ENERGY SYSTEM TRANSITION THROUGH STAKEHOLDER ACTIVATION, EDUCATION AND SKILLS DEVELOPMENT

ENTRUST

Innovation Pathways to Transition

Deliverable D6.3

John Morrissey[1], Stephen Axon[1], Joanne Hillman[1], Soraya Molinero Perez[2], Breffni Lennon[3], Niall Dunphy[3]

[1] *School of Natural Sciences and Geography, Liverpool John Moores University, Liverpool, United Kingdom*
[2] *LGI Consulting, Paris, France*
[3] *Cleaner Production Promotion Unit, School of Engineering, University College Cork, Ireland*

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List of Acronyms:

BAU	Business as usual
CBA	Cost Benefit Analysis
CCS	Carbon Capture and Storage
CO2-eq	Carbon Dioxide equivalent
FiT	Feed-in-Tariff
Gtc	Gigatonnes of carbon
GW	Gigawatts
KTOE	Kilotonnes of oil-equivalent
PEST	Political, Economic, Social and Technological
PV	Photovoltaic
SSP	Shared Socio-economic Pathway

About the ENTRUST Project

ENTRUST is mapping Europe's energy system (key actors and their intersections, technologies, markets, policies, innovations) and aims to achieve an in-depth understanding of how human behaviour around energy is shaped by both technological systems and socio-demographic factors (especially gender, age and socio-economic status). New understandings of energy-related practices and an intersectional approach to the socio-demographic factors in energy use will be deployed to enhance stakeholder engagement in Europe's energy transition.

The role of gender will be illuminated by intersectional analyses of energy-related behaviour and attitudes towards energy technologies, which will assess how multiple identities and social positions combine to shape practices. These analyses will be integrated within a transitions management framework, which takes account of the complex meshing of human values and identities with technological systems. The third key paradigm informing the research is the concept of energy citizenship, with a key goal of ENTRUST being to enable individuals to overcome barriers of gender, age and socio-economic status to become active participants in their own energy transitions.

Central to the project will be an in-depth engagement with five very different communities across Europe that will be invited to be co-designers of their own energy transition. The consortium brings a diverse array of expertise to bear in assisting and reflexively monitoring these communities as they work to transform their energy behaviours, generating innovative transition pathways and business models capable of being replicated elsewhere in Europe.

For more information see **http://www.entrust-h2020.eu**

Project Partners:

University College Cork, Ireland
- Cleaner Production Promotion Unit (Coordinator)
- Institute for Social Science in 21st Century

Liverpool John Moores University, UK

LGI Consulting, France

Integrated Environmental Solutions Ltd., UK

Redinn srl, Italy

Stam srl, Italy

Coordinator Contact:

Niall Dunphy, Director, Cleaner Production Promotion Unit, University College Cork, Ireland

t: + 353 21 490 2521 | e: n.dunphy@ucc.ie | w: www.ucc.ie/cppu

Executive Summary

The transformation of the energy sector is important in addressing the challenges of both climate change mitigation and adaptation. Energy is crucial for supporting basic human needs, development and well-being. The future evolution of the energy system will be fundamentally shaped by socio-economic conditions and drivers, available energy resources, technologies of energy supply and transformation, and end-use energy demand, as well as social acceptance and policy choices. The energy sector transformation also has important implications for social and environmental sustainability goals. Consequently, bottom-up and practice-based social innovations need to be incorporated in an integrated manner to achieve the required paradigm shift.

This Deliverable has presented outcomes of Task 6.3 of the ENTRUST project. This task is framed in recognition that technological innovation alone is insufficient to achieve low-carbon transitions. The key framing question has been: "how can new technologies and practices be best supported/disseminated to achieve 'lift-off' and impact?"

Innovation studies approaches, including Strategic Niche Management thinking have been applied in this Deliverable. Innovation needs, and specific and tailored innovation responses have been identified for 4 of the ENTRUST communities of practice; these are Stockbridge, Le Trapèze, Secondigliano and Dunmanway. The outcomes of this innovation needs-mapping and an in-depth review of the Strategic Niche Management literature has produced outcomes which point to new policy mixes and practice-based changes at the community level to inform innovation pathways for each community.

To identify innovation needs for each community, an analytical framework was developed based on the Shared Socio-economic Pathway (SSP) concept. The SSPs are a set of five storylines on possible trajectories for human development and global environmental change, which include five different global futures (SSP1-5). The SSPs complement, and build upon, existing scenario development frameworks by adding socio-economic narratives and quantitative pathways consistent with the challenges to mitigation of and adaptation to climate change. These scenarios allow exploration of different futures with and without climate policy responses. The different characteristics and main dynamics of each SSP scenario are as follows:

1) SSP1: Sustainability
2) SSP2: Middle-of-the-road
3) SSP3: Regional Rivalry
4) SSP4: Inequality
5) SSP5: Fossil fuelled Development

In this deliverable, a qualitative description and identification of where constituent components of the SSPs match the characteristics of the profiled communities serves to highlight where innovations are required. These areas include population growth, energy use, agriculture, urbanisation rates, income, and emissions and climate change. For this Deliverable, a spreadsheet was applied to 'map' the constituent components of the SSPs including population size, migration, consumption and diet, land use, and environmental policy according to the characteristics of each of the 4 studied communities. Developed SSP profiles outline how the characteristics of the profiled communities match with constituent components of the SSPs, and where each community most likely aligns to one of the 5 SSPs. The developed profiles are then applied to identify where innovation for sustainability is required for each of the communities in a bespoke and community specific manner. Innovation needs identified from the SSP analysis are collated with appropriately matching

innovations from the policy tool-kit presented in D4.4. In addition, community based innovations from the literature are identified and matched with the specific requirements of each of the 4 communities.

Each of the 4 studied communities displayed a different innovation needs profile.

Stockbridge is a community with considerable challenges, particularly on social and economic fronts. Poor health, high unemployment, marginalisation, and energy and fuel poverty represent considerable challenges to the community. Five specific innovations are forwarded for Stockbridge. Community Energy Projects are deemed of particular importance in the context of this community, with the scope to develop community 'benefits payments' mechanisms to address local social issues. In addition, more imaginative use of ICT, for example through local schools could serve to address social cohesion and build invaluable social capital in the community.

While the project of Le Trapèze has been designed to optimise its ecological and environmental goals through best practice approaches in the built environment, the community faces challenges in developing social cohesion and in fostering a community identity. As with other communities, Community Energy Projects are deemed important and appropriate to the community in Le Trapèze. Innovation on the social domain could include use of community heritage or history projects to develop community identity and social cohesion. In addition, as the community is relatively prosperous, environmental issues are strongly linked to consumption patterns, particularly in view of the relatively environmentally friendly nature of the built environment. Community partnerships in healthy eating and lifestyle promotion therefore potentially represent an innovation to address unsustainable consumption as well as issues with social cohesion in this community.

There are significant environmental issues in Secondigliano, especially related to waste management, directly attributable to deficiencies in infrastructure provision and governance /institutional weaknesses. Economic growth remains very clearly fossil fuel driven in this community. Therefore, and as with other communities, Community Energy Projects are deemed important and appropriate to the community in Secondigliano, coupled with community benefits payment mechanisms to address local social issues. Secondigliano, along with Stockbridge and Dunmanway is very much in need of investment in infrastructure development and upgrade. For this reason, a large-scale urban retrofit programme with goals of energy reduction and improved residential thermal comfort is appropriate for Secondigliano. On the social domain, Regular Community Health Fairs represent a cost-efficient innovation for dissemination of preventive services to vulnerable populations and would seem to be especially suitable for the community in Secondigliano. In addition, financial support schemes for local female entrepreneurs could begin to address economic development and gender inequality problems locally.

Dunmanway, like many rural communities across Europe is faced with challenges of depopulation, an aging resident population, changing land use patterns, shrinking local employment opportunities, along with the homogenising influence of multinational retail and the inability of local business to compete. It is a highly car-dependent community, owing to poor public transport infrastructure, and as a result, is a very carbon and energy intensive community. Therefore, and as with other communities, Community Energy Projects are deemed important and appropriate to the community in Dunmanway. In addition, transport related innovations from D4.4 are deemed to be especially appropriate for Dunmanway. Infrastructure in the form of Rural Broadband and ICT infrastructure as deemed as essentials for economic functioning and resilience for Dunmanway.

For all studied communities, community energy projects, for example based on a social enterprise model, were identified as a clear innovation to help achieve an SSEP 1: Sustainability pathway trajectory. The capability of social enterprises to create both social and economic value is considered a 'win-win'. However, there are clear potentials for social enterprise models to be more extensively applied to address

contemporary ecological challenges of neo-liberal market economies, moving towards 'win-win-win' outcomes across social, economic and ecological domains; particularly as these organisations are not motivated by a relentless profit imperative. The autonomous nature of the social-economic model applied by social enterprises can represent a viable means to target social, environmental and economic multiple-bottom lines. Such organisations can develop strong links to their local communities and provide positive externalities in generating financial revenue, while also remaining fully cognisant of, and structured towards social outcomes. There are clear potentials for social enterprise models to be more extensively applied to address contemporary ecological challenges of neo-liberal market economies, moving towards 'win-win-win' outcomes across social, economic and ecological domains; particularly as these organisations are not motivated by a relentless profit imperative.

For all of the innovations identified for each community, a number of factors were identified as important from the Strategic Niche Management Literature.

1) Identifying and Tackling System / Structural Issues
2) Supporting Innovation
3) Empowering Change Agents
4) Network Learning
5) Reflexive Governance

Key policy implications forwarded to address these include:

- In the absence of serious consideration and addressing of local community level systems issues, efforts for community level niche innovation will be seriously impaired.
- These are underlying, cross-cutting, embedded challenges in the study communities, each which requires a high degree of prioritisation and political engagement to address. Structural issues therefore present 'first order' challenges for policy makers in each of the study communities
- The specific and tailored innovations, identified as suitable on a community by community basis through the pathways analysis, need appropriate policy support to make any meaningful impact at the community level.
- A hierarchy of support measures is evident from the literature, starting with fundamental level of 'shielding' whereby individual niches are protected at the community level. The next level of support, 'nurturing' would see efforts to enable networking and social learning across niche spaces – potentially with measures to allow communities to coordinate, cooperate and work together. The 'empowering' level would involve more widespread policy intervention.
- Innovation policy support schemes should make explicit reference to the personnel and roles responsible for Knowledge co-creation; Upscaling; Outscaling functions.
- Vertical and Horizontal linkages between innovation schemes, and decision makers and the wider community (including business, industry and civic groups) should be fostered through clear reporting and dissemination requirements.
- Policy support for 'grassroots' as well as 'market-based' innovations is required.
- For community level innovations, provide space for deliberative democracy process to debate innovations and their evolution at the local level
- Principles of subsidiarity and local control to the extent possible, to enable ownership and investment in local innovation schemes
- Application of ICT, and citizen science approaches to enable leaning and knowledge exchange across communities.

Outcomes from D6.3 will be applied in ENTRUST T6.4, whereby feedback from the communities of practice will be sought on the innovations identified in D6.3, and other innovation ideas will be canvased.

1 Introduction

1.1 Background

The impetus for reducing carbon dioxide emissions is real and present, but its translation into action has to date lacked immediacy and severity. The recent Paris agreement outlines a global deal to limit global temperatures to "well below" 2°C above pre-industrial levels, with the ultimate objective to reduce this to 1.5°C, limits associated with dangerous climate change. To address climate change, a combination of mitigation and adaptation solutions are required (Mulugetta, Jackson, & van der Horst, 2010; Pacala & Socolow, 2004). Furthermore, there is growing recognition that technological innovations are unable to solely address climate change and that behavioural interventions are required to support changes in individual practice (Axon, 2017; Dietz, Gardner, Gilligan, Stern, & Vandenbergh, 2009; Gilligan, Dietz, Gardner, Stern, & Vandenbergh, 2010). This has also been demonstrated in Deliverables 4.4 and 6.2 of ENTRUST.

Given the need for radical transformations to the ways in which energy is produced and consumed, the energy sector is undergoing changes towards a more diversified, low-carbon and decentralised model. However, new models for energy production and consumption require public engagement, acceptability and practice changes to become effective and meaningful components of a low-carbon transition (Whitmarsh, O'Neill, & Lorenzoni, 2013; Wolf & Moser, 2011). Research indicates that without behavioural change programmes at the community level motivating participation, low-carbon transitions are rarely successful (Axon, 2016; Heiskanen, Johnson, Robinson, Vadovics, & Saastamoinen, 2010; Moloney, Horne, & Fien, 2010). Geels (2011) describes failures at the niche level within the Multi-Level Perspective, where unsuccessful innovations ultimately fail to bring about changes to the dominant unsustainable regime.

The transformation of the energy sector is important in addressing the challenges of both climate change mitigation and adaptation. Energy is crucial for supporting basic human needs, development and well-being. The future evolution of the scale and character of the energy system will be fundamentally shaped by socio-economic conditions and drivers, available energy resources, technologies of energy supply and transformation, and end-use energy demand (Bauer *et al.*, 2017). However, because energy-related activities are significant sources of greenhouse gas (GHG) emissions and other environmental and social externalities, energy system development will also be influenced by social acceptance and strategic policy choices (Bauer *et al.*, 2017). Yet these uncertainties have important implications for many aspects of economic and environmental sustainability, and climate change in particular (Bauer *et al.*, 2017).

1.2 Aims and Objectives

This Deliverable presents outcomes of Task 6.3 of the ENTRUST project. This task is framed in recognition that technological innovation alone is insufficient to achieve low-carbon transitions. Consequently, bottom-up and practice-based social innovations need to be incorporated in an integrated manner to achieve the required paradigm shift. Yet how such social innovations can be incorporated within transitions that appear to be dominated by technological interventions is yet to be fully investigated in depth. Building on Deliverables 6.1 and 6.2 of the ENTRUST project, the means to achieve low-carbon transitions will be investigated in Deliverable 6.3.

The Key framing question is: how can new technologies and practices be best supported/disseminated to achieve 'lift-off' and impact?

Innovation studies approaches, including Strategic Niche Management thinking have been applied in this Deliverable. The outcomes and findings of this Deliverable are particularly useful in the context of ENTRUST Work Package 6 research as a foundational basis for testing innovation pathways for transition. Within the

ENTRUST project, this Deliverable forms the foundation for reflexive action research testing to be applied in Task 6.4. However, beyond this project, the findings from this Deliverable should be applied to inform new policy mixes, innovative cooperation mechanisms and practice-based changes at the community level to inform innovation pathway testing.

In meeting these aims and objectives, **the Deliverable is structured as follows:**

Section 2 presents an overview of published literature relevant to the Deliverable. In this section, the means by which innovation pathways become established through **Strategic Niche Management** is explored. Additionally, pathway scenario development is also explored, with an up-to-date review of literature exploring **Shared Socio-economic Pathways (SSP)**. These scenarios present state-of-the-art thinking in pathway analysis.

Section 3 presents the **profiles of 4 communities across the UK, France, Ireland and Italy, using the Shared Socio-economic Pathways methodology**. Application of the SSP framework allows an analytical basis to identify required innovations for sustainability at the community level, with tailored responses forthcoming for each of the 4 communities. Following this analysis, Section 4 highlights where innovation is required across economic, social and environmental domains at the community level, with appropriate reference to Sections 2 and 3.

In Section 4 targeted innovations at the community level are divided between **Social/Demographic, Economic/Governance and Technology/ Environment innovations**. Examples include community-based carbon reduction strategies; behavioural interventions such as feedback and information provision; social enterprises; and smart meters and electric vehicles. Based on SNM literature learnings, Section 5 recommends, **new policy mixes and cooperation mechanisms**, drawing upon the findings of the previous sections.

Section 6 summarises the best means for **achieving pathway lift-off in energy transitions,** underpinned by earlier ENTRUST research on energy **visions and sustainability interventions**. When combined with the innovation findings from this Deliverable, it is clear how findings from Deliverable 6.1 and 6.2 can contribute to supporting innovation pathways.

Section 7 concludes the Deliverable.

1.3 Scope

This Deliverable examines the extent to which new technologies and practices can be supported and/or disseminated to achieve lift-off and impact. Four communities across Europe (ENTRUST communities of Practice in the UK, France, Ireland and Italy) are profiled, with the aim of exploring and identifying specific socio-economic pathway elements for low carbon transition, tailored to the conditions, environment and context of each community. In this way, a range of innovation options are specified for individual communities. These innovations meet the specific needs of communities, while also addressing sustainability at the community level, as assessed through the Shared Socio-economic Pathways framework.

In line with the primary areas of investigation of the ENTRUST project, D6.3 focuses on practice-based, bottom-up innovations at the community level. Additionally, research suggests that changes at the community level have the largest potential to be scaled-up and have substantial impacts towards low-carbon transitions (Moloney *et al.*, 2010; Mulugetta *et al.*, 2010). In so doing, D6.3 profiles four communities applying the Shared Socio-economic Pathway framework (O'Neill *et al.*, 2017; Riahi *et al.*, 2017; van Vuuren *et al.,* 2017) to explore where innovation is required in these communities.

2 Literature Review

2.1 Introduction to Strategic Niche Management

A range of approaches to framing and interpreting transition processes have emerged across the socio-technical transitions literature. Markard, Raven, & Truffer (2012) provide an overview of these, distinguishing between transition management, technological innovation systems, strategic niche management and the multi-level perspective (MLP). Further details on these and other transitions approaches can also be found in the review paper by Lachman (2013).

Specifically of interest is the MLP as it has become a frequently utilised model across transitions literature (Coenen *et al.*, 2012; Crabbé *et al.*, 2013; Kern, 2012a; Schot & Geels, 2008; Seyfang & Haxeltine, 2012). The MLP distinguishes three levels of heuristic, analytical concepts, which combine as a nested hierarchy to create a socio-technical system: landscape, regime, and niches (Crabbé *et al.*, 2013). A central tenet in MLP is the stabilising influence of a socio-technical regime, defined by Rip and Kemp (1998, p. 338) as;

> *"The coherent complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, established user needs, regulatory requirements, institutions and infrastructures".*

MLP also explores the idea of 'niche innovations' (Schot & Geels, 2007). Niches constitute a fundamental conceptual construct of STT theory. Depending on timing and quality of different niche-regime-landscape interactions across the system, transitions can evolve following different types of transition pathways (Geels, 2002; Kemp, 1994; Rip & Kemp, 1998). Niches are therefore critical in instigating and perpetuating systemic transition.

Niches can be defined as a series of ground up experiments, which emerge and develop in a protected space affording given niches sufficient opportunity to develop. In terms of directing change, Raven *et al.* (2010) state that experimental niches are to be used to guide social change and to develop more forward-thinking research and practical advice. Protected space enables emerging niches sufficient support so that they are able to compete with the status quo of the regime (Temmes *et al.*, 2013). The change induced by niche innovations breaking through into the regime can be trigged through several mechanisms, described in the transitions literature (Geels & Schot, 2007). Geels *et al.*, (2007, 2016) provides different scenarios in which transitions can happen, referred to as transition pathways. There are four different pathways suggested: transformation path, de-alignment and re-alignment path, technological substitution and reconfiguration. The transition pathway will be determined based on variations of two factors; (1) Is the niche developed? (2) How does the niche interact with the landscape developments and the regime? Geels adds to this, two further scenarios, one being a control where there are no landscape pressures and therefore the regime remains stable and replicates itself. The final scenario, reconfiguration, represents a specific sequence where a transition starts on one pathway and shift through the others.

The common consensus is that being sufficiently developed alone does not determine success for emerging niches. Other factors such as timing, the opportune emergence of openings for niches and key actor support are also of critical importance (Geels & Schot, 2007).

Strategic Niche Management is concerned with the development of niche innovation and therefore seeks to explore how niches are best supported and can develop enough to become an embedded part of the regime in transition (Temmes *et al.*, 2013). Schot, *et al.* (1996) define strategic niche management as learning about niches and developing the application rate of technologies through the creation, development and controlled phase out of protected spaces.

Kemp, *et al.* (1998) developed this further by stating that niches are formed through the following three steps; Aligning expectations, learning through sharing information and lessons learnt and forming networks. With this in mind SNM should be viewed as a tool for transition with the purpose of allowing experimentation of options as well as assisting niche innovations to become embedded within the regime (Kemp *et al.*, 1998). For this, Kemp *et al.* (1998) describe 4 stages of SNM which distinguish this transitions approach as a tool specifically for regime transition rather than simply a strategy to introduce a new innovation to an existing market;

- The selection of an experiment
- The set-up of the experiment
- Scaling up the Experiment
- The Breakdown of Protection

Consideration should also be given to the literature around alternative approaches to SNM. One such example of this is Transitions Management (TM) which according to Raven *et al.* (2010) traditionally centres on four main activity clusters;

1. Structuring the problem in question and establishing and organisation a multi-actor network
2. Developing a sustainability vision, transition agenda and driving the necessary transition paths
3. Mobilising actors and establishing and executing transition experiments
4. Monitoring, evaluating and learning

Raven *et al.* (2010) argue that Transitions Management is more of a strategy development tool for transitions and differs from SNM which is often of a very technical in nature. In contrast to TM, there is a greater need for SNM to be tested in a wider range of scenarios to develop the tool further (Raven *et al.*, 2010). This need for testing of SNM on a wide range of scenarios is also mentioned by Truffer *et al.* (2002). The development of transitions tools such as TM and SNM across the literature has focused on the need for the growing body of knowledge on transitions theory to be transposed to a form that can be utilised by practitioners (Raven *et al.* 2010; Mourik & Raven 2006). However, many academics have noted that there has been a reliance on historical case studies across the literature (Smith, *et al.* 2014; Mourik & Raven 2006; Raven, *et al.* 2010).

Table 1: Overview of Studies of Innovation Niches

Source	Studies of Innovation Niches	Type of innovation	Date of study
(Laak, Raven, & Verbong, 2007)	3 case studies on biofuels in the Netherlands; Solar Oil Systems, Biofuel boats and vehicles in Friesland, OPEK	Technological artefacts	2002 – 2005, 1990's – 2003, 2003-2004
(Hermans, Stuiver, Beers, & Kok, 2013)	Agricultural networks in the Netherlands	Technological artefacts	1992 - 2010
(Seyfang & Longhurst, 2013)	Community currency developments over 30 - 40 years	Civil society and economical	1973 – 2007
(Smith *et al.*, 2014)	Solar photovoltaic in the UK	Technological artefact	1970's - 2010
(Sushandoyo & Magnusson, 2014)	The use of field testing in hybrid-electric vehicles	Technological artefact	2009 - 2010
(Temmes *et al.*, 2013)	Electric vehicles in Finland	Technological artefact	2009 - 2013

Mourik & Raven (2006) acknowledge that there is a need for more of a practitioner focus and set out three inter-related internal niche processes that contribute to the success or failure of a niche; the voicing and shaping of expectations, networking and learning. In their work, they also establish a plethora of research

questions which require further exploration in order to develop practitioner guidance through the use of knowledge creation. This work has been continued by Raven *et al.* (2010) through the development of a strategic niche management toolkit, where by three discreet competence layers enable practitioners to adopt a flexible approach in the application of SNM; a practical layer, an illustrative layer and a theoretical layer.

Truffer, *et al.* (2002) investigate the testing of innovations and how to predict the means through which innovations may become embedded within the regime. Truffer, *et al.* suggest that societal embedding can be viewed as three interlinked processes; network management, infrastructure, matching and expectation building. This redefining of the original three SNM processes (Expectation alignment, learning and networking) allows space for exploration of the means through which influences external to the niche and protected space can be incorporated within a SNM framework. Intermediaries are another external influence that are often discussed in the literature as an important aspect which can help to connect the niche with the regime and help to empower niches (Bush, *et al.* 2017; Hermans, *et al.* 2013; Temmes, *et al.* 2013). Other external factors such as political changes and research projects can also play both nurturing and damaging influences on the testing of niche innovation (Smith, *et al.* 2014). The protected space, and therefore the niche, can be influenced by powerful actors and the conditions they set such as funding requirements, regulation or terms for collaboration (Hermans, *et al.* 2013).

The literature also examines the specifics of niche formation; managing expectations, learning and networking. Hermans, *et al.* (2013) investigated networks across niches in agriculture over a 15 year period and found that an erosion of trust can occur when there is a lack of consensus and the visions of the niche become fragmented. Another consideration is the credibility of actors across the network and how much influence they can have across the niche in terms of managing expectations, key activities that increase credibility would be advocacy and publicity work (Temmes, *et al.* 2013). The need for learning and developing new skills at an earlier stage of design is also required for sustainability focused technologies seeking a place within the regime. Ceschin (2014) suggests that fundamental skills and questions should be developed during the design phase in order to ensure that new products have a place within the society in transition. Low rates of adoption of niche innovations to the main regimes may also be attributed to the lack of governance and operational frameworks as this can lead to false expectations and poor learning processes (Verbong, Geels, & Raven, 2008). .

SNM and social innovation

In discussing the case of community energy in the UK, Seyfang & Haxeltine (2012) highlight the need for social innovation coming from a grassroots level. Using the three inter-related niche process as described by Raven *et al.* (2010) as a basis for analysis they found that SNM is relevant and important for social innovation as it helps innovations to become part of the new regime through **replication, translation and by growing in scale**. Analysis of the community energy sector in the UK also highlights the importance of considering the development phase of the niche from a local-level phase to a global phase niche (Seyfang & Haxeltine, 2012). This distinguishes between many local-level niche practices becoming more connected to sufficiently establish a niche for successful regime breakthrough, or not (Geels & Deuten, 2006).

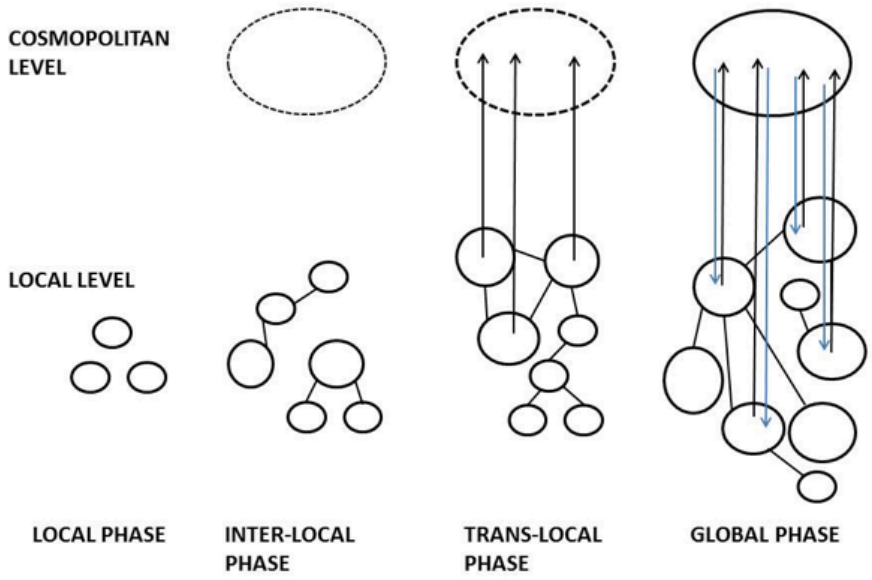

Figure 1: Development Phase of Niches (Geels & Deuten, 2006)

This work has more recently been followed up in the context of photovoltaics projects in Austria as a form of social innovation (Hatzl, Seebauer, Fleiss, & Posch, 2016). When comparing grassroots projects with market-based initiatives Hatzel *et al.* (2016) found that while both approaches were deemed capable of growing out of the niche and into the regime, there were significant differences in the types of actors with their networks - a key determining factor in their success or not. The grassroots movement was a local tight-knit network whereas the market-based network was much more heterogeneous. As network building is a key aspect of SNM this is interesting and highlights that solutions for niche development may not always follow a similar pattern. This is supported by Bakker, *et al.* (2014) who suggested that niches were prevented from aggregating to the point of a global phase as the standards were not aligned. This is due to practices being developed locally and therefore based on local needs not global ones. In terms of the application to social innovation, scenarios research shows that it is appropriate to use SNM theory and approaches in the context of radical social innovation (Witkamp, Raven, & Royakkers, 2011). However, there is a need to rethink the framing of socio-technical regimes as comprising social as well as technical elements, and not just consisting of technological artefacts (Witkamp *et al.*, 2011).

Application of SNM

A SNM analysis should identify the interventions, resources, policies and interactions required to develop a robust niche with greater potential for influence (Seyfang, Hielscher, Hargreaves, Martiskainen, & Smith, 2014). In the literature, three ways by which niches can influence the regime are forwarded (Seyfang & Haxeltine, 2012; Seyfang & Longhurst, 2013):

- Niches can enable **replication of projects within the niche**, bringing about aggregative changes through many small initiatives;
- Niches can enable **constituent projects to grow in scale** and attract more participants;
- Niches can facilitate the **translation of niche ideas into mainstream settings**

Diffusion of new technologies alone may not be sufficient to describe a process of transition. Rather, transitions involving the re-design and re-ordering of a system, through which **new actors, relationships, logics, norms and performance criteria will emerge** may offer a more complete conceptualisation of such processes (Turnheim *et al.*, 2015). Due to the inherent political negotiation processes involved, an innovation can change dramatically in shape over time and from region to region (Hermans, Stuiver, *et al.*,

2013). From a SNM perspective, a focus on single projects may overemphasise the significance of internal processes and underrepresent the higher-level development of the niche within the prevailing regime (Hatzl *et al.*, 2016). Geels and Schot (2007)) suggest a typology of four transition pathways based on the main actors involved:

1. **Transformation:** The regime actors adjust established technologies and practices in response to external pressure.
2. **Technological substitution:** The incumbent firms promoting regime technologies compete with the new firms promoting alternative technologies.
3. **Reconfiguration:** The regime actors adopt component innovations developed by the new suppliers. The new suppliers compete with the established suppliers.
4. **De-alignment and re-alignment:** The regime completely loses its legitimacy, and competition ensues among the new niche actors promoting various alternative technologies.

Of these four pathways, technological substitution and reconfiguration describe different kinds of regime–niche interactions. In the case of technological substitution, the existing technology is eventually replaced by new technology through a process of 'niche accumulation' (Geels and Schot, 2007 p410), in which the new technology promoted by the niche actors captures larger segments of the market (Berggren, Magnusson, & Sushandoyo, 2015).

2.2 Innovation Pathways

A whole systems approach to transition allows niche innovations to be explored whilst taking key macro issues into account. Such macro issues can include policy changes, new legislation, the changing nature of the energy system and broader ideas around climate change.

Geels *et al.*, (2007, 2016) describes different mechanisms or processes through which transitions can happen, referred to as transition pathways. There are four different pathways suggested, transformation path, de-alignment and re-alignment path, technological substitution and reconfiguration. The transition pathway will be determined based on variations of two factors; (1) Is the niche developed? (2) How does the niche interact with the landscape developments and the regime? Geels adds two further scenarios, one being a control where there are no landscape pressures and therefore the regime remains stable and replicates itself. The final scenario, reconfiguration, represents a specific sequence where a transition starts on one pathway and shift through the others.

In terms of the first factor, is the niche developed? Geels & Schot (2007) set out four proxies to assess this;

- Learning processes have stabilised in a dominant design
- Powerful actors have joined the support network
- Price/performance improvements have improved and there are strong expectations of further improvement (*e.g.,* learning curves)
- The innovation is used in market niches, which cumulatively amount to more than 5% market share.

The second factor is whether niche innovations and landscape developments have a disruptive or reinforcing effect on the regimes and the type of relationship the niche innovation has within the regime. Geels & Schot (2007) state that this relationship can either be **symbiotic** or **competitive** in nature.

2.3 Shared Socio-economic Pathways

Energy is crucial for supporting basic human needs, development and well-being. The future evolution of the scale and character of the energy system will be fundamentally shaped by socio-economic conditions and drivers, available energy resources, technologies of energy supply and transformation, and end-use energy demand (Bauer *et al.*, 2017). However, because energy-related activities are significant sources of greenhouse gas (GHG) emissions and other environmental and social externalities, energy system development will also be influenced by social acceptance and strategic policy choices (Bauer *et al.*, 2017). Yet these uncertainties have important implications for many aspects of economic and environmental sustainability, and climate change in particular (Bauer *et al.*, 2017). In the Shared Socio-economic Pathway (SSP) framework these uncertainties are structured into five narratives, arranged according to the challenges to climate change mitigation and adaptation.

Scenarios form an essential part of climate change research and assessment. They help to develop understanding of long-term consequences of near-term decisions, and enable researchers to explore different possible futures in the context of fundamental future uncertainties (Riahi *et al.*, 2017). Most importantly, scenarios have been crucial in the past for achieving integration across different research communities *e.g.,* by providing a common basis for the exploration of mitigation policies, impacts, adaptation options and changes to the physical earth system (Riahi *et al.*, 2017). Such 'community' scenarios need to cover many aspects: they need to describe different climate futures, but ideally also cover different possible socio-economic development scenarios, important to enable envisaging of adaptation possibilities and mitigation options (Riahi *et al.*, 2017).

The SSPs are a set of five storylines on possible trajectories for human development and global environmental change during the 21st Century (van Vuuren *et al.*, 2017). The SSPs include five different global futures (SSP1-5) that start at the narrative for alternative development pathways, and vary, depending on how energy challenges are addressed (Bauer *et al.*, 2017; O'Neill *et al.*, 2017). Vuuren *et al.* (2017) state that the SSPs framework forms the most comprehensive set of scenarios for environmental and sustainable development research produced so far. The SSPs complement, and build upon, existing scenario development frameworks by adding socio-economic narratives and quantitative pathways consistent with the challenges to mitigation of and adaptation to climate change.

The SSPs have been developed over recent years as a collaborative research community effort and form part of a larger set of community scenarios for analysis of climate change, global environmental change and sustainable development issues (van Vuuren *et al.*, 2017). Together, these scenarios allow exploration of different futures with and without climate policy responses. SSPs are intended to serve as reference scenarios for various assessments of climate change challenges as well as broader sustainability issues (Bauer *et al.*, 2017), essentially by providing a key tool to link climate change research across different academic disciplines, from the driving forces of climate change to the physical climate system, climate impacts and adaptation and mitigation strategies (van Vuuren *et al.*, 2017). Furthermore, the SSPs can be used across different geographical scales (local, regional, and global scales) or to link different sectors (O'Neill *et al.*, 2017; Riahi *et al.*, 2017).

The SSPs include five vastly different global futures (SSP1-5) that start at the narrative for alternative development pathways, and vary, depending on how energy challenges are addressed (Bauer *et al.*, 2017; O'Neill *et al.*, 2017). The different characteristics and main dynamics of each SSP scenario are as follows:

- SSP1: Sustainability (Vuuren *et al.*, 2017)
- SSP2: Middle-of-the-road (Fricko *et al.*, 2017)
- SSP3: Regional Rivalry (Fujimori *et al.*, 2017)
- SSP4: Inequality (Calvin *et al.*, 2017)

- SSP5: Fossil fuelled Development (Kriegler *et al.*, 2017)

2.3.1 *Characterising Shared Socio-economic Pathways*

The basic SSP narratives provide the overall framing for the various dimensions that determine the challenges to mitigation and adaptation (Bauer *et al.*, 2017; O'Neill *et al.*, 2017). The general characteristics of the basic SSPs relevant for the energy sector are summarised in Figure 2. These also relate to the energy sector challenges mentioned previously. These narratives are designed to interpret the basic quantitative dimensions of the SSPs and serve to qualitatively harmonise the models providing more detail in three domains of the energy sector: (1) final energy demand development; (2) energy conversion technologies including specific mitigation technologies; and (3) the fossil fuel supply.

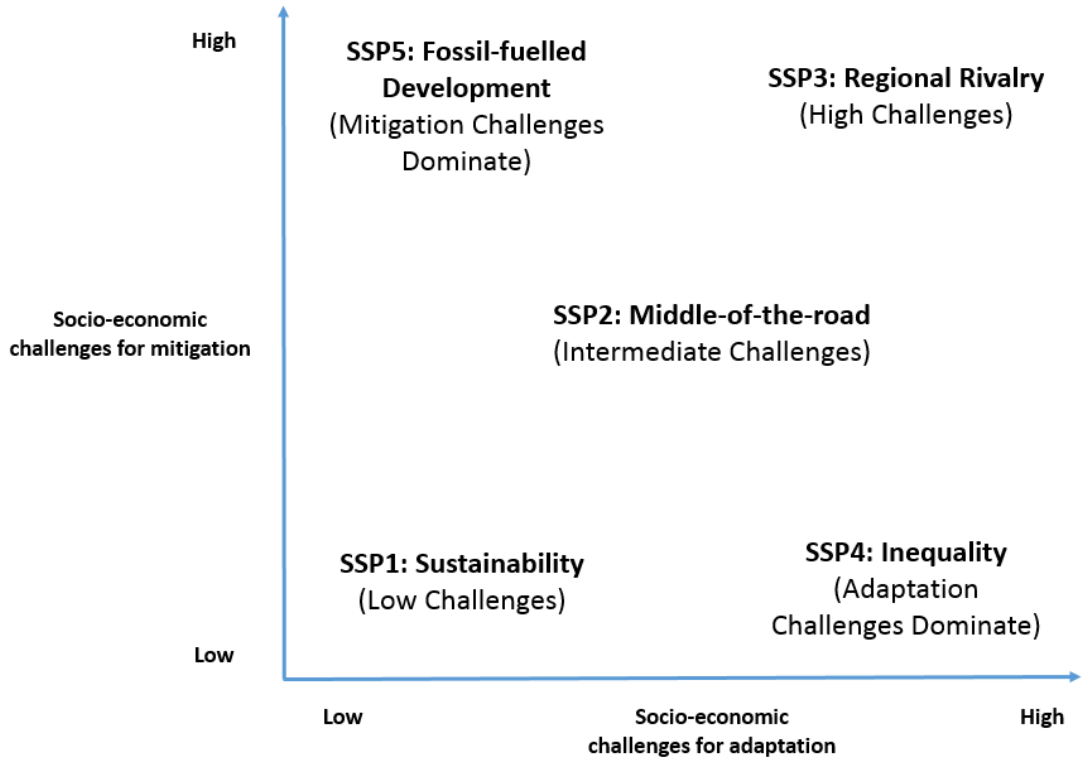

Figure 2: Shared Socio-economic Pathways and the different challenges to mitigation and adaptation (after Bauer *et al.*, 2017; O'Neill *et al.*, 2017).

The SSP narratives aim to capture the combinations of challenges to mitigation and adaptation illustrated in Figure 2. These challenges are discussed in more depth in Section 2.3.3. SSP1 leads to low challenges to both mitigation and adaptation due to a combination of substantial income growth, a reduction in inequality, strong institutions, and a sustained value shift over time that prioritises sustainable development (Fricko *et al.*, 2017; O'Neill *et al.*, 2017; Vuuren *et al.*, 2017). As discussed, SSP2 is a scenario in which elements follow middle-of-the-road trends, leading to intermediate challenges to both mitigation and adaptation (Fricko *et al.*, 2017). In contrast, SSP3 leads to high challenges to both mitigation and adaptation resulting from slow growth in income and slow technological change, ineffective institutions, and low investment in human capital (Fujimori *et al.*, 2017).

SSPs 4 and 5 are mixed scenarios in which a particular set of challenges dominates (O'Neill *et al.*, 2017). SSP4 is a world in which it may not be too difficult to mitigate climate change, but would be quite difficult to adapt to it (Calvin *et al.*, 2017). A central feature of this pathway is growing inequality both across and within countries, including in the currently industrialised world (O'Neill *et al.*, 2017). Mitigation challenges

are relatively low due to modest economic growth combined with availability of technologies and expertise within the portion of the economy in which power is concentrated, while adaptation challenges are high for the substantial portion of the population with relatively low income education and little access to effective institutions (Calvin *et al.*, 2017; O'Neill *et al.*, 2017). In SSP5, economic growth is very high, enabling many development goals to be achieved within short time frames, so that challenges to adaptation are relatively low. However energy demand grows rapidly and the energy system continues to rely heavily on fossil fuels, leading to high challenges to mitigation (Kriegler *et al.*, 2017; O'Neill *et al.*, 2017).

2.3.1.1 SSP1: Sustainability

In this SSP, economic value creation decouples from material consumption and final energy demand. This is combined with a strong modernisation of energy use due to technological development, lifestyle changes and policies supporting energy efficiency improvements (Bauer *et al.*, 2017; O'Neill *et al.*, 2017; Vuuren *et al.*, 2017). Social acceptability is generally low for all technologies (particularly nuclear) except non-biomass renewables. The latter is subject to rapid technological improvements but these are particularly slow in the fossil fuel sector (Bauer *et al.*, 2017).

With respect to Figure 2, the combination of directed development of environmentally friendly technologies, a favourable outlook for renewable energy, institutions that can facilitate international co-operation, and relatively low energy demand results in relatively **low challenges to mitigation**. At the same time, the improvements in human well-being, along with strong and flexible global, regional, and national institutions imply **low challenges to adaptation** (O'Neill *et al.*, 2017).

SSP1, with its central features of commitment to achieving development goals, increasing environmental awareness in societies around the world, and a gradual move toward less resource-intensive lifestyles, constitutes a break with recent history in which emerging economies have followed the resource-intensive development model of industrialised countries (O'Neill *et al.*, 2017). To some extent, elements of this scenario can already be found in the proliferation of "green growth" and "green economy" strategies in industrialised and developing countries, although their efficiency has been questioned (O'Neill *et al.*, 2017). For these strategies to succeed there would need to be innovation in both industrialised and developing countries and adequate human and financial resources. Such innovation has been spurred by environmental policy, and this SSP assumes that policy changes are driven by changing attitudes (Vuuren *et al.*, 2017). The focus on equity, and the de-emphasis of economic growth as a goal in and of itself in high-income countries, leads industrialised countries to support developing countries in their development goals, including green growth strategies, by providing access to human and financial resources and new technologies (O'Neill *et al.*, 2017).

Table 2: Summary and narrative of SSP1: Sustainability (after Bauer *et al.*, 2017; Riahi *et al.*, 2017).

Narrative	The world shifts gradually, but persuasively, toward a more sustainable path, emphasising more inclusive development that respects perceived environmental boundaries. Management of the global commons slowly improves, educational and health investments accelerate the demographic transition, and the emphasis on economic growth shifts towards a broader emphasis on human well-being. Driven by an increasing commitment to achieving development goals, inequality is reduced both across and within countries. Consumption is oriented toward low material growth and lower resource and energy intensity.
Economy and lifestyle	Connected markets, regional production. Low growth in material consumption.
Policies and institutions	Improved management of local and global issues, tighter regulation of pollutants. Policy oriented towards sustainable development. Institutions effective at national and international levels.

Technology	Technological change directed away from fossil fuels, towards efficiency and renewable energy.
Environment and natural resources	Preferences shift away from fossil fuels. Improving environmental conditions over time.
Mitigation scenarios, Shared climate Policy Assumptions (SPA)	Fragmentation up to 2020. Transition to globally uniform carbon price directly thereafter.

2.3.1.2 SSP2: Middle-of-the-road

In this SSP, energy intensity improvements continue at global historical growth rates with a medium degree of regional convergence (Bauer *et al.,* 2017). Technological improvements are medium for all technologies and social acceptance does not shift markedly (Bauer *et al.*, 2017; Fricko *et al.*, 2017). This results in moderate growth of the energy sector, no remarkable shifts in the primary energy mix and continued modernisation of the final energy mix (Bauer *et al.*, 2017; Fricko *et al.*, 2017).

With respect to Figure 2, this growth, along with income inequality that persists or improves only slowly, continuing societal stratification, and limited social cohesion, maintain challenges to reducing vulnerability to societal and environmental changes and constrain significant advances in sustainable development. These moderate development trends leave the world, on average, facing **moderate challenges to mitigation and adaptation**, but with significant heterogeneities across and within countries (O'Neill *et al.*, 2017).

SSP2 does not imply a simple extrapolation of recent experience, but rather a development pathway that is consistent with typical patterns of historical experience observed over the past century (Fricko *et al.*, 2017; O'Neill *et al.*, 2017). For example, emerging economies grow relatively quickly and then slow as incomes reach higher levels, the demographic transition occurs at average rates as societies develop, and technological progress continues without major slowdowns or accelerations (Dellink, Chateau, Lanzi, & Magne, 2017; Fricko *et al.*, 2017; O'Neill *et al.*, 2017). It is, therefore, a dynamic pathway, yet one in which future changes in various elements of the narrative are consistent with middle of the road expectations, rather than falling near the upper or lower bounds of possible outcomes (Fricko *et al.*, 2017; O'Neill *et al.*, 2017). There are likely many reasons that trends in SSP elements could end up being moderate, and no specific stance is provided in the literature as to motivating forces (O'Neill *et al.*, 2017).

Table 3: Summary and narrative of SSP2: Middle-of-the-road (after Bauer *et al.*, 2017; Riahi *et al.*, 2017).

Narrative	The world follows a path in which social, economic and technological trends do not shift markedly from historical patterns. Development and income growth proceeds unevenly, with some countries making relatively good progress while other fall short of expectations. Global and national institutions work toward but make slow progress in achieving sustainable development goals. Environmental systems experience degradation, although there are some improvements and overall the intensity of resource and energy use declines. Global population growth is moderate and levels off in the second half of the century. Income inequality persists or improves only slowly and challenges to reducing vulnerability to societal and environmental changes remain.
Economy and	Semi-open globalised economy. Material-intensive consumption, medium meat consumption.

lifestyle	
Policies and institutions	Concern for local pollutants but only moderate success in implementation. Weak focus on sustainability. Uneven, modest effectiveness.
Technology	Some investment in renewables but continued reliance on fossil fuels. Medium carbon intensity, uneven energy intensity, higher in low-income countries.
Environment and natural resources	No reluctance to use unconventional fossil resources. Continued environmental degradation.
Mitigation scenarios, Shared climate Policy Assumptions (SPA)	Fragmentation up until 2020. Thereafter, transition to globally uniform carbon price up until 2040.

2.3.1.3 SSP3: Regional Rivalry

In this SSP, fast population growth in developing countries is combined with slow economic growth and income convergence (Bauer *et al.*, 2017). Slow technological development, material intensive lifestyles and little environmental awareness maintain the strong link between economic activity and final energy demand (Bauer *et al.*, 2017; Fujimori *et al.*, 2017). Modernisation of final energy use is slow and traditional bioenergy use remains important. Concerns about energy security and national policies support the use of domestic coal and limit trade in energy (Bauer *et al.*, 2017; Fujimori *et al.*, 2017).

With respect to Figure 2, growing resource intensity and fossil fuel dependency along with difficulty in achieving international cooperation and slow technological change imply **high challenges to mitigation**. The limited progress on human development, slow income growth, and lack of effective institutions, especially those that can act across regions, implies **high challenges to adaptation** for many groups in all regions (O'Neill *et al.*, 2017).

SSP3, with its theme of international fragmentation and a world characterised by regional rivalry can already be seen in some of the current regional rivalries and conflicts, but contrasts with globalisation trends in other areas (Fujimori *et al.*, 2017; O'Neill *et al.*, 2017). It is based on the assumption that these globalisation trends can be reversed by a number of events. For example, economic challenges in major economies could spark increasing discontent with globalisation and spur protectionist instincts (O'Neill *et al.*, 2017). Alternatively, regional conflict over territorial or national issues could produce larger conflict between major countries, giving rise to increasing antagonism between and within regional blocs (Fujimori *et al.*, 2017; O'Neill *et al.*, 2017). Such a reversal of globalisation trends due to regional conflict has happened before, for example on the eve of World War 1 (O'Neill *et al.*, 2017). Regional rivalries reduce support for international institutions and development partners, thus weakening progress toward development goals, resulting in substantial changes to current trends in population growth, human health and well-being, and environmental protection in some low- and middle-income countries (Fujimori *et al.*, 2017; O'Neill *et al.*, 2017).

Table 4: Summary and narrative of SSP3: Regional Rivalry (after Bauer *et al.*, 2017; Riahi *et al.*, 2017).

Narrative	A resurgent nationalism, concerns about competiveness and security, and regional conflicts push counties to increasingly focus on domestic or, at most, regional issues. Policies shift over time to become increasingly oriented toward national and regional security issues. Countries focus on achieving energy and food security goals within their own regions at the expense of broader-based development. Population growth is low in industrialised and high in developing countries. A low international priority for addressing environmental concerns leads to strong environmental degradation in some regions.
Economy and lifestyle	De-globalising, regional security. Material-intensive consumption.
Policies and institutions	Low priority for environmental issues. Policy oriented towards security. Weak global institutional/national governments dominated societal decision-making.
Technology	Slow tech change, directed toward domestic energy sources. High energy and carbon intensity in regions with large domestic fossil fuel resources.
Environment and natural resources	Unconventional resources for domestic supply. Serious environmental degradation.
Mitigation scenarios, Shared climate Policy Assumptions (SPA)	Fragmentation up until 2020. Regions with income greater than $12,600 in 2020 start linear transition to global carbon price up until 2040. Others start only 10 years later with transition up until 2050.

2.3.1.4 SSP4: Inequality

In this SSP, final energy demand is moderately couple to economic activity, which results in large disparities in energy consumption because of slow income convergence (Bauer *et al.*, 2017; Calvin *et al.*, 2017). In poor countries, the use of traditional bioenergy use remains important. Technological improvements in conventional oil and gas extraction are high, but policies are restrictive in high-income countries because of local pollution problems (Bauer *et al.*, 2017; Calvin *et al.*, 2017). There are significant technological improvements in nuclear power, and investments are risky because of generally volatile markets (Bauer *et al.*, 2017).

With respect to Figure 2, the combination of some development of low carbon supply options and expertise, and a well-integrated international political and business class capable of acting quickly and decisively, implies **low challenges to mitigation**. **Challenges to adaptation are high** for the substantial proportions of populations at low levels of development and with limited access to effective institutions for coping with economic or environmental stresses (O'Neill *et al.*, 2017).

SSP4, with its emphasis on both across- and within-country inequality, seems less well represented in previous scenario literature (O'Neill *et al.*, 2017). Its central feature of rising inequality is assumed to arise from a number of factors discussed in the inequality literature, including skill-biased technology development where technology replaces many low-skill jobs or capital returns (Calvin *et al.*, 2017; O'Neill *et al.*, 2017). Another key factor is the assumed generally low and highly unequal investments in education. Expanded education has been an important contributor to lowering inequality in the recent past (OECD,

2011); this narrative assumes the converse, that limited access to education can increase inequality (O'Neill *et al.*, 2017). Additionally, less affluent groups are assumed to have weak political power, fewer economic opportunities, and have limited access to credit. These factors serve to constrain both educational opportunities and income growth and make inequality more persistent (Calvin *et al.*, 2017; O'Neill *et al.*, 2017). At the same time, those at the top end of the income scale see their relative position reinforced through institutional changes that strengthen their bargaining power at the expense of low earners (O'Neill *et al.*, 2017). Across countries, the assumption that economic growth results in separation into different country income groups is consistent with the idea of ''convergence clubs'' (Dellink *et al.*, 2017; Kc & Lutz, 2017) as opposed to the conditional convergence hypothesis (O'Neill *et al.*, 2017). SSP4 assumes increasingly restricted access to education, which could plausibly halt or reverse improvements. In addition downturns in inequality from populist governments rarely endure (O'Neill *et al.*, 2017).

Finally, the assumptions that inequality and a perception of scarce energy resources lead to a decline in social cohesion and increased potential for conflict are consistent with scholarship in these areas (O'Neill *et al.*, 2017). Empirically, there is a significant negative relationship between inequality and social cohesion across a variety of measures *e.g.,* trust, solidarity, dysfunction (O'Neill *et al.*, 2017). Similarly, there is historical precedent for conflict over energy resources in consuming countries and in producing countries, with potential for intensification if resources are further constrained (Calvin *et al.*, 2017; O'Neill *et al.*, 2017).

Table 5: Summary and narrative of SSP4: Inequality (after Bauer *et al.*, 2017; Riahi *et al.*, 2017).

Narrative	Highly unequal investments in human capital, combined with increasing disparities in economic opportunity and political power, lead to increasing inequalities and stratification both across and within countries. Over time, a gap widens between an internationally connected elite and the strata of society that work in a labour intensive, low-tech economy. Social cohesion degrades and conflict and unrest become increasingly common. Technology development is high in the high-tech economy and sectors. The globally connected energy sector diversifies, with investments in both carbon-intensive fuels like coal and unconventional oil, but also low-carbon energy sources. Environmental policies focus on local issues around middle and high-income areas.
Economy and lifestyle	Globally connected elites. Elites: high consumption lifestyles. Rest: low consumption and low mobility.
Policies and institutions	Focus on local environment in middle income countries. High income countries have little focus on vulnerable areas and global areas. Towards the benefit of the political and business elite. Institutions are effective for political and business elite, not for rest of society.
Technology	Diversified investments including efficiency and low-carbon sources. Low/medium carbon and energy intensity.
Environment and natural resources	Anticipation of fossil fuel constraints drives up prices with volatility. Environment is highly managed and improved near high/middle-income living areas.
Mitigation scenarios, Shared climate Policy Assumptions (SPA)	Fragmentation up to 2020. Transition to globally uniform carbon price directly thereafter.

2.3.1.5 SSP5: Fossil-fuelled Development

In this SSP, energy demand growth is strongly coupled to economic growth, particularly in the transportation sector due to materially intensive lifestyles with a strong preference for intensive material consumption patterns including high transportation demand (Bauer *et al.*, 2017; Kriegler *et al.*, 2017). Technological development in the fossil fuel sector, including carbon capture and storage based mitigation technologies, is rapid and social acceptance is high (Bauer *et al.*, 2017; Kriegler *et al.*, 2017). Non-biomass renewables, however, are subject to low social acceptance (Bauer *et al.*, 2017).

With respect to Figure 2, the strong reliance on fossil fuels and the lack of global environmental concern result in potentially **high challenges to mitigation**. The attainment of human development goals, robust economic growth, and highly engineered infrastructure results in relatively **low challenges to adaptation** to any potential climate change for all but a few (O'Neill *et al.*, 2017).

SSP5 foresees accelerated globalisation and rapid development of developing countries, including a significant improvement of institutions and the economic participation of disadvantaged population groups (Kriegler *et al.*, 2017; O'Neill *et al.*, 2017). Such trends have little historic precedent, particularly on the global scale. Only a limited number of nations have managed the transition to a market economy with effective institutions, and the long-term prospects of currently rapidly developing economies such as China, India and Brazil remain uncertain (Kriegler *et al.*, 2017; O'Neill *et al.*, 2017). However, two historically unprecedented developments in the recent past suggest a break from past trends. First, the economic success of emerging economies and more recently, least developed countries, has given rise to an emergent global middle class that has been lacking in most regions of the world (Kriegler *et al.*, 2017; O'Neill *et al.*, 2017). The new middle class could stabilise global economic development by promoting robust growth in demand for services and goods. It may also generate societal pressure toward improved institutions and more participatory societies as for example has been observed in Brazil (O'Neill *et al.*, 2017). Second, the digital revolution enables a global discourse of a significant and increasing fraction of the global population for the first time in human history which may lead to a rapid rise in global institutions and promote the ability for global co-ordination (O'Neill *et al.*, 2017).

Table 6: Summary and narrative of SSP5: Fossil fuelled Development (after Bauer *et al.*, 2017; Riahi *et al.*, 2017).

Narrative	The world places an increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. Global markets are increasingly integrated. There are also strong investments in health, education, and institutions to enhance human and social capital. At the same time, the push for economic and social development is coupled with the exploitation of abundant fossil fuel resources and the adoption of resource and energy intensive lifestyles around the world. All these factors lead to rapid growth of the global economy, while global population peaks and declines in the 21st Century. Local environmental problems like air pollution are successfully managed. There is faith in the ability to effectively manage social and ecological systems, including by geoengineering if necessary.
Economy and lifestyle	Strongly globalised, increasingly connected, materialism, status consumption, tourism, mobility and meat-rich diets.

Policies and institutions	Focus on local environment with benefits to well-being, little concern with global problems. Towards development, free markets and human capital. Increasingly effective, oriented towards fostering competitive markets.
Technology	Directed towards fossil fuels, alternative sources not actively pursued. High carbon intensity.
Environment and natural resources	No constraints on fossil fuel use. Highly engineered approaches and successful management of local issues.
Mitigation scenarios, Shared climate Policy Assumptions (SPA)	Fragmentation up until 2020. Thereafter, transition to globally uniform carbon price up until 2040.

2.3.2 SSP Development Pathways

Regarding the range of development pathways the SSPs describe, Tables 7-9 summarise assumptions about key elements of the narratives. These tables illustrate that the SSPs span a wide range of assumptions about individual elements of the pathways (O'Neill *et al.*, 2017). Demographic trends vary widely. For example, SSPs 1 and 5 experience low population growth paths at the global level driven in part by rapid improvements in education, fast income growth, and rapid urbanisation, leading to relatively rapid declines in fertility in high fertility countries (Kriegler *et al.*, 2017; O'Neill *et al.*, 2017; Vuuren *et al.*, 2017). In contrast, SSPs 3 and 4 experience high population growth rates, a consequence of much slower improvements in education and income in high fertility countries (Calvin *et al.*, 2017; Fujimori *et al.*, 2017; O'Neill *et al.*, 2017). In countries where fertility is already low, there is no single widely accepted theory of the determinants of future fertility change. Therefore, demographic trends in these countries are not chosen primarily by appealing to existing theory, but rather to either contribute to the challenges each SSP is intended to present or increase the range of demographic outcomes achieved across the full set of SSPs (O'Neill *et al.*, 2017). For example, the combination of low fertility and migration in SSP3 would produce a very old age structure in the industrialised world, which could make it more difficult to cope with some types of climate change impacts (Fujimori *et al.*, 2017; O'Neill *et al.*, 2017). SSP5 assumes high net immigration and fertility above replacement level in the high-income countries in order to provide one pathway in which industrialised country population growth is more substantial (Kc & Lutz, 2017; O'Neill *et al.*, 2017).

Economic development is rapid and broad-based in SSPs 1 and 5, which gives rise to substantial reductions in inequality, both between and within countries, and is accompanied by continued globalisation and international trade (O'Neill *et al.*, 2017). SSP1 differs in that there is a pronounced value shift, resulting in somewhat less rapid economic growth as compared to SSP5, but compensated by other factors such as better environmental quality and higher level of equity (Kriegler *et al.*, 2017; O'Neill *et al.*, 2017; Vuuren *et al.*, 2017). Accounting for better livelihoods, the environment, equity as well as other factors, overall welfare is higher in SSP1 as compared to SSP5 (Kriegler *et al.*, 2017; O'Neill *et al.*, 2017; Vuuren *et al.*, 2017). In contrast, economic growth is slow and inequality is compounded in SSPs 3 and 4, with inequality within countries especially high in SSP4 (Calvin *et al.*, 2017; Fujimori *et al.*, 2017). SSP3 also envisions substantial obstacles to global trade, with implications for development as well as for challenges to adaptation (O'Neill *et al.*, 2017).

Table 7: Summary of Assumptions Regarding Demographic and Human Development Elements of SSPS (O'Neill *et al.*, 2017)

SSP Element	SSP1			SSP2			SSP3			SSP4			SSP5		
	Country fertility groupings for demographic elements														
	High fert.	Low fert.	Rich OECD	High fert.	Low fert.	Rich OECD	High fert.	Low fert.	Rich OECD	High fert.	Low fert.	Rich OECD	High fert.	Low fert.	Rich OECD
Demographics															
Population															
Growth	Relatively low			Medium			High		Low	Relatively high		Low	Relatively low		
Fertility	Low	Low	Med	Medium			High	High	Low	High	Low	Low	Low	Low	High
Mortality	Low			Medium			High			High	Med	Med	Low		
Migration	Medium			Medium			n/a			Medium			High		
Urbanisation															
Level	High			Medium			Low			High	High	Med	High		
Type	Well managed			Continuation of historical patterns			Poorly managed			Mixed across and within cities			Better management over time, some sprawl		
Human Development															
Education	High			Medium			Low			v. low, unequal	Low, unequal	Med, unequal	High		
Health Investments	High			Medium			Low			Unequal within regions, low in LICs, medium in HICs			High		
Access to health facilities, water, sanitation	High			Medium			Low			Unequal within regions, low in LICs, medium in HICs			High		
Gender equality	High			Medium			Low			Unequal within regions, low in LICs, medium in HICs			High		
Equity	High			Medium			Low			Medium			High		
Social cohesion	High			Medium			Low			Low, stratified			High		
Societal participation	High			Medium			Low			Low			High		

Table 8: Summary of assumptions regarding Economy and Lifestyle and Policies and Institutions elements of SSPs (O'Neill *et al.*, 2017)

SSP Element	SSP1	SSP2	SSP3	SSP4	SSP5
Economy and lifestyle					
Growth (per capita)	High in LICs, MICs; medium in HICs	Medium, uneven	Slow	Low in LICs, medium in other countries	High
Inequality	Reduced across and within countries	Uneven moderate reductions across and within countries	High, especially across countries	High, especially within countries	Strongly reduced, especially across countries
International trade	Moderate	Moderate	Strongly constrained	Moderate	High, with regional specialisation in production
Globalisation	Connected markets, regional production	Semi-open globalised economy	De-globalising, regional security	Globally connected cities	Strongly globalised, increasingly connected
Consumption and Diet	Low growth in material consumption, low-meat	Material-intensive consumption, medium meat consumption	Material-intensive consumption	Elites: high consumption lifestyles; Rest: low consumption, low mobility	Materialism, status consumption, tourism, mobility, meat-rich diets
Politics and institutions					
Environmental Policy	Effective	Relatively weak	Weak, uneven	Effective for globally connected, not for vulnerable populations	Effective in pursuit of development goals, more limited for environmental goals
Environmental Policy	Improve management of local and global issues; tighter regulation of pollutants	Concern for local pollutants but only moderate success in implementation	Low priority for environmental issues	Focus on local environment in MICs, HICs; little attention to vulnerable areas or global issues	Focus on local environment with obvious benefits to well-being, little concern with global problems
Policy Orientation	Towards sustainable development	Weak focus on sustainability	Oriented towards security	Towards the benefit of the political and business elite	Toward development, free markets, and human capital
Institutions	Effective at national and international levels	Uneven, modest effectiveness	Weak global institutions/nat'l govts. Dominate societal decision making	Effective for political and business elite, not for rest of society	Increasingly effective, oriented towards fostering competitive markets

Table 9: Summary of assumptions regarding Technology and Environment and Natural Resource elements of SSPs (O'Neill *et al.*, 2017)

SSP Element	SSP1	SSP2	SSP3	SSP4	SSP5
Technology					
Development	Rapid	Medium, uneven	Slow	Rapid in high-tech economies and sectors; slow in others	Rapid
Transfer	Rapid	Slow	Slow	Little transfer within countries to poorer populations	Rapid
Energy tech change	Directed away from fossil fuels, towards efficiency and renewables	Some investment in renewables but continued reliance on fossil fuels	Slow tech change, directed towards domestic energy sources	Diversified investments including efficiency and low-carbon sources	Directed towards fossil fuels; alternative sources not actively pursued
Carbon intensity	Low	Medium	High in regions with large domestic fossil fuels resources	Low/medium	High
Energy intensity	Low	Medium, higher in LICs	High	Low/medium	High
Environment and natural resources					
Fossil constraints	Preferences shift away from fossil fuels	No reluctance to use unconventional resources	Unconventional resources for domestic supply	Anticipation of constraints drives up prices with high volatility	None
Environment	Improving conditions over time	Continued degradation	Serious degradation	Highly managed and improved near high/middle-income living areas, degraded otherwise	Highly engineered approaches, successful management of local issues
Land use	Strong regulations to avoid environmental tradeoffs	Medium regulations lead to slow decline in the rate of deforestation	Hardly any regulation; continued deforestation due to competition over land and rapid expansion of agriculture	Highly regulated in MICs, HICs; largely unmanaged in LICs leading to tropical deforestation	Medium regulations lead to slow decline in the rate of deforestation
Agriculture	Improvements in agricultural productivity; rapid diffusion of best practices	Medium pace of tech change in agricultural sector; entry barriers to agricultural markets reduced slowly	Low technology development, restricted trade	Agricultural productivity high for large scale industrial farming, low for small-scale farming	Highly managed, resource intensive; rapid increase in productivity

2.3.2.1 SSP Income Projections

Dellink *et al.* (2017) outline that global GDP levels by the end of the century vary substantially across SSPs, varying from around 280 trillion USD$ in SSP3 to more than 1000 trillion USD$ in SSP5. This pattern is similar for income (i.e. per capita GDP) levels. SSP5, with its narrative focused on ''conventional'' economic development, projects a global GDP increase by 2100 of more than 15-fold the 2010 level (Dellink *et al.*, 2017; Kriegler *et al.*, 2017). In this scenario, growth rates of income remain above 2% per annum throughout the century, leading to a 14-fold increase of income by 2100 (Dellink *et al.*, 2017; van Ruijven *et al.*, 2014).

SSPs 3 and 4, which represent the scenarios with lowest levels of international co-operation and trade, are at the bottom of the range (Calvin *et al.*, 2017; Dellink *et al.*, 2017; Fujimori *et al.*, 2017). They both see marked reductions in global growth of income to 0.5% and 0.7% per annum, respectively. The drop in global growth starts almost immediately in SSP3 while it is more gradual in SSP4, which first follows the growth pattern of the SSP2 scenario (Dellink *et al.*, 2017; van Ruijven *et al.*, 2014). SSP3 in particular shows very low growth in income (a bit more than doubling in income levels over the century), following the assumptions of low growth rates for the economic drivers (Dellink *et al.*, 2017; Fujimori *et al.*, 2017). SSPs 1 and 2 have intermediate growth rates. In the first decades, SSP1 presents higher growth at global level as it assumes a quicker convergence (Dellink *et al.*, 2017; Fricko *et al.*, 2017; Vuuren, Stehfest, *et al.*, 2017). Given the higher population projections in SSP2, income levels diverge more than absolute GDP levels between SSP1 and SSP2 (Dellink *et al.*, 2017; van Ruijven *et al.*, 2014)

2.3.3 SSP Challenges to Mitigation and Adaptation Strategies

Figure 3 summarises the pathway elements that lead to the particular combinations of challenges represented by each SSP.

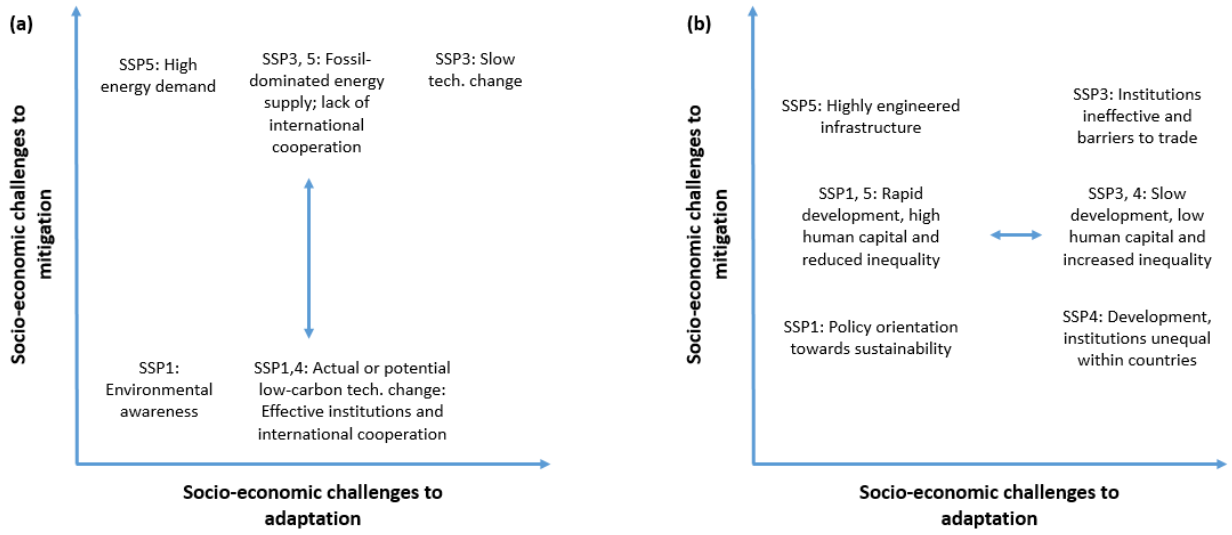

Figure 3: A summary of SSP elements that contribute to high or low challenges to mitigation (a) and adaptation (b) (O'Neill *et al.*, 2017).

Figure 3 outlines these challenges to mitigation and adaptation. Elements listed toward the top or bottom of the challenges space in figure (a) apply to pathways with high or low challenges to mitigation, respectively, while elements listed toward the left or right side of the challenges space in figure (b) apply to pathways with low or high challenges to adaptation, respectively (O'Neill *et al.*, 2017).

High challenges to mitigation are hypothesised to be driven in these narratives by fossil-dominated energy supply either globally or regionally, along with a lack of capacity (or desire) for international cooperation on

global environmental issues (O'Neill *et al.*, 2017). These challenges are exacerbated in SSP5 by very high energy demand and in SSP3 by slow technological change (Fujimori *et al.*, 2017; Kriegler *et al.*, 2017; O'Neill *et al.*, 2017). In contrast, low challenges to mitigation are driven by development of low-carbon energy technologies (or the capacity for that development) and effective means of cooperating on international policy (O'Neill *et al.*, 2017). These challenges are further reduced in SSP1 by a general orientation towards environmental sustainability (Vuuren *et al.*, 2017).

High challenges to adaptation are assumed to be driven by a combination of slow development, low investments in human capital, and increased inequality (O'Neill *et al.*, 2017). These challenges are exacerbated in SSP3 by ineffective institutions and barriers to trade, and in SSP4 by high inequality within (as well as across) countries (Calvin *et al.*, 2017; Fujimori *et al.*, 2017; O'Neill *et al.*, 2017). In contrast, low challenges to adaptation are driven by rapid development and formation of human capital and reduced inequality, further reduced in SSP5 by highly engineered infrastructure and in SSP1 by an orientation towards environmental sustainability (Kriegler *et al.*, 2017; O'Neill *et al.*, 2017).

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Mitigation costs and attainability of climate targets depend strongly on the design and effectiveness of future mitigation policies (Riahi *et al.*, 2017). Likewise, adaptation costs and the ability to buffer climate impacts depend on the scope and effectiveness of adaptation measures. These policies may differ greatly across the SSPs, and need to be consistent with the overall characteristic of the different narratives (Bauer *et al.*, 2017; O'Neill *et al.*, 2017; Riahi *et al.*, 2017). Riahi *et al.* (2017) develop shared climate policy assumptions (SPAs) for the implementation of the SSP mitigation scenarios. The mitigation SPAs generically describe the most important characteristics of future mitigation policies, consistent with the overall SSP narrative as well as the SSP baseline scenario developments.

3 Profiling Innovation Needs for the Four Communities

3.1 Applying the Shared Socio-economic Pathways Method at Community Level

The transformation of the energy sector is important in addressing the challenges of both climate change mitigation and adaptation. On the one hand, energy is the main contributor to GHG emissions and air pollution resulting in much emphasis on emission mitigation (Bauer *et al.*, 2017). On the other hand, global energy systems are vulnerable to climate change and can serve as a means for adaptation to a changing climate (Bauer *et al.*, 2017). The energy sector transformation also has important implications for social and environmental sustainability goals. SSPs provide a framework for assessing socio-economic challenges to climate change mitigation and adaptation, as well as analysing broader social and environmental sustainability issues (Bauer *et al.*, 2017; Riahi *et al.*, 2017; van Vuuren *et al.*, 2017). While the development of the SSPs outlined by Bauer *et al.* (2017), Riahi *et al.* (2017) and Vuuren, Riahi, *et al.* (2017) are developed from Integrated Assessment Models, the key components for Task 6.3 of the ENTRUST project is to highlight where elements of innovation are required in the profiled communities (outlined in the following sub-section). To that end, a qualitative description and identification of where constituent components of

the SSPs match the characteristics of the profiled communities serves to highlight where innovations are required. These areas include population growth, energy use, agriculture, urbanisation rates, income, and emissions and climate change (van Vuuren *et al.*, 2017).

Yet while scenario development frameworks are often related to quantitative analyses of regions, the SSP framework can be applied qualitatively (see Bauer *et al.*, 2017; O'Neill *et al.*, 2017). Indeed, both Bauer *et al.* (2017) and O'Neill *et al.* (2017) identify specific narratives for the energy sector for each SSP as previously identified in Section 2.3.1. For this Deliverable, a spreadsheet was applied to 'map' the constituent components of the SSPs including population size, migration, consumption and diet, land use, and environmental policy. The results of this qualitative analysis are presented in Section 3.

3.2 Overview of Communities

It is essential to understand the background of each community and the main issues they face. An overview of each of the profiled communities against the SSP method is provided in this section.

3.2.1 Stockbridge Village, UK

Located 6 miles east of Liverpool, Stockbridge Village is one of England's most socio-economically deprived communities. The residents of Stockbridge Village face a number of issues within their community such as poor health, high unemployment, marginalisation, and energy and fuel poverty. Indeed, 40% of those who are of working age are unemployed with 13% of the community identified as being "long term sick or disabled" according to statistics by Knowsley Council in 2016 (Knowsley Council, 2016). Thus only 58% of residents in Stockbridge are economically active in comparison to the UK average of 70%. Home ownership is also lower than the national average (63%) with 32% of those in Stockbridge Village owning their own home. Additionally, education levels are also much lower in Stockbridge Village with only 10% of those holding a level 4 qualification (HNC) or above in comparison to the national average of 27%.

The Villages Housing Association (VHA) is the housing association with which ENTRUST researchers are liaising with in relation to the Stockbridge Village community. The VHA was established in 1983 when Knowsley Metropolitan Borough Council transferred 3000 of its properties in Cantril Farm – now known as Stockbridge Village – to the company. VHA manages other properties in the North West such as Fitton Hill, Oldham, including a mixture of family homes, apartments and sheltered accommodation, as well as two specialist dementia schemes in St Helens, Merseyside. Villages Housing's mission statement is "to be more than just a landlord by working in partnership to create an environment for communities to flourish" (Villages Housing, 2017). VHA have previously undertaken some energy interventions in Stockbridge Village, such as upgrading wall insulation in their housing stock, as well as undertaking some initial behaviour change initiatives across the community. They are keen to engage with the ENTRUST project to help pursue behaviour change in the community, and have already identified a number of 'energy champions' for engagement.

In order to halt the decline and improve the area, the Stockbridge Village Trust was established in 1983 (which later became the VHA in 1995). The trust set about trying to improve the area through remodelling to low-rise housing, improving security and amenity, altering the layout of the estate, increasing shopping and leisure facilities, as well as increasing private home ownership. While some improvement has been made since the early 1980s, the area still has many problems – in 2013, the economist labelled Stockbridge '…one of Britain's most concentrated urban ethnic ghettos' (The Economist, 2013). According to the 2011 census, the population is just over 6,000, with 96% of the population being white, and 43% of working-age adults depend on benefits (Knowsley Council, 2016).

Stockbridge Village has a deep sense of community and this is often exemplified with numerous community events that occur throughout the year. Each year, the community holds the Stockbridge Village Gala Day

with organisations and charities providing entertainment, food stalls, advice and support for residents. However, for outside organisations, Stockbridge can be a hard-to-engage community and few previous community engagement projects have succeeded in meaningfully involving residents on issues of importance, with projects often suffering from short-term focuses and meaningless outcomes for the community; resulting in a lack of community buy-in and a trust-gap.

3.2.2 Le Trapèze, France

Le Trapèze, in the Boulogne-Billancourt commune of Paris, is home to a number of so-called "eco-neighbourhoods." Situated in one of the wealthier suburbs of Paris, the neighbourhoods in and around Le Trapèze have been built on the site of an old Renault automotive plant and are divided into 15 neighbourhoods, comprising of 5 to 6 buildings in each. The communities use a combination of renewable energy sources and have been designated as eco-neighbourhoods due to the utilisation of district heating by residents, the higher standards of insulation in the buildings compared to elsewhere, and an emphasis on pedestrian walkways and green spaces in the public spaces provided.

The project of Le Trapèze has been designed to optimise its ecological and environmental ambitions through architectural design balancing function and form in terms not only of its environmental impact, but also in economic and social terms. The neighbourhood is designed to achieve a balance between private and social housing, offices, retail outlets and shops, as well as in terms of its amenities. One of the main attractions of Le Trapèze is its seven-hectare public park that runs parallel to the Seine. The park has two large planted areas and is criss-crossed by a network of landscaped walkways. The neighbourhood is organised in macro-lots (around 10) with ownership comprising a combination of private and collective ownership models. Communal garden areas and parking facilities are shared between several buildings. The management of these buildings and communal areas is organised through a series of associations coordinated by a management company. Communication between residents on a macro-scale occurs through an online forum, which has nearly 900 members.

The project has been designed to optimise its ecological and environmental ambitions through architectural design, balancing function and form in terms not only of its environmental impact, but also along economic and social terms too. The neighbourhood is designed to achieve a balance between private and public spaces; with private and social housing, offices, retail outlets and shops, as well as social amenities all being carefully planned out. The types of social amenities that facilitate neighbourhood living include nurseries, a school group and a multi-media library. These are complimented by one of the main attractions of Le Trapèze, its seven-hectare public park that runs parallel to the Seine. The park has two large planted areas and is criss-crossed by a network of landscaped walkways.

Communal garden areas and parking facilities are shared between several buildings. The management of these buildings and the communal areas is organised through a series of associations coordinated by the management company AFUL. One significant limitation to the project that has been identified is the absence of a community centre such as a “town hall” where residents can meet. Instead cross-community communication between residents is only possible through an online forum. This is problematic for a number of reasons and while initially there was a significant take-up for this means of communication on the part of the residents with nearly 900 members, there are only between 50 and 100 members currently active. Effective communication across the community is therefore somewhat limited.

At present, there are between 10,000 and 15,000 inhabitants living in the now completed Trapèze West development and the soon to be completed Trapèze East development. By 2018, it is estimated that this district will be home to up to 18,000 people. Also, 65% of the energy supplied to this neighbourhood comes from renewable sources at present, mainly geothermal energy, with plans underway to expand the role of solar energy here. Along with roof-top water recovery systems for cooling and heating, the goal is to have

100% of its domestic energy needs coming from renewable sources. La Trepèze is serviced by the Metro and by an innovative public bicycles scheme. It was the first area outside of Paris central to have Vélib 'stations (public bikes), which launched in 2009. There is also an urban community subsidy scheme to encourage residents to purchase electric bikes, in an effort to reduce congestion and pollution levels from privately owned cars. As a result of these initiatives, homes here and the transport system are less energy intensive than elsewhere in Paris.

Le Trapèze has set up a number of ambitious targets and commitments towards realising a more sustainable future. These include: a strong emphasis on promoting and developing cleaner energy infrastructure and attitudes to energy consumption, using renewable energy sources where possible; the implementation of an innovative system of water management; and promoting of "green" public spaces, healthy lifestyle aspirations and soft measures to improve travel systems in the district. The area has been widely recognised for its commitment to sustainable development and it was awarded the term of 'EcoQuartier' in 2013.

3.2.3 Dunmanway, Ireland

Dunmanway is a busy inland market town located in the centre of West Cork, 38 miles northwest of Cork city, and acts as a commercial and cultural focal point for it largely rural hinterland. The main road through the town is the R586, which is designated a secondary route in Ireland's road network classification system. Sited between the Sally and Brewery rovers, two tributaries of the River Brandon, it was founded in the 17th century as an English colony and acted as a resting point for troops travelling between the garrison towns of Bandon and Bantry. Its establishment as the primary market town for the area was led by Sir Richard Cox, Lord Chancellor of Ireland 1703–1707, with trading in flax for the linen industry being a significant commercial activity. The town's two original triangular squares still survive.

According to the 2011 National Census, the demographic profile of the area shows a larger than national average population of older people in the area with 36.2% falling into the category 65 years plus. 19.6% of adults have primary education only, which is marginally above the national average. The third-level education attainment figure is 19.2% and is significantly below the national average. In terms of social class, the Dunmanway catchment area has a 29.6% share of professional classes – slightly below the national average – and a 17.5% share of unskilled classes which is identical to the national average. Unemployment rates in the area correspond with national rates. The high level of house ownership in the Dunmanway catchment area is noteworthy at 78.3%, while local authority rented housing accounts for 5.9%.

The issues facing Dunmanway are those that can be identified in rural communities across Europe. These include depopulation resulting in an aging resident population, changing land use patterns, shrinking local employment opportunities, along with the homogenising influence of multinational retail and the inability of local business to compete. In addition, the continuing decline in state investment in rural areas has further diminished public services more generally and resulted in outdated infrastructure that was better suited to earlier historic economic models that are no longer extant. This is especially true in relation to incoherent strategies for the rolling out of rural broadband and the absence of a viable public transport network in many areas. A recent 2015 Teagasc report indicates that only 37% of Irish farms are considered to be economically "viable", where family farm incomes adequately meeting family labour costs. The same report also indicated that only 29% of farms in the state were considered "sustainable", where the farm is not economically viable, but farmer and/or spouse had an off-farm job to supplement incomes. Furthermore, 34% of farms were considered economically "vulnerable" where the farm is not viable and neither farmer nor spouse have an off-farm job. This vulnerability has contributed to numerous rural issues outlined (and evident in Dunmanway), with electrical districts in Dunmanway bucking increasing population trends at both the county and national level. One Dunmanway Rural District, Milane, recorded as much as a 20.1% population decrease in the 2016 National Census.

3.2.4 Secondigliano, Italy

Situated in the Bay of Naples, and in sight of the iconic volcano Mount Vesuvius, Naples the third most populous city in Italy after Milan and Rome, and is the most densely populated city in the state. The metropolitan area of the City of Naples is home to over 4 million people and remains vulnerable to volcanic and seismic activity from both Vesuvius (east) and Campi Flegrei to the west of the city. The Post-war period has seen much expansion and reconstruction activity due to the heavy fighting that took place there during the Second World War, with the port of Naples considered one of Europe's busiest and most economically important. It has the fourth largest economy in Italy after Milan, Rome and Turin. The historic city is a UNESCO World Heritage Site, covering some 1,700 hectares in total, and has long been considered an important cultural centre. Its culinary contributions include the now ubiquitous pizza, which while historically a staple for the city's poorer residents it is now considered one of the mainstays of Italian cuisine. Naples also has a rich and long running architectural heritage, with numerous palaces, churches and piazzas found throughout the city. The historic quarter is also home to numerous museums, parks and gardens.

The demographic profile of the city is younger than the national average of Italy and it is home to a sizeable student population. The University of Naples Federico II, considered one of the oldest universities in the world, and has nearly eighty thousand students enrolled across its 13 faculties. The rapid expansion of the city during the Post-war years saw what were once rural communities, like that in Secondigliano, merged into the wider metropolitan area of Naples. Secondigliano was still a largely rural town up until 1960. The 1970s saw significant construction work beginning, with extensive social housing developments there and in the adjacent neighbourhood of Scampia. A devastating earthquake in 1980 resulted in an additional 35,000 families from the historic city requiring new housing and these families (some with significant social problems) were moved from the historic and central parts of Naples into areas like Secondigliano.

These new developments consisted mainly of large tower blocks of flats, which housed the significant numbers of people being moved from the historic city of Naples. Consistent poor planning from the beginning, along with ill thought out strategies for providing additional supporting facilities to these housing units, such as the lack of an integrated transport network linking back to the city, poor recreational amenities to facilitate families and young people, and minimal commercial investment in the area has seen considerable social problems develop. According to the 2001 National Census, both Scampia and Secondigliano have higher percentages of young people than elsewhere in Naples. The percentages of older people, 65plus years of age, is also lower than the national average.

The rapid industrial decline seen elsewhere in Italy has had a particularly devastating effect in Naples generally. The once thriving industrial-based economy, which supported the large working class population has shrunk considerably. Consequently, unemployment, poverty, drug addiction and crime have risen sharply. These trends have been exacerbated by the loss of social networks and community supports people once had in their old neighbourhoods. Also, the continuing presence of organised crime syndicates, referred to collectively as the Camorra, contribute to the persistent high rates of unemployment, especially youth unemployment, the significant truancy and drop-out rates from school, and the easy access to drugs. Access to tertiary education remains elusive for many young people. In Secondigliano, these social problems are more acutely felt than in other parts of Naples due to its peripheral location in relation to the rest of the city, a situation that has been ruthlessly manipulated by the many organised crime factions there.

Housing in the city is almost entirely comprised of permanent buildings, including in the most deprived neighbourhoods. A notable exception is Campo Autorizzato, a Roma encampment in Secondigliano, located beside the Carcere Di Secondigliano maximum security prison. Recent research examining how Italian authorities continue to ambiguously frame the concept of *nomadism* – whether for Roma or for more

recent migrants from Africa and the Middle East – within public policy and bureaucratic practices suggest deliberate efforts on the part of authorities to legitimise segregation policies for certain minorities living in the area. These have been tied up with government efforts to house all of Naples inhabitants in permanent building structures, and has helped to manipulate Roma – and by extension, migrant – identities in contrast to the ethnic Italian majority. Despite its economic significance to Italy, Naples continues to be one of the least ethnically diverse cities in the country, according to official statistics. However, given the nature of work available to new migrants – primarily in agriculture – and the desire by some to remain screened from official scrutiny, even when it comes to accessing state supports the real figure is likely to be much higher.

Access to structured employment pathways is low amongst women in Secondigliano, who often have to rely on informal working arrangements, working for example as domestic cleaners or similar types of casual labour often resulting in precarious employment conditions and low job security. With employment opportunities for men also being precarious, many families rely on casual labour availability for survival.

The issue of waste disposal and recycling has long been an issue in Naples. Referred to as the "Waste Crisis" the criminal influence on the waste services in Naples has resulted in over 20 years of dysfunctional waste management. At a national level, Italy has made strides in improved waste recycling rates, however, Naples still must export significant percentages of its own waste (much of which could be recycled) to incinerators in Germany and the Netherlands. It is also dealing with the legacy of decades of illegal dumping of toxic and domestic waste in and around the city. The so-called 'Triangle of Death', situated north of the city has, negatively impacted on the human health, food security and environment of the affected populations there. More positively, some small progress has been made towards improving the waste situation in the area with recent pilot projects in select Naples neighbourhood encouraging separate waste collection practices amongst the population there. This still does not resolve the problem of recycling or responsibly disposing of the waste once it has been collected however.

3.3 Development of Community Shared Socio-economic Pathway Profiles

Shared Socio-economic Pathway profiles were developed and are presented here in Section 4.3 for four of the ENTRUST communities. These profiles outline how the characteristics of the profiled communities match with constituent components of the SSPs, and where each community most likely aligns to one of the 5 SSPs. The developed profiles are then applied to identify where innovation for sustainability is required for each of the communities in a bespoke and community specific manner.

3.3.1 Stockbridge:

Stockbridge Village has a relatively low consumption and development rate, indicating areas that may enable aspects of sustainability. While Stockbridge Village has a relatively small carbon footprint in comparison to other communities of a similar size, this relatively smaller energy intensity is dependent upon frugality and poverty rather than consumption. There is little development in Stockbridge Village that inhibits progression to an SSP1 paradigm. Its inherent challenges include minimal development around sustainability and attempting to transition a substantial number of residents out of energy poverty.

Table 10: Overview of Count of all SSP Elements for Stockbridge

Pathway	Count / 28 elements
SSP1: Sustainability	2
SSP2: Middle of the road	13
SSP3: Regional rivalry—A rocky road	9
SSP4: Inequality—A road divided	4
SSP5: Fossil-fuelled development—Taking the highway	0

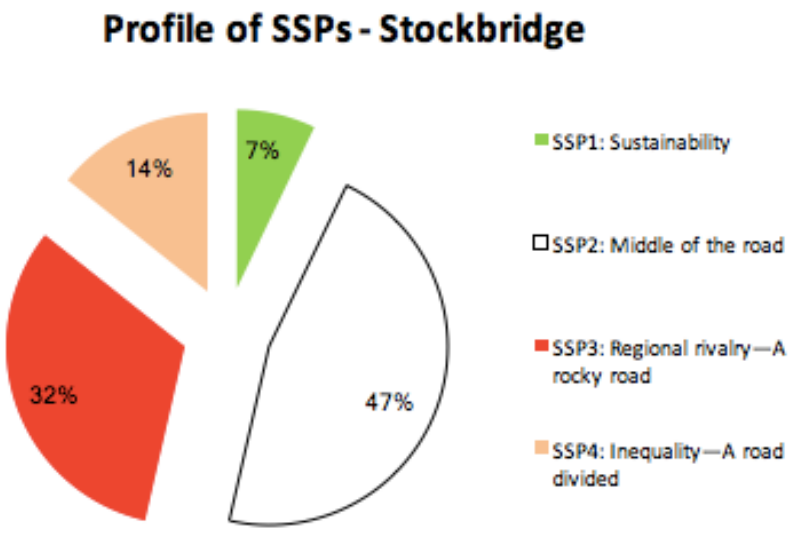
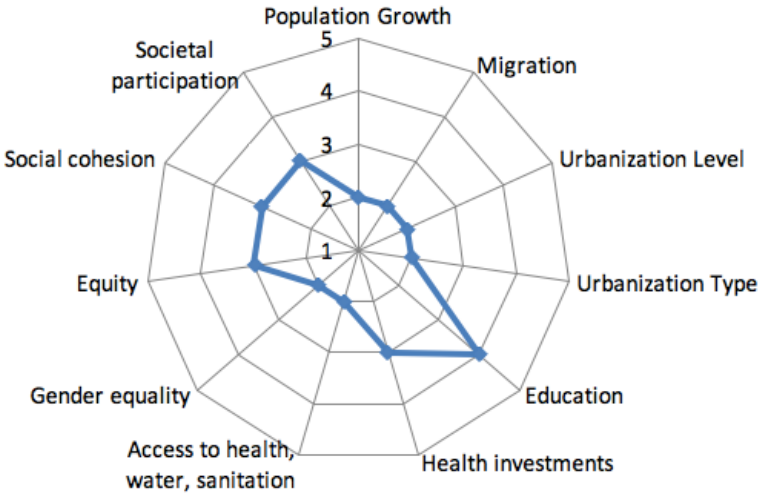


Figure 4: Profile of SSPs, Stockbridge

While the policy orientation attempts to support an energy transition, these are often remedial attempts to move towards sustainability at the local level. There are substantial risks to Stockbridge Village that could risk it sliding from a predominantly SSP2 paradigm to a SSP3 outlook. These include minimal attempts to engineer technology development and societal participation in these areas indicates weaknesses within the fabric of public engagement with sustainability. Referring to demographic pathway elements, population growth is slightly below the national average and migration in Stockbridge Village is low, primarily local within the Liverpool City Region, with few choosing to settle in Stockbridge. In terms of urbanisation level there has been little change within the urban environment in the past 30 years. Around 30% of the high-rise buildings in the village have been demolished in favour of building low-rise dwellings. Existing infrastructure has remained and residential buildings have been retrofitted with more contemporary technologies. The urbanisation type within Stockbridge represents a continuation of historical patterns whereby in the past 20 years low-rise buildings rather than high-rise have been built, with minimal green space being used to protect local environment. While some high-rise buildings have been demolished, five high-rise buildings have been retrofitted rather than removed.

With respect to human development, poor levels of education exist around Stockbridge as a result of historical education policies and settlement of Stockbridge in 1950's and 60's in comparison to the national average. Historically there was a clearer focus on work for older generations, while younger generations are now subjected to compulsory attendance to primary and secondary school. Little health investments are identified in Stockbridge and those that are implemented are a reactionary measure rather than a precautionary one. Access to GPs is poor within Stockbridge Village, with closure of local services a key issue in recent years. Water and sanitation facilities are generally positive yet health facilities remain challenging to access. Payment for water and sanitation are issues for those who struggle to pay their bills and whom may be considered to be in relative poverty. There appears to be no issues surrounding gender inequality yet employment opportunities for females are poorer than males. Home ownership is low in Stockbridge Village in comparison with the national average yet personal financial equity in companies is very low. The community has a strong sense of cohesion yet divides exist with issues of anti-social behaviour and crime related to guns and drugs. With respect to social participation the local population are relatively well engaged with community issues of concern and organise attempts to address issues, yet marginal participation is identified on issues accorded lower priority.



From Table 11 and Figure 5, the Social / Demographic Pathway Elements most in need of innovation and policy focus for Stockbridge include Equity, Social cohesion, Societal participation as well as Health. No sustainability pathway elements were identified in Stockbridge for the Social / Demographic dimension.

Table 11: Social / Demographic Pathway Element Characterisation - Stockbridge

Social / Demographics Pathway Element	Local Description	Corresponding Pathway
Population Growth	Relatively Low	SSP2: Middle of the road
Migration	Low	SSP2: Middle of the road
Urbanisation Level	Low	SSP2: Middle of the road
Urbanisation Type	Continuation of historical patterns	SSP2: Middle of the road
Education	Low; unequal	SSP4: Inequality—A road divided
Health investments	Low	SSP3: Regional rivalry—A rocky road
Access to health facilities, water, sanitation	Medium	SSP2: Middle of the road
Gender equality	Medium	SSP2: Middle of the road
Equity	Low	SSP3: Regional rivalry—A rocky road
Social cohesion	Medium	SSP3: Regional rivalry—A rocky road
Societal participation	Medium	SSP3: Regional rivalry—A rocky road

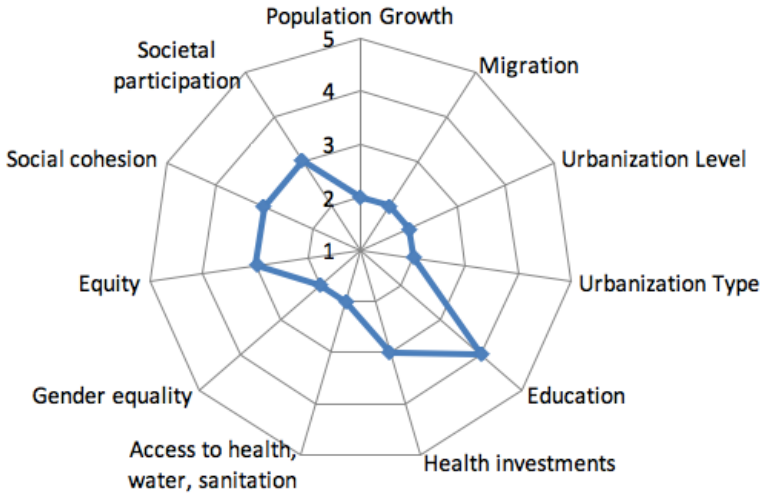


Figure 5: Spider-diagram of Social / Demographic Pathway Element Characterisation - Stockbridge

As a socio-economically deprived community Stockbridge Village has a low growth rate of GDP per capita. Supportive measures including job seekers support is being provided. Attempts to reduce inequality can be found within the community with organisations and charities working in the area to support employment and crime rates. Furthermore, organisations have also developed projects to overcome health inequalities within the local community. Stockbridge Village has no international companies that support trading at an international level, and international trade is therefore constrained. While Stockbridge Village has little international companies and organisations, there are some locally based companies that remain open to globalisation forces and pressures. Given that many residents in Stockbridge are on very low-incomes, their consumption, mobility and diets are often on the lower end of consumption rates. Specifically, unhealthy options including fast food chains operate in the centre of the village and therefore make these options more accessible and visible in comparison to healthier options.

From Table 12 and Figure 6, Economics / Governance Pathway Elements most in need of innovation and policy focus include international trade and Institutional strength. No sustainability pathway elements were identified in Stockbridge for the Economics / Governance dimension.

Table 12: Economics / Governance Pathway Element Characterisation - Stockbridge

Economics / Governance Pathway Element	Local Description	Corresponding Pathway
Economic Growth (per capita)	Low	SSP4: Inequality—A road divided
Inequality	Reduced within community	SSP2: Middle of the road
International trade	Strongly constrained	SSP3: Regional rivalry—A rocky road
Globalisation	Semi-open globalised economy	SSP2: Middle of the road
Consumption & Diet	Low consumption, low mobility	SSP2: Middle of the road
Environmental Policy	Concern for local pollutants but only moderate success in implementation	SSP4: Inequality—A road divided
Policy Orientation	Oriented toward security	SSP2: Middle of the road
Institutions	Weak institutions/ natl. govts. dominate societal decision-making	SSP3: Regional rivalry—A rocky road
Level of Local Control (Subsidiarity)	Limited	SSP4: Inequality—A road divided

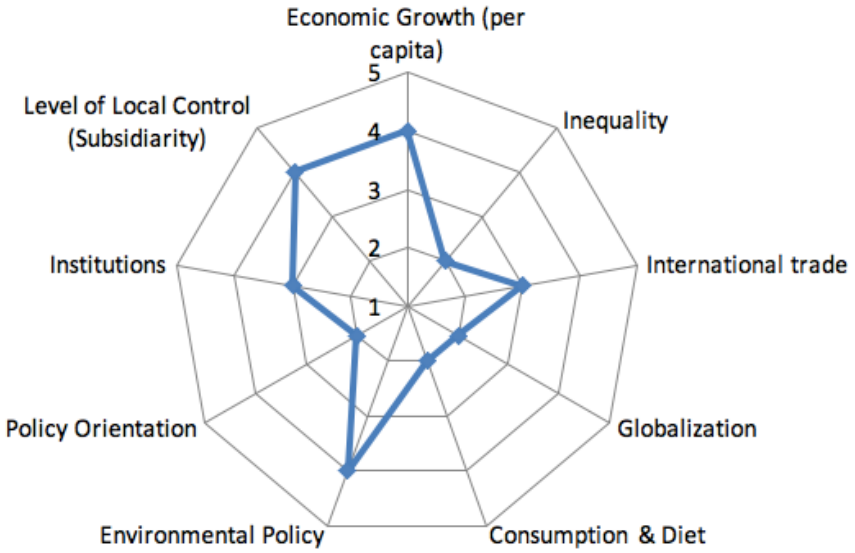


Figure 6: Spider-diagram of Economics / Governance Pathway Element Characterisation - Stockbridge

Recent environmental policies have protected local environments yet wider changes to improving energy technologies and domestic technologies have resulted in mixed success. While some sustainability policies exist, the focus of most policies is to support those who are struggling to pay their energy bills, have difficulty finding a job and supporting access to healthcare. This has been the outcome in order to address substantial levels of unemployment and energy poverty. Decision making within Stockbridge Village is heavily dominated at the reginal and national level that sometimes neglects nuances at the local level. This is often the case with health-related options available within the community.

Technologies being implemented in Stockbridge are occurring at a very slow rate, yet evidence suggests this could change with the implementation of the biomass energy system. Few new technologies are being implemented in Stockbridge to address issues of concern to residents; rather this is being led by market demand. Some investments in energy technology changes are being implemented within Stockbridge such as biomass energy system, insulation upgrades, and energy efficient lightbulbs and smart meters.

Given the lack of energy consumption due to low-incomes, residents in Stockbridge Village live relatively low-carbon lifestyles mainly through conscious choice, poverty and frugality. Homes and transport within Stockbridge are relatively low energy intensive and the community is serviced by good public transport links to Liverpool and existing energy efficient measures. Collectively, residents in Stockbridge Village identify that a shift towards renewables are preferable to fossil fuels recognising the limited supply these offer and the ability to generate clean energy as part of a renewable energy model. While Stockbridge Village has environmental policies focusing on hard infrastructural changes, actions resulting from policies have protected environmental spaces yet have not prevented environmental degradation completely.

With respect to land use, some environmental policies have protected areas around Stockbridge Village and some spaces particularly forested areas have special protection orders to prevent deforestation. There are no current plans to build further on green spaces around the community, and previous proposals have failed to be successful in attempting to develop on this land.

From Table 13 and Figure 7, Technology / Environment Pathway Elements most in need of innovation and policy focus include technology development, technology transfer and environment. Sustainability pathway elements identified in Stockbridge for the Technology / Environment dimension include Energy

Intensity and Carbon Intensity, however these can be attributed to low levels of economic wealth rather than pro-active environmental behaviour change.

Table 13: Technology / Environment Pathway Element Characterisation - Stockbridge

Technology / Environment Pathway Element	Local Description	Corresponding Pathway
Technology Development	Slow	SSP3: Regional rivalry—A rocky road
Technology Transfer	Slow	SSP3: Regional rivalry—A rocky road
Energy Tech Change	Some investment in renewables but continued reliance on fossil fuels	SSP2: Middle of the road
Carbon Intensity	Low	SSP1: Sustainability
Energy Intensity	Low	SSP1: Sustainability
Fossil Constraints	Preferences shift away from fossil fuels	SSP2: Middle of the road
Environment	Uneven	SSP3: Regional rivalry—A rocky road
Land Use	Medium regulations lead to slow decline in the rate of deforestation	SSP2: Middle of the road

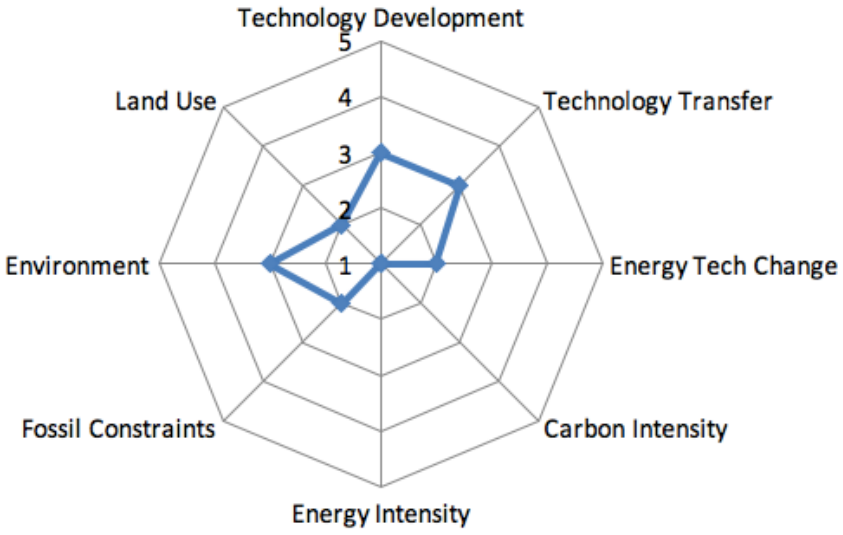


Figure 7: Spider-diagram of Technology / Environment Pathway Element Characterisation - Stockbridge

Summary of Stockbridge Village Innovation Requirements:

- **Social / Demographic:** Equity, Social cohesion, Societal participation & Health
- **Economics / Governance**: International trade and Institutional strength.
- **Technology / Environment:** Technology development, Technology transfer and Environment.

3.3.2 Le Trapèze:

Le Trapèze benefits from having a policy orientation towards sustainability and strong transition away from fossil fuels. The development of an eco-neighbourhood comprising of private and social housing illustrates

an inclusive approach towards affordable sustainable communities. Le Trapèze has also built an elementary school that focuses on biodiversity principles and home ownership comprises private and collective ownership. While investments in energy system continue, development is also continuing that could increase the carbon and energy intensity of the neighbourhood pushing this community towards an SSP2 paradigm where sustainability may be the overall goal but becomes less important over time. Of the four communities included in this analysis, Le Trapèze demonstrates the strongest match to a SSP1 sustainability pathway, although risks towards an SSP3 regional rivalry were also identified.

Table 14: Overview of Count of all SSP Elements for Le Trapèze

Pathway	Count / 28 elements
SSP1: Sustainability	9
SSP2: Middle of the road	9
SSP3: Regional rivalry—A rocky road	3
SSP4: Inequality—A road divided	1
SSP5: Fossil-fuelled development—Taking the highway	6

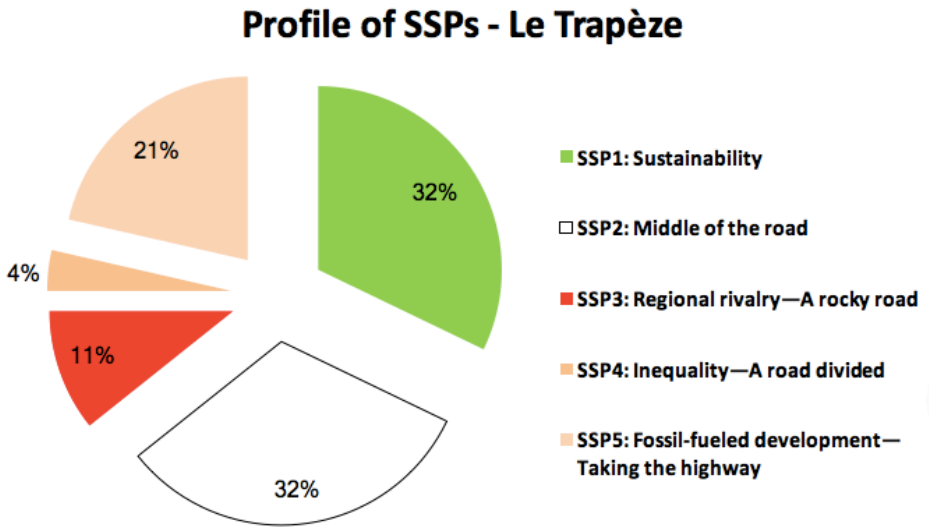


Figure 8: Profile of SSPs, Le Trapèze

By 2018, this new district will house 15,000 to 18,000 inhabitants, from 10 to 15,000 workers. In 2013, 5,000 inhabitants and 4,200 workers were already benefiting from the neighbourhood. In terms of migration, most of the residents come from other neighbourhoods of Paris, only 26% have already been living in Boulogne. There appears to be a strong representation of young couples (30-39 years) with young children (49%). In terms of urbanisation level, there has been a lot of change within the urban environment. Le Trapèze have been built on the site of an old Renault automotive plant and are divided into 15 neighbourhoods, comprising of 5 to 6 buildings in each. The construction time is 15 years and it is expected to end in 2018. New buildings have been built. The neighbourhood is designed to achieve a balance between private and social housing, offices, retail outlets and shops, as well as in terms of its amenities. The area also includes a number of amenities that facilitates neighbourhood living such as nurseries, a school group and a multi-media library.

In terms of the human development pathway elements, in 2014 a school of biodiversity with a kindergarten and an elementary school of 18 classes had been built. These innovative schools integrate green walls, birds, orchards and vegetable gardens. In addition, all teachers are bilingual. The area also includes a

number of amenities that facilitates neighbourhood living such as nurseries. These include 15 public facilities (education, culture, health, *etc.*), and more than 60 stores. With respect to gender equality, Le Trapèze comprises 53.2% women and 46.8% men.

The neighbourhood is organised in macro-lots (around 10) with ownership comprising a combination of private and collective ownership models. The management of these buildings and communal areas is organised through a series of associations coordinated by the management company AFUL. One significant limitation to the eco-neighbourhood project that has been identified is the absence of a community centre such as a "town hall" where residents can meet. Instead, communication between residents on a macro-scale is only possible in an online forum; however, there has not been a significant take-up of this means of communication. On the online forum, which has nearly 900 members, there are only between 50 to 100 individuals currently active. The neighbourhood is designed to achieve a balance between private and social housing.

From Table 15 and Figure 9, the Social / Demographic Pathway Element most in need of innovation and policy focus for Le Trapèze is societal participation. Sustainability pathway elements identified for Le Trapèze include Gender Equality and Access to health facilities, water and sanitation and Education.

Table 15: Social / Demographic Pathway Element Characterisation – Le Trapèze

Social / Demographics Pathway Element	Local Description	Corresponding Pathway
Population Growth	Relatively High	SSP4: Inequality—A road divided
Migration	Low	SSP2: Middle of the road
Urbanisation Level	High	SSP5: Fossil-fuelled development—Taking the highway
Urbanisation Type	Better mgmt. over time, some sprawl	SSP5: Fossil-fuelled development—Taking the highway
Education	High	SSP1: Sustainability
Health investments	Medium	SSP2: Middle of the road
Access to health facilities, water, sanitation	High	SSP1: Sustainability
Gender equality	High	SSP1: Sustainability
Equity	Medium	SSP2: Middle of the road
Social cohesion	Medium	SSP2: Middle of the road
Societal participation	Low	SSP3: Regional rivalry—A rocky road

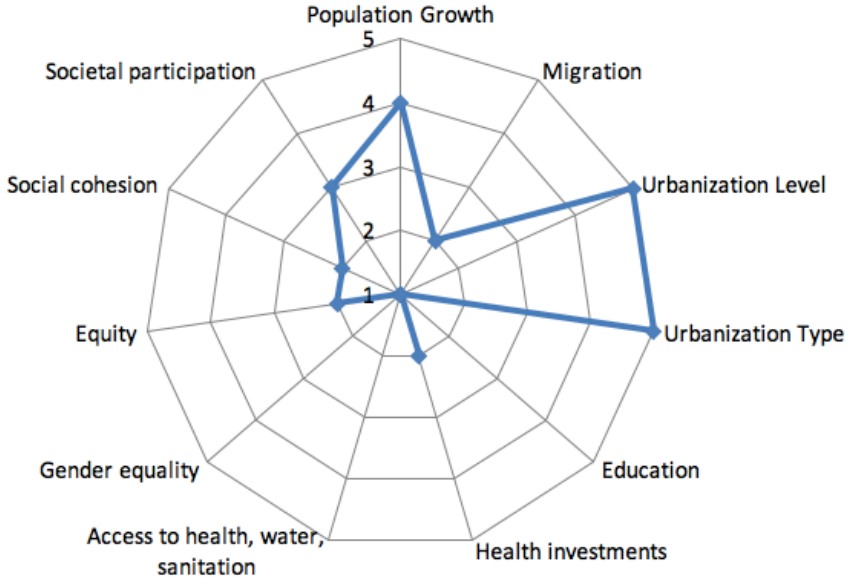


Figure 9: Spider-diagram of Social / Demographic Pathway Element Characterisation – Le Trapèze

Le Trapèze benefits from the dynamism of the Boulogne-Billancourt area, which counts an impressive 17,000 enterprises, including the head offices of several French and international companies. Boulogne-Billancourt is also a showcase for Boulogne-Billancourt is at the heart of the urban community of Grand Paris Seine Ouest and counts 3.4 million m² of office space, making it the third most important business district in the Île-de-France region, just after Paris-Centre and La Défense. The district has 215,000 jobs, dominated by companies from the media, telecommunications, new technologies and services sectors. The region also offers a particularly attractive lifestyle to its 330,000 locals, with top-quality residential offerings, permanent urban facilities, excellent public transport (30 stations within local reach) and lots of nature areas covering 36% of the region's surface area. The enterprises include laboratories (Ipsen, Roche, Gilead), media and communication (L'Équipe, W & Cie, beIN Sport), retail distribution chains (Carrefour Management), technologies and services (Michelin, Texas Instrument, Q-Park, National Cloud), sport (PSG), *etc.* Residents are highly mobile, they have access to cars, public transport, restaurants, *etc.*

From Table 16 and Figure 10, Economics / Governance Pathway Elements most in need of innovation and policy focus in Le Trapèze include Economic Growth per capita and Consumption and Diet. No sustainability pathway elements were identified for the Economics / Governance dimension for Le Trapèze.

Table 16: Economics / Governance Pathway Element Characterisation - Le Trapèze

Economics / Governance Pathway Element	Local Description	Corresponding Pathway
Economic Growth (per capita)	Low	SSP3: Regional rivalry—A rocky road
Inequality	Uneven moderate reductions	SSP2: Middle of the road
International trade	High	SSP5: Fossil-fuelled development—Taking the highway
Globalisation	Strongly globalised, increasingly connected	SSP5: Fossil-fuelled development—Taking the highway
Consumption & Diet	Material-intensive consumption, medium meat consumption	SSP3: Regional rivalry—A rocky road

Environmental Policy	Focus on local environment; little attention to vulnerable areas or global issues	SSP2: Middle of the road
Policy Orientation	Weak focus on sustainability	SSP2: Middle of the road
Institutions	Increasingly effective, oriented toward fostering competitive markets	SSP5: Fossil-fuelled development—Taking the highway
Level of Local Control (Subsidiarity)	Limited	SSP2: Middle of the road

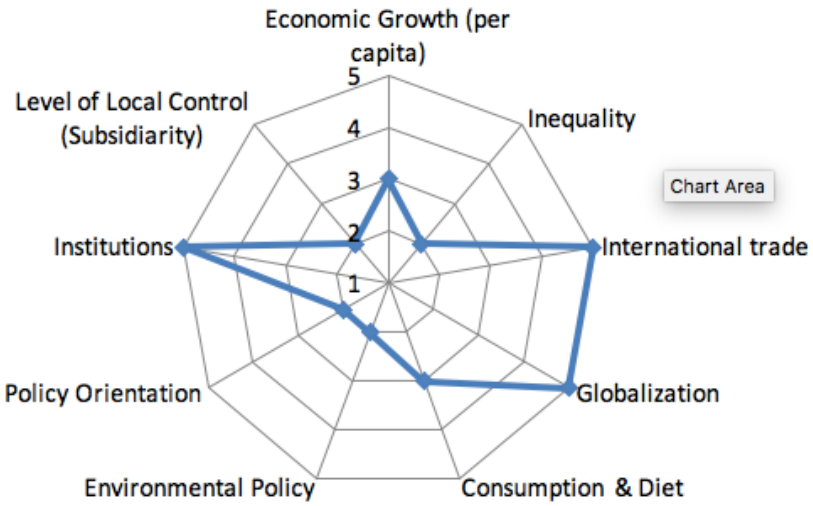


Figure 10: Spider-diagram of Economics / Governance Pathway Element Characterisation - Le Trapèze

Recent national environmental policies in France have protected local environments as a result, in 2013 Le Trapèze has received the EcoQuartier label. The town authorities of Boulogne-Billancourt as well as the SAEM Val de Seine Aménagement were committed to an innovative partnership to implement this project. Yet there are no local policies that favour the energy transition within the eco-district. Additionally, 65% of the energy supply comes from renewable sources (geothermal energy). The goal is to reach 100% renewable sources by the performance of solar panels and water recovery systems on the roof. New technologies are being implemented such as water recovery systems for cooling and heating, solar panels. Some investments in energy technology changes such as geothermic energy systems, water recovery for heating and cooling, solar panels among others.

With respect to carbon intensity, the residents of Le Trapèze have a relatively low-carbon lifestyle mainly through conscious choice and frugality. Homes and transport are relatively low energy intensive. La Trepèze is serviced by good public transport such as metro and public bicycles. Indeed, it was the first city in 2009 to have Vélib 'stations (public bikes) outside Paris. In addition, the urban community subsidises the purchase of an electric bike. Most of the residents in Le Trapèze identify that a shift towards renewables are preferable to fossil fuels recognising the limited supply these offer and the ability to generate clean energy as part of a renewable energy mode. Le Trapèze has a seven-hectare public park that runs parallel to the Seine. The park has two large planted areas and is criss-crossed by a network of landscaped walkways. Le Trapèze was built in an industrial area so deforestation is not a subject to consider here. However, a certain number who are interested in the subject of land use, have fought against the replacement of part of the park of Billancourt by a football/rugby field.

From Table 17 and Figure 11, Technology / Environment Pathway Elements most in need of innovation and policy focus is environment for Le Trapèze, although this is in the 'amber' rather than 'red' categorisation at present. Six SSP1 Sustainability pathway elements were identified in Le Trapèze, including Technology Development, Technology Transfer, Energy Tech Change, Carbon Intensity, Energy Intensity and Fossil Constraints due to the EcoQuartier status of the community. This strength needs to be consolidated and maintained.

Table 17: Technology / Environment Pathway Element Characterisation - Le Trapèze

Technology / Environment Pathway Element	Local Description	Corresponding Pathway
Technology Development	Rapid	SSP1: Sustainability
Technology Transfer	Rapid	SSP1: Sustainability
Energy Tech Change	Directed away from fossil fuels, toward efficiency and renewables	SSP1: Sustainability
Carbon Intensity	Low	SSP1: Sustainability
Energy Intensity	Low	SSP1: Sustainability
Fossil Constraints	Preferences shift away from fossil fuels	SSP1: Sustainability
Environment	Improving conditions over time	SSP5:Fossil-fuelled development—Taking the highway
Land Use	Medium regulations	SSP2: Middle of the road

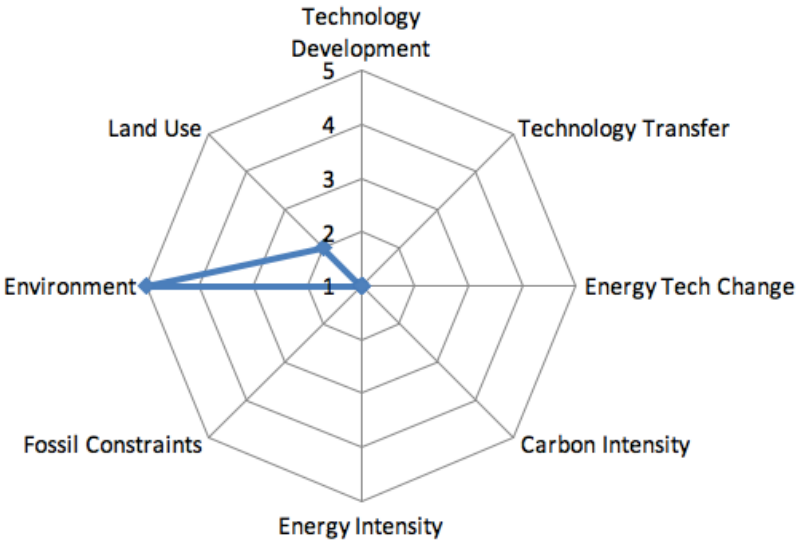


Figure 11: Spider-diagram of Technology / Environment Pathway Element Characterisation - Le Trapèze

Summary of Le Trapèze Innovation Requirements:

- **Social / Demographic:** Social cohesion
- **Economics / Governance**: Economic Growth
- **Technology / Environment:** Environment and Consumption and Diet

3.3.3 Secondigliano:

Secondigliano is predominantly focused towards SSP2 and 3 pathways. Its strength is identified by social cohesion and participation whereby local residents are engaged with important local issues. Yet there is substantial mistrust in local and national authorities. There are numerous barriers include gender inequality with respect to economics and casual labour. Its largest barrier includes addressing organised crime by the Comorra. So far, attempts to address environmental issues, particularly waste management, have, to date been largely unsuccessful. The community profile of Secondigliano thus faces a number of challenges that, if not addressed, may lead to orientating towards SSP3 and SSP4 paradigms, characterised by inequality and continuing security issues.

Table 18: Overview of Count of all SSP Elements for Secondigliano

Pathway	Count / 28 elements
SSP1: Sustainability	1
SSP2: Middle of the road	10
SSP3: Regional rivalry—A rocky road	7
SSP4: Inequality—A road divided	6
SSP5: Fossil-fuelled development—Taking the highway	4

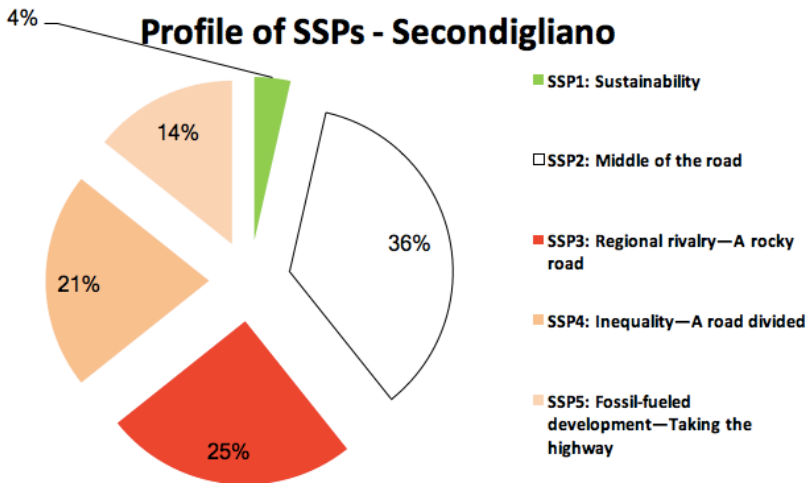


Figure 12: Profile of SSPs, Secondigliano

In Secondigliano population growth has been described as 'stable' at 0.52%. There is a higher ratio of female immigrants living in city. Male migrants tend to move to northern cities for work. Additionally, there is also a major Roma encampment, Campo Autorizzato, situated here. Largely rural up until the 1960s, massive developments in the 1970s and 1980s have transformed the area into one of the most densely populated urban areas in Italy. In terms of urbanisation level, Secondigliano comprises residential social housing units, comprising high-density housing such as tower blocks *etc.* In terms of human development, statistics for Campania for persons with upper secondary or tertiary education attainment is around 47%. Figures for Secondigliano are unavailable, but thought to be lower given the issues facing people there. Consumer spending on healthcare is above the national average. The decades-long “Waste Crisis” continues with much of its domestic and industrial waste exported or dumped illegally by criminal gangs. Women continue to work predominantly in low-income, casual labour position or work in the home. Furthermore, there are deep internal inequalities within the welfare system. While there is a strong sense of cohesion amongst the community through Catholic Church organisations, organised crime is endemic and acts as both a cohesive and destructive influence on the local population. There is significant mistrust

of local and national civic authorities. With respect to societal participation, local people are engaged in local issues, usually through church-based groups.

From Table 19 and Figure 13, the Social / Demographic Pathway Elements most in need of innovation and policy focus include Health investments, Access to health facilities, water, sanitation and Gender equality. No sustainability pathway elements were identified in Secondigliano for the Social / Demographic dimension.

Table 19: Social / Demographic Pathway Element Characterisation – Secondigliano

Social / Demographics Pathway Element	Local Description	Corresponding Pathway
Population Growth	Medium	SSP2: Middle of the road
Migration	Medium	SSP4: Inequality—A road divided
Urbanisation Level	High	SSP4: Inequality—A road divided
Urbanisation Type	Continuation of historical patterns	SSP2: Middle of the road
Education	Very Low; unequal	SSP4: Inequality—A road divided
Health investments	Low	SSP3: Regional rivalry—A rocky road
Access to health facilities, water, sanitation	Low	SSP3: Regional rivalry—A rocky road
Gender equality	Low	SSP3: Regional rivalry—A rocky road
Equity	Low; statified	SSP4: Inequality—A road divided
Social cohesion	Low; statified	SSP4: Inequality—A road divided
Societal participation	Medium	SSP2: Middle of the road

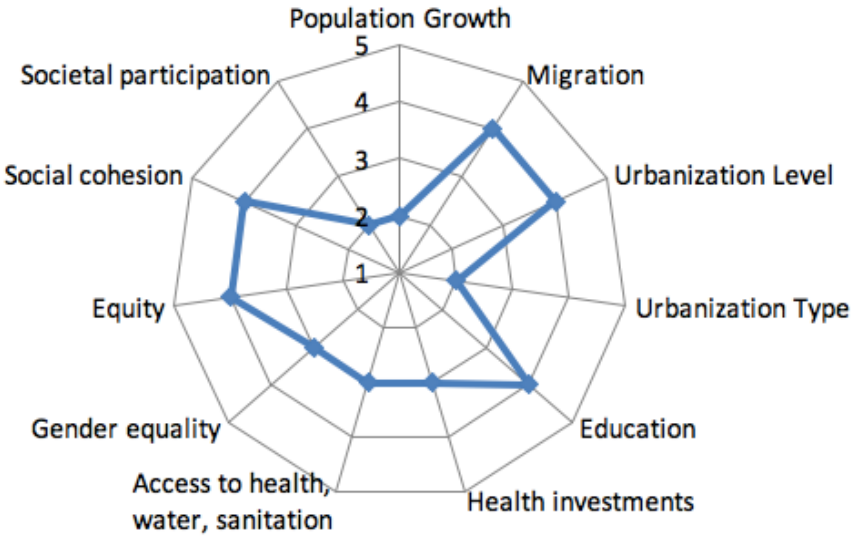


Figure 13: Spider-diagram of Social / Demographic Pathway Element Characterisation – Secondigliano

Naples has been rapidly deindustrialising over recent decades, and growth in service sector has not been strong enough to replace job losses. Construction only industry to see growth (30%), but this is heavily influenced by organised crime gangs, the Camorra. Locally cohesion supported by church-groups and charities, though threatened by organised crime syndicates. Also, high unemployment (42.7% plus). The Port of Naples is considered one of Europe's busiest and most economically important. With regard to globalisation, Naples has been rapidly deindustrialising over recent decades. The Comorra use the port facilities to smuggle counterfeit goods from the Far East to sell on the black market. Many residents are on very low-incomes with their consumption, mobility and diets are reflective of this.

From Table 20 and Figure 14, Economics / Governance Pathway Elements most in need of innovation and policy focus include Economic Growth (per capita), Inequality, Environmental Policy and Policy Orientation. Consumption and diet was identified as an SSP1 Sustainability pathway element. However, as in the case of Stockbridge, low levels of consumption are linked to low incomes, rather than to pro-environmental behaviour change.

Table 20: Economics / Governance Pathway Element Characterisation - Secondigliano

Economics / Governance Pathway Element	Local Description	Corresponding Pathway
Economic Growth (per capita)	Low	SSP3: Regional rivalry—A rocky road
Inequality	High	SSP3: Regional rivalry—A rocky road
International trade	Moderate	SSP2: Middle of the road
Globalisation	Globally connected elites	SSP4: Inequality—A road divided
Consumption & Diet	Low growth in material consumption, low-meat diets	SSP1: Sustainability
Environmental Policy	Low priority for environmental issues	SSP3: Regional rivalry—A rocky road
Policy Orientation	Orientated towards security	SSP3: Regional rivalry—A rocky road
Institutions	Uneven, modest effectiveness	SSP2: Middle of the road
Level of Local Control (Subsidiarity)	Limited	SSP2: Middle of the road

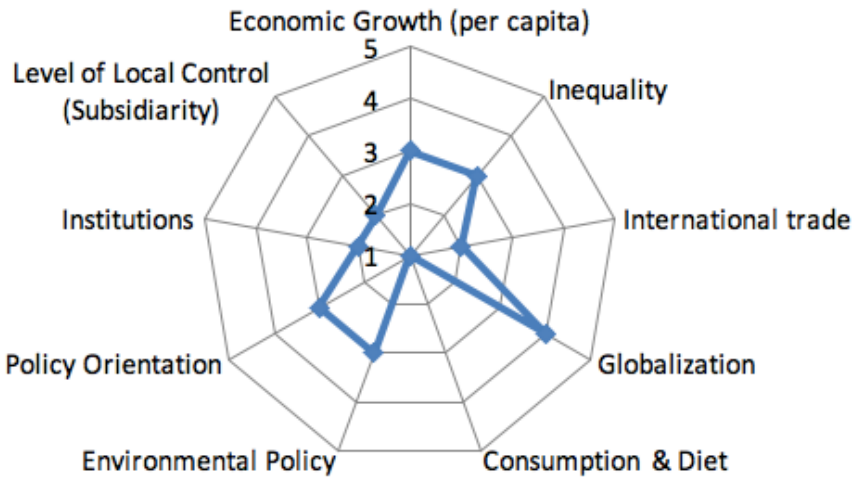


Figure 14: Spider-diagram of Economics / Governance Pathway Element Characterisation - Secondigliano

There are significant environmental issues in Secondigliano, especially waste management. The so-called 'Triangle of Death', situated north of the city has, some suggest irreversibly, damaged the human health, food security and environment of the affected populations there. Organised crime activities significantly undermine local civic government initiatives, and thus policy orientation seeks to address this as a priority. Political institutions are weak, with police having mixed luck tackling organised crime gangs. In addition, decades-long "Waste Crisis" continues with city exporting much of its recyclable waste for incineration in Germany and the Netherlands. Between central government and the local influence of the Comorra, local control is rather limited at best. The influence of the Comorra has continued undue influence in terms of technology development and on planning and construction. The Camorra has undermined local slow food movements among other things. There has been a strong push to maintain the status quo, especially from organised crime interests, with respect to energy intensity. Furthermore, there have been no fossil constraints that have had any meaningful influence in the area. Recent pilot schemes to improve waste management aside, the environment continues to be adversely impacted by illegal dumping of domestic and toxic waste. With respect to land use, there has been significant destruction of housing stock due to the Great Earthquake of 1980 continued to impact on the city throughout the 1980s and 1990s. Much of the resources concentrate on upkeep of the historic city centre of Naples to the expense of peripheral areas like Secondigliano.

From Table 21 and Figure 15, Technology / Environment Pathway Elements most in need of innovation and policy focus include Energy Tech Change, Carbon Intensity, Energy Intensity, Fossil Constraints although these are currently rated 'Amber' rather than 'Red'. No SSP1 Sustainability Pathway elements were identified for the Technology / Environment dimension.

Table 21: Technology / Environment Pathway Element Characterisation - Secondigliano

Technology / Environment Pathway Element	Local Description	Corresponding Pathway
Technology Development	Medium, uneven	SSP2: Middle of the road
Technology Transfer	Slow	SSP2: Middle of the road
Energy Tech Change	Directed toward fossil fuels; alternative sources not actively pursued	SSP5: Fossil-fuelled development—Taking the highway
Carbon Intensity	High	SSP5: Fossil-fuelled development—Taking the highway

Energy Intensity	High	SSP5: Fossil-fuelled development—Taking the highway
Fossil Constraints	None	SSP5: Fossil-fuelled development—Taking the highway
Environment	Continued degradation	SSP2: Middle of the road
Land Use	Uneven	SSP2: Middle of the road

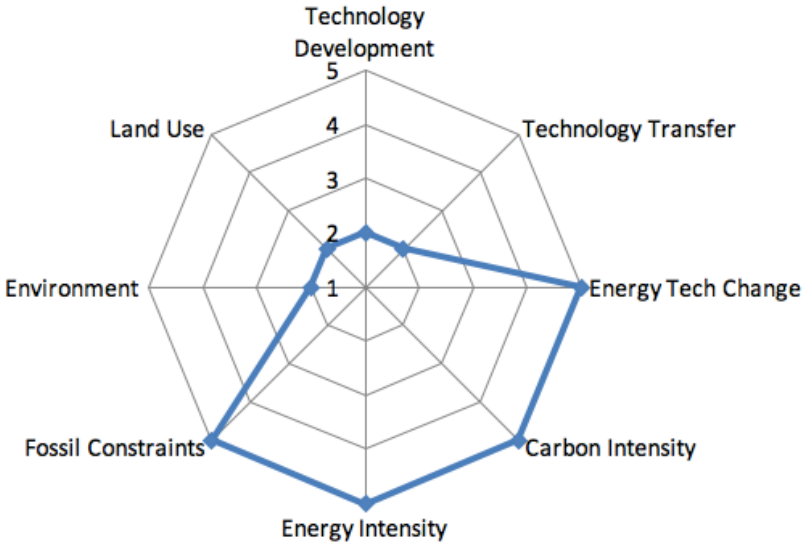


Figure 15: Spider-diagram of Technology / Environment Pathway Element Characterisation - Secondigliano

Summary of Secondigliano Innovation Requirements:

- **Social / Demographic:** Health investments, Access to health facilities, water, sanitation and Gender equality.
- **Economics / Governance:** Economic Growth (per capita), Inequality, Environmental Policy and Policy Orientation
- **Technology / Environment:** Energy Tech Change, Carbon Intensity, Energy Intensity, Fossil Constraints

3.3.4 Dunmanway:

Dunmanway has clear strengths towards environmental, social and economic sustainability. Rates of home ownership and gender equality are higher than the national average in Ireland resulting in an overall SSP2 paradigm for the community. Additionally, local people are well engaged with local community issues such as wind farm development and community garden projects. While technology development is occurring at a slow pace, there is an over-reliance on traditional energy infrastructure and private transport given that the community is situated in a rural area. Continued reliance on private transport and little environmental policy and special protections areas for the natural environment are threats that could push this community to move towards an SSP3 pathway.

Table 22: Overview of Count of all SSP Elements for Dunmanway

Pathway	Count / 28 elements
SSP1: Sustainability	2
SSP2: Middle of the road	16
SSP3: Regional rivalry—A rocky road	3
SSP4: Inequality—A road divided	3
SSP5: Fossil-fuelled development—Taking the highway	4

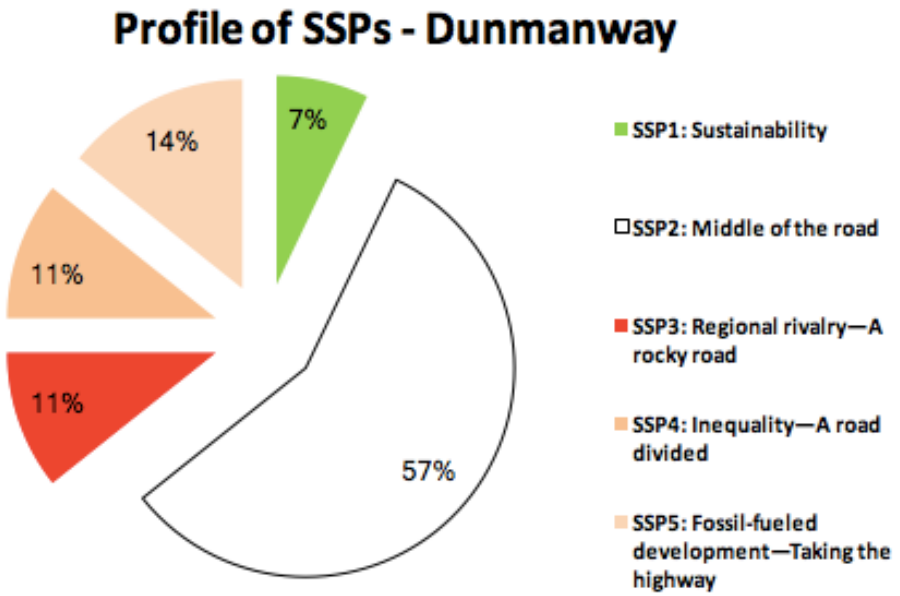


Figure 16: Profile of SSPs, Dunmanway

A 2016 census in Dunmanway indicated a population of 1,655 people, a +0.86% increase from 2011 figures. Non-Irish nationals account for 8.2% of the population compared to a national average figure of 12%. Polish nationals were the largest group, followed by UK nationals. In terms of urbanisation type level, in 2011, 63.8% of dwellings were owner occupied while 34.7% were rented. 94.5% of households live in houses or bungalows with only 5.5% living in apartments, flats or bedsits. In addition, 24.2% of the dwellings were built in the last ten years prior to the 2011 census. The average number of people per household was 2.5 compared with 2.7 nationally. Dunmanway is the primary market town for this area of county Cork. In terms of human development pathway elements, of those aged 15+ years who have finished full-time education: 19.2% were educated to at most primary level only; a further 61.2% attained second level while 19.6% were educated to third level. A recent survey found that 87.0% of people who participated considered themselves to be in very good or good health, compared to 88.3% nationally. While 1.3% of people who participated considered themselves to be in bad or very bad health compared 1.5% nationally. People in Dunmanway town have relatively good access to health facilities there. Access for those in the hinterland is considerably more patchy. Statistics relating to gender equality for Dunmanway specifically are difficult to obtain. Nationally, Ireland scores 56.5, just above the EU average of 52.9 on the European Institute for Gender Equality's "Gender Equality Index".

Just over 4% of the population provide regular unpaid personal help for a friend or family member with a long-term illness, health problem or disability. Of these, one fifth provide over 6 hours of unpaid personal help. Dunmanway is considered an unemployment blackspot with nearly 20% of the population able to work, currently unemployed. Local people are well informed about community issues and organise around

those that concern them most, whether in reaction to wind farms proposal in the area or contributing towards a community garden as part of the "Grow it Cook it Eat it - Growing Together" anti-obesity initiative.

From Table 23 and Figure 17, the Social / Demographic Pathway Elements most in need of innovation and policy focus include urbanisation level (linked to population growth). Access to health facilities, water, and sanitation was identified as an SSP1 sustainability pathway element in Dunmanway for the Social / Demographic dimension.

Table 23: Social / Demographic Pathway Element Characterisation – Dunmanway

Social / Demographics Pathway Element	Local Description	Corresponding Pathway
Population Growth	Low - Medium	SSP2: Middle of the road
Migration	Low	SSP2: Middle of the road
Urbanisation Level	Low	SSP3: Regional rivalry—A rocky road
Urbanisation Type	Continuation of historical patterns	SSP2: Middle of the road
Education	Medium	SSP2: Middle of the road
Health investments	Medium	SSP2: Middle of the road
Access to health facilities, water, sanitation	High	SSP1: Sustainability
Gender equality	Medium	SSP2: Middle of the road
Equity	Medium	SSP2: Middle of the road
Social cohesion	Stratified	SSP4: Inequality—A road divided
Societal participation	Medium	SSP2: Middle of the road

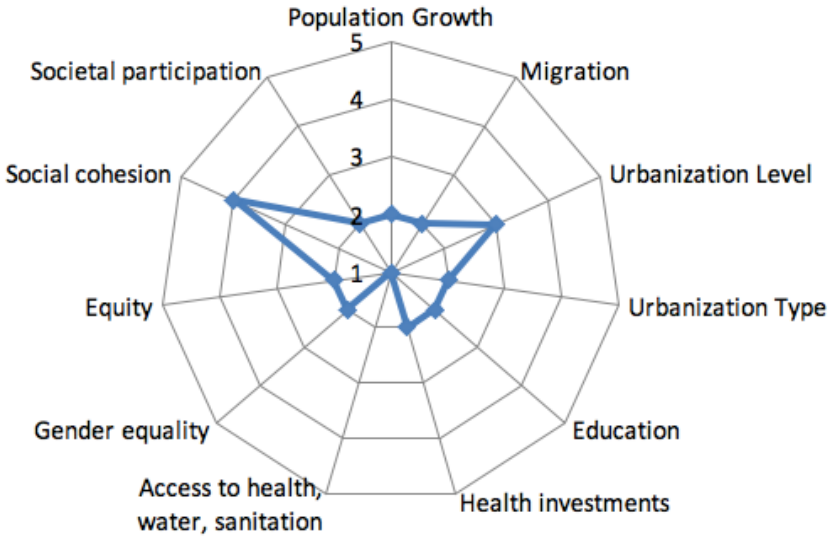


Figure 17: Spider-diagram of Social / Demographic Pathway Element Characterisation – Dunmanway

Traditional manufacturing jobs have declined in the area, with the majority of paid employment taken up in retail and trade, and the professional services. The environs north of Dunmanway, the upper Lee Valley (including the Múscraí Gaeltacht or designated Irish Language speaking area) are considered deprived and

pose significant challenges in achieving future economic and social viability. Local enterprise units house a number of companies (*e.g.,* Spice of Life Ltd.) that trade both in Ireland and abroad, most notably the UK. Dunmanway continues to suffer legacy effects from large-scale closure of major manufacturing plants. Residents come from a mixed level of incomes with their consumption, mobility and diets reflective of this.

From Table 24 and Figure 18, Economics / Governance Pathway Elements most in need of innovation and policy focus include Economic Growth and Globalisation. No SSP1 sustainability pathway elements were identified in Dunmanway for the Economics / Governance dimension.

Table 24: Economics / Governance Pathway Element Characterisation - Dunmanway

Economics / Governance Pathway Element	Local Description	Corresponding Pathway
Economic Growth (per capita)	Low	SSP3: Regional rivalry—A rocky road
Inequality	Uneven, moderate reductions	SSP2: Middle of the road
International trade	Moderate	SSP2: Middle of the road
Globalisation	De-globalising	SSP3: Regional rivalry—A rocky road
Consumption & Diet	Uneven consumption across social-strata	SSP4: Inequality—A road divided
Environmental Policy	Focus on local environment with obvious benefits to well-being, little concern with global problems	SSP4: Inequality—A road divided
Policy Orientation	Toward development, free markets, human capital	SSP5: Fossil-fuelled development—Taking the highway
Institutions	Increasingly effective, oriented toward fostering competitive markets	SSP5: Fossil-fuelled development—Taking the highway
Level of Local Control (Subsidiarity)	Limited	SSP2: Middle of the road

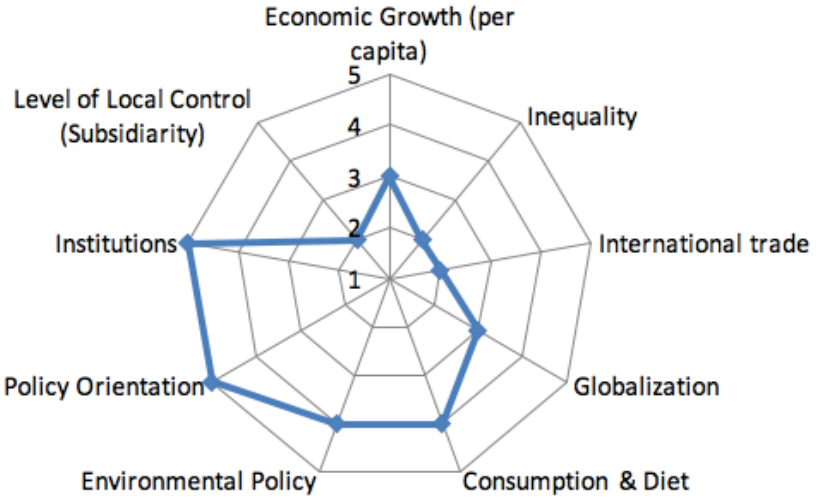


Figure 18: Spider-diagram of Economics / Governance Pathway Element Characterisation - Dunmanway

With respect to environmental policy, there are no designated Areas of Conservation (SACs), Special Protection Area (SPAs) around Dunmanway, which explains the concentration of wind farm proposals for this area. The area is in keeping with Ireland's open, highly globalised economy with an emphasis on

agriculture and small-to-medium scale manufacturing. National and local institutions are present in the town, with a number of key health centres for the area located in the town. Political power rests with the local authority, which is based in Cork city.

Technology development is occurring at a slow rate, with continued reliance on tradition energy infrastructure. Car-sharing, car-pooling is becoming more popular, however. There is little in the way of significant changes to current technology configurations. However, electric car charging points have been set up in the town. There is some investment in wind farms from wind developers thought this has translated in to growing opposition levels from some in the local community. The dispersed settlement patterns in rural Ireland are replicated in Dunmanway too. Therefore, a reliance on private transport is high. Public transport is relatively minimal compared to elsewhere in Europe and the dispersed settlement pattern, and one-off housing, means group heating schemes are difficult to establish. The need to shift to a low-carbon economy is recognised by most of the people we spoke to. However, people are concerned how the new configuration will impact in terms of social equality and justice for all citizens. The local authority, Cork County Council, has a generally positive reputation when it comes to environmental protection strategies. There are no designated Areas of Conservation (SACs), Special Protection Area (SPAs) around Dunmanway, which explains the concentration of wind farm proposals for this area. Much of the agricultural land falls under national and European protection guidelines.

From Table 25 and Figure 19, Technology / Environment Pathway Elements most in need of innovation and policy focus include Carbon Intensity and Energy Intensity, although these are in the 'Amber' rather than 'Red' categorisation. Environment was characterised as an SSP1 Sustainability pathway element for the Technology / Environment dimension in Dunmanway.

Table 25: Technology / Environment Pathway Element Characterisation - Dunmanway

Technology / Environment Pathway Element	Local Description	Corresponding Pathway
Technology Development	Medium, uneven	SSP2: Middle of the road
Technology Transfer	Slow	SSP2: Middle of the road
Energy Tech Change	Some investment in renewables but continued reliance on fossil fuels	SSP2: Middle of the road
Carbon Intensity	High	SSP5: Fossil-fuelled development—Taking the highway
Energy Intensity	High	SSP5: Fossil-fuelled development—Taking the highway
Fossil Constraints	No reluctance to use unconventional resources	SSP2: Middle of the road
Environment	Improving conditions over time	SSP1: Sustainability
Land Use	Medium regulations	SSP2: Middle of the road

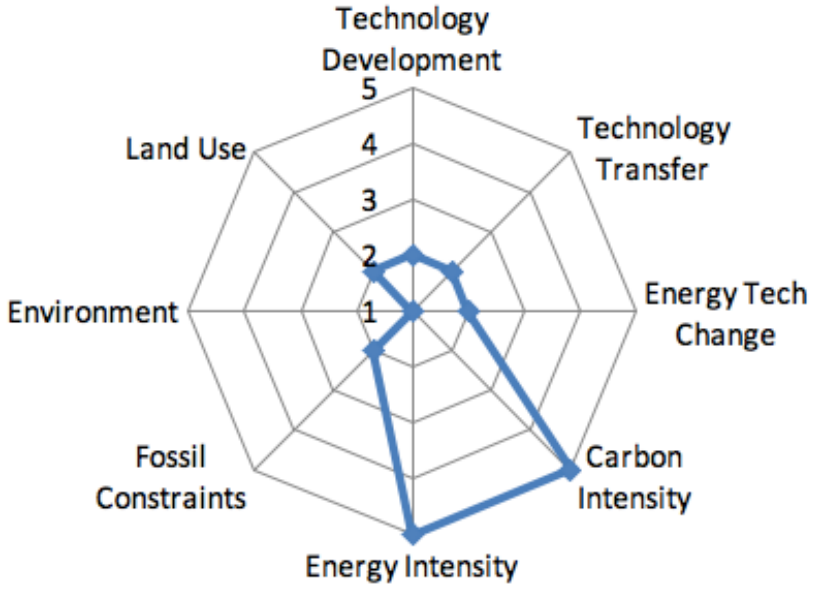


Figure 19: Spider-diagram of Technology / Environment Pathway Element Characterisation - Dunmanway

Summary of Dunmanway Innovation Requirements:

- **Social / Demographic:** Urbanisation level (linked to lack of population growth).
- **Economics / Governance:** Economic Growth and Globalisation
- **Technology / Environment:** Carbon Intensity and Energy Intensity

4 Targeted Innovations for the Four Communities

4.1 Policy Innovations Identified in D4.4

Task 4.4 of the ENTRUST produced a policy toolkit designed for policymakers and practitioners who seek to engage the public and influence their behaviour to deliver improved outcomes. As such, it presents a set of policy recommendations aimed at reducing the environmental impacts from energy consumption. The policy toolkit covers both supply and demand sides of the energy system *e.g.,* transport, buildings and local energy production. Within these high energy–consuming sectors, eight key objectives were outlined as follows:

- Increasing the purchase and use of electric vehicles;
- Increasing the practice of car sharing;
- Encouraging automobiles commuters to carpool;
- Encouraging the use of public transport;
- Reducing electricity usage through smart technologies;
- Initiating thermal refurbishments in buildings;
- Promoting subscription to green-energy suppliers; and

- Enabling green energy self-consumption.

The policy toolkit follows a series of steps that, are applicable to any country or region, depict the process of developing policies that can lead to changing behaviours. These include identifying the target behaviour; mapping the individual, social and material contexts of behaviours; mapping existing policy options and interventions; identifying gaps not covered by existing policies and ideate how these gaps can be addressed; engage key stakeholders to assess the ideas generated; prioritise policy options; and develop a mix of policy options that can be applied to target the behaviour. Table 26 indicates the potential policy options that can be employed to change the eight key objectives outlined above.

Table 26: Potential policy options for influencing environmental behaviours (Aze *et al.*, 2017)

Behaviour Targeted	Potential Policy Options
Increasing the purchase and use of electric vehicles	Provide fiscal initiatives for organisations (charities, companies, councils, associations *etc.*) that buy electric vehicles for their automobile fleets; Implement an incentive programme that allows electric vehicles to not receive highway charges at toll booths; Provide fiscal advantages for organisations to build their own charging networks for electric vehicles; Provide information (maps and apps) of the electric vehicle infrastructure; Standardise the electric plug system for electric vehicles via a norm; Create a 'cradle-to-cradle' best practices in the design and manufacturing process of electric vehicles; and Build electric vehicle parking spots at public transport stations in rural areas.
Increasing the practice of car sharing	Offer the possibility for participants of a car-sharing service to book vehicles and park in non-dedicated spots; Serious gaming – Cumulate 'smart mobility' points when using car sharing vehicles; Propose a pro-rated car-sharing membership based on income; Allocate specific parking spots for drivers of car-sharing services; Include a range of car models within citywide car sharing programmes; Subsidise the creation of electric car sharing programmes in medium cities; and Offer training sessions to enhance car-sharing practices.
Encouraging automobiles commuters to carpool	Provide fiscal advantages for business to actively encourage carpooling programmes for their employees; Develop a carpooling app for short-distance rides as part of the public transport options (up to 100km); Develop a public app-based or dynamic ridesharing platform for daily rides (up to 100km); and Create a carpooling ranking with occupancy requirements during peak pollution days.
Encouraging the use of public transport	Provide fiscal advantages for businesses in dense urban areas to implement flexible working hours and/or teleworking Include spaces for bikes on the metro, trains and buses; Set a strategy to have a bus fleet that is 100% electric/biofuel/hybrid by 2025; Offer free or discounted public transport tickets to attendees of major entertainment events; Increase security measures in public transport stations; and Offer a metro service that runs 24 hours a day on the weekends.
Reducing electricity usage through smart technologies	Provide fiscal incentives to energy companies developing freemium services that enable the public to use smart technologies for the electricity bills; Create a programme to involve citizens in the co-design of smart technologies; Attribute the data ownership to final users and set up mechanisms to control the protection of data; and Hold public show case events to popularise smart meters and energy efficient technologies.

Behaviour Targeted	Potential Policy Options
Initiating thermal refurbishments in buildings	Provide fiscal advantages for individuals to implement energy refurbishments; Facilitate energy refurbishments by creating a one-stop shop that can provide all the relevant information to households; Promote 'energy refurbishment clubs' in neighbourhoods or communities; Set up a quality norm/label for the energy refurbishment companies; and Develop a school education programme related to energy and its challenges.
Promoting subscription to green-energy suppliers	Provide fiscal advantages for green energy cooperatives to operate and up-scale; Provide fiscal advantages for local communities to establish local energy cooperatives; Provide fiscal assistance to create and develop 'Energy Clubs' within local communities; Implement a regulatory framework that provides consumers with information on the energy sources used; and Implement a regulatory framework that offers lower energy tariffs to citizens in communities directly affected by large-scale renewable energy projects.
Enabling green energy self-consumption	Implement a feed-in-tariff scheme for households/cooperatives to sell excess electricity back to the grid; Create a public web platform to inform citizens about energy self-consumption; Use of public assets to stimulate demonstrations of self-consumption solutions and encourage new business models; Create and implement win-win financing schemes for tenants and owners to adopt renewable energy installations; and Set up a European Directive to redesign the network and promote the self-consumption of electricity.

The policy options in Table 26 comprise a combination of top-down, bottom-up and hybrid approaches to influence behaviour. Additionally, the key objectives are influenced by numerous policy instruments that can be classified by the behaviour change wheel proposed by Michie, van Stralen, & West (2011). Examples of the approaches and policy instruments applied to the key objectives are illustrated in Figure 20 below.

Figure 20: Approaches and Policy Instruments applied in influencing environmental behaviours (Aze *et al.*, 2017)

4.2 Identified Community Innovations

Table 27- Table 30 present an overview of identified innovation needs for each of the 4 studied communities analysed for D6.3. Innovation needs identified from the SSP analysis are collated with appropriately matching innovations from the policy tool-kit presented in D4.4. In addition, community based innovations from the literature are identified and matched with the specific requirements of each of the 4 communities. Table 27 presents an overview of targeted innovations for Stockbridge Village. Stockbridge is a community with considerable challenges, particularly on social and economic fronts. Poor health, high unemployment, marginalisation, and energy and fuel poverty represent considerable challenges to the community. Five specific innovations are forwarded for Stockbridge (Table 27). Community Energy Projects are deemed of particular importance in the context of this community, with the scope to develop ccommunity 'benefits payments' mechanisms to address local social issues. In addition, more imaginative use of ICT, for example through schools could serve to address social cohesion and build invaluable social capital in the community.

Stockbridge Community	**Social / Demographic Innovation Need**	**Economic / Governance Innovation Need**	**Tech. / Environment Innovation Need**
Broad Trend – Identified Innovation Needs	Equity, Social cohesion, Societal participation & Health	International trade and Institutional strength	Technology development, Technology transfer and Environment
Innovations - D4.4:	• *Initiating thermal refurbishments in buildings*		• *Enabling green energy self-consumption*
Other Potential Community Innovations:	• *Use of ICT to link schools for community cohesion* (Austin, Hunter, & Hollywood, 2015)	• *Grassroots community innovation for sustainability* (Seyfang, Hielscher, Hargreaves, Martiskainen, & Smith, 2014), *eg. Community Energy Projects* (Martiskainen, 2017)	
	• *Community 'benefits payments' from Energy Projects* (Kerr, Johnson, & Weir, 2017)		

Table 27: Targeted Innovations for Stockbridge

Table 28 presents an overview of targeted innovations for Le Trapèze. While the project of Le Trapèze has been designed to optimise its ecological and environmental goals through best practice approaches in the built environment, the community faces challenges in developing social cohesion and in fostering a community identity. As with other communities, Community Energy Projects are deemed important and appropriate to the community in Le Trapèze. Innovation on the social domain could include use of community heritage or history projects to develop community identity and social cohesion. In addition, as the community is relatively prosperous, environmental issues are strongly linked to consumption patterns, particularly in view of the relatively environmentally friendly nature of the built environment. Community partnerships in healthy eating and lifestyle promotion therefore potentially represent an innovation to address unsustainable consumption as well as issues with social cohesion in this community (Table 28).

Le Trapèze Community	**Social / Demographic Innovation Need**	**Economics / Governance Innovation Need**	**Technology / Environment Innovation Need**
Broad Trend – Identified Innovation Needs	Social cohesion	Economic Growth	Environment and Consumption and Diet
Innovations - D4.4:		• *Enabling green energy self-consumption*	
Other Potential	• *Use of ICT to link schools*	• *Grassroots community*	• *Community Citizen*

Community Innovations:	*for community cohesion* (Austin *et al.*, 2015) • *Use of community heritage / history projects to develop community ethos and identity* (Cauchi-santoro, 2016).	*innovation for sustainability* (Seyfang *et al.*, 2014), *eg. Community Energy Projects* (Martiskainen, 2017)	*Science Projects on Environment, consumption and Diet (Aristeidou, Scanlon, & Sharples, 2017)* • *Community partnerships in healthy eating and lifestyle promotion* (An *et al.*, 2017)

Table 28: Targeted Innovations for Le Trapèze

Table 29 presents an overview of targeted innovations for Secondigliano. There are significant environmental issues in Secondigliano, especially related to waste management, directly attributable to deficiencies in infrastructure provision and governance /institutional weaknesses. Economic growth remains very clearly fossil fuel driven in this community. Therefore, and as with other communities, Community Energy Projects are deemed important and appropriate to the community in Secondigliano, coupled with community benefits payment mechanisms to address local social issues. Secondigliano, along with Stockbridge and Dunmanway is very much in need of investment in infrastructure development and upgrade. For this reason, a large-scale urban retrofit programme with goals of energy reduction and improved residential thermal comfort is appropriate for Secondigliano. On the social domain, *Regular Community Health Fairs* represent a cost-efficient innovation for dissemination of preventive services to vulnerable populations and would seem to be especially suitable for the community in Secondigliano. In addition, financial support schemes for local female entrepreneurs could begin to address economic development and gender inequality problems locally (Table 29).

Secondigliano Community	Social / Demographic Innovation Need	Economics / Governance Innovation Need	Technology / Environment Innovation Need
Broad Trend – Identified Innovation Needs	Health investments, Access to health facilities, water, sanitation and Gender equality	Economic Growth (per capita), Inequality, Environmental Policy and Policy Orientation	Energy Tech Change, Carbon Intensity, Energy Intensity, Fossil Constraints
Innovations - D4.4:		• *Initiating thermal refurbishments in buildings*	• *Enabling green energy self-consumption* • *Reducing electricity usage through smart technologies*
Other Potential Community Innovations:	• *Regular Community Health Fairs (Health fairs are a cost-efficient platform for dissemination of preventive services to vulnerable populations) (Opperman, Hanson, & Toro, 2017)*	• *Grassroots community innovation for sustainability* (Seyfang *et al.*, 2014), *eg. Community Energy Projects* (Martiskainen, 2017) • *Large Scale Urban Retrofit Programmes (eg. investing in cross-cutting strategies to reduce exposures harmful to health and to establish conditions that support healthful daily practices* (Miller, Pollack, & Williams, 2011)	
	• *Financial support mechanisms for female innovators* (Fhlatharta & Farrell, 2017) • *Community 'benefits payments' from Energy Projects (Kerr et al., 2017)*		

Table 29: Targeted Innovations for Secondigliano

Table 30 presents an overview of targeted innovations for Dunmanway. Dunmanway, like many rural communities across Europe is faced with challenges of depopulation, an aging resident population, changing land use patterns, shrinking local employment opportunities, along with the homogenising

influence of multinational retail and the inability of local business to compete. It is a highly car-dependent community, owing to poor public transport infrastructure, and as a result, is a very carbon and energy intensive community. Therefore, and as with other communities, Community Energy Projects are deemed important and appropriate to the community in Dunmanway. In addition, transport related innovations from D4.4 are deemed to be especially appropriate for Dunmanway. Infrastructure in the form of Rural Broadband and ICT infrastructure as deemed as essentials for economic functioning and resilience for Dunmanway (Table 30).

Dunmanway Community	**Social / Demographic Innovation Need**	**Economics / Governance Innovation Need**	**Technology / Environment Innovation Need**
Broad Trend – Identified Innovation Needs	Urbanisation level (linked to lack of population growth).	Economic Growth and Globalisation	Carbon Intensity and Energy Intensity
Innovations - D4.4:	• *Increasing the purchase and use of electric vehicles* • *Increasing the practice of car sharing* • *Encouraging automobiles commuters to carpool*	• *Initiating thermal refurbishments in buildings*	• *Enabling green energy self-consumption* • *Reducing electricity usage through smart technologies*
Other Potential Community Innovations:		• *Grassroots community innovation for sustainability (Seyfang et al., 2014), eg. Community Energy Projects (Martiskainen, 2017)*	
	• *Rural Broadband and ICT infrastructure as essentials for economic functioning and resilience* (Roberts, Anne, Skerratt, & Farrington, 2016)		

Table 30: Targeted Innovations for Dunmanway

4.3 Social Enterprise as Community Niche Innovation

Summary Box 1 presents **an** overview of Social Enterprise as Community Niche Innovation. This work is currently going through the peer-review process, and will go on to inform analysis as part of ENTRUST T6.4 *Reflexive and action approach testing of innovation pathways.*

Social Enterprise as Community Niche Innovation for Community Energy – Summary of analysis reported in (Hillman, Axon, & Morrissey, 2017)[1]

Social enterprises are neither typical charities nor typical businesses; rather they combine aspects of both (Ebrahim *et al.*, 2014). Social enterprises target economic sustainability with a wider social mission, reinvesting profits generated to achieve multiple bottom lines (Cieslik, 2016). The primary revenue source is commercial, relying on market activity instead of donations or grants operate and to scale-up their operations (Ebrahim *et al.*, 2014). The capability of social enterprises to create both social and economic value is considered a 'win-win'. However, there are clear potentials for social enterprise models to be more extensively applied to address contemporary ecological challenges of neo-liberal market economies, moving towards 'win-win-win' outcomes across social, economic and ecological domains; particularly as these organisations are not motivated by a relentless profit imperative.

The autonomous nature of the social-economic model applied by social enterprises can represent a viable means to target social, environmental and economic multiple-bottom lines. Such organisations can develop strong links to their local communities and provide positive externalities in generating financial revenue, while also remaining fully cognisant of, and structured towards social outcomes. There are clear potentials for social enterprise models to be more extensively applied to address contemporary ecological challenges of neo-liberal market economies, moving towards 'win-win-win' outcomes across social, economic and ecological domains; particularly as these organisations are not motivated by a relentless profit imperative.

From a transitions perspective, the SNM literature also highlights the importance of a protected incubation space so that niches can become developed enough to break through to the regime. Within the context of community energy in the UK the incubation space provided by the government through provision of Feed-in-Tariffs (FITs) has been reduced before expected. However, post FIT, organisations are innovating their business models to move away from subsidy based models in favour of becoming financially sustainable in their own right.

A number of barriers exist which in the medium-long term may limit the potential of social enterprises to deliver regime transformation, or to act as 'transitions engines'. Primarily, a lack of clarity or certainty on the policy and regulatory landscape in which they operate. This is true in particular of the energy and environmental policy landscape, more-so than the regulatory landscape for social enterprises. *Ad hoc* and reactionary policy change in the UK has acted as a major challenge to energy focused social enterprises. It is clear that social enterprises are already playing an important role in the energy sector. However, there is considerable scope for this role to be scaled up, potentially with minimal grant or subsidy support. However, support for the 'take-off' stage was identified as being particularly important. What is also clear is that the social enterprise model could in fact deliver a regime transformation, the evidence suggests that this represents a realistic goal only in tandem with transformative innovation across the regime, including for example, associated changes in practices of consumer behaviour and expectation, and in wider consumer value considerations. Table 31 presents an overview of **future implications for social enterprise in a low carbon energy system.**

Table 31: Future implications for social enterprise in a low carbon energy system

Pathway	Is the niche innovation developed?	Nature of interaction between 3 levels	Possible role of social enterprise in the future
Reproduction process	May or may not be sufficiently developed	Landscape is stable and reinforces the regime	Even if social enterprise is considered developed, there is little chance of it breaking through to the regime without landscape pressures to destabilise the regime
Transformation path	Not sufficiently developed	Moderate landscape pressure causing disruptive change to the regime	Social enterprise is not developed enough to take advantage of the disruption to the regime. Therefore, regime actors will respond by modifying innovation activities.
De-alignment and re-alignment path	Not sufficiently developed	Landscape change is divergent, large and sudden.	Regime actors lose faith in the landscape and regime eroded. Therefore, social enterprise would co-exist with other niche innovations as there is no clear substitute. Eventually

[1] Research reported in (Hillman *et al.*, 2017) was developed as part of ENTRUST Work Package 6 research

			one will becomes dominant re-aligning the regime.
Technological substitution	Niche innovation is sufficiently developed	Landscape change is disruptive – this could be due to a 'specific shock' or 'avalanche' change	Social enterprise could have been operating successfully for some time as a niche, however the regime has remained stable. Disruption to the regime allows social enterprise as a radical developed innovation to replace the regime.
Reconfiguration	Niches are sufficiently developed	Niche innovations are symbiotic with the regime	Social enterprises are adopted to solve local regime problems and elements of social organisations may be adopted by other regime actors. This could make it difficult for social enterprises to differentiate in a regime market when competing with private firms.
Sequential transitions pathways: Transformation, Reconfiguration, then Substitution *or* Re-alignment	Niche innovations may or may not be sufficiently developed	Slow disruptive landscape change, perceived by regime actors as moderate. The disruption increased over time as pressure on the regime increases.	Regime actors will initially seek to resolve problems. They may then look to incorporate social enterprise in to the regime. If this alters the regime but landscape pressures increase, developed social enterprises can take advantage of this and move in to the regime. If undeveloped, social enterprise will coexist with other niche-innovations until one becomes dominant

Summary Box 1: Social Enterprise as Community Niche Innovation

5 Developing New Policy Mixes

5.1 Strategic Niche Management - Policy Implications

Strategic Niche Management provides an interesting platform for policy makers to consider given its holistic nature and focus on supporting niche innovations to succeed. SNM research also provides evidence which demonstrates the impact that external factors and quick changing policy decisions can have on the success or failure of niche testing within the protective space (Seyfang & Haxeltine, 2012; Smith *et al.*, 2014; Temmes *et al.*, 2013). SNM as a tool is starting to move towards a more action-based and practitioner led research approach (Raven *et al.*, 2010).

SNM could be utilised more extensively as a tool by policy makers in order to make key decisions on determining potential areas for more extensive long-term government support. Public policy measures such as product subsidies, investment grants and preferential treatment in legal frameworks are identified as ways to intentionally shape technological niches (Smith *et al.*, 2014).

More short-term policy support should be focused around ensuring that protected spaces and support are phased out rather than removed overnight with little warning. There may also be a skills gap across practitioners in terms of how to manage a niche innovation thought to have potential to become part of the regime. In addition to this, the scaling up and aggregating with other niches to move beyond the local level could be hindered by inappropriate standards (Witkamp *et al.*, 2011). SNM therefore can provide substantial contributions on as the diffusion of grassroots movements and organisational innovation into the regime during a transition (Seyfang & Longhurst, 2013). Real-world experiments can be seen as 'pre-figurations' of alternative socio-technical-ecological systems, drawing attention to the kinds of struggles

encountered on the ground, and so deliver crucial lessons for the feasibility of different options for future-oriented scenarios (Turnheim *et al.*, 2015).

5.2 Identifying and Tackling System / Structural Issues

Lamprinopoulou, Renwick, Klerkx, Hermans, & Roep (2014) identify several 'system failures' which may disable innovation system functions:

- **Infrastructural failures:** the (absence of) the physical infrastructure, such as railroads telecom, machines, buildings, harbours *etc.* are constraints requiring major investments that cannot be made independently by the actors of the system. They also concern investments in knowledge infrastructure (*e.g.,* R&D facilities, libraries, training systems, knowledge, expertise, know-how and strategic information), and financial infrastructure (*e.g.,* subsidies, grants, incentives from banks *etc.*).
- **Institutional failure**: refers to either laws, regulations and strategies any other formalised rules (the so-called 'hard institutions'), or a set of unwritten rules, common habits, routines and shared norms/values used by humans in repetitive situations i.e. 'the way business is done' (the co-called 'soft institutions'), that are missing or 'malfunction', hampering innovation.
- **Capacities failure:** encompasses insufficient networking or negotiation skills, and organisational capacity of actors to adapt to and manage technological and organisational innovations. Lack of capacity to learn, innovate or use available resources or to identify / articulate needs.
- **Policy coordination failure:** coordination and coherence problems at policy levels *e.g.,* regional-national-European or technological versus sectoral innovation policies.
- **Demand articulation failure:** deficit in anticipating and learning about user needs.
- **Directionality failure:** lack of shared vision, and inability of collective coordination of fragmented change agents

Policy Implications – Structural Issues

- Each of these systems failures is present in some way in the studied communities. It is likely that in the absence of serious consideration and addressing of local community level systems issues, efforts for community level niche innovation will be seriously impaired.
- For example, Dunmanway suffers from lack of ICT infrastructure (high speed broadband); Stockbridge evidences institutional failure, whereby local residents are disaffected with local political processes; Le Trapèze has a clear capacities failure in the social domain and Secondigliano has issues with infrastructure, policy coordination and directionality failure.
- These are underlying, cross-cutting, embedded challenges in the study communities, each which requires a high degree of prioritisation and political engagement to address.
- Structural issues present 'first order' challenges for policy makers in each of the study communities.

5.3 Supporting Innovation

Features of protective spaces important for the development of low-carbon technologies include (Raven, Kern, Verhees, & Smith, 2016):

- **Shielding niche innovations** - achieved by technology advocates through mobilisation of passive spaces such as geographic locations (*e.g.,* off-grid sites), generic innovation schemes or cultural milieus (*e.g.,* environmentalists) or through more active measures such as technology-specific public policies, market subsidies, and political support

- **Nurturing niche innovations** - interacting processes for social learning, articulating technological expectations, and social network development
- **Empowering niche innovations** – *fit-and-conform* strategies involve advocates improving the socio-technical competitiveness of their technology along conventional regime lines. That is, it will perform profitably in existing markets, and does not require far-reaching changes to institutions, infrastructures, skills and knowledge bases. In contrast, *stretch-and-transform* empowerment is defined as processes through which mainstream selection environments are changed in ways that make them more amenable for the niche innovation. Stretch-and-transform empowerment seeks to reframe the rules of the game, and reform institutions that influence prevailing performance criteria

Long-term commitments and signals are important, but so are the timing and modulation of interventions in accordance to innovation dynamics (*e.g.,* experimentation, sunset clauses), and more generally a reflexive disposition (Turnheim *et al.*, 2015).

Policy Implications – Supporting Innovation

- The specific and tailored innovations, identified as suitable on a community by community basis through the pathways analysis, need appropriate policy support to make any meaningful impact at the community level.
- A hierarchy of support measures is evident from the literature, starting with fundamental level of 'shielding' whereby individual niches are protected at the community level. The next level of support, 'nurturing' would see efforts to enable networking and social learning across niche spaces – potentially with measures to allow communities to coordinate, cooperate and work together. The 'empowering' level would involve more widespread policy intervention, through for example, nationwide rollout of grant schemes, changes in laws and regulations or increased tariffs on for example, fossil fuel incumbent technologies, thereby indirectly supporting renewable alternatives.
- At the minimum level, 'shielding' support at the community level is required. For each of the studied communities, community energy schemes are deemed a highly appropriate innovation to enable a shift to a sustainability SSP. Shielding in the form of short term tax relief, grant support and Feed-In-Tariffs are proven support mechanisms. Further to the evidence presented in Hillman *et al.* (2017), there is an argument that longer-term and more established roll-out of such measures (constituting an 'empowering' level of policy support) would significantly aid in the success and proliferation of community energy schemes.

5.4 Empowering Change Agents

- Hermans, Stuiver, *et al.* (2013) classify three broad functions that have to be performed for a local innovation to be successfully integrated in the broader innovation system:
    - **Knowledge co-creation** - there is widespread consensus on the importance of learning and collaboration as a source of new knowledge and practices, as well as growing criticism on the linear transfer of technology model
    - **Upscaling** - the process of upscaling deals with the necessity to gain support of an actor higher up in the hierarchy. Upscaling is done by institutional entrepreneurs in the innovation network as they perform a political function within the network: lobbying and translating the results of an innovation in political terms. In the case of innovation networks these are often the administrative authorities.

- **Outscaling** - a horizontal process that concerns how knowledge travels between different types of organisations. Frequently, brokers are necessary to connect the different types of organisations and to understand and translate the discourses, rules and practices of various types of organisations

- Innovation brokers can help to articulate knowledge demands through problem diagnosis and foresight exercises; they can facilitate linkages between possible cooperation partners; and they can enhance alignment in heterogeneous networks that consist of actors with different frames of reference, norms and values through facilitation of learning processes (Hermans *et al.*, 2013).
- The organisers of innovation networks should take try to organise their collaboration in such a way that it becomes easier for individuals to perform multiple roles within an innovation network (Hermans *et al.*, 2013).
- Intermediary actors are crucial to aggregate knowledge in individual local projects. Their activities carry it to a global niche level and then again guide local projects on the ground (Hatzl, Seebauer, Fleiss, & Posch, 2016).

Policy Implications – Change Agents

- Official policy recognition of the role of so-called change agents and their critical role in innovations could enhance the legitimacy of such actors
- Innovation policy support schemes should make explicit reference to the personnel and roles responsible for **Knowledge co-creation; Upscaling; Outscaling** functions.
- Vertical and Horizontal linkages between innovation schemes, and decision makers and the wider community (including business, industry and civic groups) should be fostered through clear reporting and dissemination requirements.
- Regional community innovation coordinators appointed to enable policy integration and better facilitate reflexive governance approaches.

5.5 Network Learning

Highly-mobile and contested public debates emerge around new technologies, and these are subject to the emergence of new narratives, and coalitions of advocacy and resistance (Turnheim *et al.*, 2015). A good learning process (crucial for successful innovation) enables adjustment of the technology and/or societal embedding to increase chances of successful diffusion (Laak, Raven, & Verbong, 2007). Niches thus constitute platforms which enable interactive learning about technical and economic feasibility and they are also instrumental to create institutional connections and adaptations which are necessary for further diffusion of the technology (Sushandoyo & Magnusson, 2014).

> *"Transition processes towards more sustainable socio-technical energy, transport or production systems, however, are hardly imaginable without a broader participation of engaged citizens"* (Ornetzeder & Rohracher, 2013 p856).

- While networking and intermediary organisations can effectively spread some types of learning necessary for diffusion, this is not sufficient: tacit knowledge, trust and confidence are essential to these projects' success, but are more difficult to abstract and translate to new settings (Seyfang *et al.*, 2014).
- Learning approaches to transitions pathways emphasise the role of (protected) experimentation contexts as fruitful for trialling and adjustment of formulas that may be replicated and scaled-up

elsewhere. Their focus on uncertainties and contingencies in local pathways allows capturing the possibility of failure and success (Turnheim *et al.*, 2015).

Policy Implications – Network Learning

- Policy provision for infrastructure provision for sharing lessons for example through platforms, regular meetings and symposia (Laak *et al.*, 2007).
- Alignment within networks to be facilitated through regular interactions between the actors (Laak *et al.*, 2007).
- Support for niche 'failures' as well as for niche 'successes'
- Support for 'grassroots' as well as 'market-based' innovations[2] ie. *"Niches grounded in local and collective values, based on notions of solidarity, rather than efficiency and profit-seeking; and their niche protection consists of being a space for alternative – i.e. green, sustainability-oriented"* (Seyfang *et al.*, 2014 p24).

5.6 Reflexive Governance

Bottom up identification of needs through the direct involvement of community members is highlighted as an important factor influencing the effectiveness of community initiatives (Ahmadi, 2017). Turnheim *et al.* (2015) elaborate five key challenges for the analysis and governance of transitions pathways:

1) Multiple scales, geographies and temporalities of transformational processes
2) Uncertainties associated with radical innovation and the limits of prediction
3) Interplay between the inertia of existing socio-technical systems and the emergence of novelty
4) Problem of shaping innovation in relation to multiple social objectives and public goods
5) Contested perspectives about the governance of complex processes of social, economic and technical change.

Policy Implications – Reflexive Governance

- Continuity in monitoring and appraisal, and an ability to project the bigger picture (Turnheim *et al.*, 2015).
- For community level innovations, provide space for deliberative democracy process to debate innovations and their evolution at the local level
- Principles of subsidiarity and local control to the extent possible, to enable ownership and investment in local innovation schemes
- Application of ICT, and citizen science approaches to enable leaning and knowledge exchange across communities.

6 Energy Transitions: Achieving Pathway Lift-off

While identifying pathways for achieving energy transitions is a key component of the sustainability transitions literature (Chmutina & Goodier, 2014; Foxon, 2013; Geels *et al.*, 2016; Hillebrandt *et al.*, 2015; Kainuma, Miwa, Ehara, & Akashi, 2013; Turnheim *et al.*, 2015), this research has over-relied upon the lessons of past energy transitions. While historical case studies have a place within the sustainability

[2]Market-based / industrial based innovation networks: coalition between firms, universities and government agencies. Grassroots innovations: coalitions of political activists, scientists, citizens' initiatives, unorganised lay people, hobbyists, craftsmen or local entrepreneurs (Ornetzeder & Rohracher, 2013).

transitions field, this literature has, so far, failed to take into account "transitions in practice". Current examples of energy transitions have yet to be explored, with action research approaches also seemingly lacking from the sustainability transitions field. Consequently, an understanding of energy visions and how local residents and communities identify and support changes to the future of the energy system is required. Furthermore, identifying stakeholders to support such a transition, or transitions, are also needed alongside sustainability interventions that can facilitate and maintain technological and behavioural changes. To that end, it is essential that the findings from Deliverable 6.1 and 6.2 also be considered when identifying effective approaches to achieving pathway lift-off. Without doing so risks overlooking public acceptability of energy transitions and the methods that support energy transitions. These findings are summarised in this section (5), while Section 5.3 identifies where gaps and areas of innovation for sustainability and energy transitions are highlighted, and where policy and practice should focus.

6.1 Visions of Innovation and Transition: Summary of D6.1

Deliverable 6.1 utilised a mixed methods approach to gain insights into the complex understandings, expectations and feelings towards the energy system and its future development. Both citizen and expert opinions identified a series of preferred visions and expectations for the future of the energy system. Based on findings from citizens and experts, portfolios of energy system visions were developed and analysed with a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis and appraisal of Lifecycle and Cost-benefit implications.

Visioning exercises, including scenario development, as applied in D6.1 provided an essential foundation from which to highlight the key mechanisms for long-term and strategic evaluation of policies and strategies, particularly in the context of preparing society, institutions, actors and infrastructure for lasting change. Importantly, these exercises can, and should, serve to unite often-competing interests of differing stakeholder actors through senses of shared visions or goals even if there may be disagreements relating to the methods by which these visions are achieved. From the extensive stakeholder engagement carried out with local community residents, transitions interest group members, SME's, and academics and practitioners, five distinct visions for the future of the energy system emerge from the analysis. These five energy visions are characterised as follows:

- Continuity Vision (CONT);
- Directed Decentralisation Vision (DD);
- Gradual Path Reduction Vision (GPR);
- Accelerated Path Reduction Vision (AER); and
- Deep Green Vision (DG).

These five distinct visions are predicated on an "…ideal, desirable future state of the energy system" that provide an insight into the ways in which different communities (whether of residents, workers, interest group members, or practitioners) consider how the energy system should transition in the coming years. These five visions constitute a portfolio of scenarios of what the energy system could transition to, outlining in particular what residents in their communities want and expect the future of the system to look like. These visions illustrated the role of different energy sources, interventions and stakeholders, and the extent to which each would play within each vision for the future of the energy system. To date, the sustainability transitions literature has largely focused on lessons learned from past, historical transitions and has developed a range of theoretical frameworks and typologies to explain the processes that underpin socio-technical transitions, however D6.1 presents unique empirical data gathered on community perspectives on current, ongoing transitions. In so doing, D6.1 provides breadth and depth of understanding of how individuals make sense of low-carbon configurations for the energy system.

The overall perspective held by nearly all stakeholders was that change would not be easy and that the energy system will face numerous challenges before any of the desired changes can materialise. A range of social, political, economic, technical, and behavioural reasons, originating from the national to local levels, challenge energy system change. In particular, stakeholders highlighted foremost that the existing political, governance and policy structures for energy were weak. For example, there was a unanimous desire to see a reduction in the reliance on fossils fuels and for alternatives to be developed, particularly more renewable energy and decentralised generation and supply. However, stakeholders viewed that this type of change is prevented by an inert centralised top-down energy system of supply, dominated by a monopoly of the political and economic power of large energy companies. Furthermore, there was a widespread view that politicians in central and local government lacked the political will to prioritise desired energy system changes in decision-making. Qualitative findings illustrated that there were concerns about barriers to systemic change, lack of funding for renewable energy projects, poor infrastructure and a lack of appropriate public understanding of energy. Many identified the need for both technological and behavioural solutions to tackle such challenges.

There was an overwhelming sense of expectation that the existing energy system change would be slow and imperceptible over the next 20 years. Moreover, the 20 years' timescale was perceived to be a relatively short period and there was a perception that transformational change would require a much longer period of time to materialise. Many expected that in reality a future energy mix would mean a continuation in the reliance and dominance of fossil fuels and that nuclear energy, with the addition of fracking of shale gas, would be used as a transitional fuel prior to the use of renewable sources of energy becoming more prevalent in the future of the energy system. More localised growth in renewable energy sources and the development of other energy sources such as biomass was expected to exist alongside these more dominant renewable energy sources such as solar and wind.

Some respondents expected that technological innovations could provide a boost for renewable energy generation through greater battery storage capabilities, for instance. A greater level of investment in renewable energy, and into the technologies associated with it to aide transition, was presented as desirable. The viewpoints presented by Stockbridge Village residents reflected a particular dichotomy in the perspectives on specific energy sources which also reflected the wider opinions expressed by other groups in this research, *e.g.,* that people favoured more solar and wind energy and less nuclear energy. Here, 'more' was attributed to relating to 'good' and 'green' sources of energy and 'less' being viewed as 'bad' sources of energy. These viewpoints may well permeate from wider normative and popular social and political discourses of desirable and less desirable energy sources in relation to protecting the environment and addressing climate change. Many participants identified the need for both technological and behavioural solutions *e.g.,* re-thinking and re-orienting lifestyles to pave the way for change. Consequently, the five energy visions clearly illustrate that alongside particular preferences for differing energy sources, there are particular pathways to transition predicated on the various technological and behavioural interventions and the stakeholders involved within each vision. Deliverable 6.2 further explored sustainability interventions, particularly behavioural and technological interventions for efficiency and sustainability.

6.2 Interventions of Innovation and Transition: Summary of D6.2

Deliverable 6.2 comprised a gap analysis of where technological and behavioural interactions require targeted and specific action. D6.2 examined the extent to which alignment between technological and behavioural elements may occur in practice in the deployment of specific technological and behavioural interventions. It examines whether there are gaps in this process and how these could be addressed in an attempt to address the sociotechnical challenges underpinning climate mitigation approaches. In so doing, this supports the identification of current gaps in technology and behaviour focused interventions. The

analysis signposts where specific and targeted action is needed and where new technologies and better application of existing technologies and practice-based approaches is likely to be required to achieve significant carbon reduction goals.

Profiling interventions across five member states as part of the ENTRUST project (the UK, Ireland, France, Spain and Italy), D6.2 identified and analysed the contribution and impact of 5 technological interventions (pre-payment meters; building insulation; LED lightbulbs; smart meters; and solar PV) and 5 behavioural interventions (information provision and awareness raising; feedback systems; legal measures and sanctions; community-based sustainability projects; and personal carbon allowances). Each intervention was evaluated using a SWOT analysis, with both technological and behavioural interventions further analysed overall as part of a PEST (Political, Economic, Social and Technological) analysis.

For technological interventions, the PEST analysis in D6.2 illustrated the diverse makeup of technological measures that offer specific solutions to reducing domestic end-user energy consumption. Each presented technology holds the potential to contribute to carbon reduction in different ways, *e.g.,* enable energy management, fix-and-forget fabric efficiency and renewable microgeneration. For example, smart meters and PPMs are active energy management interventions; both offer a form of feedback and monitoring mechanism directly to occupant users. In contrast, building insulation, LED lighting and solar PV represent more indirect and inactive fix-and-forget fabric efficiency interventions at the building level. In particular, building insulation can enhance the building's energy performance by reducing the amount of energy that is lost through the buildings envelope thereby enabling users to use less energy. This can be further enhanced by the adoption of efficient appliances such LED lightbulbs and solar energy for microgeneration of renewable energy thereby reducing energy demand from the national grid and contributing to overall reduction of the domestic sector carbon footprint.

Increasingly, political support on the whole for these technological interventions appears well established - through a range of legislation, regulations, codes and standards. For example, in response to EU level policy interventions there have been significant shifts in social and political commitments across national contexts in EU member states. These push the market for technology development and innovations. The economic dimension is interlinked to the political, and suggests that market supply of most of these products is now well established and supported by a number of government instruments. There appears to be some level of government directed financial support for interventions. The costs of most technologies remain the responsibility of individuals and householders, and their adoption is voluntary. This means that cost, specifically upfront investment costs, remains a major barrier for the adoption of proven cost-effective technological interventions. It seems that while many of these technologies are being increasingly adopted, there are government concerns that energy efficiency uptake is not occurring at a fast enough rate and at requisite scale needed to meet national and international goals (*e.g.,* EU climate change policy goals for 2020). Furthermore, while social acceptance for smart meters is developing, the prepayment meters appear to be losing favour socially. Technological innovations mean that there are proposals for prepayment meters to transition into smart meter pay as you go technologies that will offer the same potential benefits as smart meters do. New technological innovations should mean in principle that they are more effective in delivering their attributed energy efficiency credentials, easier to install and cost less, so there is greater adoption of these measures across society.

Each behavioural intervention reviewed in D6.2 has the potential to influence the attitudes and actions of energy stakeholders in different ways. These interventions can be applied through a top-down or bottom-up approach, with each specifically targeting particular behaviour and practice to encourage sustainable lifestyles. From the PEST analysis in D6.2, it is clear that political support for behavioural interventions is mixed, confirming somewhat that technological interventions are favoured more so than behavioural interventions. This can be attributed to a fear of political backlash and public unacceptability of a 'forcing

factor' to change public lifestyles. Clear interventions that constrain choice are seen as an undesirable option by governments who wish to remain in power. However, particular behavioural interventions are subjected to favourable political support such as community-based sustainability projects that are congruent with recent transitions towards localism. Yet support for regulating behaviour beyond interventions such as the carrier bags levy in Ireland and congestion charging in Sweden is limited. Economic factors illustrate that while many behavioural interventions are a cost effective approach to reducing energy consumption, some initial costs are high due to the relative dependence on digital and smart technologies (such as personal carbon allowances). For residents, these interventions may lead to savings in energy bills that result from a reduction of energy consumption. However, negative spillover effects may result should this money then be spent on other carbon intensive products or services.

With respect to social factors of the reviewed behavioural interventions, public acceptance is generally high. In some examples, particularly those interventions that are regulatory in nature including personal carbon allowances, public acceptability may be low initially with concerns reflecting 'forcing factors' towards behaviour change and issues towards practicality of establishing congestion charges. Behavioural interventions that are interactive and allow for widespread participatory approaches such as community-based sustainability strategies promote multiple pathways to engagement; cognitively, affectively and behaviourally. Should these approaches be scaled-up, these may contribute significantly to what Dietz, *et al.* (2009) identify as a behavioural wedge in stabilising carbon emissions. While termed as behavioural interventions, these approaches can be disseminated and applied through technology including digital and smart technologies. Historically, interventions such as information provision and feedback systems may have been applied via paper-based methods or through peer-to-peer exchanges. Interactive forms of engagement require face-to-face involvement with other residents and individuals that provide key social dimensions to interventions (particularly community-based sustainability projects). However, new forms of disseminating behavioural interventions exist through smart technologies that include continuous feedback such as smart meters. Interventions such as personal carbon allowances rely on technology to monitor and record carbon emissions.

6.3 Moving Forward towards Innovation Pathways to Transition

Deliverables 6.1 and 6.2 of the ENTRUST project lay the foundation for identifying innovation pathways to transition. Most importantly, these deliverables illustrate the importance of consensus building and the need to build, foster and develop acceptance of multiple pathways to sustainability. As part of this consensus, there increasing debate on whether stakeholders across the energy system should take control of their own transition – related to emerging discourses on the concept of energy citizenship (Brondi, Sarrica, Caramis, Piccolo, & Mazzara, 2016; Devine-Wright, 2007). D6.1 specifically highlighted the importance of providing citizens, experts, practitioners and SME's a voice towards what they expect, and what they want, the future of the energy system to look like. This visioning activity comprised of reaching a consensus regarding the different energy sources available, the types of interventions that can be used to support transitions and the different stakeholders that should participate in bringing about the transition in the future of the energy system. Additionally, D6.2 provided an overview of technological and behavioural interventions, and suggested 5 technological and 5 behavioural interventions that could bring about meaningful changes to practices and technology deployment for efficiency as part of a transition.

Together, these deliverables suggest that there are numerous elements that comprise pathways that citizens in local communities can identify for themselves as part of their own energy transitions as well as changes in the policy and practice spheres that can substantially bring about transition through the development of particular interventions or the support of stakeholders. These elements are as follows:

- Energy sources *e.g.,* renewables, fossil fuels, nuclear energy, and fracking of shale gas *etc.*,

- Broader scale interventions *e.g.,* local ownership of energy, public education, tax measures and direct government action *etc.*,
- Stakeholder support *e.g.,* teachers, politicians, local councils, national government, energy suppliers and universities *etc.*,
- Technological interventions *e.g.,* microgeneration, smart meters and solar PV *etc.*,
- Behavioural interventions *e.g.,* feedback systems, community-based projects, legal measures and sanctions and personal carbon allowances *etc.*

Furthermore, D6.2 highlighted numerous gaps that could (if not, should) be explored for further innovations for transition. These gaps particularly relate to behaviour change. It is clear that while these gaps exist, there is clear promise for solutions to address these and any barriers to sustainability-related actions and practices. Drawing on Deliverable 4.4, D6.2 identified significant gaps in the application of behavioural change programmes across EU member states. Applying the concept of the behaviour change wheel (after Michie, van Stralen, & West, 2011), there is striking evidence that policy categories including guidelines, planning, legislation, regulation and fiscal measures are not well-established approaches for behavioural change initiatives. Rather, there is an over-reliance on communication and marketing strategies as well as on service provision.

D6.2 identified that there were a number of reasons for why these patterns have emerged. Primarily, considerations of top-down measures enforced through regulation and legislation are undesirable to governments who wish to remain in power, particularly where short-term fixed parliaments are concerned. There is evidence that that top-down behaviour change programmes can, and do, work. The examples of the Ireland smoking ban in 2004, the Irish and Welsh plastic bag charges and the Stockholm congestion charge prove that regulation and legislation do work to achieve environmental, economic and social outcomes. Should regulation and legislative categories of behaviour change be implemented in similar ways to the examples of the Stockholm congestion charge and the Irish single-use carrier bag charge, it is not unreasonable to assume that such approaches cannot yield similar positive outcomes for energy consumption and lifestyle changes.

Fiscal measures, guidelines and restrictions are other policy categories where gaps exist in implementing behavioural change programmes. While examples do exist, restrictions and guidelines are often viewed as being prescriptive and clearly identifiable as forcing individuals to reduce consumption. Moreover, fiscal measures do exist yet these measures have decreased in recent years in the aftermath of the Global Financial Crisis (GFC). Fiscal measures are often short-term behavioural change initiatives, and while these may lay the groundwork for incorporating sustainable technologies, other financial incentives often have limited impacts on sustaining behaviour change following the withdrawal of such incentivised behaviours.

Incentives rarely work to create lasting behavioural change. Rather than financial rewards, a potential reconsideration of incentives could be reoriented towards satisfaction and happiness related outcomes of behaviour change. Such an approach would clearly support and underpin a public engagement framework; that individuals need to be motivated and care about climate change. Relating affective engagements with actions and involvement in sustainability-related activities presents new pathways for engagement with behaviour change programmes. Unlocking this potential requires creative interventions and activities for residents and communities to become involved with. The behavioural change wheel, as such, could (if not, should) be amended to incorporate social components as an intervention function whereby these activities enable individuals to participate in sustainability-related behaviour change programmes as part of a collective. Thus, the behaviour change wheel may, itself, be flawed insofar as many behavioural change programmes (particularly at the local level) involve some social and collective elements that address feelings of powerlessness.

From the analyses in D6.2 reviewing the behaviour change programmes presented in D4.4, it is clear that application of particular top-down intervention functions such as coercion, restrictions and incentivisation are minimal. To date, many behavioural change projects have been established, and run, in local communities with an emphasis on informing individuals about strategies for energy saving. While these projects have been beneficial to minimising energy consumption, there impact on overall consumption levels to date has been limited. Consequently, the full range of intervention functions across the behaviour change wheel would, collectively, provide a pathway to further transition to a low-carbon energy system than is currently being realised. The gaps that are highlighted from the analysis of interventions reviewed in D4.4 reflects a concentration on some, limited approaches to behaviour change and a failure to apply the full range of policy approaches available and highlighted in the literature.

7 Conclusions

This Deliverable has presented outcomes of Task 6.3 of the ENTRUST project. This task is framed in recognition that technological innovation alone is insufficient to achieve low-carbon transitions. The key framing question has been: "how can new technologies and practices be best supported/disseminated to achieve 'lift-off' and impact?"

Innovation studies approaches, including Strategic Niche Management thinking have been applied in this Deliverable. Innovation needs, and specific and tailored innovation responses have been identified for 4 of the ENTRUST communities of practice; these are Stockbridge, Le Trapèze Secondigliano and Dunmanway. The outcomes of this innovation needs mapping and an in-depth review of the Strategic Niche Management literature has produced outcomes which point to new policy mixes and practice-based changes at the community level to inform innovation pathways for each community.

To identify innovation needs for each community, an analytical framework was developed based on the Shared Socio-economic Pathway (SSP) concept. The SSPs are a set of five storylines on possible trajectories for human development and global environmental change, which include five different global futures (SSP1-5). The SSPs complement, and build upon, existing scenario development frameworks by adding socio-economic narratives and quantitative pathways consistent with the challenges to mitigation of and adaptation to climate change. These scenarios allow exploration of different futures with and without climate policy responses. The different characteristics and main dynamics of each SSP scenario are as follows:

1) SSP1: Sustainability
2) SSP2: Middle-of-the-road
3) SSP3: Regional Rivalry
4) SSP4: Inequality
5) SSP5: Fossil fuelled Development

In this deliverable, a qualitative description and identification of where constituent components of the SSPs match the characteristics of the profiled communities serves to highlight where innovations are required. These areas include population growth, energy use, agriculture, urbanisation rates, income, and emissions and climate change. For this Deliverable, a spreadsheet was applied to 'map' the constituent components of the SSPs including population size, migration, consumption and diet, land use, and environmental policy according to the characteristics of each of the 4 studied communities. Developed SSP profiles outline how the characteristics of the profiled communities match with constituent components of the SSPs, and where each community most likely aligns to one of the 5 SSPs. The developed profiles are then applied to identify where innovation for sustainability is required for each of the communities in a bespoke and community

specific manner. Innovation needs identified from the SSP analysis are collated with appropriately matching innovations from the policy tool-kit presented in D4.4. In addition, community based innovations from the literature are identified and matched with the specific requirements of each of the 4 communities.

Each of the 4 studied communities displayed a different innovation needs profile. However, for all studied communities, community energy projects, for example based on a social enterprise model, were identified as a clear innovation to help achieve an SSEP 1: Sustainability pathway trajectory. The capability of social enterprises to create both social and economic value is considered a 'win-win'. However, there are clear potentials for social enterprise models to be more extensively applied to address contemporary ecological challenges of neo-liberal market economies, moving towards 'win-win-win' outcomes across social, economic and ecological domains; particularly as these organisations are not motivated by a relentless profit imperative. The autonomous nature of the social-economic model applied by social enterprises can represent a viable means to target social, environmental and economic multiple-bottom lines. Such organisations can develop strong links to their local communities and provide positive externalities in generating financial revenue, while also remaining fully cognisant of, and structured towards social outcomes. There are clear potentials for social enterprise models to be more extensively applied to address contemporary ecological challenges of neo-liberal market economies, moving towards 'win-win-win' outcomes across social, economic and ecological domains; particularly as these organisations are not motivated by a relentless profit imperative.

In addition, or all of the innovations identified for each community, a number of factors were identified as important from the Strategic Niche Management Literature.

1) Identifying and Tackling System / Structural Issues
2) Supporting Innovation
3) Empowering Change Agents
4) Network Learning
5) Reflexive Governance

Outcomes from D6.3 will be applied in ENTRUST T6.4, whereby feedback from the communities of practice will be sought on the innovations identified in D6.3, and other innovation ideas will be canvased.

8 References

Ahmadi, D. (2017). Serving diverse communities: The role of community initiatives in delivering services to poverty neighbourhoods. *Cities*, *69*(July), 86–94. http://doi.org/10.1016/j.cities.2017.07.017

Axon, S. (2016). "The Good Life": Engaging the public with community-based carbon reduction strategies. *Environmental Science and Policy*, *66*, 82–92.

Axon, S. (2017). "Keeping the ball rolling" : Addressing the enablers of, and barriers to, sustainable lifestyles. *Journal of Environmental Psychology*, *52*, 11–25. http://doi.org/10.1016/j.jenvp.2017.05.002

Aze, F., Molinero Perez, S., Tart, S., Sanvincente, E., Dunphy, N., Lennon, B., … Woolford, J. (2017). Policy toolkit typology.

Bakker, S., Maat, K., & van Wee, B. (2014). Stakeholders interests, expectations, and strategies regarding the development and implementation of electric vehicles: The case of the Netherlands. *Transportation Research Part A: Policy and Practice*, *66*(1), 52–64. http://doi.org/10.1016/j.tra.2014.04.018

Bauer, N., Calvin, K., Emmerling, J., Fricko, O., Fujimori, S., Hilaire, J., … van Vuuren, D. P. (2017). Shared Socio-Economic Pathways of the Energy Sector - Quantifying the Narratives. *Global Environmental Change*, *42*, 316–330. http://doi.org/10.1016/j.gloenvcha.2016.07.006

Berggren, C., Magnusson, T., & Sushandoyo, D. (2015). Transition pathways revisited : Established firms as multi-level actors in the heavy vehicle industry. *Research Policy*, *44*(5), 1017–1028. http://doi.org/10.1016/j.respol.2014.11.009

Brondi, S., Sarrica, M., Caramis, A., Piccolo, C., & Mazzara, B. M. (2016). Italian parliamentary debates on energy sustainability: How argumentative 'short-circuits affect public engagement. *Public Understanding of Science*, *25*(6), 737–753. http://doi.org/10.1177/0963662515580067

Bush, R. E., Bale, C. S. E., Powell, M., Gouldson, A., Taylor, P. G., & Gale, W. F. (2017). The role of intermediaries in low carbon transitions e Empowering innovations to unlock district heating in the UK. *Journal of Cleaner Production*, *148*(April 2013), 137–147. http://doi.org/10.1016/j.jclepro.2017.01.129

Calvin, K., Bond-lamberty, B., Clarke, L., Edmonds, J., Eom, J., Hartin, C., … Wise, M. (2017). The SSP4: A world of deepening inequality. *Global Environmental Change*, *42*, 284–296. http://doi.org/10.1016/j.gloenvcha.2016.06.010

Ceschin, F. (2014). How the Design of Socio-technical Experiments Can Enable Radical Changes for Sustainability, *8*(3), 1–22.

Chmutina, K., & Goodier, C. I. (2014). Alternative future energy pathways : Assessment of the potential of innovative decentralised energy systems in the UK. *Energy Policy*, *66*, 62–72. http://doi.org/10.1016/j.enpol.2013.10.080

Coenen, L., Benneworth, P., & Truffer, B. (2012). Toward a spatial perspective on sustainability transitions. *Research Policy*, *41*(6), 968–979. http://doi.org/http://dx.doi.org/10.1016/j.respol.2012.02.014

Crabbé, A., Jacobs, R., Van Hoof, V., Bergmans, A., & Van Acker, K. (2013). Transition towards sustainable material innovation: evidence and evaluation of the Flemish case. *Journal of Cleaner Production*, *56*(0), 63–72. http://doi.org/http://dx.doi.org/10.1016/j.jclepro.2012.01.023

Dellink, R., Chateau, J., Lanzi, E., & Magne, B. (2017). Long-term economic growth projections in the Shared Socioeconomic Pathways. *Global Environmental Change*, *42*, 200–214. http://doi.org/10.1016/j.gloenvcha.2015.06.004

Devine-Wright, P. (2007). Energy Citizenship: Psychological Aspects of Evolution in Sustainable Energy Technologies. In J. Murphy (Ed.), *Governing Technology for Sustainability* (p. 240). Routledge.

Dietz, T., Gardner, G. T., Gilligan, J., Stern, P. C., & Vandenbergh, M. P. (2009). Household actions can provide a behavioral wedge to rapidly reduce U.S. carbon emissions. *Proceedings of the National Academy of Sciences*, *106*(44).

Dietz, T., Gardner, G. T., Gilligan, J., Stern, P. C., & Vandenbergh, M. P. (2009). Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proceedings of the National Academy of Sciences of the United States of America*, *106*(44), 18452–6. http://doi.org/10.1073/pnas.0908738106

Foxon, T. J. (2013). Transition pathways for a UK low carbon electricity future. *Energy Policy*, *52*, 10–24. http://doi.org/10.1016/j.enpol.2012.04.001

Fricko, O., Havlik, P., Rogelj, J., Klimont, Z., Gusti, M., Johnson, N., … Riahi, K. (2017). The marker quantification of the Shared Socioeconomic Pathway 2: A middle-of-the-road scenario for the 21st century. *Global Environmental Change*, *42*, 251–267. http://doi.org/10.1016/j.gloenvcha.2016.06.004

Fujimori, S., Hasegawa, T., Masui, T., Takahashi, K., Silva, D., Dai, H., … Kainuma, M. (2017). SSP3: AIM implementation of Shared Socioeconomic Pathways. *Global Environmental Change*, *42*, 268–283. http://doi.org/10.1016/j.gloenvcha.2016.06.009

Geels, F., & Deuten, J. J. (2006). Local and global dynamics in technological development: a socio-cognitive perspective on knowledge flows and lesons from reinforced concrete. *Science and Public Poicy*, *33*(4), 265–275.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes : a multi-level perspective and a case-study. *Research Policy*, *31*, 1257–1274.

Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions*, *1*(1), 24–40. http://doi.org/10.1016/j.eist.2011.02.002

Geels, F. W., Kern, F., Fuchs, G., Hinderer, N., Kungl, G., Mylan, J., … Wassermann, S. (2016). The enactment of socio-technical transition pathways: A reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990-2014). *Research Policy*, *45*(4), 896–913. http://doi.org/10.1016/j.respol.2016.01.015

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, *36*(3), 399–417. http://doi.org/10.1016/j.respol.2007.01.003

Gilligan, J., Dietz, T., Gardner, G. T., Stern, P. C., & Vandenbergh, M. P. (2010). The behavioural wedge: reducing greenhouse gas by individuals and households. *Significance*, *7*, 17–20.

Hatzl, S., Seebauer, S., Fleiss, E., & Posch, A. (2016). Market-based vs. grassroots citizen participation initiatives in photovoltaics: A qualitative comparison of niche development. *Futures*, *78–79*, 57–70. http://doi.org/10.1016/j.futures.2016.03.022

Heiskanen, E., Johnson, M., Robinson, S., Vadovics, E., & Saastamoinen, M. (2010). Low-carbon communities as a context for individual behavioural change. *Energy Policy*, *38*(12), 7586–7595. http://doi.org/10.1016/j.enpol.2009.07.002

Hermans, F., Apeldoorn, D. Van, Stuiver, M., & Kok, K. (2013). Niches and networks : Explaining network evolution through niche formation processes. *Research Policy*, *42*(3), 613–623. http://doi.org/10.1016/j.respol.2012.10.004

Hermans, F., Stuiver, M., Beers, P. J., & Kok, K. (2013). The distribution of roles and functions for upscaling and outscaling innovations in agricultural innovation systems. *Agricultural Systems*, *115*, 117–128. http://doi.org/10.1016/j.agsy.2012.09.006

Hillebrandt K. *et al.* (2015). *Pathways to Deep Decarbonization in Germany* (DE 2015 Re). Sustainable Development Solutions Network (SDSN) and Institute for Sustainable Development and International Relations (IDDRI). Retrieved from http://deepdecarbonization.org/wp-content/uploads/2015/09/DDPP_DEU.pdf

Hillman, J., Axon, S., & Morrissey, J. (2017). An alternative approach: Social enterprise as a niche innovation for low-carbon transition. *In Review*.

Kainuma, M., Miwa, K., Ehara, T., & Akashi, O. (2013). A low-carbon society: Global visions, pathways, and challenges. *Climate Policy*, *3062*(July), 5–21. http://doi.org/10.1080/14693062.2012.738016

Kc, S., & Lutz, W. (2017). The human core of the shared socioeconomic pathways: Population scenarios by age, sex and level of education for all countries to 2100. *Global Environmental Change*, *42*, 181–192. http://doi.org/10.1016/j.gloenvcha.2014.06.004

Kemp, R. (1994). Technology and the transition to environmental sustainability. *Futures*, *26*(10), 1023–1046. http://doi.org/10.1016/0016-3287(94)90071-X

Kemp, R., Schot, J., & Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management. *Technology Analysis & Strategic Management*, *10*(2), 175–198. http://doi.org/10.1080/09537329808524310

Kern, F. (2012). Using the multi-level perspective on socio-technical transitions to assess innovation policy. *Technological Forecasting and Social Change*, *79*(2), 298–310. http://doi.org/10.1016/j.techfore.2011.07.004

Knowsley Council. (2016). Stockbridge Ward Profile. Retrieved July 28, 2017, from http://knowsleyknowledge.org.uk/areas/

Kriegler, E., Bauer, N., Popp, A., Humpenöder, F., Leimbach, M., Stre, J., … Edenhofer, O. (2017). Fossil-fueled development (SSP5): An energy and resource intensive scenario for the 21st century. *Global Environmental Change*, *42*, 297–315. http://doi.org/10.1016/j.gloenvcha.2016.05.015

Laak, W. W. M. Van Der, Raven, R. P. J. M., & Verbong, G. P. J. (2007). Strategic niche management for biofuels : Analysing past experiments for developing new biofuel policies. *Energy Policy*, *35*, 3213–3225. http://doi.org/10.1016/j.enpol.2006.11.009

Lachman, D. a. (2013). A survey and review of approaches to study transitions. *Energy Policy*, *58*, 269–276. http://doi.org/10.1016/j.enpol.2013.03.013

Lamprinopoulou, C., Renwick, A., Klerkx, L., Hermans, F., & Roep, D. (2014). Application of an integrated systemic framework for analysing agricultural innovation systems and informing innovation policies : Comparing the Dutch and Scottish agrifood sectors. *Agricultural Systems*, *129*, 40–54. http://doi.org/10.1016/j.agsy.2014.05.001

Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy*, *41*(6), 955–967. http://doi.org/http://dx.doi.org/10.1016/j.respol.2012.02.013

Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, *6*(1), 42. http://doi.org/10.1186/1748-5908-6-42

Moloney, S., Horne, R. E., & Fien, J. (2010). Transitioning to low carbon communities-from behaviour change to systemic change: Lessons from Australia. *Energy Policy*, *38*(12), 7614–7623. http://doi.org/10.1016/j.enpol.2009.06.058

Mulugetta, Y., Jackson, T., & van der Horst, D. (2010). Carbon reduction at community scale. *Energy Policy*, *38*(12), 7541–7545. http://doi.org/10.1016/j.enpol.2010.05.050

O'Neill, B. C., Kriegler, E., Ebi, K. L., Kemp-Benedict, E., Riahi, K., Rothman, D. S., … Solecki, W. (2017). The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century. *Global Environmental Change*, *42*, 169–180. http://doi.org/10.1016/j.gloenvcha.2015.01.004

Ornetzeder, M., & Rohracher, H. (2013). Of solar collectors, wind power, and car sharing: Comparing and understanding successful cases of grassroots innovations. *Global Environmental Change*, *23*(5), 856–867. http://doi.org/10.1016/j.gloenvcha.2012.12.007

Pacala, S., & Socolow, R. (2004). Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies. *Science*, *305*(August), 968–972.

R.Mourik, & Raven, R. (2006). *A practioner ' s view on Strategic Niche Management Towards a future research outline*.

Raven, R., Bosch, S. Van Den, & Weterings, R. (2010). Transitions and strategic niche management: towards a competence kit for practitioners. *International Journal of Technology Management*, *51*(1), 57. http://doi.org/10.1504/IJTM.2010.033128

Raven, R., Kern, F., Verhees, B., & Smith, A. (2016). Environmental Innovation and Societal Transitions Niche construction and empowerment through socio-political work . A meta-analysis of six low-carbon technology cases. *Environmental Innovation and Societal Transitions*, *18*, 164–180. http://doi.org/10.1016/j.eist.2015.02.002

Riahi, K., van Vuuren, D. P., Kriegler, E., Edmonds, J., O'Neill, B. C., Fujimori, S., … Tavoni, M. (2017). The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global Environmental Change*, *42*, 153–168. http://doi.org/10.1016/j.gloenvcha.2016.05.009

Rip, A., & Kemp, R. (1998). Technological change. In E. L. Rayner, S., & Malone (Ed.), *Human choice and climate change: an international assessment* (pp. 327–399). Wasington D.C.: Batellle Press.

Schot, J., & Geels, F. W. (2007). Niches in evolutionary theories of technical change: A critical survey of the literature. *Journal of Evolutionary Economics*, *17*(5), 605–622. http://doi.org/10.1007/s00191-007-0057-5

Schot, J., & Geels, F. W. (2008). Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. *Technology Analysis and Strategic Management*, *20*(5), 537–554. http://doi.org/10.1080/09537320802292651

Schot, J., Slob, A., & Hoogma, R. (1996). De invoering van duurzame technologie : Strategisch Niche Management als beleidsinstrument. In *Programma DTO, Delft University of Technology, Delft, The Netherlands*.

Seyfang, G., & Haxeltine, A. (2012). Growing grassroots innovations: Exploring the role of community-based initiatives in governing sustainable energy transitions. *Environment and Planning C: Government and Policy*, *30*(3), 381–400. http://doi.org/10.1068/c10222

Seyfang, G., Hielscher, S., Hargreaves, T., Martiskainen, M., & Smith, A. (2014). A grassroots sustainable energy niche? Reflections on community energy in the UK. *Environmental Innovation and Societal Transitions*, *13*, 21–44. http://doi.org/10.1016/j.eist.2014.04.004

Seyfang, G., & Longhurst, N. (2013). Desperately seeking niches: Grassroots innovations and niche development in the community currency field. *Global Environmental Change*, *23*(5), 881–891. http://doi.org/10.1016/j.gloenvcha.2013.02.007

Smith, A., Kern, F., Raven, R., & Verhees, B. (2014). Technological Forecasting & Social Change Spaces for sustainable innovation : Solar photovoltaic electricity in the UK. *Technological Forecasting & Social Change*, *81*(March 2012), 115–130. http://doi.org/10.1016/j.techfore.2013.02.001

Sushandoyo, D., & Magnusson, T. (2014). Strategic niche management from a business perspective : taking cleaner vehicle technologies from prototype to series production. *Journal of Cleaner Production*, *74*, 17–26. http://doi.org/10.1016/j.jclepro.2014.02.059

Temmes, A., Räsänen, R., Rinkinen, J., & Lovio, R. (2013). The Emergence of Niche Protection through Policies : The Case of Electric Vehicles Field in Finland. *Science & Technology Studies*, *26*(3), 37–62.

The Economist. (2013). A New Kind of Ghetto. Retrieved August 27, 2017, from https://www.economist.com/news/special-report/21589230-britain-no-longer-has-serious-race-problem-trouble-isolation-new-kind

Truffer, B., Metzner, a, & Hoogma, R. (2002). The Coupling of Viewing and Doing. Strategic Niche Management and the electrification of individual transport. *Greener Management International*.

Turnheim, B., Berkhout, F., Geels, F., Hof, A., McMeekin, A., Nykvist, B., & van Vuuren, D. (2015). Evaluating sustainability transitions pathways: Bridging analytical approaches to address governance challenges. *Global Environmental Change*, *35*, 239–253. http://doi.org/10.1016/j.gloenvcha.2015.08.010

van Ruijven, B. J., Levy, M. A., Agrawal, A., Biermann, F., Birkmann, J., Carter, T. R., … Schweizer, V. J. (2014). Enhancing the relevance of shared socioeconomic pathways for climate change impacts, adaptation and vulnerability research. *Climatic Change*, *122*(3), 481–494. http://doi.org/10.1007/s10584-013-0931-0

van Vuuren, D. P., Riahi, K., Calvin, K., Dellink, R., Emmerling, J., Fujimori, S., … O'Neill, B. (2017). The Shared Socio-economic Pathways: Trajectories for human development and global environmental change. *Global Environmental Change*, *42*, 148–152. http://doi.org/10.1016/j.gloenvcha.2016.10.009

Verbong, G., Geels, F. W., & Raven, R. (2008). Multi-niche analysis of dynamics and policies in Dutch renewable energy innovation journeys (1970–2006): hype-cycles, closed networks and technology-focused learning. *Technology Analysis & Strategic Management*, *20*(5), 555–573.

Villages Housing. (2017). Vision, values and priorities. Retrieved August 28, 2017, from https://www.villages.org.uk/vision--values-and-priorities

Vuuren, D. P. Van, Stehfest, E., Gernaat, D. E. H. J., Doelman, J. C., Berg, M. Van Den, Harmsen, M., … Ruijven, B. J. Van. (2017). Energy, land-use and greenhouse gas emissions trajectories under a green growth paradigm. *Global Environmental Change*, *42*, 237–250. http://doi.org/10.1016/j.gloenvcha.2016.05.008

Whitmarsh, L., O'Neill, S., & Lorenzoni, I. (2013). Public engagement with climate change: what do we know, and where do we go from here? *International Journal of Media and Cultural Politics*, *9*, 7–25.

Witkamp, M. J., Raven, R. P. J. M., & Royakkers, L. M. M. (2011). Strategic niche management of social innovations: the case of social entrepreneurship. *Technology Analysis & Strategic Management*, *23*(July), 667–681. http://doi.org/10.1080/09537325.2011.585035

Wolf, J., & Moser, S. C. (2011). Individual understandings, perceptions, and engagement with climate change: Insights from in-depth studies across the world. *Wiley Interdisciplinary Reviews: Climate Change*. http://doi.org/10.1002/wcc.120