden Bridge Community in the Problem Formulation stage in developing the CEFS, the Council has taken steps to engage with organisations at the Hebden Bridge level. In addition to the Town Council, there is also a town partnership (Hebden Bridge Partnership, 2014) which describes itself as a town team, bringing together community and voluntary organisations in the town 'concerned with initiatives to improve the economic and community life' of Hebden Bridge. The partnership was formed in 2001 and became the Town Team for Hebden

Bridge as part of Yorkshire Forward's Upper Calder Valley Renaissance programme in 2003 and its membership comprises 33 community and voluntary organisations, plus Calderdale Council, the Town Council and the 4 surrounding Parish Councils. The Partnership produces Action Plans which set out their priorities for action. The latest version is 2020 Vision, Hebden Bridge in 2020: a better place for all (ibid.) and contains six sections, of which one is 'Low Carbon Hebden Bridge' with an associated priority action:

> 'The Partnership will actively support initiatives in Hebden Bridge which help meet Calderdale Council's wider objective of a 40% reduction in carbon emissions by 2020 (2005 base). We also welcome the proposal to develop a community benefit society, Calderdale Community Energy, to fund renewable energy projects and to improve energy efficiency of households.'
>
> (Hebden Bridge Partnership, 2014)

Hebden Bridge also has an ATC, set up in 1999, with a mission statement to work with the local community to make 'sustainability achievable and irresistible'. It is a not-for-profit organisation that operates as an educational resource centre, providing advice and access to information to work towards its goal (ATC, 2014).

The ATC manages and hosts projects, such as the Power From The Landscape project, a LEADER funded programme to provide information, advice and practical help to potential micro-hydro groups to help them develop micro hydro generation across the south Pennine study area (Power From The Landscape, 2014). Both the ATC and the Power from the Landscape projects fed in data to the modelling that was used to assess the capacity of renewable energy in Calderdale district to inform the development of the Energy Future Strategy.

A Transition Towns group also set up in Hebden Bridge in May 2010, with the aim of working with existing networks to build resilience and reduce carbon emissions in the community (Transition Network, 2011), although efforts to contact the group for this research have been unsuccessful and their website is no longer operational, so the group may have folded .

Pennine Community Power is a Community Benefit Society, in the Upper Calder Valley, established in 2012 to support development of community renewable energy. It managed the successful share offer and installation of a 10kW wind turbine at Blackshaw Head near Hebden Bridge (Pennine Community Power, 2014)

In January 2014, Calderdale Council's Cabinet approved a report that a community energy company, Community Energy Calderdale, be set up to assist the development of renewable energy schemes by and for the community, with the intention of reinvesting any surplus income generated 'into a community fund to be used to support further schemes or to provide energy efficiency services improving the wellbeing of Calderdale residents' (Calderdale's Energy Future, 2014b).

This indicates that there are existing and planned organisations who could take a leadership role in the management and delivery of the CEFS actions at a Hebden Bridge level. However, as there was no engagement at the community level when the strategy was developed, there will need to be a significant amount of resource provided to effectively engage with the community in the delivery phase.

Structural Capacity: External expertise. External expertise was used in the problem formulation phase in developing the CEFS by Andy Gouldson, a professor from Leeds University who worked on different energy scenarios to inform the CEFS development. Consultants were appointed by Calderdale Council to undertake a mapping exercise of renewable energy resources that have potential for community development with a focus on council owned land.

Structural Capacity: Funding. All resource for the development of the Energy Future Strategy so far has been provided by Calderdale Council. In terms of delivery, individual shareholders have invested in a small community owned wind turbine at Blackshaw Head (Pennine Community Power, 2014).

Infrastructural Capacity: Community energy systems. The CEFP agreed an action plan for 2013-14, setting out actions against 11 objectives for the early stage delivery of the Energy future Strategy. There are a number of gaps in terms of how actions will be funded and delivered. A 12 month progress report was produced by Calderdale council in November 2013 (Calderdale Council, 2013). As the implementation of the strategy is at an early stage, whilst a number of actions have been delivered, such as the mapping exercise, this hasn't yet resulted in any actual delivery of renewable energy projects yet in the district. The wind turbine developed by Pennine Community Power (2014) at Blackshaw Head was being developed anyway and has been noted as the kind of partnership approach to community owned renewable energy that the CEFS should be supporting (Calderdale's Energy Future, 2014b). However, as interviewee HB4 noted:

> "I wouldn't like to say in energy terms it works effectively at all yet, as it is early days and I'm being completely honest."

Calderdale Council thinks that there is real potential for Hebden Bridge to generate all of its power from renewable sources and is an ideal place to pilot some elements that could contribute to achieving the targets in the CEFS, as described by interviewee HB1:

> "Well I think somewhere like Hebden Bridge, you've got all the attributes. Not only have you got the resource there, so you've got the potential energy generation, you've got the wind........you've got the water. You've also got the people who are enthusiastic about it......you can't create a cluster, you've got to enhance one. Now we've got one in Hebden Bridge to a certain extent, we've got all the ingredients, we've got to, not only try to put the recipe together with them, but actually bake the cake."

However, the challenges in achieving this are firstly to deliver energy efficiency improvements and for communities to support perhaps more controversial renewable energy systems, such as wind power, as one interviewee HB2 commented:

> "Yes. The potential is there. You know, for the energy efficiency, first port of call it's a problem because of the type of housing and actually getting people to reduce their energy use.... And using wind obviously. You stick two big turbines in, problem solved, but is that going to happen? It's certainly not going to happen through hydro."

Some individuals in Hebden Bridge are developing their own renewable energy systems on their own initiative, such as a 10 kW Archimedes screw installed in 2012 by David Fletcher on the Hebden water, next to Bridge Mill, which he owns in the centre of Hebden Bridge, see figure 28.

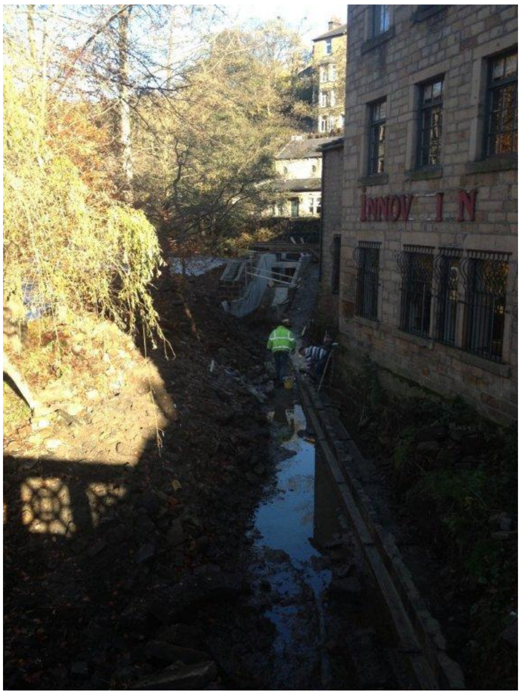

Figure 28. Installation of Archimedes screw at Bridge mill, Hebden Bridge

The Council is looking at a number of future energy projects that could involve Hebden Bridge:

- possibilities of district heating across the district and the use of geothermal energy for this, but this is at the very early stages
- development of small scale hydro projects by the ATC at two council owned sites; Copley and Cromwell Bottom
- development of a Calderdale owned wind farm, generating income for the council
- developing a funding pot for renewable energy systems, through for example a Joint Venture Agreement, that generates an income stream in the long term to develop future projects

It is likely that the energy projects that will need to be delivered if Calderdale is to get anywhere near the ambitious carbon emission reduction set in the Energy Future Strategy will be a combination and range of schemes as interviewee HB4 noted:

> "we've got great possibilities with wind obviously, but huge opposition as well to turbines. We're looking at hydro……. We're working on a big community switch thing……So it's a kind of a bit here, a bit there. Large scale wind farms, very small scale."

5.7.4 *Communication*

Individual and Cultural Capacities: The role of trust and the individual. As the CEFS was produced by Calderdale council, it is perceived as a council document, Awareness of this in Hebden Bridge is at a low level, although engagement with groups has improved since its adoption in 2012. There is no individual seen as leading the CEFS delivery and so there is no-one with whom community members can start to build a level of trust.

Structural capacities: strategy and policy. There was no consultation during the development of CEFS with the community in Hebden Bridge. Once the strategy had been developed, it was sent to Hebden Royd Town Council for comment, as the Town Council is a statutory consultee for the Local Authority. Whilst during discussions with the Town Council, it was recognised that having such a high level strategy was a good thing; the only formal response, however by the Town Council had been to note the strategy. It was felt that there should have been some education to support the consultation on the strategy in order for Town Councillors to realise the importance of this.

The main contact for the Council with the Hebden Bridge community is through its membership of the town's Partnership and the Upper Calder Valley Renaissance partnership and also through its own ward forum meetings. Since the CEFS was adopted by the Council, it has communicated on the development work and action plan, which has led to recognition of its importance by the partnership and their adoption of the action outlined in the above.

The Council has expressed a desire to integrate more with the Hebden Bridge community to progress the Energy Future strategy and achieve the higher level of dialogue referred to earlier, but recognises that it does not yet have effective means of engaging and communicating with communities such as Hebden Bridge on the CEFS and the challenges it will meet in doing this, as interviewee HB4 commented:

> "If I'm being honest, the situation around energy discussions in Hebden Bridge is quite divided……I don't know Hebden Bridge incredibly well, but fairly well and in a lively community like that, that is very developed in civic terms, you just get big disagreements. And again, that's potentially a role for the council. If we can just find a way to kind of integrate ourselves inside it."

As a first step, this could be via the ward forum meetings, which already take place. This approach would also inevitably require more staff resource from the Council. There is a view within the council that people in Hebden Bridge are already engaged in the issues of sustainable energy use and generation and that it would be better for the council to focus its resource on other less engaged communities in the district. However when asked whether most people in Hebden Bridge are aware of the existence of the Energy Future Strategy, the view locally was that they weren't. This supports the findings in Yorkshire Forwards Low Carbon Rural Capitals Scoping study (2008), which identified strong signs of change in Hebden Bridge on energy and climate change, as well as community, citizenship and governance. However the study also found that of the nine rural settlements in the study, Hebden Bridge had the highest carbon footprint per capita, and was also higher than the national average, so it appears that awareness and action on low carbon energy at a community level is a mixed picture.

The awareness of the potential and constraints of different renewable energy systems in Hebden Bridge is also limited. For example, there is a lot of opposition in Calderdale to wind turbines, mainly because of the impact on visual amenity, but there is more support for hydro schemes. However, based on the data and modelling of renewable energy capacity in Calderdale that informed the development of the strategy, if all the potential hydro sites in the district were developed, they would produce less power than one of the large wind turbines, as interviewee HB3 noted:

> "Hydro power is not the answer to an energy crisis."

Communication on the CEFS so far has been mainly from Calderdale council to other stakeholders, from the initial stages in developing the strategy where the council held some consultation workshops to gauge the response to an ambitious vision led approach and what such a strategy should contain, to providing the secretariat for the Calderdale Carbon Club and CFEP and uploading documents and updates on this onto the Calderdale Council website. The council also communicated with statutory consultees, such as Hebden Royd Town Council on the draft and final versions on the CEFS.

From the outset, the council has indicated that it does not wish to lead the delivery of the CEFS. This is, in no small part, because of the significant cuts in the council budget and associated staff resource it will have in the future. This leadership role is seen as closely linked to how information about the CEFS is communicated, as interviewee HB1 commented:

> "I think the days of us being the communicator are limited. I think we have to be a facilitator, a player in that, so if you look at the whole idea of the Energy Future Panel, it was not for us to lead it. We might have to lead it at the beginning to get people together, but actually what you want is some sort of organisation.... that takes the lead."

Whilst the council has articulated that it does not want a leadership, or communication role for the CEFS, it does acknowledge that it will need to do some of this, at least in the short term, as there are some real challenges in implementing the strategy with the awareness at a very low level and generally low down people's priority list in Calderdale district. If there is to be a transformation to renewable energy systems in Hebden Bridge, then there needs to be a step change in type, amount and quality of information provided to enable effective engagement.

Structural Capacity: Sharing learning. As the CEFS is in a relatively early stage of its evolution, there has been little information to share with a wider audience. A conference was held in October 2013 to share information and to discuss how to progress the CEFS (Calderdale's Energy Future, 2014). There is also Calderdale's Energy Future website (ibid.) and a page on Calderdale Council's website (Calderdale Council, 2014), but these do not appear to be up to date, with no information added since January 2014.

The ATC in Hebden Bridge was set up specifically as a not-for-profit educational resource to help people towards sustainable living (ATC, 2014). In this capacity, the ATC has done a huge amount of networking and information sharing since it was established in 1999 with schools, communities, public and private sector organisations on a range of issues relating to sustainability, including energy. ATC staff worked with Calderdale Council on a contract basis, raising awareness of community energy schemes in 2012 at ward forum meetings.

5.7.5 *Outcomes*

The CEFS is in its infancy. By early 2014, two years after its adoption, there are small signs of progress towards the ambitious Energy Future strategy targets in Hebden Bridge itself as a result of the Energy Future strategy. Building on the Power from the Landscape project, the ATC in Hebden Bridge has secured 60% funding to develop an 'off the shelf' hydro system as interviewee HB2 described:

> "We've since then got some funding from the Technology Strategy Board, to actually install on eight small sites in the upper valley. They're all very small sites, but the idea is that we will come up with a small turbine and system that is pretty much out of the box that we can then go on and sell and install for people. So we're trying to work with universities in developing and adapting."

Other CEFS achievements to 2014 are:

The Calderdale Energy Future Panel (CEFP) was set up in September 2012, (Calderdale Energy Future Panel, 2012).

The Energy Future Panel agreed a methodology in February 2013 for monitoring carbon emissions against the targets in the Energy Future Strategy (Calderdale Energy Future Panel, 2013).

The council has centralised its energy purchasing.

A business led Carbon Club (Calderdale Carbon Club, 2014) was set up in 2013 as part of the Calderdale Energy Future to provide peer to peer support for businesses with premises in Calderdale to reduce carbon emissions and improve efficiency. As part of this they can join a free Environmental Business pledge accreditation scheme, through which businesses can work towards a gold, silver or bronze award in reducing their carbon emissions and receive free advice. By early 2014, the numbers of business of varying sizes receiving these awards were as follows; three gold, five silver, four bronze and five were classed as Associates (ibid.).

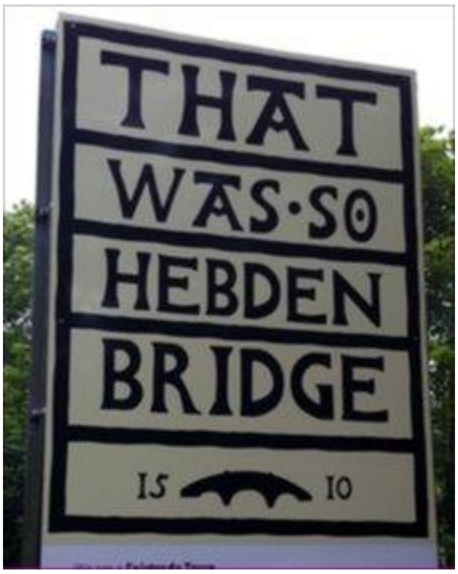

Figure 29. Sign Leaving Hebden Bridge. Photo courtesy of BBC news

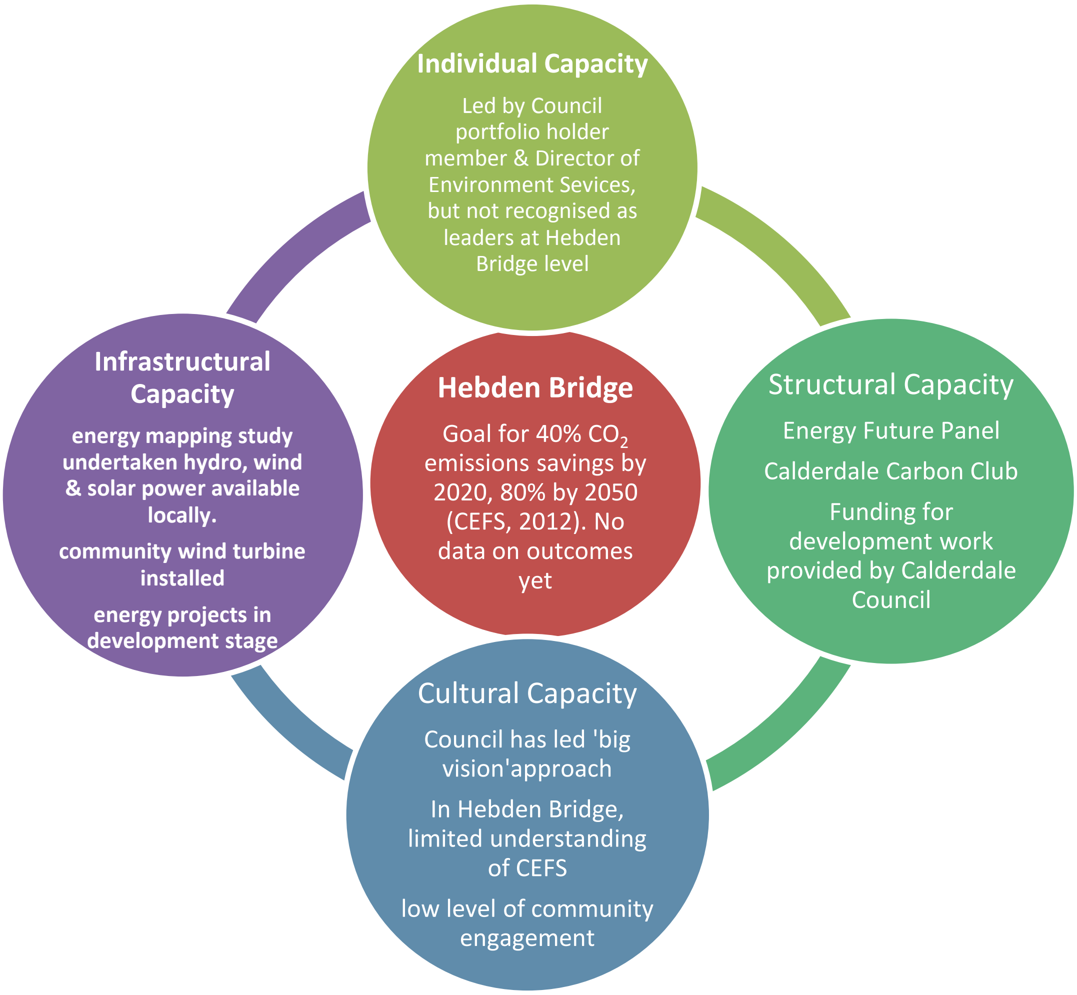

Figure 30. Summary of capacities in Hebden Bridge in the development and implementation of the CEFS

5.8 Energy self-sufficiency outcomes of the UK cases

Table 13 below summarises the energy self-sufficiency outcomes of the UK cases

Community	Energy Goal	Achieved
Eigg	To produce as much electricity as possible on the island from renewable sources (Community viability rationale – economic, social and environmental)	Average 85% of the islands electricity has been powered by renewable sources to 2013 (Isle of Eigg, 2014). (Additional 20kW PV array added in August 2013 and contribution of this has yet to be assessed)
Ashton Hayes	To become a carbon neutral community (Environmental rationale)	CO2 emissions in the community reduced by 23% in the first five years from a combination of behaviour change and installation of energy efficiency measures and small scale renewable systems (AHGCN, 2014)
Fintry	To become a carbon neutral community (Environmental rationale)	The Fintry wind turbine produces 73.5% of the electricity consumed in the village (FDT, 2009)
Hebden Bridge	A District wide goal to reduce CO_2 emissions by 40% by 2020 and 80% by 2050 compared to a 2005 baseline in the Calderdale Energy Future Strategy (Economic, social and environmental rationale)	Progress on implementation of the CEFS has yet to be reported, as the monitoring data provided DECC, is released two years in arrears.

Table 13. UK cases energy self-sufficiency outcome

5.9 Qualitative Comparative Analysis of UK Cases

This chapter has set out the 'stories' of the development and implementation of transformation towards energy self-sufficiency in four very different UK rural case communities, using an adapted structure from Mårtensson and Westerberg (2007) as a framework for presenting the data from the primary and secondary sources. The capacities present in each of these cases have been identified using the conceptual framework. As with the European cases set out in Chapter 4, initial Qualitative Comparative and Boolean analysis was undertaken of the UK cases, presented below.

The capacities identified in the European cases informed the selection of the UK cases. The next step uses the same process described above, presenting the data from the detailed UK cases on capacities present in a Truth table then an initial analysis of these through Boolean algebra.

Table 14. UK Cases Truth Tables

UK cases Truth Table

Variable/ Town	Problem Formulation														Mobilisation						Communication			Outcomes			Comments
Capacity	Cultural/Structural Capacity: Rationale	Cultural/Structural Capacity: Whole place Energy self sufficiency aim at start	Cultural Capacity: Importance of place	Individual Capacity: Skills	Structural Capacity: Vision & Strategy	Structural Capacity: Government and Governance	Cultural Capacity: Boundary object	Infrastructural Capacity: Energy Infrastructure & renewable resources							Individual Capacity: The role of the individual	Structural Capacity: Government & Governance	Structural Capacity: External expertise	Structural Capacity: Funding			Individual/Cultural Capacity: Individual & Trust	Structural Capacity: strategy & policy	Structural Capacity: Sharing learning	Energy self-sufficiency achieved			
								Fuel Source				Community ownership						Public	Private Fun	Individual				Heat	Electricity	Transport fuels	
								Wind	Biomass	Hydro	Solar/PV	Heat	Electricity	Transport fuels													
Eigg	VR	PW	PLACE	PIS	PV	PO	BO	W	b	H	S/PV	COH	COE	cot	MI	MO	MEE	MPUBF	MPRIVF	MIF	CI/T	CSTRAT	CSL	esh	ese	est	Average 85% of the islands electricity has been powered by renewable sources to 2013. (The Isle of Eigg, 2014) (Additional 20kW PV array added in August 2013 and contribution of this has yet to be assessed)
Ashton Hayes	ENVR	PW	PLACE	PIS	PV	PO	BO	w	b	h	S/PV	coh	COE	cot	MI	MO	MEE	MPUBF	MPRIVF	MIF	CI/T	CSTRAT	CSL	esh	ese	est	CO2 emissions in the community reduced by 2% in the first five years from a combination of behaviour change and installation of energy efficiency measures and small scale renewable systems (Alexander et al, 2010).
Fintry	ENVR	PW	PLACE	PIS	PV	PO	BO	W	b	h	s/pv	coh	COE	cot	MI	MO	MEE	MPUBF	MPRIVF	MIF	CI/T	CSTRAT	CSL	esh	ese	est	The Fintry wind turbine produces 73.5% of the electricity consumed in the village (Fintry Community Energy Project , 2009)
Hebden Bridge	SR	PW/D	PLACE	pis	PV	PGOV	BO	W	b	h	s/pv	coh	COE	cot	mi	MGOV	MEE	MPUBF	mprif	MIF	c/t	CSTRAT	csl	esh	ese	est	Progress on implementation of the CEFS has yet to be reported, as the monitoring data provided by the Department for Energy and Climate Change, is released two years in arrears. However data from the year prior to CEFS adoption showed a reduction in CO2 emission from 2005 baseline of 1.395m tonnes, to 1.190m tonnes, a 14.7% reduction (Calderdale's Energy Future, 2014)

Key: VR – Community Viability Rationale (economic, social and environmental) ENVR – Environmental Rationale, SR – Sustainable Development Rationale (economic, social and environmental). PW – whole place approach at start. pw - not whole place approach at start. PLACE – sense of place was important for approach. place - sense of place was not important for approach. PIS – Individuals with key skills played leadership role at start, pis - Individuals with key skills did not play a leadership role at start. PV – there was a vision/strategy at the start. pv – there was no vision/strategy at the start. PGOV – local government played a leadership role at the start. PO – other organisations played a leadership role at the start. BO – the idea of whole place energy self-sufficiency was a boundary object. W – wind was a fuel source. w – wind was not a fuel source, B – biomass was a fuel source. b – biomass was not a fuel source. H – hydro was a fuel source. h – hydro was not a fuel source. S/PV – solar/photovoltaics were a fuel source. s/pv - solar/photovoltaics were not a fuel source; COH – community ownership of heating infrastructure. coh – no community ownership of heating infrastructure. COE – community ownership of electricity infrastructure; coe – no community ownership of electricity infrastructure; COT - community ownership of transport fuels infrastructure; cot – no community ownership of transport fuels infrastructure. MI – no leadership role of individuals in mobilisation; mi - leadership role of individuals in mobilisation; MGOV - leadership role of local government in mobilisation; mgov – no leadership role of local government in mobilisation; MEE – use of external expertise; MBUBF – public funding used for capital works; MPRIV – private funding used for capital works; IF – individuals' funding used for capital works; CI/T – contribution of individual & trust in communication; ci/t – no contribution of individual & trust in communication; CSTRAT – communication of strategy, CSL – sharing learning & experiences; ESH – energy self-sufficient in heat; esh - not energy self-sufficient in heat; ESE - energy self-sufficient in electricity; ese – not energy self-sufficient in electricity; est – not energy self-sufficient in transport fuels

5.10 Boolean equations of UK cases

As for the European cases in section 4.8.2, Boolean algebraic analysis was applied to the findings of the desk based study for the UK cases and the Boolean equations from this are presented in Table 15.

Boolean equations of UK cases	
Case community	**Equation**
Eigg	VR+PW+PLACE+PIS+PV+PO+BO+W+H+S/PV+COH+COE+MI+MO+MEE+MPUBF+MPRIVF+MIF + CI/T+CSTRAT+CSL=esh+ese+est
Ashton Hayes	ENVR+ PW+PLACE+PIS+PV+PO+BO +S/PV+COE+MI+MO+MEE+ MPUBF+MPRIVF+MIF+ CI/T+CSTRAT+CSL=esh+ese+est
Fintry	ENVR+PW+PLACE+PIS+PV+PO+BO+W+COE+MI+MO+MEE+MPUBF+MPRIVF+MIF+CI/T+CSTRAT+CSL=esh+ese+est
Hebden Bridge	SR+PW/D+PLACE+PV+PGOV+BO+W+COE+MGOV+MEE+MPUBF+MIF+CSRAT+CSL=esh+ese+est

Table 15. UK Cases Boolean equations

5.11 Discussion of capacities present

As was found with the European cases, none of the UK cases have the same combinations of capacities or causal factors. There are, however, ten capacities attributable to all the cases as follows:

- That the energy transition was a whole place approach from the start, albeit in the case of Hebden Bridge, this was district wide, not settlement wide.
- A sense of place was important, although again in the case of Hebden Bridge with respect to the CEFS, this was not at the settlement level.
- A vision or strategy was developed that informed delivery.
- The idea of whole place energy self-sufficiency did function as a boundary object, although only at the district, not settlement level in the case of Hebden Bridge.

- There was community ownership of at least some electricity infrastructure; this was the generation system in three of the cases and all electricity infrastructure in the fourth.
- External expertise was used in all cases.
- Public funding was provided in all cases, although in one case, Hebden Bridge, this was not for capital works.
- Funding was provided by individuals in all cases that contributed to capital works.
- Communication of the energy approach to the community to gain support.
- The last common capacity was sharing the learning and experiences.

In addition, there were a number of capacities present in the three cases that were community led. These are:

- The leadership by individuals in both the problem formulation and mobilisation phases
- Other organisations have taken a leadership role in the development and delivery of the energy transitions.
- The trust in individuals who played a leadership role from their communities and the contribution they made in communicating information with their communities on the energy transitions

In terms of the energy self-sufficiency outcomes, none of the cases had achieved energy self-sufficiency in heat, electricity or transport. However, Eigg achieves an annual average of 85% of electricity being produced from renewable sources (Isle of Eigg, 2014), Ashton Hayes has achieved a 20% reduction in CO_2 emissions through behaviour changes in energy use and some small scale renewable energy installations (Alexander et al, 2010), Fintry produces the equivalent of 70% of its electricity demand from renewable sources. Changes in CO_2 emissions since the CEFS strategy have yet to be reported (Calderdale's Energy Future, 2014).

5.12 Conclusions

In this chapter I set out the stories of the four UK cases with respect to energy self-sufficiency. In doing this, I identified the capacities that were present in each of the cases and by representing these in the Truth table and using Boolean analysis (Ragin, 1989 pp.87-88; Georges & Romme, 1995) have determined that there were no cases that had identical combinations of capacities present. However, there were ten capacities that were present in all cases:

- Seven of these are Structural Capacities; a whole place approach from the start, a vision or strategy was developed, community ownership of some of the electricity infrastructure, public and individual funding was used (albeit public funding was not for capital delivery in Hebden Bridge), use of external expertise, communication of the approach within the community and sharing the learning and experiences with a wider audience
- two are Cultural Capacities; the idea was a boundary object and a sense of place was important, although not at a settlement level in Hebden Bridge
- one is an Infrastructural Capacity; community ownership of at least some electricity infrastructure

A more detailed analysis of the data from these UK cases and the initial findings of capacities and similarities and differences to those found in the European cases is discussed in Chapter 6.

Chapter 6. Analysing the Case Studies

> 'through participating in the governance of our communities that we can take the necessary measures to create a sustainable society'
>
> (Roseland; 2000, p.108).

6.1 Introduction

In the first three chapters I set out my approaches to researching capacities present in rural whole settlement approaches to energy self-sufficiency, based on findings and gaps identified in the literature. Chapters four and five describe my research data and findings emerging from this through a cross case desk based analysis of European settlements and then more detailed study of UK cases, based on mainly primary data sources, and a preliminary assessment of the capacities present in both. In this chapter I analyse the ideas emerging from these and the community renewable energy conference and draw my findings from on the research.

My research set out to examine four research questions identified in Chapter 2:

1. Why do rural communities embark on approaches to whole settlement energy self-sufficiency?

2. In rural settlements that develop a whole settlement approach to energy self-sufficiency, what capacities are present and how do these capacities contribute to the development and delivery of this?

3. Do whole settlement approaches to energy self-sufficiency function as a boundary object?

4. Does the rationale for a rural community starting its journey towards energy self-sufficiency make a difference to its progress in achieving this; was a whole community approach to energy self-sufficiency present at the start and was there was a relationship between these and the energy self-sufficiency outcomes achieved?

The conceptual framework I have used to guide the research is below, with the idea of whole place energy self-sufficiency forming a boundary object, but also the level of achievement of this being the dependent variable as a result of the presence and actions of the four different types of capacities:

Figure 31. Conceptual Framework, adapted from Middlemiss and Parrish (2010)

As described in Chapter 3, whilst I recognise that case studies are generalisable, but to theoretical propositions only, not to wider populations (Yin, 2009 p.15) I have used the case study approach to undertake causal investigations and analysis to identify causal pathways (Gerring, 2007; George and Bennett, 2005; Tilly; 2001). In this way, the case study approach used in this research as one of the main research methods is used to facilitate the emergence of theory and causal pathways through analysis of the case study data collected, which can help inform future research, policy and practise.

In arriving at the decision to use the conceptual framework above to guide this research, I recognised that use of the Capacities framework could be considered reductionist; flattening distinctions between different types of explanatory variables.

Other approaches I considered using for framing the data included transitions theory, mentioned in section 2.7, such as bottom-up, local led community approaches to energy solutions. Such 'sustainability transitions' can be used to understand governance, directions and dynamics of grassroots sustainable energy transitions (Seyfang and Haxeltine, 2012) and transition pathways used to examine potential low carbon energy systems in the UK (Foxon, Hammond and Pearson, 2010). One of the benefits of using these is that they use a multi-level perspective to examine interactions between technological niches, socio-technical regimes and landscapes to frame the data, where technological niches include engineering practices, socio-technical regimes include the dominant practices that actors use and landscapes include the wider political, social and cultural values (ibid.). They can be used to understand the relationships between structure and agency in energy transitions and the shift from one energy regime to another. Indeed, Foxon, Hammond and Pearson suggest that 'Particular institutional arrangements strongly influence the governance of energy systems and consequently frame the ways in which these conflicts are resolved', where conflicts may include pursuit of personal/corporate advantage, affordable energy supplies and security of supply. Foxon (2013) also suggests that there are three types of actors identified as influencing changes in energy system transitions: government actors, market actors and civil society actors. In the cases considered here, the majority of key actors have been from civil society.

Whilst such theoretical framings could have been an alternative approach for the research and may have provided a complementary understanding of the moves towards whole community energy self-sufficiency, the Capacities framework used here was adopted as a more appropriate approach, as there was very little documentary evidence, of any socio-technical regimes, including institutional arrangements that either helped or hindered the energy transition of the case communities and this was further justified as no evidence of this was volunteered in case study interviews. Therefore use of transitions theory to further discussion of structure and agency would not have added to the thesis.

I now return to each of my research questions to identify my findings.

6.2 The First Research Question: Why do Rural Communities Embark on Approaches to Whole Settlement Energy Self-sufficiency?

There were a number of different rationales in the rural cases considered here for embarking on the journeys towards WSESS. In the European cases, there were four different rationales; economic in the case of Güssing and Mureck, environmental in the case of El Hierro, research led in the case of Jühnde and opportunistic in the case of Samsø, albeit with strong environmental reasons behind this.

In the UK cases there were two different rationales; environmental in the cases of Ashton Hayes and Fintry, and for Eigg and Hebden Bridge (Calderdale Council), the rationales were a combination of economic, environmental and social, with the rationale in Eigg being more fundamentally about the future viability of the island community.

Economic – as a means of transforming a local economy through reduced energy costs, increased local employment and the multiplier effect of re-circulation of money within a local economy

Environmental - as a means of reducing the impact of a community's energy use on climate change by reducing the carbon emission produced and/or to conserve landscapes of high ecological and amenity value.

Opportunistic – where an opportunity presents itself from outside the community that in the first instance galvanises a community to take action to develop an approach to energy self-sufficiency, such as a university research programme, or a national competition. There may then be secondary reasons (environmental, economic) for continuing with this, but arguably the energy transition would not have been initiated without that external opportunity presenting itself.

Community viability – where the future viability of a community is at stake, such as declining population and may include economic, social and environmental factors

Economic, environmental and social – where each of these factors is considered important and interlinked, so by addressing one of these it is possible to have a positive impact on all three.

This leads me to **Research finding number one: There are a number of different reasons why communities start a journey towards whole place energy self-sufficiency. This finding supports previous research on low carbon communities (Seyfang et al, 2014).**

6.3 The Second Research Question: In Rural Settlements that Develop a Whole Settlement Approach to Energy Self-sufficiency, What Capacities are Present and how do these Capacities Contribute to the Development and Delivery of this?

From the analysis of Capacities, there were no instances where the same combination of Capacities was present in any of the European or UK cases. However, there were eight capacities that were present in all European cases. Six of these are Structural Capacities; public, private and individual capital funding, use of external expertise, communication of the approach within the community and sharing the learning and experiences with a wider audience; one is a Cultural Capacity, the idea was a boundary object and one is an Infrastructural Capacity, community ownership of electricity generation plants.

There were ten capacities that were present in all the UK cases. Seven of these are Structural Capacities; a whole place approach from the start, a vision or strategy was developed, community ownership of some of the electricity infrastructure, public and individual funding was used (albeit public funding was not for capital delivery in Hebden Bridge), use of external expertise, communication of the approach within the community and sharing the learning and experiences with a wider audience. Two are Cultural Capacities; the idea was a boundary object and a sense of place was important, although not at a settlement level in Hebden Bridge. One is an Infrastructural Capacity; community ownership of at least some electricity infrastructure.

There were seven Capacities present in all the European and UK cases, set out in Table 16.

Capacity Type	Capacity
Structural	Public funding
	Individual funding
	Use of external expertise
	Communication of approach within the community
	Sharing learning and experience with wider audience
Infrastructural	Community ownership of some of the electricity infrastructure
Cultural	The idea was a boundary object

Table 16. Capacities present in all European and UK cases

In addition, the same capacities were present in a number of cases as described in the sections below:

6.3.1 *Individual Capacities*

Key individuals were responsible for the inception and leadership in delivery of the energy transitions in two of the European cases; Güssing and Mureck and three of the UK cases, Eigg, Fintry and Ashton Hayes. In a further two European cases; Samsø and Jühnde individuals played a key role in gaining community support for the energy plans and in delivery of these, so became involved at a slightly later stage. Through their energy transitions, a high level of trust was developed between these individual leaders and their communities. Key to this and the successful development of the WSESS approaches was engagement with and provision of reliable information to the communities (Ostrom 1996; 1990 pp.61-102).   This trust is considered a fundamental element of community approaches to renewable energy and the civic engagement activities undertaken in building this have also been shown to further enhance collective action and wider community trust in renewable energy technologies (Walker et al, 2010).

In one European case; El Hierro, there were no identified individuals who took a leadership role and in the remaining UK case, Hebden Bridge, the individuals who were associated with the energy transitions were a councillor and a senior officer, as part of their wide ranging portfolios. However, they were not identified in the community as having a leadership role on this.

6.3.2 *Summary of Individual Capacities present*

- In seven of the nine cases, respected local individuals played a crucial role in the development and delivery of the whole settlement approach to energy self-sufficiency.
- There was a high level of trust in the individuals who played a leadership role from their communities and the contribution they made in communicating information with their communities on the energy transitions

6.3.3 *Structural Capacities*

In three of the European cases; Güssing , Samsø and El Hierro, the municipal authority took the lead in both the development of the energy self-sufficiency approach and in its delivery, with new delivery bodies also being established in each of these. In the remaining two European cases; Jühnde and Mureck, new organisations were also established to lead the delivery of the energy projects, with the project initiation coming from an external organisation in one case and from a local individual in the other.

Of the UK cases, the energy self-sufficiency approach was initiated by local individuals in three of the cases; Eigg, Fintry and Ashton Hayes with the other case, Hebden Bridge being initiated by the principal local authority over its whole area.

Whilst recognising the limitations of drawing conclusions based on a small number of cases, this does indicate a difference between the European and UK cases, with most of the European cases being led from the start by the municipal council and the councils being involved in the others. In the UK cases, however, the local authorities did not take a leadership role in three of the cases and the only one where the council did take the lead; Hebden Bridge, has had very little engagement with, or impact in the case community so far. One of the differences between the European and UK cases considered is the size of area of responsibility of local authorities, supported by comments in the community renewable energy conference I organised with NIReS. Comments from the conference suggest that local authorities in the UK are too large, compared to many municipal authorities in European countries.

In all of the European and UK cases new organisations were established to lead on different elements of their energy transitions. In all, but one of these, the organisations were incorporated bodies, such as private companies limited by guarantee, co-operatives or charitable trusts, or a combination of more than one of these and they are all responsible for delivery of energy projects. The exception to this being Hebden Bridge where a panel has been established by the local authority, incorporating interests from the public, private, academic and third sectors, and it is responsible for overseeing the development and delivery of the district wide energy strategy. However, it is not an incorporated body and is not responsible for delivering energy projects and the local authority acts as its accountable body. As it has the same area of responsibility as the local authority, the area this panel is responsible for is too large to have an impact at the case community level and has no representation from or engagement at the community level.

Given that local authorities were not involved in the leadership of the energy transitions in three of the UK cases; Eigg, Fintry and Ashton Hayes, it is interesting to note that in these cases other existing organisations; a charitable trust, a community council and a parish council respectively were crucial to the development of the energy goals and supported the delivery of these.

These findings support Ostrom's suggestion that working with existing organisations in such ventures is an obvious choice, as it can involve incremental change and less cost (Ostrom, 1990, p.140). However, as most of the cases then went on to establish new organisations this indicates that there is a point at which the cost of setting up new institutions is more preferable.

Local ownership of the energy systems was present for the district heating systems in all four of European cases where district heating systems were installed; Güssing, Jühnde, Mureck and Samsø and of the electricity generating plants in all of the European cases. There was local ownership of all or part of the electricity generating plant in all the UK cases and in one case; Eigg, there was local ownership of the distribution system as well. This indicates that local ownership is an extremely important element of the move towards energy self-sufficiency.

When considering the role of local organisations, existing and new and the predominance of local ownership of energy infrastructure in the case communities, the connection between an existing organisation and its local community in terms of whether it has a role in the development and delivery of the energy transition, appears to be crucial. Where the municipal authorities in the European cases have taken a lead on the energy transition, this has been for their whole area of responsibility, be that a town and its immediate hinterland in the case of Güssing, or a whole island in the cases of El Hierro or Samsø. In the UK cases, where existing organisations have taken a leadership role, again this has been at the whole settlement/community level, with one exception; Hebden Bridge where the local authority took the lead and is responsible for a much larger area, which I will return to later. Where new organisations have been established with responsibility for delivering and managing the renewable energy systems, this has been supported by the existing organisations.

In all cases both existing and new organisations have fulfilled the role of boundary organisations.

I suggest that this, together with the local ownership of the energy infrastructure is the development of a new form of participative local energy governance, where local citizens can develop ideas, play a role in delivery and make decisions on the long term operation and management of their energy systems (PBL, 2011). This builds on the existing understanding of the need for local democratic processes to be participative and collaborative in order to achieve sustainable, long term change in communities (Rydin, 2010 p.58, pp.138-9; Ostrom, 2009; Barton, 2000 p.248).

In all of the European cases public, private and individual funding contributed to the development or delivery of the energy schemes and in all of the UK cases public and individual funding contributed to the development or delivery of energy schemes.

In all cases external expertise, was used to develop and deliver the energy self-sufficiency approach. In most cases members of the community identified a need for particular expertise that was lacking within the community, which ranged from technical expertise from a university in the case of Güssing to design and develop the bed fluidised bed steam gasification CHP system, to planning, design and construction of a wind turbine by wind farm developer in the case of Fintry. In two of the cases, Jühnde and Ashton Hayes, sources of expertise approached the communities. In the case of Jühnde, this was the Gottingen and Kassel University who wanted to find a community to become their pilot Bioenergy village and in the case of Ashton Hayes, this was a representative from the DNO industry. In all cases the external expertise has played a crucial role in the development of low carbon energy processes or systems.

In eight of the nine cases the approach taken was a whole settlement one, with the one exception being the UK local authority led approach which was a district wide approach. However, whilst not specifically a whole settlement approach, by its definition, it does encompass the entire settlement of Hebden Bridge, so has been classed as such. A whole settlement approach was considered to be important and in some cases, such as Fintry determined how they could deliver their energy projects to benefit the whole community, not just part of it.

6.3.4 *Summary of Structural Capacities present*

- The leadership role of local government was important in three of the five European cases; Güssing, Samsø and El Hierro and as an important partner in the remaining two cases; Jühnde and Mureck. In the UK cases, leadership was provided by a local authority in one of the cases, Hebden Bridge but was largely absent in the other cases.
- Existing organisations have played an important role in the development and delivery of WSESS in the majority of cases, as has local ownership of energy infrastructure.
- New organisations were also established in the majority of cases to manage delivery and operation of new energy systems.
- External expertise played a crucial role in successful development of energy processes or systems in all cases.
- A whole settlement approach was considered important in the majority of cases.
- Together, these Capacities show the emergence of new forms of participative governance working towards local energy self-sufficiency, but importantly they have regard to existing organisations in their development.

6.3.5 *Infrastructural Capacity*

In terms of the European cases studied, biomass was used in four of the five cases: Güssing, Jühnde, Mureck and Samsø, solar technologies in three; Güssing, Samsø and El Hierro, and wind was used in two; Samsø and El Hierro. Hydro in the form of a wind pumped hydro system was used only in El Hierro. In the UK cases, a mix of wind, hydro and solar power was used in Eigg, wind power in Fintry and photovoltaics in Ashton Hayes. In all cases, the choice of renewable energy sources used were a combination of what was most abundant/available locally and what was the most cost effective way of developing the systems to harness these for community benefit.

Community ownership of energy infrastructure was important in all of the cases. There were a number or reasons for this. In all cases, it was important that the financial benefits remained in the community, which enabled Güssing to attract more businesses into the area and Fintry to further its carbon neutral goal and other reasons included security of supply in the cases of El Hierro and Eigg.

One of the suggestions from chapter 2 was that these rural case communities might have an advantage of proximity (Hauber and Ruppert-Winkel, 2012) which could predispose the community to adopt the original vision/idea of energy self-sufficiency and its delivery and is linked to the communities' sense of place, part of Cultural capacity. This research has shown that there was strong association of the citizens with their sense of place and community in three of the UK cases; Eigg, Ashton Hayes and Fintry and one of the European cases; Mureck, which contributed to their willingness to adopt a new way of doing things in terms of moving towards energy self-sufficiency. That's not to say that there wasn't opposition to some elements in some of the cases, however the community support was overwhelmingly positive. In the case of Hebden Bridge, the place identity was at the district level in developing the CEFS, not at the Hebden Bridge level. As the data sources for the European cases were secondary, it is possible that the lack of information may be the result of no research in this area.

As for the advantage of proximity translating into benefits for the delivery phase of the schemes, this is less clear. For example, whilst the residents of the Isle of Eigg were extremely supportive of developing a renewable powered microgrid for the island, they also felt strongly that all the cabling should be underground so as not to have a detrimental impact on the landscape. The settlements on the island are extremely dispersed, so burying the cable was the most costly part of the scheme. This dispersed settlement pattern has also been a barrier to development of an island wide district heating system, which is unlikely to be viable. In another example, co-locating the different energy plants in Mureck on the outskirts of the settlement had many advantages, but also increased the capital costs for the district heating system, as it meant the network had to be longer.

6.3.6 *Summary of Infrastructural Capacities present*

- In all cases, the choice of renewable energy sources used were a combination of what was most abundant/available locally and what was the most cost effective way of developing the systems to harness these for community benefit.
- There was strong association of the citizens with their sense of place and community in four of the nine cases: Mureck and the three UK community led cases; Eigg, Ashton Hayes and Fintry, which may have contributed to their willingness to adopt a new way of doing things in terms of moving towards energy self-sufficiency.
- Community ownership of energy infrastructure was important in all the European cases and in three of the UK cases; Eigg, Fintry and Ashton Hayes, although progress in Ashton Hayes on this has been limited so far. There is also an aspiration for there to be community ownership of energy infrastructure on a district wide basis in Calderdale, but there was limited evidence of this in Hebden Bridge.
- It is unclear whether advantages of proximity of the case communities translated into benefits for the communities in delivery of new energy schemes.

6.3.7 *Cultural Capacity*

As described in Chapter 2, cultural capacity in the context of this research is whether the goal of energy self-sufficiency can sit comfortably with a community's history and ideals, including legitimacy, integrity and pursuit of autonomy (Bomberg and McEwen, 2012). It also includes the development role and impact of trust in working towards energy self-sufficiency. As recognised previously, there is some cross over between cultural and individual capacities.

Trust in individuals in communicating the ideas and issues associated with their energy transitions and the support from the community as a result of this was important. From this research, it is clear that there was a high level of trust in the individuals who led the energy transitions in the case communities and this was crucial for the successful communication and delivery of the energy transitions. In some cases, they were already respected members of their community, in others they earned the respect and trust of their communities during the early stages of the energy through engaging with the community and in delivering the projects. There were two cases where individuals have not been associated as leading the energy schemes, and in both of these cases it was the local authority that led the scheme at the start, with one taking a lead in the delivery of the energy projects as well.

The idea of whole place energy self-sufficiency did function as a boundary object, a cultural capacity and will be discussed in detail in 6.4.

In addition, whilst all the cases were rural, there were some differences in their relative geographic or economic isolation. In the European cases, there was geographic or economic isolation in all of the cases, but only in two of the UK cases; Eigg and Fintry so whilst this isolation could be a contributing factor to the development of the energy self-sufficiency; this was not in all cases. However, the seven cases that were more isolated had achieved more in terms of energy self-sufficiency than the two that weren't: Ashton Hayes and Hebden Bridge so it is possible that the intensity of achievement in energy self-sufficiency could in part be determined by the level of historic geographic or economic isolation. This isolation can also confer 'outsider' status on a community which may be one contributing factor that incentivised the case communities to take action on energy (Bomberg & McEwen, 2012), a willingness to try the untested.

6.3.8 *Summary of Cultural Capacities present*

- Trust in individuals leading the energy transitions was important for the successful development and delivery of WSESS in the majority of cases.
- Economic or geographic isolation was a feature of the majority of cases considered and these had achieved a higher degree of energy self-sufficiency than the ones that were not isolated. Historic geographic or economic isolation therefore may be a contributing factor to the intensity of achievement of WSESS.
- The idea of energy self-sufficiency was a boundary object in all cases.

6.3.9 *Capacities in Summary*

There were no instances of the same combinations of capacities in any cases. There were seven capacities present in all European and UK cases, five of these were Structural, one was Infrastructural and one was Cultural. There were a number of capacities present in the majority of cases and some significant differences in capacities present between the European and UK cases. These capacities, individually and collectively, made significant contributions to the development WSESS approaches in each case. Building on the work identified in Chapter 2 on resources needed for actors to mobilise and sustain action on aspects of sustainable development, including communities working on low carbon energy (Porritt, 2007; Middlemiss and Parrish 2010; Dale and Newman, 2010; Bomberg and McEwen; 2012; Seyfang et al, 2014), I identify a collective term for the capacities communities use in developing these approaches as Community Capacities for WSESS.

This leads me to ***Research finding number two:*** **There were no instances of identical combinations of capacities found in any of the cases considered here, so there is no blue print of capacities identified necessary to the success of whole settlement energy self-sufficiency. However there were a number of capacities present in all the cases. These were:**

Structural Capacities:	**Public Funding**
	Individual funding
	Use of external expertise
	Communication of approach within the community
	Sharing learning and experience with wider audience
Infrastructural Capacity:	**Community ownership of some of the electricity infrastructure**
Cultural Capacity:	**The idea of energy self-sufficiency was a boundary object**

There were also a number of Capacities present in the majority of cases and so are important for development and delivery of whole settlement approaches to energy self-sufficiency. These were:

- **The leadership by inspirational, charismatic local leaders**
- **Historic geographic or economic isolation may be a determining factor on the intensity of achievement in energy self-sufficiency**

I now go on to consider how these capacities contribute to the development and delivery of a whole settlement approach to energy self-sufficiency?

6.3.10 *Contribution of Individual Capacities*

The presence of knowledgeable political or technical 'pioneers' (Hauber and Ruppert-Winkle, 2012) or 'citizen entrepreneurs' (Foxon et al, 2009) has played an important role in both the development and delivery in four of the European and three of the UK cases. In two of the European and all three of the UK cases, these individuals were involved in the inception of the idea for the community's energy transitions and were instrumental in persuading local organisations in positions of influence and local residents and businesses to support the idea. In the other two European cases, the individuals became involved soon after the initial idea and played a critical role in getting wider community support for the energy schemes. It is recognised that without their involvement the projects would have been unlikely to have succeeded.

All of these 'pioneers' or 'entrepreneurs' have committed significant time to the projects, either as volunteers, or if in a paid capacity, have contributed in excess of their contracted hours to ensure the projects succeed. Interestingly, two of the individual leaders in the European cases were mayors, supporting in part the key role that these are the: ''entrepreneurial', figures with the charisma and commitment to support others and to promote the sustainability agenda', (Evans et al, 2005, p.109). All of these individuals demonstrated a willingness to try untested systems or processes to achieve their energy goals, so have an appetite for 'managed' risk and all have taken time to learn new systems and processes. All are respected members of their community; whilst some had a wide community respect at the start, such as Karl Totter in Mureck, some have earned that respect through the energy projects, such as the Fintry Four. The Fintry Four learned through developing their project how to maximise the benefits for their community, for example, they realised that their optimum 'window of opportunity' to get support from the wind farm developer was prior to planning approval; the chances of getting planning approval for an energy scheme is greatly enhanced if it has support from the community (Houghton, 2000, p.192).

Sustaining momentum throughout the processes was important for most of the cases and the different regular forms of communication identified assisted in this, such as public meetings, events, newsletters, updates on websites and articles in the media. This was also identified as an issue by delegates attending the Community Renewables conference and delegates suggested that regular information provisions was crucial, as well as not imposing things on community members and managing the process so that it was enjoyable to be part of.

6.3.11 *Contribution of Structural Capacities*

Government and Governance involved in the development of energy self-sufficiency schemes are identified as structural capacities in this research. The close involvement of existing local organisations in the development and delivery of the energy schemes has been a significant contributing factor to their success in all of the European cases and three of the UK cases. This may be a municipal authority in a leading role in three of the European cases, or the IEHT, Ashton Hayes Parish Council or Fintry Community Council in the UK cases. They provide a range of support, which may include legitimacy and financial and democratic accountability, as well as resource to deliver energy projects, or an ability to secure external resources for delivery. A key factor for all of these is the focus of these existing organisations is at the community level for which the energy project is planned.

The only case not included here is Hebden Bridge. Whilst the lead organisation in initiating and setting up the co-ordinating bodies for the CEFS is an existing organisation as the principal local authority, the area covered by this is far greater than the township of Hebden Bridge. As such, the council has to be mindful of not favouring one geographical part of its area over another, unless there are good reasons for that intervention, such as areas of deprivation or there is funding available to fund a particular focus on an area. The primary evidence collected in this research shows that there is a lack of awareness of the CEFS in Hebden Bridge and also there was a lack of involvement of community representatives in its development, other than to receive copies of the strategy as a statutory consultee in the case of the Town Council.

Given the recent cuts in local authority budgets and the move to become facilitators, rather than deliverers in part as a consequence of this, it is understandable why there has not been the resource available to undertake extensive community consultation and engagement in the development and delivery of the CEFS. One of the local authority delegates at the Community Renewable Energy workshop commented that the recent cuts to local authority budgets were making it difficult for local authorities to invest in schemes and that they were prioritising resources on statutory responsibilities; 'the stuff they can end up in court over'. However, given the important role identified earlier of local 'pioneers' in a community that can enthuse and influence the local populace to support and become involved in energy self-sufficiency, then in Hebden Bridge; the UK case led by a local authority, the CEFS may not deliver unless a mechanism is found to do this. In a study of governance in rural towns in Australia, it was found that community governance was an outcome of a 'minimal state' approach, combined with a desire of local community groups to ensure sustainable development services in their communities (O'Toole & Burdess, 2004). In Hebden Bridge, the CEFS is operating under a 'minimal state' approach due to cuts in the Council's budgets, but as there was no community level engagement in development of the CEFS there is no desire yet within the Hebden Bridge community to assume responsibility for its delivery. The level of engagement with the Hebden Bridge community on the CEFS will need to increase significantly if they are to take ownership and work towards the CEFS targets and resources will need to be found to do this.

Returning to a suggestion in chapter 2, that the greater achievements in sustainable development have been described as being almost always part of a higher level of dialogue between local authorities and civil society (Evans at el, 2005, p111); I suggest that the findings from the European cases support this. In three of the five European cases: Güssing, El Hierro and Samsø, the municipal authority took a leading role in the energy transitions, working with their local community and in the remaining two cases; Jühnde and Mureck the municipal authority was involved in the energy transitions and their involvement was seen as crucial to success in both cases, but their involvement was not in a leadership capacity. However, the findings from the UK cases are at odds with this suggestion. Whilst only one UK case, Hebden Bridge, was selected because the local authority had a leadership role, in the other three cases at best the local authorities were identified as having smaller facilitation roles in their energy transition. Dialogue between the council and the community in Hebden Bridge during the development of the CEFS had been almost non-existent, but has improved a little since.   It was also noted in the Community Renewables conference that communities had experienced difficulties in engaging their local authorities in community renewable energy projects, problems finding someone to speak to, getting hold of information and were left with a feeling that the council was remote and disinterested.

Interestingly in the UK, even prior to the recent local authority budget cuts, the number of local authority low carbon community programmes was relatively low (Peters, Fudge and Sinclair, 2010) and there is little evidence of their impact on behaviour change (CSE, 2007), which indicates that the current age of austerity is not the only factor as to why local authorities in the UK have not led whole settlement approaches to energy self-sufficiency in rural communities. Community delegates attending the Community Renewables workshop commented that they came across barriers and delays in dealing with their local authorities to progress community renewable energy schemes and one of the local authority delegates said they experienced the same problems inside the local authority; that there was a risk averse culture and a lack of cross organisational working It appears that austerity budget cuts are not the only reason for lack of leadership in this area; there may be other reasons and I return to the suggestion that one of the reasons the UK is unable to replicate the success of municipal council led schemes on the continent may be because the local authority areas of responsibility are too large.

This idea is supported by comments from delegates during workshops as part of the community renewable energy conference held at Newcastle University, that principal local authorities in the UK cover too large an area to take a leadership role in development and delivery of energy self-sufficiency schemes in individual communities, as one delegate noted:

> "I think there's a problem in this country – at least in Scotland that the size of the local authorities are so big. In most of the European countries they've got really small local authorities, so they can get close to their identified community and actually do something in partnership with them and people know each other."

There may be other reasons why the European cases where municipal councils led the WSESS programmes have been more successful than the UK council led case here. Municipal councils in Europe have the power to take any actions they deem to be in the interest of their communities, unless they are specifically banned from doing this. Whereas in the UK, local authorities are only allowed to do what they have statutory permissions to do, be they compulsory or discretionary (Bulkeley and Kern, 2006; Bulkeley & Betsill, 2003, p59). The 2000 Local Government Act, however did include a new duty for local authorities, 'to promote or improve the economic, social or environmental well-being of their area' (Great Britain, *Local Government Act, 2000)* and it has enabled local authorities to have some discretion in interpretation of this new duty (Bulkeley and Kern, 2006). It has been argued that UK local authorities do have some a level of autonomy in the services they deliver and what contribution they make in addressing issues, so this apparent difference between the two different types of local authority in reality may not be as important.

The apparent lack of leadership by local authorities in the UK at a rural settlement level on WSESS evidenced in this research is in stark contrast to that provided in the European cases and implies a gloomy outlook for their ability to address the broader issue of climate change, as the Isaac Cordal sculpture In Figure 32 suggests.

Figure 32. Isaac Cordal's miniature sculpture in Berlin: 'Follow the leader' or 'Politicians discussing climate change' (CreArtivism, 2014)

Perhaps of more significance is the role that many municipal authorities in Europe have had over a number of decades in being partners in providing utility services for their communities, including heat and power services (ibid.; Collier and Löfstedt, 1997). This can also allow the municipal authority to generate a profit, as well as running the energy companies for the benefit of their residents who are in effect their shareholders. It is only relatively recently that local authorities in the UK been allowed to sell electricity generated from renewable sources (DECC, 2010), which is likely to be a contributing factor to the lack of historic leadership on WSESS, but should be less of an issue over recent years.

In three of the UK cases and all of the European cases new organisations were established to deliver particular energy schemes, these include Gorona del Viento, El Hierro in El Hierro and FREE in Fintry. Considering the apparent importance of existing organisations, at least at the start of the energy self-sufficiency journey for a community, the development of these new organisations, sometimes independent of the existing organisation and sometimes wholly owned by them is an interesting development. This may be for purely practical reason, to enable an existing organisation to retain its charitable status, for example in the cases of Eigg and Fintry, but I suggest this approach through existing and new structures is perhaps the development of alternative governance systems, which develops more participatory governance with active, engaged citizens helping to shape policy and delivery, rather than having decisions made for them and things done to them (PBL, 2011). This would build on existing understanding that collaborative, participative democracy is fundamental to achieving long term sustainable change in communities (Rydin, 2010 p58, pp.138-9; Ostrom, 2009; Barton, 2000 p.248).

Whilst in the case of Hebden Bridge a new organisation has been established, that is the Energy Future panel to oversee the delivery of the CEFS, it is an unincorporated body and does not have responsibility for delivery of energy schemes. Calderdale Council acts as the accountable body for the panel, so it has not been included here as a delivery vehicle for energy self-sufficiency projects for Hebden Bridge.

Funding has been necessary for the delivery of energy schemes in all of the European and UK cases. In all the European cases, funds have been secured from public and private sources and from individuals – often in the form of connection fees to new energy systems, or as shares in new energy co-operatives. In the UK cases, public funds and individual funds have been secured for all of the cases, albeit in Hebden Bridge public funding has only been for development work so far, not in capital scheme delivery. In Fintry private finance was secured on commercial terms to deliver an energy scheme, but the council provided funding for undertaking energy efficiency schemes in the village. In Ashton Hayes private funding was secured for specific smaller scale initiatives. As with some of the European cases, Eigg secured individual contributions in the form of connection fees to the microgrid. In all of the cases that have delivered new energy systems, external sources of funding have been necessary to do this and funding is identified in this research as structural capacity.

6.3.12 *Contribution of Infrastructural Capacities*

Energy sources and systems are included in the definition of infrastructural capacities for this research. Unsurprisingly the sources of renewable energy that have been harnessed in all of the European cases and three of the four UK cases have been the ones that are most abundant in that area. Given the challenges of intermittency of most forms of renewable energy, many of the cases have developed schemes with different contributing energy sources, such as in Samsø, or have developed storage systems in the case of electricity systems to maintain consistent supplies during periods of low generation, such as the battery system on Eigg, or the Pumped Hydro Storage system on El Hierro.

Community ownership of the electricity generating plant occurred in most cases and of the distribution network in all four of the European cases that had district heating systems. Local ownership of the distribution system enables even greater local control of the systems, as the tariffs are determined locally and any profits generated are recirculated within the local economy. The UK Government in considering a variety of community energy ownership models recognises that they could generate more than 12 times the local economic benefits than 100% purely commercial owned models, estimated to value at £1.3bn to 2040 (DECC, 2014b; DECC, 2014c). In Eigg, the electricity plant and distribution network are both locally owned by Eigg Electric Ltd, which sets the tariff and whilst this is more than the average paid on the mainland, it is lower than islanders paid for their individual diesel generator systems previously.

6.3.13 *Contribution of Cultural Capacities*

The contribution of cultural capacities to the successful development of whole settlement approaches to energy independence is more difficult to assess. All of the cases are rural in nature, so most have some level of geographic or economic isolation, which may make a willingness to try to develop new renewable energy systems more likely, although this isolation wasn't present in all cases, it was in the majority considered.

As Long and Perkins argue, place-based bonds that individuals have on an emotional level are fundamental tenets of personal and community identity which can be the basis for both change and stability for communities, (Long and Perkins, 2007)

> 'Such place-based emotional bonds are essential to personal and social community facets of identity and afford a basis of change as well as stability for individuals and groups/communities alike' (ibid., p.566).

I also perceived that there was a spirit of independence in many of the case communities, which may in part be due to this isolation. It is possible that being a rural community, even if close to a larger urban centre may make it easier for a community to identify with a settlement, as the settlement is quite distinctive in form. This 'advantage of proximity' (Hauber and Ruppert-Winkel, 2012, p.2) or sense of place (Sarason, 1974, p.157) may engender a willingness to participate in innovative community activity, such as approaches to WSESS.

In the case of Hebden Bridge, the lack of awareness and action at the Hebden Bridge level of the CEFS is likely to be a result of lack of community engagement and local negotiations in both its development and delivery. In effect as Raven et al observe, such a 'ready-made solution' (the strategy) has been dropped into a community and is likely to have little chance of success (Raven et al, 2008).

One issue identified in Chapter 3 was that Ragin's Qualitative Comparative Analysis did not account for the temporal order with which attributes contribute to an outcome and the impact of this (Caren and Panofsky, 2005). Whilst a detailed investigation of the contribution of the temporal order that the capacities have made to achievement of energy self-sufficiency outcomes in the cases examined here is beyond the scope of this research, it is recognised that the timing of the introduction of certain capacities has had an impact on the outcomes, e.g. community engagement in fossil fuel free energy activity in Samsø only gained momentum once Soren Hermansen (represented by individual capacity) became involved (Droege, 2009, pp.102-103).

6.3.14 *Summary of Contribution of Capacities*

The key conclusions drawn as to how do these capacities contribute to the development and delivery of a whole settlement approach to energy self-sufficiency are:

- The leadership role of local authorities in the European cases in the initiation and delivery of the energy transitions have been fundamental to their success. Even the cases where the local authority has not been the lead body, their role was still regarded as crucial to the successful development of the energy systems (Tomescu, 2005, p.41).

- The areas covered by primary local authorities in the UK may be too large for the local authorities to effectively lead a transition in individual rural communities in their area towards energy self-sufficiency. The data in this research shows that little action in terms of problem formulation, mobilisation and communication of the issue of whole rural settlement energy independence has occurred in the UK case that has been led by the local authority. This finding supports the suggestion that having institutional arrangements at too high a jurisdictional level is a major cause of policy failure (Ostrom, 1996). One of the reasons for this, may be rivalry between communities in competition for resources (Powe, Pringle, Hart, 2014) and jealousy between communities, as articulated by delegates of the community renewable energy conference and by a local authority councillor during this research. The geographic area of responsibility of the municipal authorities in the European cases where they took the lead are of the case community settlement or groups of settlement and their immediate hinterland, but no more. Part of this may be due to poor communication and engagement with the case community in this research, but as Evans et al recognise: ‘Even the most sustainable local initiative is worth little if it is not communicated properly to all citizens and interest organisations.’ (Evans et al, 2005, p.119).

This leads me to ***Research finding number three:*** **Local Authorities in the UK may be too large to lead successful whole settlement energy transitions for individual rural communities**

- Following on from this, the role of dynamic, charismatic individuals in leading the energy transitions has been a key capacity in the success of the majority of the cases considered here. These individuals have a range of skills that have enabled them to persuade their communities to support the whole settlement approaches to energy self-sufficiency and earned their trust. This trust has been important and it is interesting to note that the trust is between individuals not between institutions (Evans et al, 2005, p.112).

This leads me to **Research finding number four: Key individuals were responsible for the inception and leadership in delivery of the energy transitions the majority of cases considered here.**

- Following on from this, there was regular interaction and communication in the case communities that made the most progress towards energy self-sufficiency and this information flow and transparency helped build social networks and develop trust (Ostrom, 1990 pp.88-89, 1996).
- All the cases considered here are rural in nature and had a strong sense of place. The majority of these have some level of geographic or economic isolation, which may make a willingness to try to develop new renewable energy systems more likely.
- This research presents a mixed picture, as to whether as Evans et al (2005, p.112) suggest that the highest levels of achievement in sustainable development are where civil society has a track record of being more active. This is the case in some, such as the isle of Eigg, but in others, such as Ashton Hayes, this is less obvious.

6.4 The Third Research Question:

Do whole settlement approaches to energy self-sufficiency function as a boundary object?

As described in chapter 2 in the conceptual framework used in this research a whole settlement approach to energy self-sufficiency is considered as a Cultural Capacity, that as an idea it is a boundary object around which the diverse interests in a rural community can coalesce without losing their autonomy even though they may have very different interests in it (Hauber and Ruppert-Winkel, 2012), as well being the dependent variable; the outcome, i.e. achievement of energy self-sufficiency.

Did this happen in the cases consider here? As set out in the previous two chapters, the answer in all cases was yes; the approach required new and in some cases diverse actors to come together to facilitate the development of energy self-sufficiency in the communities. In a number of cases, the idea was a ground breaking development and took a while for the design of specific projects to emerge, such as in Güssing or El Hierro and during this period the idea became a boundary object, drawing public, private, community and other actors together around an idea that was malleable enough that they could all contribute to its development through exchange of knowledge, without needing to have a consensus on their aims (Brand and Jax, 2007; White et al, 2010). In six of the cases: Güssing, Jühnde, Mureck, Ashton Hayes, Eigg and Hebden Bridge new actors were introduced from academia who had not previously engaged with those communities; individuals became involved as leaders in seven of the cases; Güssing, Jühnde, Mureck, Samsø, Eigg, Ashton Hayes and Fintry and the wider communities became involved in a variety of ways, such as energy customers, members of co-operatives, participants in surveys, and their support was essential in the successful development of energy self-sufficiency in eight of the nine cases. The ninth case, Hebden Bridge, in which the energy transition has been initiated by the local authority has also acted as a boundary object in the early development stages through the establishment of the Energy Future Panel, which brings together interests from the public, private, community and academic sectors who had not previously worked together. However, as described in Chapter 5, this did not directly engage with the community of Hebden Bridge.

My research suggests that in all of the cases the idea of whole settlement approaches to energy self-sufficiency was a boundary object; whether it is described as a 100% move to renewable energy, a research approach to biomass fuelled energy systems, or a move to become carbon neutral. As described in chapters four and five, this has seen individuals and organisations with a diverse range of interests come together to progress the idea. Often they have not worked together in the past and have very different reason for being involved. It was important that for these diverse actors that they were able to shape the development and delivery process and were not presented with a prescribed strategy. This supports findings from research into European energy schemes, that ready-made solutions cannot be imposed on a place without local negotiations (Raven et al, 2008) In most of the cases, the idea only became a boundary object as consideration was given to how the ideas could be realised and what organisations were necessary to do this, which supports Cash et al's (2003) proposition that for effective boundary work it is essential to develop procedures or organisations that span the boundaries. In one of the UK case; Hebden Bridge, it should be noted that the idea of the CEFS acted as a boundary object, drawing together organisations and individuals from a variety of backgrounds to form the CEF Panel at a district wide, not a settlement level.

In section 6.3.3 I identified that the whole settlement aspect of the energy self-sufficiency approach was considered important in eight of the nine cases. I now consider the different ways that the whole settlement and energy self-sufficiency elements of WSESS were utilised in the cases and their roles in WSESS as a boundary object.

In three of the European and three of the UK cases, the idea of working towards energy self-sufficiency through a whole settlement/community approach was adopted at the start. In two of these; Jühnde and Samsø, this whole settlement/community approach was part of a framework introduced by external bodies that these communities responded to. These were, respectively: an opportunity to be part of a research led approach to maximise use of bio energy fuel sources in a village setting and a response to a national competition for areas or islands to submit masterplans for 100% transition to energy self-sufficiency based on renewable energy. The whole community approach in both of these was therefore 'dictated' by external organisations. It should also be noted, as described earlier, that whilst the plan developed was a whole island one for Samsø to become 100% self-sufficient in energy from renewable sources, it wasn't until a local teacher started championing the approach with the community that it actually became supported by the whole island community.

In El Hierro, Eigg, Ashton Hayes and Fintry the whole community approach was locally determined from the start. Of course for the two island communities, this may have been a very obvious decision, due to their geographic isolation and the common issues of cost and security of energy supplies facing all islanders. For the other two, both village communities, there was a very clear and strong mandate from within the communities that the approaches should be whole settlement from the start, with everyone having the opportunity to be involved and to benefit from these.

For Güssing and Mureck, the whole settlement approach to energy self-sufficiency came later, once successful initial renewable energy systems had been delivered. However in both of these cases, the adoption of that goal was deemed critical to the ongoing successful development of renewable energy schemes.

As described above, whilst the idea of WSESS was a boundary object at a Calderdale district level, this was not the case at the town level for Hebden Bridge. For all the other cases considered here, whole settlement approaches did act as boundary objects, with actors having very different reasons becoming involved. However, did actors engage because the approach was a whole settlement one, or because they had a contribution to make on some aspect of energy self-sufficiency?

In the cases of Jühnde and Samsø, the whole community approaches were critical for the involvement of the Göttingen and Kassel University and the Danish Energy Authority (now Agency), respectively. The university provided project management, academic research, communication tools and invested funding in the whole village bioenergy approach in Jühnde and in Samsø the Danish Energy Authority provided grants for undertaking feasibility studies and for installation of different energy systems.

The whole settlement approach in Ashton Hayes was also a reason why Professor Alexander of the University of Chester became involved, providing staff and student resource to support the baseline and subsequent annual assessment of carbon footprints. A whole settlement approach, such as that adopted in Ashton Hayes had not been done before, so was a rich source of material for academic research.

For the other five cases and for delivery of other individual energy projects in the above, actors became involved at different stages for more specific reasons. For example, Falck Renewables Ltd became involved in the Fintry approach to become a carbon neutral settlement in order to facilitate the granting of planning permission for the Earlsburn wind farm. The fact that it moved Fintry towards its goal was serendipitous, but was not the primary reason for their involvement. On Eigg, the company Econnect Ventures Ltd were commissioned to undertake the feasibility study of a renewable powered microgrid for the island and were then were commissioned as a sub-contractor in the delivery of the microgrid. Similarly in Güssing, Professor Herman Hofbauer and his team at Vienna Technical University became involved in the energy transition there in order to do a field scale trial of their experimental fluidised bed steam gasification system. (Douthwaite, 2006; Juza & Marhold, 2010). In all of these examples the contribution of these actors to the moves towards WSESS was significant and positive, but this was of secondary importance to them. In most cases they were interested in supporting delivery of individual energy projects that incrementally moved the community towards their WSESS goal. Arguably some of these would have worked with the communities if their aims had been just to deliver a single energy scheme. However, a number were interested in both the whole settlement and the energy self-sufficiency elements of WSESS, for example the Göttingen and Kassel University in the case of Jühnde, the Danish Energy Authority in the case of Samsø and the University of Chester in the case of Ashton Hayes.

There does, therefore appear to be a difference in how the boundary object of WSESS is viewed by different actors at different times. In the cases described here, there are core groups of actors in each case, be they individuals or organisation or a combination of the two, who appear to safeguard and champion the whole settlement and the energy self-sufficiency elements of the transition towards energy self-sufficiency. These include: the municipal councils in El Hierro and Güssing, the energy co-operative in Jühnde, the municipal council and Energy academy in Samsø, the IEHT in Eigg, AHGCN in Ashton Hayes and FDT and FREE in Fintry. In doing this, they act as custodians of the boundary object and actively seek opportunities to work with partners to further their WSESS goals. Other actors engage in the WSESS boundary objects at specific times for specific reasons, primarily to further their own aims. Some deliver energy projects that contribute more to the energy self-sufficiency element of the WSESS goal and others contribute to both the whole settlement and energy self-sufficiency elements, for example through research and funding. In all of the cases, different actors have engaged at different times, working with the core groups or custodians of WSESS and whilst the reasons for their involvement may have been self-serving, their contributions had mutual benefits, as they moved the case communities towards their WSESS goals.

This leads me to **Research finding number five**: **The idea of whole settlement energy self-sufficiency was a boundary object in all, but one of the European and UK cases and in the last case, it was a boundary object on a whole district level. In the majority of cases, this occurred soon after the idea was mooted and was essential in mobilising support from a diverse range of actors for the successful delivery of low carbon energy schemes that worked towards the energy self-sufficiency goal. Different actors may engage at different times with this boundary object in a mutually beneficial way, but have very different reasons for becoming involved.**

6.5 The Fourth Research Question:

Does the rationale for a rural community starting its journey towards energy self-sufficiency make a difference to its progress in achieving this; was a whole community approach to energy self-sufficiency present at the start and was there was a relationship between these and the energy self-sufficiency outcomes achieved?

6.5.1 *Outcomes compared to rationales*

In terms of energy outcomes compared to rationales, arguably Samsø and Jühnde have achieved the highest levels of energy self-sufficiency of the European cases. Samsø achieved a total of 99.6% energy self-sufficiency by 2006 (EnergiPlan, 2007) and had an opportunistic rationale for starting its transition, backed by strong environmental reasons. Jühnde achieved 99% energy self-sufficiency in heat and 200% in electricity (IEA, 2009; IZNE, 2005) and took a opportunistic, research led approach to energy self-sufficiency, starting out looking at energy from biomass led by a local university. Both of them had whole settlement approaches from the start.

Güssing and Mureck both had economic rationales for starting their energy transitions, so it was a means to an end, rather than an end in itself. Both have delivered transformations in their local economies through their energy transitions to renewable energy systems, although achieving less in energy self-sufficiency; Güssing at 71% (Keglovits, 2013) and Mureck at 85% for heat (Droege, 2009, p.121). In Güssing over 1,100 jobs have been created and more than 50 businesses have been created or moved to the town (Vadasz, 2011) and the town receives 400 eco-tourists per week (Droege, 2009, p111). Mureck has created between 43-48 jobs directly through the MEC (Bio-energy Cycle Mureck, 2005), plus additional jobs associated with the energy plants; electricians, machine fitters and joiners and in job retention in farming through production of biomass. Mureck also receives 6,000 visitors per year to learn about the energy systems, (Bioenergie Mureck, 2007). This may be due in part to the multiplier effect and overcoming the 'leaky bucket' effect through keeping more money circulating in a local economy, (New Economics Foundation, 2002), which means the economic benefits to the rural community is likely to be stable over time (Blair, Kay and Howe, 2011).

El Hierro had an environmental rationale for its 100% REI plan and it was a whole island approach from the outset. It has set itself an ambitious target and has recently launched its innovative PHS for producing electricity on the island. This is expected to produce 70% of the islands electricity demand, but is at too early a stage for any monitoring information to be available (Hallam et al, 2012; Gorona del Viento, El Hierro, 2014).

Of the UK cases, both Eigg and Fintry have made significant steps towards energy self-sufficiency in electricity, with Eigg achieving an average of 85% electricity produced from renewable sources (Isle of Eigg, 2014) and Fintry 73.5% (FDT , 2009). Their rationales were future viability of the community (economic, social and environmental) and environmental respectively and both adopted a whole community approach from the start.

Ashton Hayes achieved 23% CO_2 emission reductions in the first five years, since the start of AHGCN (AHGCN, 2014) through behaviour change, energy efficiency measures and delivery of small scale renewable energy systems. Plans are in development for a renewable powered microgrid in the village, with the formation of a community energy company. Ashton Hayes's rationale was environmental and it was a whole community approach from the start.

Hebden Bridge has been part of a whole district approach, led by Calderdale Council through its development of the CEFS in 2012. The primary research indicates that there has been very little involvement of the community in Hebden Bridge in the development of the CEFS, or in any delivery so far that would work towards achieving the ambitious targets set out in the plan for CO_2 emission reductions. It is also not possible to assess the progress towards achieving the target, as DECC releases the monitoring data two years in arrears. As described in chapters two and three, it is extremely challenging for a council led initiative in the UK to deliver plans for energy self-sufficiency on a settlement basis than for municipal councils in Europe, as their area of responsibility is much larger. Whilst the CEFS is at an early stage in delivery, there does not appear to have been the 'hearts and minds' embracing of the approach at the Hebden Bridge level, as has been evidenced in the other UK cases that have been led by the community. As acknowledged during interviews with a council officer and member, it is going to be a challenge to deliver the targets in an era of massive cuts to council budgets and to get partners to lead on delivery of the CEFS.

Due to the limited number of case studies, generalisibility is limited to theoretical propositions (Yin, 2009, p.15). However, from the case studies examined it is possible to draw a causal link between the rationale and the energy self-sufficiency outcome achieved, which may inform communities in the future when considering energy self-sufficiency and also future policy makers:

Of the two European cases that had an economic rationale; Güssing and Mureck, Güssing achieved 71% overall energy self-sufficiency for heat and power and Mureck achieved 85% energy self-sufficiency in heat, with some power also being produced. Both achieved significant economic benefits through their energy transitions creating local jobs, large numbers of eco-tourists visit each place, new businesses have been established and there have been energy cost savings for local consumers.

The European case that had an environmental rationale; El Hierro is estimated to produce in excess of 70% of its power from local renewable sources, although the main scheme contributing to this was only launched in summer 2014, so is too early to confirm this.

The European case that was opportunistic in that it developed its energy transition in response to a competition; Samsø produces more than 100% of the power and 70% of the heat it consumes from local renewable sources.

The last European case, Jühnde was research led and produces more than twice the amount of power and 99% of the heat consumed from local renewable sources

Of the UK cases, Eigg had community viability as a rationale and achieved 85% self-sufficiency in power from local renewable sources.

Two of the UK cases had an environmental rationale; of these Fintry produced 73.5% of the electricity consumed from a local renewable source. The other; Ashton Hayes has reduced its CO_2 emissions by 23% through energy efficiency measures, changes in behaviour and installation of small scale renewable energy systems.

The last UK case; Hebden Bridge had an economic, environmental and social rationale for setting its energy and CO_2 emission reduction targets. It is too early to say whether there has been any progress since the CEFS was adopted due to a two year delay in DECC producing data. However, progress on the action plan in an early stage of development.

The greatest progress towards energy self-sufficiency in both power and heat of the European cases was Jühnde, which had a research led (opportunistic), rationale for embarking on its energy transition, being just 1% short in meeting the community's heat demand and producing in excess of 100% of the electricity demand . The other case that had an opportunistic rationale, Samsø produces 100% of electricity demand and most of its heat from local renewable sources. Significant progress was also made in both of the European cases with an economic rationale, Güssing and Mureck, who produce most of their heat and some of their power and transport fuels from renewable sources. The progress in these cases should not be a surprise as it has been recognised that pioneering behaviour in energy and climate change is associated with high levels of economic development (McEwen and Bomberg, 2014). El Hierro had an environmental rationale and is making significant progress in becoming self-sufficient in power (70% projected from the PHS).

As with the European cases, none of the UK cases have achieved energy self-sufficiency in both power and heat. The UK case with the community viability rationale; Eigg and one of the cases with an environmental rationale; Fintry have made significant progress in moving towards energy self-sufficiency in power. The second case with an environmental rationale; Ashton Hayes has made significant progress in energy efficiency and behaviour change, but limited progress to date on energy generation and the last UK case with a combined economic, environmental and social rationale; Hebden Bridge is unable to report on progress yet, but it is at an early stage and indications are that progress is limited so far.

Whilst none of the European or UK cases have achieved energy self-sufficiency in both power and heat, the European research led approach has come the closest, although one of the European cases with an economic rationale had previously achieved energy self-sufficiency in both, but this reduced as a result of the impact national policy changes on procurement. In conclusion, all of the European and two of the UK cases have made great strides to becoming energy self-sufficient and all have plans to continue to work towards their goals irrespective of their rationale for doing so.

This leads me to **Research finding number six: The reason for a community embarking on its energy self-sufficiency journey does not appear to be a determining factor on the outcomes achieved.**

Three of the five European cases took a whole community approach at the start, two of these: El Hierro and Samsø related to energy self-sufficiency, whereas for Jühnde the idea was looking for opportunities to support use of biomass energy systems. However, once Jühnde became the Bioenergy village settlement, the idea of a whole settlement transition from fossil fuel to renewable energy for power and heat was adopted. Güssing and Mureck both developed the whole settlement approach at a later date. For Güssing, the initial approach was for all public buildings and services to become fossil fuel free, but as the municipal authority delivered this, the idea of the whole community becoming fossil fuel free through energy self-sufficiency was developed. The starting point for Mureck was to transform the agricultural economy of the area through development of biomass energy systems. As for Güssing, Mureck developed a whole place approach following successful delivery of the early energy projects and set an ambition to meet all energy needs of the town from renewable energy sources (McCormick & Kåberger, 2007).

Three of the four UK cases took a whole community approach at the start, the exception being Hebden Bridge, which was a district wide approach, which by default encompasses the whole of Hebden Bridge, but was not a settlement specific approach.

Given that Mulugetta, Jackson & Van der Horst (2010) suggest that the right mix of strategy and policy is crucial in determining the organisation of community carbon reduction measures. If the right mix includes community involvement in the development of strategy and policy, it should not be a surprise that the places where the community have been involved in development of the approach have achieved more in energy self-sufficiency.

This leads me to Research finding number seven: All cases adopted a whole settlement approach, the majority of these from the start. Whether the whole settlement approach was adopted from the start or at a later date does not appear to be a determining factor on the level of energy self-sufficiency achieved. However, the adoption of a whole settlement approach was considered an important factor by the communities on the level of energy self-sufficiency achieved.

6.6 Conclusions

This research shows that there have been some outstanding examples of rural communities in Europe and the UK that have embarked on journeys towards energy self-sufficiency and whilst none have achieved their goals yet, most have made significant progress towards achieving them and some are almost there. The communities had different reasons for starting these journeys and they all took different approaches in working towards their goals.

Seven findings have emerged from the research undertaken in this study. Whilst I recognise the limitations the small number of cases has in being able to generalise these findings, they do make an important contribution to the understanding of whole rural settlement approaches to energy self-sufficiency and the capacities that play a role in the delivery of this.

Can these case study approaches be replicated elsewhere? Not exactly. This research has shown that none of the cases had the same combination of capacities present, so it is not possible to use any given case as a blue print for development of energy self-sufficiency approaches in other communities. However, in recognising that a process that has been followed in any one of the cases considered here cannot be precisely replicated elsewhere due to tensions between transferability and situatedness (Rydin, 2010, p.85; Bulkeley, 2006); rather than dismissing this as unquestionable 'terminal uniqueness', where nothing is transferable because of the unique circumstances in any given place, there are some points for policy makers or communities to consider that may assist when contemplating how best to support the development of such an approach:

- The role of inspirational, committed individuals in leading the process including initiation and delivery and in gaining the support of the wider community for this should not be underestimated. Often volunteers, these individuals commit a huge amount of time, sometimes years as full time volunteers. I will explore how these individuals may be supported to achieve their potential in whole place energy self-sufficiency in the UK in Chapter 7.
- In an age of austerity, what role can local government play?
- Public funding contributions have been essential for successful delivery of community renewable energy schemes considered here. In an era of public funding constraints and competing priorities, how can public funding bodies consider whole place energy self-sufficiency a priority for funding.
- The approach can be a boundary object that draws actors together from a diverse range of interests who perhaps have not co-operated previously and this can have the effect of producing more than the sum of the parts.
- Through this boundary object approach new forms of participative local governance can be developed for WSESS.

- Whilst a number of cases here produce more electricity than they consume, the local benefits can be limited if the electricity distribution systems are not locally owned.
- Access to external expertise is critical to support communities in moving towards whole place energy self-sufficiency
- How can communities be supported to develop the Capacities needed to move towards whole place energy self-sufficiency?

These will be considered in the following chapter to inform future approaches to whole settlement approaches to energy self-sufficiency in the UK.

Chapter 7. How can the Case Study Research Inform Future Whole Settlement Energy Self-sufficiency in the UK?

> 'It ought to be remembered that there is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things. Because the innovator has for enemies all those who have done well under the old conditions, and lukewarm defenders in those who may do well under the new'.
>
> Nicolo Machiavelli (2010, p.21).

7.1 Introduction

The previous chapter answered my research questions and in doing so, identified the key findings from the research. In this chapter I prescribe some recommendations for pushing forward the central theme of how the UK can do better at WSESS for rural communities and end with some concluding remarks about the research.

7.2 How can the UK do Better?

The key recommendations emerging from the research findings described in the previous chapter are discussed under two sections:

- Leadership
- Policy

7.2.1 ***Leadership***

This research has shown the importance of effective leadership in whole place transitions to energy self-sufficiency, by individuals, local councils and other organisations.

The potential of community energy has been recognised as making an important contribution to energy generation, security of supply, emission reductions and sustainable rural economies (DECC, 2014a). In doing this, who can take a leadership role and how can this be supported? As this research shows, there are some notable whole place energy self-sufficiency transformations already happening in the UK, and where this has happened, these communities have had access to and harnessed a range of internal and external capacities to support them in doing this. However, this is happening in a limited number of communities, whilst the majority are not tackling such schemes, so what are the potential options that can support such transformations and avoid the inequalities and a two tier system we have seen in rural communities as a result of 'uneven capacity of local place-based communities'? (Shucksmith, 2012).

This research has demonstrated the critical role played of inspirational, committed individuals in the majority of cases considered in leading the whole place energy transition to energy self-sufficiency. The contribution in the initiation and delivery and in gaining the support of the wider community for this should not be underestimated. Often volunteers, these individuals commit a huge amount of time, sometimes years as full time volunteers. The research also demonstrated the key role that existing local organisations played that operate at a sub local government level in the UK cases. The issue of local leadership is intrinsically linked to that of effective government and governance at a local level. In three of the UK cases in this research, the local authority was absent in a leadership role and in the fourth case where the local leadership has been provided by the local authority, but at a district wide level, in an era of declining budgets, it recognises that it does not have the capacity to provide that leadership at the settlement level of the case community.

This raises a question as to whether the three UK cases that were led by the community would have embraced the transition to energy self-sufficiency to the extent that they have if the local authority had led the process from the outset? Given the research findings of the critical leadership role that individuals played in the initiation and delivery of these transitions in the majority of the cases considered, the answer to this in part relates in the leadership abilities of individuals to inspire and co-ordinate local support and action, in combination with organisational governance at a whole settlement level. I consider here how leadership for whole place energy self-sufficiency can be developed by individuals and local organisations and also by local government.

The Community Energy Strategy (DECC, 2014a) recognises the importance for communities considering developing community energy projects of learning from those that have already delivered projects, through supporting a peer mentoring scheme and such lateral learning by community groups can further collective agency (Flora and Flora, 2004, p341). The Community Energy Strategy (DECC, 2014a) also identifies a list of skills that communities need to develop successful community energy schemes and sets out plans for capacity building for communities to develop such skills. However, leadership as a skill is noticeable by its absence. In fact the only reference to leadership in the whole document is that that can be provided by local authorities, but the description of activities given that local authorities can provide to do this at best are to facilitate, not lead. Even if the plans for delivering capacity building schemes are realised; if funded by the public sector, by their very nature these will be time limited and dependent upon delivery of specific outputs, or worse still, government funded programmes aimed at fostering community capacity building can do the opposite by building a dependency upon external funding and staff (Healey, 2013).

So the question still remains, 'What does this mean for local leadership for whole place energy self-sufficiency? How can these leaders be identified and is it possible for individuals to develop the leadership skills necessary? This is a question that has taxed generations of scholars, politicians, policy makes and practitioners across a range of disciplines and subjects for many years and the solution will not be presented here. However, there are some ways that these leaders can be supported.

Leadership by local 'political' or 'technical' 'pioneers' was found to be a key element in successful development and delivery in most of the cases considered in this research, supporting other research findings (Brook Lyndhurst, 2010; Hauber and Ruppert-Winkel, 2012). The development of a relationship between these leaders and the communities they represent has resulted in a high level of trust developing. Individuals such as these in leading community projects have entrepreneurial skills in networking and mobilising and through their leadership and passion, others become drawn towards the project and through their involvement, transform their own capacities and appreciation of what can be achieved (Healey, 2013).

This research shows that this involvement is galvanised through a strong association of citizens with their sense of place and community in the UK community led cases and that contributed to their willingness to adopt a new way of doing things in terms of moving towards energy self-sufficiency. There was also a high level of trust in the individuals who led the energy transitions and this was key for their successful delivery in those places. This is in contrast to localism when initiated by government organisations, which is often mistrusted, as it is seen as a way for government bodies to save money by supporting community level service delivery rather than a genuine desire of enabling community level governance. Described by Powe, Pringle and Hart as ‘more rhetoric than reality’ (Powe, Pringle, Hart, 2014).

Some of the individual leaders in this research were elected representatives, but most were local citizens. However in the majority of cases where individuals played a leadership role, they self-presented; only in one case, Jühnde was the individual sought out because they were a highly trusted member of their community, holding a position of influence. This presents something of a challenge; how to find or develop local leaders for energy self-sufficiency in order to avoid a two tier system of rural communities; those that have the leadership capacity and those that don’t.

Capacity-building at a rural community level is considered essential, with government playing a crucial enabling and fostering role in this (Carnegie Trust, 2013). As mentioned above, there are plans set out in the Community Energy Strategy (DECC, 2014a) for capacity building programmes to be developed. However as with the one stop shop for community energy described in the strategy, it is likely any public funding will be short term, which will undermine any capacity built and in any event leadership has not specifically been identified as a priority for support. Solutions need to found that can find and support emerging leaders for energy self-sufficiency in all UK rural communities and they need to be viewed as a long term approach. There are already a number of peer to peer learning programmes of support available and further such support programme has been identified through the Community Energy Strategy (ibid.) Recommendations for supporting individuals and communities in leading whole place approaches to energy self-sufficiency are:

- As has been shown through this research, leaders often emerge, because they have been inspired to do something, which may be a result of a need, or an opportunity or both. Many people are inspired by other people, so the more events and opportunities that are provided for sharing information on whole place energy self-sufficiency, for example conferences, workshops, or via social media, the more likely leaders will emerge.
- Publicly funded capacity building schemes for community energy/energy self-sufficiency can make a positive impact at a community level. However, for the reasons outlined above, their impact and lifetime may be limited. Whilst not immune from the adverse impact of these, third sector organisations, such as Community Energy Scotland (2014), a charitable membership organisation, or Pure Leapfrog (2014), also a charitable organisation that provides social investment and professional expertise for the community energy sector may be better placed to provide sustained support to build capacity within communities for making transitions to low carbon energy futures. They are often able to generate income from a wider range or sources and be more adaptable to changes at a macro to micro level.

In an age of austerity, what role can local government play? One of my research findings was that local authorities in the UK may be too large to effectively lead a transition in individual rural communities in their area towards energy self-sufficiency. In all the European cases considered, the local authorities either led or their involvement was considered crucial to the successful development and delivery of the energy transitions and the geographic areas of responsibility of the local authorities in the European cases matched the energy transition communities. Whilst only one UK case was selected that was initiated by a local authority, the lack of leadership or involvement by local authorities in the other UK cases was in stark contrast to the European cases, which is at odds with Evans et al's suggestion that the greater achievements in sustainable development have been described as being almost always part of a higher level of dialogue between local authorities and civil society (Evans et al, 2005, p.111).

In the Community Energy Strategy (DECC, 2014a), the UK Government recognises the significant contribution that community renewable energy has made in other European countries: 'Community energy – particularly renewable electricity generation – is often reported to play a prominent role in the energy systems of other European countries, such as Germany…Denmark… and Austria'. Indeed four of the European cases considered in this research are from the states mentioned here. However, there is no acknowledgment of the difference in scale and powers of the local authorities in these countries compared to the UK and how this affects their ability to support individual settlement approaches to community energy.

In the UK the average population size of a local authority area is more than twenty times that in other European states, such as Germany and Spain (NHPAU, 2009). This presents challenges for councils in the UK to effectively engage at the ultra-local level and develop the trust that this research has shown is necessary for whole place energy self-sufficiency to become a boundary object around which actors can co-operate to successfully work towards this goal.

From research into sub state climate pioneers, McEwen and Bomberg (2014) identify one of the capacities for action is fiscal autonomy; the ability to raise revenue and/or marshal investment towards policy goals. This highlights another significant difference between European and UK local authorities; that in many European states, local authorities have tax raising powers, but this is not the case in the UK and reduces the ability of UK local authorities to generate income in response to local circumstances. There are, however, some steps that have been taken in recent years that will enable UK local authorities to develop sustainable local income streams which may help them in becoming more responsive and able to take more of a leadership role in whole settlement approaches to energy self-sufficiency. Of particular relevance to this research is that local authorities can now sell electricity generated from renewable sources (DECC, 2010).

In a continuing era of public sector fiscal restraint in the UK, it is highly unlikely that there will be a local government reorganisation to councils having smaller geographic areas of responsibility. The direction of travel for some time has been in the opposite direction, for example with smaller district councils being combined into larger unitary authorities in England 2009 and 1998 (Local Government Geography and History Annex A, pp.166-167).

However in most of the UK, there is a level of government that already operates at a rural settlement level; the town or parish council in England and the community council in Scotland and Wales. Northern Ireland is the exception where no equivalent tier of local government exists. The powers of town and parish councils in England are limited (NALC, 2009), even if they have achieved quality town or parish council status and in Scotland and Wales the main function of community councils is to represent the views of their community to other public bodies (House of Commons, 2014), although they can assume a function delegated by another authority. Prior to the Local Government Act 1972 (Great Britain *Local Government Act 1972*) and the Local Government (Scotland) Act 1973 (Great Britain, *Local Government (Scotland) Act 1973*), in rural areas there had existed rural districts comprising civil parish areas. These had significantly more powers than Town and Parish Councils. In half of the UK cases considered in this research, there was a supportive relationship developed with the parish and community councils at an early stage and in one of these the parish council has acted as accountable body for the process. Is it therefore possible to develop the powers of such town, parish and community councils to be true leaders and beacons of participative governance in their communities, including powers to be producers and suppliers of energy for their communities? In such a way, empowered town, parish or community councils could deliver a non-hierarchical, networked approach to local development and governance, bringing together actors and enhancing capacity of communities for the long term.

Although local authorities in the UK have only been allowed to sell electricity generated from renewable sources relatively recently (DECC, 2010), it would be a small additional step change to allow Town, Parish and Community Councils to have this power as well. Can this be done in a way that will enable them to play a leadership role in approaches to whole rural settlement energy self-sufficiency, without creating an unresponsive, remote and bureaucratic system that alienates the very communities they are supposed to serve? This could be the subject of future research.

There are very good reasons why local authorities in the UK should be seeking ways to actively support, if not lead whole place approaches to energy self-sufficiency in their areas. As this research has shown, there can be significant economic and environmental benefits and considerable external interest generated in an area. For local authorities playing a leadership role, this can also enhance their profile both with their local communities and external audiences (Lecours, 2002: pp.100–102; Happaerts, van den Brande and Bruyninckx, 2010 p.130; McEwen and Bomberg, 2014). Recommendations of ways that local authorities in the UK could more effectively lead and engage in whole place approaches to energy self-sufficiency are:

- Ensure that individual communities are actively engaged in the development of plans for low carbon energy/energy self-sufficiency from the start if the plans are being led by the local authority, even if the plans are for a larger area than their own communities. This would mean informed open discussions and debate in the development stages with local groups and individuals and can lead to the idea becoming the boundary object as was found in the cases in this research. This will enable co-operation on the idea and in its transition to delivery. If this is to be effective, it will need a significant amount of staff resource from the local authority.
- Use local authority owned land to install and operate renewable energy systems. This could be developed either as a council owned system, or for

maximum local involvement in partnership with a community energy company and would provide an income stream that could be re-invested in further measures that would move communities in their area towards energy self-sufficiency. There may be some initial capital investment required by the local authority, but would be recouped in the short to medium term.

7.2.2 Policy

Public funding was shown to make an essential contribution to the successful delivery of community renewable energy schemes considered here. In an era of public funding constraints and competing priorities, how can public funding bodies consider whole place energy self-sufficiency a priority for funding?

This research has shown that local ownership of energy infrastructure is an important part of whole place approaches to energy self-sufficiency. If the generation and distribution systems are all in community ownership, then in some cases the local economic benefits can be enhanced through the ability to set tariffs, which can keep costs low for local citizens and also encourage business to set up or relocate if tariffs are significantly cheaper. More money will also remain within the local economy, rather than being paid to an external energy supplier. In the UK these local benefits can be limited as communities that are part of the national electricity distribution network have not been able to gain licenses to be electricity suppliers for their communities. The technologies to manage the challenges of real time smart grids to support a distributed electricity network systems are already available. The UK Government has recognised that local distributed energy suppliers have a role to play in the future energy supply. However, its response to address this challenge in the Community Energy Strategy is to trial a 'License Lite' pilot with the Greater London Authority as a distributed electricity supplier (GLA, 2014; Great Britain, DECC, 2014a) Whilst there might be some useful high level findings from such a pilot, the scale and capacities within the sphere of influence of the GLA is much larger than any rural community in the UK, so the lessons learned are unlikely to be relevant for most rural communities.

The current government incentive schemes to encourage uptake of energy efficiency measures and changes to renewable energy systems, such as the Green Deal, FITs and the Renewable Heat Incentive schemes have not supported a whole settlement approach to reducing energy consumption and production of renewable energy. They have operated on an individual basis, which actively discouraged a community from working together on these areas and reduces the potential benefits and impacts that could be achieved by a whole community working together. A consultation on the FIT in 2014 has resulted in a widening of the definition of 'community organisations' that can benefit from FITs, but did not increase the ceiling for community energy schemes that could benefit from FITs to 10MW from 5MW as had been proposed (DECC, 2014d). Given the importance of public funding for community energy schemes demonstrated in this research, this may be a retrograde step.

An appetite for risk of organisations and individuals has been an important component of the more ground breaking cases considered in this research, for example trialling the new gasification system in Güssing. The greater the risk; financially, politically, personally, the greater the benefits if the schemes succeed. As a consequence of its early adoption of community renewable energy and new technologies, Güssing is seen as a world leader in community renewable energy and plays host both to the European Centre for Renewable Energy (EEE) and to 400 eco-tourists per week. The majority of cases in this research received public funding for delivery of energy schemes. As public funding has diminished in recent years, many public sector organisations have become risk averse; only investing in schemes that are almost guaranteed to deliver, which stunts development of new and innovative solutions. Local organisations often face real challenges in embarking on higher risk, ground breaking schemes (Boyle, 1993, p322), often limited by the need for political support (Rose, 2005, p2). If the potential of WSESS is to be realised in the UK, it is likely that some public funding will be required and there needs to be an acceptance of risk in trialling innovative energy solutions to meet local circumstances.

There are three policy recommendations emerging from the research to further develop whole place approaches to energy self-sufficiency

- A rural communities 'license lite' pilot should be trialled to test how a rural community can be an energy generator, supplier and customer for the community.
- Community renewable energy schemes should be classed as a priority for sources of public funding
- In assessing whether community renewable energy schemes should receive public funding, there needs to be an appetite built into the approval systems by public funding bodies for managing the risks associated with funding the more innovative schemes.

7.3 Future research

There is a growing body of research on community renewable energy as the subject develops and matures. This thesis adds to the literature, demonstrating what common Capacities are present in all and the majority of cases considered here and the contribution they have made to whole place approaches to energy self-sufficiency. There are some key areas that have emerged through this that future research into would deepen and broaden the understanding as to how communities can best be supported to realise the full potential of whole place approaches to energy self-sufficiency or low carbon energy as follows:

- A comparison of the geographic areas of responsibility and the powers available to local authorities in European and UK cases where the local authorities have led a process of moving energy self-sufficiency/low carbon energy transitions and the outcomes achieved.
- A pilot research programme of Town, Parish or Community Councils who have a license to be generators, suppliers and purchasers of energy for their communities.
- Research of the local social, economic and environmental benefits of community microgrids as part of distributed electricity systems

- Given the Capacities identified in this research that are present in all or the majority of the cases considered and the action in the Community Energy Strategy to build capacity for community energy by providing seed funding for a One Stop Shop (DECC, 2014a), research into how effective such approaches to community energy capacity building are would provide a useful baseline of effectiveness.
- An assessment of the appetite for risk of organisations involved in energy self-sufficiency and the relationship with outcomes achieved

7.4 Concluding Remarks

This research has been the result of four years of study, that has enabled me to bring together my professional and personal interests of sustainable development and community led planning. As is often the way, the research I have undertaken and articulated here is not necessarily what I thought it would be when I started. I thought at the outset that policy that informs the development of whole settlement approaches to energy self-sufficiency would be the main focus of my research, but it became apparent very early on that there were other capacities that played a far more fundamental role in the ability of communities to successfully develop their energy self-sufficiency approaches. I have been impressed by the dedication and commitment of the individuals involved in the energy transitions to inspire and sustain their communities in working towards their goals, often over many years.

There is a huge potential to further develop whole rural community approaches to energy self-sufficiency in the UK and the recommendations above will support this. However, I acknowledge that there is no magic wand that will inspire and support all rural communities to do this and inevitably there will still be the uneven capacity for action across different rural communities

Of course the case communities examined in this research were chosen because they had all made a start and most had made significant progress towards their energy goals, but the capacities that forms the basis of my research forms only one part of their story. Their energy journeys did not happen in a Capacities vacuum and whilst Capacities have been shown to be an important consideration, there may be other factors not considered here that may also have made an important contribution to the energy self-sufficiency achievements.

I hope that this study will help inform future policy, practice and research into how best to support communities in working towards WSESS, although I recognise the challenges in this for policy makers, for example in identifying, recognising and supporting the individuals to play a leadership role in rural community energy self-sufficiency programmes in the future. I also hope that this research will contribute to a growing body of literature on how communities can develop more sustainable approaches to energy and that I can use the knowledge I have gained to both undertake further research and in my work as a practitioner.

Appendices

Appendix one

School of Architecture Planning & Landscape
Room 6/14
6th Floor, Daysh Building
Newcastle University
Newcastle upon Tyne
NE1 7RU

Tel: 07846 923505
Email: r.pringle@newcastle.ac.uk

To:

Dear

Request for an interview for research into whole place energy independence

I am a post graduate researcher at Newcastle University investigating key factors for rural communities in the UK in moving towards energy independence. As part of this I would very much like to use x as a case study to find out more about how x has achieved its transformation to a renewable energy based electricity supply and whether lessons are transferable to other rural communities in the UK. I have read the documents and watched the videos available on the x website by way of background. X is obviously a long way towards achieving energy independence. I have also undertaken a review of literature (academic as well as policy) on the subject and am now at the stage where I need to hear about experiences and lessons learnt 'from the horse's mouth'.

I appreciate that you will be very busy and that your role as x is probably on top of the day job(s), but wonder whether you could possibly spare an hour for me to interview you on your involvement in the x? I hope to spend a week on x in late September or October and interview a number of people who have been involved in the development of x. As a x, you have obviously played an important role in the transformation of the electric system on the Isle and I would be extremely grateful if you were able to spare some time to share your experiences with me. I would of course, fit round your availability, be it morning, afternoon or evening at a place convenient for you. If you were agreeable to being interviewed, do you have any time available week commencing x? There may be a very good reason why that week is not suitable – such as a major event happening that I am unaware of. If this is the case, could you let me know when might be a better time to visit x? I am hoping to speak to as many people as possible on this subject. It would be helpful if I was able to conduct all interviews during my stay, as I find they are better for all concerned if they can be done face to face, rather than over the phone. Also, I will be able to contribute to the x economy during my stay.

In order to get as rounded a view of the x scheme as possible, I am hoping that I will also be able to interview a couple of businesses and residents. I saw from the video on the website how the businesses that x and x run have benefitted from the x system and will contact them to see if they will be willing to be interviewed. I would also like to interview a couple of residents. As well as getting input from residents supportive of the scheme, it would help inform my research to hear from any residents who have been less supportive of the scheme or less involved (if indeed there are any) to understand the reasons for this. I also am hoping to also speak to x in his role as Chair x, political and officer representatives of the x Council. If you were able to suggest any people that I might speak to about this, I would be very grateful.

I wonder also whether there might be a possibility for me to contribute something by way of exchange of my experiences. My background over the last 22 years has been in sustainable development and rural regeneration. I live in a small rural community in North Yorkshire and am passionate about these areas. I have written and implemented sustainable development strategies for local councils and until 2 years ago I led a major programme across Yorkshire and Humber – Renaissance Market Towns to support rural towns to develop long terms plans for their communities, securing £35m funding to deliver projects and programmes contained within these plans. Since then, alongside my PhD studies, I have been lecturing and tutoring at Newcastle University and also run my own business to help fund me through my studies. I am on the Management Board of the Small Towns for Tomorrow Forum, Board member of Integreatplus and am a Trustee of Ninelakes Community Trust, a major social regeneration scheme to transform 32 sq km land in West Yorkshire into a Forest Park to be run by and for the benefit of the surrounding ex coalfield communities.

I am keen that my research helps inform future policy on energy use for rural communities and my thesis will be publically available. I will also provide an agreement for the interview which will outline how any information will be used, for example how agreement is reached on attributing quotes from the interview in my thesis.

I realise that you are already very active in sharing information on the experiences you have had in transforming the electricity supply and hope you will be able to spare the time to contribute to my research to perhaps bring this to a different audience.

I will follow this letter up with a phone call once you have had a chance to consider my request.

Many thanks

Rhona Pringle

Appendix Two

Responses from proposed Interviewees :

Place Interviewees	Ashton Hayes	Eigg	Fintry	Hebden Bridge
Principal Local Authority Leader/Portfolio holder cabinet member	Cllr & Member Champion at Cheshire West and Cheshire Council for climate change. Agreed to interview	Highland Council Councillor Sub-Board Member: Isle of Eigg Heritage Ward: Email sent 31.8.12, ref No 00014149-0040-00000001-0001. No response, followed up email and got a decline and no suggested alternative	Emailed Ward Member Email sent 3.9.12, awaiting a response. No response, followed up email, said he wasn't appropriate, but couldn't suggest alternative	Calderdale Council Councillor Cabinet member for economy & environment Agreed to interview Awaiting a response
Principal Local Authority Lead officer (senior)	Sustainability manager agreed to Interview	Emailed Chief Executive No response, followed up email to sustainable development officer who passed me on to a planning officer who agree to be interviewed	Emailed Assistant Chief Executive – (Sustainability, Economy & Environment) No response, followed up & as she was leaving the organisation asked me to contact the chief executive. I did this and got agreement for interview	Calderdale Council Environmental Management team. Director agreed to be interviewed
Community leader	Contacted AH primary school and got agreement to interview a staff member	Contacted secretary of IEHT and got agreement to interview	Sent email to, Directors Fintry Development Trust & 2 of Fintry four No response follow up email and 2 agreed to be interviewed	Hebden Bridge Transition Town Email sent to TT Energy group. No response, sent follow up email, no response and website down, appears group no longer in existence ATC member agreed to be

Place Interviewees	Ashton Hayes	Eigg	Fintry	Hebden Bridge
				interviewed
Originator of idea	Agreed to be interviewed and providebusiness/resident contacts.	Chair of IEHT and Eigg Electric Ltd. agreed to be interviewed	2 of Fintry four agreed to be interviewed	Council officer and member agreed to be interviewed
Other Local Authority Leader/portfolio holder (i.e. Parish Council)	Member of Parish Council agreed to be interviewed		Emailed Community Council representative on Board of Fintry Development Trust No response, followed up email, no response, sent a letter & no response	Emailed Hebden Royd Town Council and got agreement to interview environment portfolio holder and the Clerk
Engaged resident/business		Contacted and got agreement to interview B&B owner and shop owner		
Other resident/business		SWT officer agreed to be interviewed		
Academic institution	Emailed University of Chester professor involved in AHGCN and got agreement to interview (technical adviser to Ashton Hayes going carbon neutral) Chester University,			
Experts	Agreement from Chester University and DNO industry representative to interview			Agreement to interview Power from the Landscape project lead
Representative of delivery body	Agreement to interview 2 AHGCN members	Agreement to interview secretary IEHT, Chair of IEHT project lead for microgrid project	Fintry Renewable Energy Enterprises (FREE), a trading subsidiary of Fintry Development Trust info@fintrydt.org.uk	

Place Interviewees	Ashton Hayes	Eigg	Fintry	Hebden Bridge
			Burnbank Cottage 10, Main Street Fintry Glasgow G63 0XB	
Energy company	Agreement to interview 4 members of AH Community Energy company	Agreement to interview project lead for microgrid project	Falck renewables agreed to interview	

Appendix Three

School of Architecture Planning &
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Newcastle University
Newcastle upon Tyne
NE1 7RU

Tel: 07846 923505
Email: r.pringle@newcastle.ac.uk

Use of information from interviews

Thank you very much for agreeing to be interviewed as part of my postgraduate research into how rural place in the UK work can towards energy independence.

Information collected during interviews will used in my thesis, presentation and associated academic papers. I intend using quotes anonymously. However, there may be occasion where it will be necessary to attribute quotes. In such instances, I will contact you to obtain your agreement for this. Where interviews are recorded, I will send you a copy of the transcribed interview for your records.

Thank you again for giving your time to assist in this research, it is greatly appreciated. If you have any queries, please don't hesitate to contact me at the above address.

Many thanks

R. Pl

Rhona Pringle

Appendix Four

Community Renewable Energy Workshop

14th October 2013

Delegate list

Organisation
Hartleyburn Parish Council
Durham University
Sustain Eden Project – Alston Moor Partnership
Yore Vision
North Tyneside Council
Ellingham Community Trust, Northumberland
Newcastle University
Stockton-on-Tees Borough Council
The Newcastle upon Tyne NHS Foundation Trust
Northumberland County Council
Sustainable Brampton
Wardell Armstrong LLP
Pure Leapfrog
Brinkburn Priory
Vela Homes
Gentoo
Earth Doctors Ltd
-
North Energy Associates Ltd
d3Associates Ltd
Haltwhistle Town Council
Ashington High Market Allotment Society
Humber & Wolds Rural Community Council
Northumberland County Council
Sustainable Brampton

SAC Consulting
Senergy Econnect
County Durham Community Renewable CiC
Joseph Rowntree Foundation
Durham University
-
Cumbria Action for Sustainability
Newcastle University
APL
Northumbria University
Inspired North East at the Diocese of Newcastle
Ellingham Community Trust, Northumberland
TMA Architects LLP
University of Sheffield
North Tyneside Coalition of Disabled People
Eyemouth & District Community Trust
-
Bryonn Architects
Newcastle University
Newcastle University
Developing Community Initiative
3rd Sector (Voluntary Community)
Colwell Village Hall
Durham Community Action
PassiM Developments Ltd
Solar Energy in Future Societies
Newcastle University
S.E.E Ltd (Kirkby Thore)
Hippodrome Arts CIC
North Tyneside Council
Newcastle University
Newcastle University
Newton and Bywell Connects Ltd
-
Muckle LLP
-
Green Community Buildings
Northern Community Power
-
Newcastle University
-
Newcastle University
-
-
-

Appendix Five

NIReS Community Renewables Energy Workshop 14th October 2013

Bamburgh Room, King's Road Centre, Newcastle University

Programme

9.00-9.30	**Registration & refreshments**
9.30	**Welcome & introductions – Professor Simin Davoudi**
9.45	**Whole Settlement Approaches to Community Energy: setting the context – Rhona Pringle**
10.00	**Peter Vadasz** – On the road to self-sufficiency: Güssing, an example for a sustainable energy supply
10.35	**John Hutchison** – The Isle of Eigg: Developing a Fragile Community
10.55	**Coffee break**
11.15	**John Booth** – Eigg Electric - How a project conceived by a small island community became award winning reality
11.45	**Gary Charnock –** Ashton Hayes: The Carbon Neutral Journey
12.20	**Panel Q&A**
12.45	**Lunch**
13.30	**Workshop introductions**
13.40	**Workshop 1**
14.30	**Workshop 2**
15.20	**Coffee break**
15.40	**Summing up & what's next? – Guy Garrod,** NIReS Urban and Rural Systems theme lead
16.00	**Close**

Appendix Six

Calling all cartoonists

The Newcastle Institute for Research on Sustainability

We need some quick thinking, talented artists on the afternoon of 14th October to capture workshop discussions from a Community Renewable Energy Workshop in cartoon form. PhD higher rate of pay applies for a 2 hour session.

If you are interested, please contact Rhona Pringle at r.pringle@ncl.ac.uk by 20th September

Appendix Seven. Sample of cartoons from Community Renewable Energy Workshop 14th October 2013

Cartoons courtesy of Nigel Auchterlounie

Appendix Eight

CENTRE FOR RURAL ECONOMY
NEWCASTLE UNIVERSITY

Community renewable energy for rural communities

How can rural communities deliver and manage renewable energy schemes?

What is community renewable energy?

- DECC described community energy projects as having "an emphasis on local engagement, local leadership and control and the local community benefiting collectively from the outcomes".
- Communities might develop different sources of renewable energy including solar, wind, hydropower, biomass and geothermal.

What benefits do community renewable energy schemes offer?

Many successful community renewable energy schemes have been delivered. Potential benefits include:

- Income generation
- Improved energy efficiency,
- Support for community facilities
- Increased pride/sense of community.
- In some cases the provision of all power and/or heat needs, leading to improved local economy through job creation and business start-ups, reduced energy bills and possibly their first reliable energy supply.

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School of Agriculture, Food and Rural Development
Newcastle University
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What does a community need in order to achieve success?

- Energy efficiency measures that reduce the demand for energy.
- Citizen "entrepreneurs" or "pioneers" to start and drive the project forward.
- Trust between the community and leaders of renewable energy projects.
- Community ownership or contribution to local structures and governance arrangements for the renewable energy projects.

What are the implications for UK policy?

If communities are to make a significant contribution to the UK energy mix changes are needed in the forthcoming Energy Bill and Community Energy Strategy:

- To the Balancing and Settlement Code, enabling community energy companies to connect to the National Grid both as customers and suppliers of electricity in real time.
- Enabling community energy companies as energy suppliers to supply only their community should they choose to do this.

Newcastle University

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