ENERGY SYSTEM TRANSITION THROUGH STAKEHOLDER ACTIVATION, EDUCATION AND SKILLS DEVELOPMENT

ENTRUST

# Energy system visioning and low-carbon configurations

## Deliverable D6.1


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## 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 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**

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# Executive Summary

An emerging low-carbon transition is evident across the European energy system, with a gradual incremental shift underway from a linear, highly centralised fossil fuel powered energy grid towards a de-centralised, multi-source and multi-stakeholder one. However, given the scale of the 'emissions gap' – that is the difference between greenhouse gas emissions reductions currently committed to and the level of emissions scientifically correlated to a 2°C level of warming – it is clear that more intensive, urgent and indeed a radical energy system transformation is needed. Operationalising and implementing measures to stabilise emissions in line with a 2°C warming limit presents a challenge of unprecedented scale. From a policy and decision making perspective, efforts to date have primarily been characterised by top-down, technocratic approaches. For a more meaningful energy transition within the requisite time-frames, a substantial reconfiguration of the human dimension of the energy system is required; entailing a transformation from passive to 'active consumer' roles and a shift to a more engaged, empowered and mobilised energy citizenry. Engaging citizens not only improves the prospects of sustainability transitions at the local level, but can also contribute to the development of valuable social capital. At the community level, the capacity to engage in large group deliberations and the development of consensus on, and support for, strategies to achieve future visions constitute valuable local capacity and agency development. However, stakeholder oriented studies on energy transitions have to date tended to elicit expert stakeholders with limited examples of studies that have explored local resident and community perspectives on the direction and nature of energy transitions.

In this Deliverable, a mixed methods approach (using surveys, interviews, focus groups and workshops, as well as desktop review) is applied to gain insights into the complex understandings, expectations and feelings on energy practices, the energy system, and its future. A mix of citizen and expert opinions were canvassed to identify their preferred vision and expectations for the future energy system.

**A mix of citizen and expert opinions were sought to identify preferred future energy system configurations across sectors and interest groups.**

Based on empirical research findings, portfolios of future energy system visions were developed and subjected to review and appraisal using: a Delphi-panel-like expert review and analysis; SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of outputted visions and appraisal of Lifecycle and Cost-benefit implications. The rationale for utilising these methods was to produce a coherent synthesis of the differing data sets and the range of analytical techniques applied.

Envisioning exercises, including scenario development, provide an essential foundation from which to highlight the key mechanisms for the 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 may serve to unite often competing interests of the differing stakeholder actors through a sense of a shared vision or goal even if there may be disagreements as how to arrive there. From the extensive stakeholder engagement carried out with local community residents, transitions interest group members, SME employees and expert 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. The five described 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. 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 which underpin socio-technical transitions. This paper presents unique empirical data gathered on community perspectives on current, ongoing transitions. This Deliverable provides breadth and depth to our understanding of how individuals make sense of low-carbon configurations for the energy system.

The overall perspective held by nearly all stakeholders is that change will 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 was being held back by an inert, centralised, top-down energy system of supply dominated and monopolised by 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. Most, stakeholders expressed 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 of time and there was also 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 nuclear energy. 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 energy sources. Some expect 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 sources, and into the technologies associated with them 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 less nuclear energy. Some sources were seen as 'good' energy sources such as solar or 'bad' sources such as nuclear. 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 tackling climate change. Many participants identified the need for both technological and behavioural solutions e.g. re-thinking current lifestyles to pave the way for change. In a community beset with many challenges on energy (specifically fuel poverty) the proportion of respondents with informed, positive and hopeful views on the future of the energy system was particularly noteworthy.

This deliverable presents portfolios 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.** The deliverable provides a breadth and depth of understanding of how individuals (of differing backgrounds) make sense of low-carbon configurations for the energy system. The role of visions in transitions is central and key, and in this deliverable, we have produced a summary of both 'top-down' and 'bottom-up' perspectives on a range of future visions, which will determine the nature of potential low-carbon transitions.

# 1 Introduction

## 1.1 *Background*

There is a scientific consensus that limiting the increase in global average temperature to around 2°C above pre-industrial levels is necessary to avoid unacceptable impacts on the climate system (Söderholm *et al.*, 2011*)*. The Copenhagen Accord established political consensus on the 2°C limit (in global temperature increase) and for deep cuts in greenhouse gas (GHG) emissions levels to achieve this goal (Chiodi *et al.*, 2013). Radical reduction in emissions from developed and developing nations will be required over the next 40 years (Söderholm *et al.*, 2011).

In October 2014 the European Council agreed on the headline targets for 2030 with domestic GHG reductions of at least 40%, a binding EU wide target of at least 27% renewables and an indicative target of 27% energy efficiency (Knopf *et al.*, 2015). Electricity generation is the single largest $CO_2$ emitting sector across the EU, and is responsible for more than a third of Europe's $CO_2$ emissions (Flues *et al.*, 2014). Electricity generation is therefore of key importance for the European energy profile, at present and for future targeted reductions in emissions. However, Europe is facing several other major energy challenges, including the depletion of national energy sources, increasing fuel costs and the threat of energy supply disruptions (Lise *et al.*, 2013). Policy priorities are also increasingly focused on energy efficiency and savings and the reduction of energy intensity (DeLlano-Paz *et al.*, 2016). National energy policy agendas need to balance access to energy, security of supply, energy costs, environmental issues and social acceptance (Frei, 2008). For example, a balance has to be found between greenhouse gas emission mitigation, security of supply and affordability of electricity. In addition, nuclear energy is becoming less popular as a reliable source for electricity generation, presenting further restrictions on low-carbon energy options (Lise *et al.*, 2013). Frei (2008) argues the range of energy policy priorities are not in practice subject to trade-off, but to a hierarchy that requires satisfying lower-order needs before addressing higher-order ones (Figure 1).

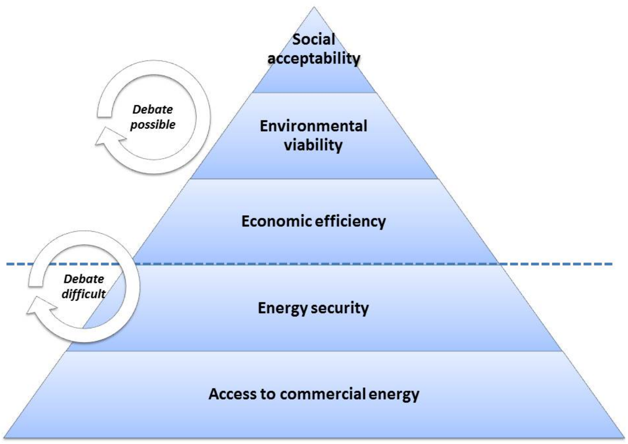


**Figure 1: Energy Policy 'Maslow Pyramid' after (Frei, 2008).**

Importantly, Figure 1 suggests that debates on energy matters can be challenging or restricted to particular policy issues, including debates on energy security issues and access to commercial energy.

A practical problem for many countries is energy security, since fossil fuels are unevenly geographically distributed across the globe (Wang *et al.*, 2017). However, some of these goals may be mutually compatible in a transitions perspective. A European energy technologies portfolio that is both environmentally and socially considered is also more likely to provide greater energy security (DeLlano-Paz *et al.*, 2016). In framing the challenge of moving to a sustainable low carbon energy system, whilst achieving other objectives of maintaining security of energy supply and affordability of energy services, governments have begun to use the language of transitions (Foxon, 2013).

In practice, a transition to low carbon systems of energy supply and energy service provision will require radical changes to technologies, institutions, business strategies and user practices (Foxon, 2013). Technologies such as biomass district heating, photovoltaic panels on roofs or geothermal heat-pumps differ considerably from existing centralised, large-scale energy networks, incorporating a far greater diversity of energy sources and technologies and a great range of stakeholders, particularly on the energy generation side (Debizet *et al.*, 2016). It will be difficult to strike a balance between these challenges, without firm changes in policymaking, according to Lise *et al.* (2013). What is required is a fundamental transformation in the nature and configuration of the energy system. Notwithstanding the challenges outlined in Figure 1, such changes cannot and should not occur without widespread input, consultation and buy-in from energy system stakeholders. It is well acknowledged that sustainability (and energy) transitions require substantial public engagement to improve the acceptability of, and participation with, such fundamental changes in infrastructure, technology, and practices (Peters *et al.*, 2012; Whitmarsh *et al.*, 2013; Axon, 2016). A failure to engage individuals and stakeholders with energy transitions risks any attempt to transform the energy system towards a new sustainable paradigm, particularly given the need for individuals to be viewed, and participate in energy transitions, as citizens rather than consumers. The public engagement literature outlines numerous ways in which that individuals and stakeholders can become involved in such initiatives, yet there is a need for creative and meaningful interventions and modes of participation to be implemented (Arnstein, 1969; Morrison and Dearden, 2013; Whitmarsh *et al.*, 2013; Axon, 2016).

## 1.2 *Aims and Objectives*

This report presents outcomes of Task 6.1 of the ENTRUST project. This task applies a futures-based approach based on extensive stakeholder engagement and a comprehensive desktop study of the future of the energy system.

**A mix of citizen and expert opinions were sought to identify preferred future energy system configurations, across sectors and interest groups.**

The developed portfolio of future energy system visions was subjected to review and appraisal using two discreet methods: a Delphi-panel-like expert review and analysis and a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of outputted visions. The rational of using these methods is to produce a coherent synthesis from the range of analytical techniques applied. This deliverable has produced a portfolio of scenarios of what the energy system will transition to, outlining in particular **what residents in their communities *want* and *expect* the future of the system to look like.** The deliverable provides a breadth and depth of understanding of how individuals make sense of low-carbon configurations for the energy system. The role of visions in transitions is central and key, and in this deliverable, we have produced a summary of both 'top-down' and 'bottom-up' perspectives on a range of future visions that will determine the nature of evolving low-carbon transitions.

Capacity to achieve carbon reduction targets as specified in European and national policy documents is reviewed and discussed. **The Deliverable is structured as follows:**

**Section 2** presents an overview of published literature relevant to the Deliverable. In this section, the ***Capacity to Achieve Carbon Reduction Targets*** is explored, including the concept of the 'Emissions Gap' between projected policy performance and scientifically established emissions levels for a 2°C warming limit. The rationale for scenario modelling and the integration of top-down and bottom up perspectives is also explored.

**Section 3** presents an overview of the mixed-methods methodology developed and applied specifically for this deliverable.

**Section 4** presents the completed ***Portfolio of Community (bottom-up) Future Vision Scenarios***, following from extensive stakeholder engagement with community and SME groups.

**Section 5** presents the completed ***Portfolio of Expert (Top-down) Future Vision Scenarios***, following from desktop review of published energy vision/scenario reports and targeted stakeholder engagement with Expert Informants.

**Section 6** presents a synthesis of ***Derived Future Energy System Configurations***, integrating insights from both the *Community (bottom-up) Future Vision Scenarios Portfolio* and the *Expert (Top-down) Future Vision Scenarios Portfolio*.

**Section 7** discusses **feasibility issues with the identified energy visions for the future of the energy system**, and discusses the key challenges and barriers to energy transitions as well as summarising how energy systems are perceived to realistically change.

# 2 Literature review

## 2.1 *Capacity to Achieve Carbon Reduction Targets - The Emissions Gap*

Achieving long-term targets for greenhouse gas emissions reductions, will require a transition in systems for meeting and shaping energy service demands, involving radical substitution to low-carbon supply technologies and improvements in end-use energy efficiency (Foxon, 2013). Fossil fuels will still meet 76% of the world's total energy demand in 2035; present economic growth models require large amounts of intensive energy that to date only fossil fuels have been able to satisfy (Wang *et al.*, 2017). Wang *et al.* (2017) argue that more radical energy transitions, as well as transformations in societal metabolisms and growth models are required to address this, in conjunction with an extensive roll out of renewable energy technologies.

Some successes have emerged to date. All major countries have set renewable energy targets, many to be achieved by national support policies. Several countries have recently implemented efficiency standards for cars (for instance the USA and Canada). New emission trading systems are spreading globally with systems adopted in Australia, South Korea and China. Brazil has succeeded in reducing its deforestation rate significantly (Roelfsema *et al.*, 2014).

However, analyses of existing climate change policies from national governments continue to reflect a growing 'emissions gap' between the greenhouse gas emissions reductions currently committed to, and the level scientifically correlated for stabilising global climate temperatures within the 'guard rail' of a 2 °C increase (Wiseman *et al.*, 2013). According to Roelfsema *et al.* (2014), currently planned policies for the EU will not be sufficient to meet the conditional pledge of 30% reduction below 1990 in 2020 – *"to deliver the conditional target of 30%, the EU would need to develop and implement additional policies and measures beyond the policies currently planned by Member States* (Roelfsema *et al.*, 2014, p786)".

Weijermars *et al.* (2012) argue that while energy policy formulation and technology improvements can decelerate the growth of greenhouse gas emissions from energy use, the rate of deceleration is not currently happening at the right pace to create a safe carbon trajectory for our planet. Global greenhouse gas emission rates continue to grow. Global $CO_2$ emissions increased by roughly 1.3 per cent annually for the period 2012 to 2014, a pace significantly slower than that of the 12 preceding years, where the average annual increase was 2.9 per cent (2000-2011), but higher than the average annual growth rate of around 1 per cent during the 1990s (UNEP, 2016). While the growth rate of global carbon dioxide emissions is slowing, the continued growth of global emissions show that the world is not yet on an emissions trajectory consistent with stated temperature goals (UNEP, 2016). A global emissions gap is probable between expected emissions as a result of national reduction pledges and emission levels consistent with putting the world on an effective emissions trajectory by 2020 to avoid expected global warming above the 2°C limit (Höhne *et al.*, 2012). The analysis presented in Rogelj *et al.* (2011) confirm that if the mechanisms needed to enable an early peak in global emissions followed by steep reductions are not put in place, there is a significant risk that the 2°C target will not be achieved.

Without pledges, global GHG emissions may increase from 45 $GtCO_2$-e[1] in 2005 to around 56 $GtCO_2$-e in 2020 (with a range of 54–60 $GtCO_2$-e) according to Business as Usual (BAU) projections (Höhne *et al.*, 2012). Likely projected emissions for 2020 of 49–53 $GtCO_2$-e (median) leave a gap of **5–9**

[1] Gigatonnes of equivalent carbon dioxide

**$GtCO_2$-e** from an emissions trajectory compatible with a 2°C warming scenario (Höhne *et al.*, 2012). According to the UNEP, the emissions gap for 2030 is **12-14 $GtCO_2$-e** compared with 2°C scenarios (UNEP, 2016)[2]. Rogelj *et al.* (2011) report that for scenarios with a 'likely' (greater than 66%) chance of staying below 2 °C, emissions peak between 2010 and 2020 and fall to a median level of 44 Gt of $CO_2$ equivalent in 2020. To have a likely chance of complying with the 2°C target, total greenhouse gas emissions in 2050 must be about 46% lower than their 1990 level, or about 53% lower than their 2005 level (UNEP, 2011).

In summary, global greenhouse gas emissions continue to grow, and while there is an encouraging indication of a halting of the growth rate of global $CO_2$ emissions from fossil fuels and industry, it is still too early to say whether this is likely to be permanent (UNEP, 2016). This highlights the challenging and urgent task of understanding how to bridge the gap between physical requirements of action to prevent runaway climate change and societal support for action at that speed and scale (Wiseman *et al.*, 2013).

## 2.2 *The Need for, and Limitations of, Scenario Modelling*

Given the increasing global 'emissions gap' and the complexity involved in creating integrated and effective emissions reduction plans, ambitious transitions strategies, involving a myriad of influential energy system actors, are required. Key questions to guide public policy and strategy choices for future energy supply and systems include (Weijermars *et al.*, 2012):

- How do we know what the right energy mix and energy consumption pattern in the future should be?
- Which technologies, knowledge, regulations and incentives are needed to support our strategy and develop a balanced energy mix?
- **Which energy vision can guide us in future choices?**
- How do we develop an energy strategy that can be successfully implemented?

However, the application of energy policies is subject to a high degree of uncertainty (DeLlano-Paz *et al.*, 2016). Scenarios, roadmaps and similar foresight methods are typically used to cope with such uncertainties (McDowall & Eames, 2006). Scenarios are possible futures built up from a consistent set of assumptions (Weijermars *et al.*, 2012). Energy scenarios are an analytical tool for the discussion of various designs of an energy system under uncertainty; potentially describing possible future systems (Lunz *et al.*, 2016), and identifying opportunities, future risks etc. In order to develop pathways for change, scenarios can be used to support decision making involving key actors and stakeholders (Wang *et al.*, 2017). Scenario analysis can play an important role in the development of shared visions of the future (McDowall & Eames, 2006). Following a review of the hydrogen futures literature, applying a six-fold typology to map the state of the art of scenario construction McDowall & Eames (2006) explored expectations found within the literature, through the 'answers' it provides to questions about the future of hydrogen. These questions were as follows. What are the drivers, barriers and challenges facing the development of a hydrogen economy? What are the key technological building blocks required? In what kinds of futures does hydrogen become important? What does a hydrogen economy look like, how and when does it evolve, and what does it achieve? The answers to these questions indicate that there is a diverse range of possible futures, from

[2] The size of the gap depends on the extent to which the pledges are implemented and how they are applied, what accounting rules are assigned, and the desired likelihood of staying below a particular temperature limit (UNEP, 2011).

decentralised systems based upon small-scale renewables, through to centralised systems reliant on nuclear energy or carbon-sequestration. The consilience of this literature illustrates that the hydrogen economy emerges only slowly, if at all, under 'Business as Usual' scenarios. Rapid transitions to hydrogen occur only under conditions of strong governmental support combined with, or as a result of, major 'discontinuities' such as shifts in society's environmental values, 'game changing' technological breakthroughs, or rapid increases in the oil price or speed and intensity of climate change (McDowall & Eames, 2006).

Scenarios can help to anticipate vulnerabilities in a strategy plan where unexpected or unlikely events were likely to happen (Weijermars *et al.*, 2012). Energy scenarios do not necessarily predict development with the highest probability but illustrate possible future paths which could occur if the assumptions made hold true (Lunz *et al.*, 2016). Scenarios are useful for low-carbon transition processes only if they can inform current decision-makers on available policy options and the policy pathways to pursue or avoid (Söderholm *et al.*, 2011). Rather than targeting one optimal solution, consideration of a broad solution space, where different solutions can be compared and their advantages and disadvantages identified is preferable (Lunz *et al.*, 2016). A key role of envisioning exercises, including scenario development, is that that they can be used to highlight the need for mechanisms for the long-term evaluation of policies and strategies, particularly in the context of preparing society, institutions, actors and infrastructure for lasting change (Mont *et al.*,2014).

According to Söderholm *et al.* (2011), previous scenario studies have typically focused primarily on analysing the impact of well-defined and uniform policy instruments. Far fewer studies factor in the role of institutional change in achieving different energy futures (Söderholm *et al.*, 2011). The negative consequences of visions may not only be related to environmental impacts, but also cause societal conflicts (Trutnevyte, 2014). Frei (2007) cited in Trutnevyte (2014) reports that four energy visions: *clean coal society, nuclear society, smart grid electricity society and bio-society* differ considerably in their acceptance by the key societal actors, such as consumers, big industries etc. Scenario studies, however, often present conflicting results regarding important issues such as future energy consumption, technology diffusion patterns, and the cost of policy compliance (Söderholm *et al.*, 2011).

Although theoretical optimisations can provide guidance for energy mix decisions from a pure physical systems engineering point of view, these solutions might not be optimal from a political or social perspective (Weijermars *et al.*, 2012). A good vision needs to be both analytically sound and socially and politically viable (Trutnevyte, 2014). Improving the transparency of the vision sharing and strategy making processes in a systematic way is therefore as important as the actual systems engineering solutions proposed by the modelling tools (Weijermars *et al.*, 2012).

Globally, an increasing number of detailed policy road maps and reports are being developed in response to the necessity and urgency of enacting a rapid transition to a just and sustainable post-carbon future (Wiseman *et al.*, 2013). Energy visions, which define the desirable state of the future energy system, are used by leaders and other societal actors in developing energy strategies. Low-carbon energy and 100% renewable energy systems are examples of such visions (Trutnevyte, 2014). While they vary significantly in scope, levels of ambition, and methodologies, futures approaches such as scenario development and energy system visioning can contribute to a clearer understanding of the steps required and demonstrate what is possible in achieving post-carbon transitions (Wiseman *et al.*, 2013). Section 4.1 presents results of a comprehensive survey of energy systems visions, including collections of future energy system scenarios, at global, national and city-region scale, collated from academic, NGO and governmental sources.

## 2.3 *Top-down & Bottom-up Perspectives*

The challenge of operationalising and implementing a 2°C carbon trajectory reveals the unprecedented scale of change that society has to undergo on the path to sustainability (Foxon *et al.*,2010; Mont *et al.*, 2014; Wiseman *et al.*, 2013). To date, technological and economic modelling have formed the dominant modes of analysis of future low carbon energy systems (Foxon, 2013). In practice, futures visioning exercises have typically taken a predominantly institutional and administrational perspective on the public and do not often directly engage in detail with citizens' values and behaviour (sustainability related or otherwise) (John *et al.*, 2015). However, the gap between theory and practice could be bridged by better engaging stakeholders, including practitioners, businesses, and consumers, according to Mont *et al.* (2014). The environmental management literature in particular, stresses the need for community involvement; useful to identify indicators to monitor progress towards sustainable development and environmental management goals, for instance (Fraser *et al.*, 2006).

It is clear that the low-carbon transformation cannot be realised by a single actor or by merely 'top-down' processes (Mont *et al.*, 2014). John *et al.* (2015) report that the inclusion of diverse actors, and participation of the public in particular, contribute to tangible (as well as intangible) positive outcomes in community visioning exercises. The creativity and leadership of many is therefore needed to achieve the widespread changes that will shift current unsustainable lifestyle trends (Mont *et al.*, 2014). The perceptions and values of a range of diverse actors impact the potential uptake of transition strategies in urban systems (Olazabal & Pascual, 2014). The process of engaging such actors can not only improve sustainability transitions prospects at the local level, but can contribute to the development of valuable social capital. At the community level, the capacity to engage in large group deliberations, consensus about targets for city development, and support for and willingness to participate in strategies to achieve visions (John *et al.*, 2015) all constitute valuable local capacity and agency development, for instance.

More broadly, Foxon (2013) highlights the need for a deeper public debate on the desirable features of a low carbon energy future and the relative priorities of different objectives that energy systems could contribute to. Further, Girard *et al.* (2015) argue that integrating top–down and bottom–up approaches could bridge the gap between investigating theoretical climate change impacts and designing pragmatic local adaptation strategies. An interdisciplinary approach that brings together both theoretical and more practically oriented knowledge is likely to help arrive at solutions that are both grounded in a robust conceptual understanding and useable in practice (Mont *et al.*, 2014).

Forrest and Wiek (2015) identify factors positively influencing transition outcomes including community governance, community capacity, organisation and management, resources, and mobilisation. Information exchange, communication and participation in decision-making processes are key to bring about effective transition processes (Olazabal & Pascual, 2014). As argued by Forrest and Wiek (2015), community sustainability initiatives can be seen not just as sites of social innovation that contribute to particular socio-technical system transition but as in situ, comprehensive transitions of the community itself. It is crucial therefore, that communities have the appropriate level of agency over, engagement with buy-in to such transformations.

# 3 A Mixed-Methods Approach for Exploring Energy System Visioning

## 3.1 *Methodology Development*

For this deliverable, a mixed methods approach was applied to gain insights into the complex understandings, expectations and feelings on energy practices, the energy system, and its future. To date, the sustainability transitions literature has focused on lessons learned from past, historical transitions of energy systems and has developed a range of theoretical frameworks and typologies to explain the processes which underpin socio-technical transitions (Foxon *et al.*, 2010; Foxon *et al.*, 2013). While these typologies take into consideration the roles of different actors and the decisions made that comprise 'transitions' (Foxon *et al.*, 2013; Geels & Schot, 2007), there has, to date, been little research which has explored transitions in progress. In particular, there remains a dearth of understanding of the role and contribution of changing attitudes, practices and social interactions on future energy system transformation. For this deliverable a mixed methodological approach is applied to explore what residents in their communities *want* and *expect* the future of the system to look like. The analysis reported herein provides both breadth and depth of understanding of how individuals make sense of low-carbon configurations for the energy system. The applied approach helps to shed light on individual considerations, decisions and choices on the future of the energy system, while also beginning to address a knowledge gap in the sustainability transitions literature.

Stakeholder oriented studies on energy transitions have to date tended to elicit expert stakeholders (such as those from academia, the energy sector, NGOs, the automotive industry, transport consultants, and central government), with limited examples of studies which have explored local resident and community perspectives on the direction and nature of energy transitions. While the literature on public (sustainability) attitudes indicates a growing understanding and concern for climate change and sustainability-related issues (Whitmarsh & Nykvist, 2008), the evidence suggests broad ranging support for technological rather than behavioural or practice based interventions. In Deliverable 6.1, a diverse approach to eliciting stakeholder perspectives on energy transitions in communities is applied, with the aim to explore the *wants* and *expectations* of individuals for the future of the energy system. Figure 2 presents an overview of the methodology developed for this purpose.

From a bottom-up perspective, data were collated from the following sources:

- Questionnaires distributed in Stockbridge (UK) community of practice
- Interviews & Focus Groups, in Stockbridge (UK) community of practice.
- Questionnaires and Workshops with "Transition Liverpool", a local transitions community interest group in Liverpool (UK)
- Opinions/ inputs from the SME sector, with emphasis on Community Energy Organisations; these were elicited using semi-structured interviews and a bespoke questionnaire.
- 'Energy Visions' community brainstorm exercise, data generation at 3 public events.

From a top-down perspective, data were collated from the following sources:

- Energy System Visioning Literature Review, including a survey of published energy system 'vision' reports
- Delphi-like expert panel review

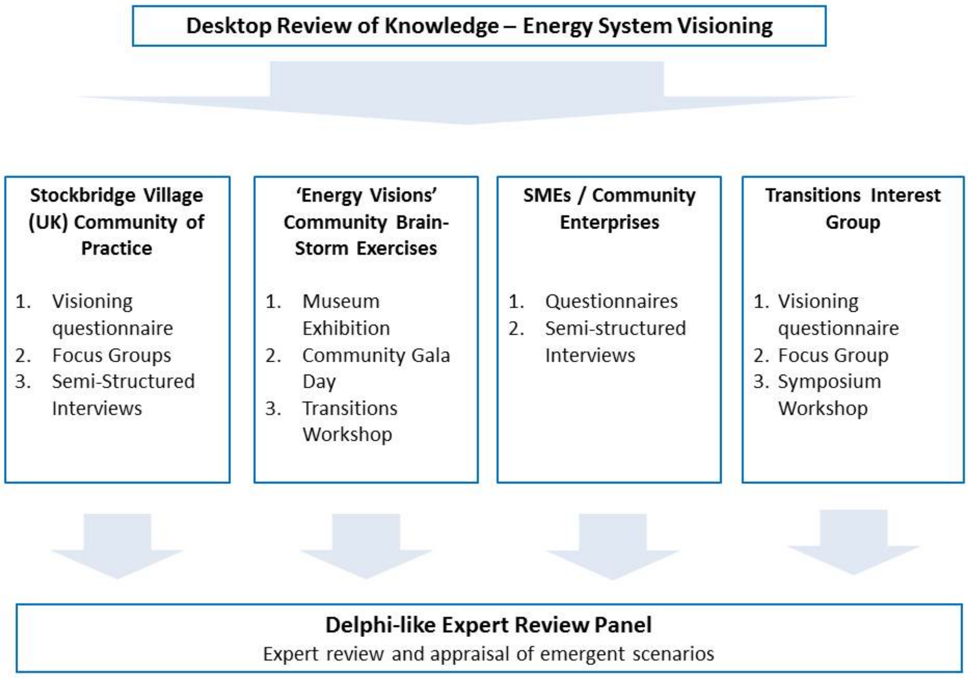


**Figure 2: Methodology / Data 'pillars' applied for Deliverable 6.1, Energy System Visioning**

Outputted data were then synthesised using a summary SWOT (Strengths, Weaknesses, Opportunities, Threats) approach.

## 3.2 *Community 'Bottom-up' Methods*

### *3.2.1 Semi-structured Interviews and Focus Groups*

The justification for applying semi-structured interviews and focus groups as the primary stage of this research was for its interpretative power to provide in-depth understanding of what individuals and stakeholders *want* and *expect* the future of the energy system to look like. Interviews and focus groups were conducted to explore the views of key stakeholders on the future of the energy system. Crang and Cook (2007) state that given the main aim of interviewing in ethnographic research is to allow people to reveal their own version of events in their own words, it is important to ask follow up questions in such a way as to encourage, and critically question, the stories told. Thus, interviews provide a flexible methodological approach for this Deliverable. Given that no two interviews are to be considered 'similar', interviewees have the opportunity to craft their energy system visions with more precision and have the time to 'flesh out' any specified elements to accompany this. In this research, semi-structured interviews were considered the most appropriate approach to explore specific issues around energy, the energy system and its future with residents in a way where insights into their considerations, decisions and choices could be freely contributed. Semi-structured interviews were applied, with a degree of predetermined order but with sufficient flexibility to allow informants to present information on their terms, and to potentially offer unexpected insights (Longhurst, 2003).

Focus groups are a useful approach to study the dynamics of emotions and perceptions on global issues such as climate change, and on people's participatory experiences and interactions with environmental issues (Conradson, 2005; Longhurst, 2003). Focus groups have been successfully employed to explore the complex understandings and interactions that people have with their everyday environments (Conradson, 2005). Focus groups explore individual perceptions and actions towards such issues in a dynamic, social context (Bryman, 2015; Stoll-Kleemann *et al.*, 2001). Importantly, focus groups provide insight into why certain relationships do, or do not, emerge and thus perform an explanatory function (Creswell, 2003). Moreover, they allow participants to express their beliefs, feelings and behaviours in their own words and expose how individuals construct issues around energy practices, the energy system and its future by drawing on different forms of knowledge, values and experiences (Conradson, 2005).

Focus groups are useful for investigating complex opinions, emotions and behaviours and for collecting a diversity of experiences (Conradson, 2005; Longhurst, 2003). For this research, focus groups are therefore an appropriate method to explore what key stakeholders *want* and *expect* the future of the energy system to look like. The discussions during each focus group was recorded with informed consent of the participants, transcribed verbatim and analysed as part of an inductive thematic analysis approach (see Batel *et al.*, 2015; Toth *et al.*, 2013). Thematic analysis is a widely used qualitative analytical framework focusing on identifying themes from lived, everyday experience (Aronson, 1995; Braun & Clarke, 2006). Thematic analysis involves different stages including becoming familiar with the data; generating initial codes; and developing, reviewing and defining themes (Braun & Clarke, 2006). Following the stages suggested by Braun and Clarke (2006) initial codes were defined into broader themes that were reviewed and validated to ensure all coded data fitted within each theme and that the themes represented the data accurately. For example, interventions applied to support lifestyle choices included suggestions such as information and feedback whilst factors that affect (supporting or inhibiting) sustainable lifestyles included "powerlessness" and collective action were also identified.

### *3.2.2 Summary of D6.1 Participant Information*

Table 1 indicates the stakeholder engagement undertaken as part of the ENTRUST project across Stockbridge Village community of practice, including additional engagement activities for D6.1.

**Table 1: Summary of D6.1 Participants, Stockbridge Community of Practice**

| Engagement Description | Participant Code | Interview date | Age | Gender |
|---|---|---|---|---|
| Stockbridge Resident Interviews | IP1 | 22/07/2016 | 48 | Male |
| Stockbridge Resident Interviews | IP2 | 22/07/2016 | 73 | Female |
| Stockbridge Resident Interviews | IP3 | 22/07/2016 | 75 | Male |
| Stockbridge Resident Interviews | IP5 | 04/10/2016 | 49 | Male |
| Stockbridge Resident Interviews | IP6 | 12/10/2016 | 51 | Female |
| Stockbridge Resident Interviews | IP7 | 12/10/2016 | 36 | Female |
| Stockbridge Resident Interviews | IP8 | 19/10/2016 | 71 | Female |
| Stockbridge Resident Interviews | IP10 | 19/10/2016 | 57 | Female |
| Stockbridge Resident Interviews | IP11 | 19/10/2016 | 83 | Female |
| Stockbridge Resident Interviews | IP12 | 09/11/2016 | 58 | Female |
| Stockbridge Resident Interviews | IP13 | 25/11/2016 | 63 | Male |
| 'Scoping Exercise' Group 1 Discussion | FG1P1 | 07/06/2016 | 46 | Male |
| 'Scoping Exercise' Group 1 Discussion | FG1P2 | 07/06/2016 | 58 | Male |
| 'Scoping Exercise' Group 1 Discussion | FG1P3 | 07/06/2016 | 29 | Female |
| 'Scoping Exercise' Group 1 Discussion | FG1P4 | 07/06/2016 | 30 | Female |
| 'Scoping Exercise' Group 2 Discussion | FG2P1 | 07/06/2016 | 45 | Male |
| 'Scoping Exercise' Group 2 Discussion | FG2P2 | 07/06/2016 | 73 | Female |
| 'Scoping Exercise' Group 2 Discussion | FG3P3 | 07/06/2016 | 44 | Female |
| 'Scoping Exercise' Group 2 Discussion | FG2P4 | 07/06/2016 | 37 | Male |
| Stockbridge Residents Focus Group | FG5P1 | 23/11/16 | 31 | Female |

| Engagement Description | Participant Code | Interview date | Age | Gender |
|---|---|---|---|---|
| Stockbridge Residents Focus Group | FG5P2 | 23/11/16 | 24 | Female |
| Stockbridge Residents Focus Group | FG5P3 | 23/11/16 | 42 | Female |
| Stockbridge Residents Focus Group | FG5P4 | 23/11/16 | 28 | Female |
| Stockbridge Residents Focus Group | FG5P5 | 23/11/16 | 49 | Female |
| Stockbridge Residents Focus Group | FG5P6 | 23/11/16 | 40 | Female |
| Stockbridge Residents Focus Group | FG5P7 | 23/11/16 | 32 | Female |
| Stockbridge Residents Focus Group | FG5P8 | 23/11/16 | 34 | Female |

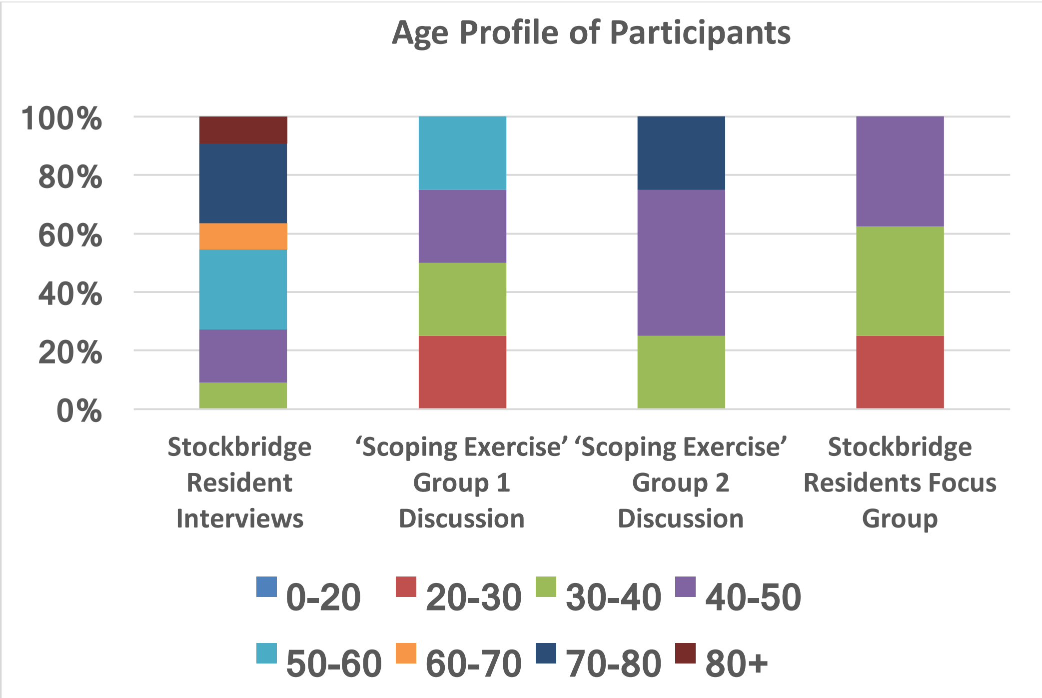


**Figure 3: Age Profile of D6.1 Participants, Stockbridge Community of Practice**

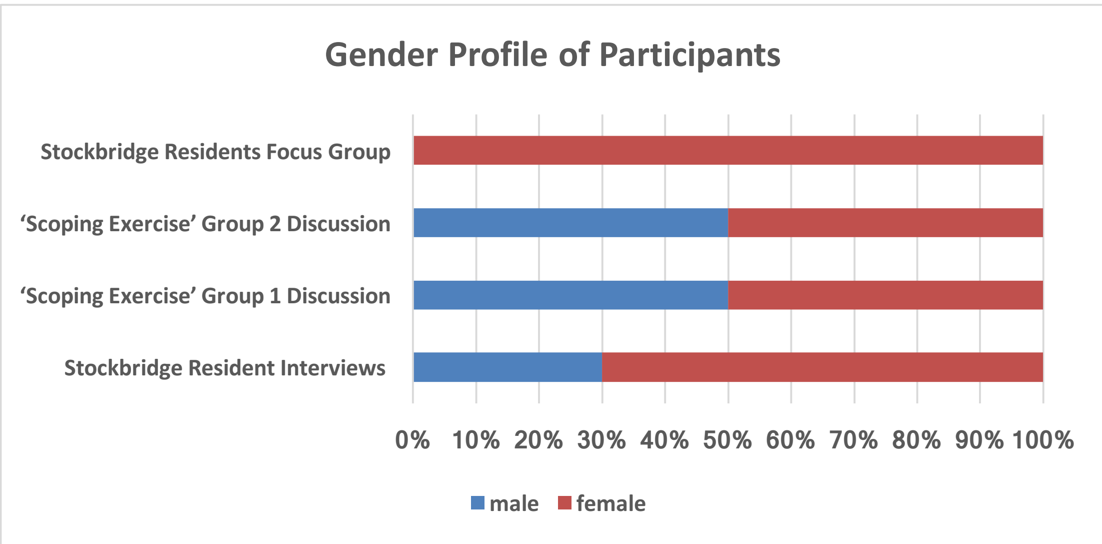


**Figure 4: Gender Profile of D6.1 Participants, Stockbridge Community of Practice**

**Table 2: Summary of D6.1 Participants, Transition Liverpool, Community of Interest**

| Engagement Description | Participant Code | Interview date | Age | Gender |
|---|---|---|---|---|
| Transitions focus group 1 | FG3P1 | 13/07/2016 | -[3] | Male |
| Transitions focus group 1 | FG3P2 | 13/07/2016 | 41 | Male |
| Transitions focus group 1 | FG3P3 | 13/07/2016 | 43 | Female |
| Transitions focus group 1 | FG3P4 | 13/07/2016 | 60 | Male |
| Transitions focus group 1 | FG3P5 | 13/07/2016 | 26 | Male |
| Transitions focus group 1 | FG3P6 | 13/07/2016 | 63 | Male |
| Transitions focus group 1 | FG3P7 | 13/07/2016 | 60 | Female |
| Transitions Symposium focus group 2 | FG4P1 | 15/10/2016 | 38 | Female |
| Transitions Symposium focus group 2 | FG4P2 | 15/10/2016 | 20 | Male |
| Transitions Symposium focus group 2 | FG4P3 | 15/10/2016 | 56 | Male |
| Transitions Symposium focus group 2 | FG4P4 | 15/10/2016 | 59 | Male |
| Transitions Symposium focus group 2 | FG4P5 | 15/10/2016 | 55 | Male |
| Transitions Symposium focus group 2 | FG4P6 | 15/10/2016 | 57 | Female |
| Transitions Symposium focus group 2 | FG4P7 | 15/10/2016 | 32 | Male |
| Transitions Symposium focus group 2 | FG4P8 | 15/10/2016 | 31 | Female |
| Transitions Symposium focus group 2 | FG4P9 | 15/10/2016 | 35 | Male |
| Transitions Symposium focus group 2 | FG4P10 | 15/10/2016 | 37 | Male |
| Transitions Symposium focus group 2 | FG4P11 | 15/10/2016 | 58 | Male |
| Transitions Symposium focus group 2 | FG4P12 | 15/10/2016 | 55 | Female |
| Transitions Symposium focus group 2 | FG4P13 | 15/10/2016 | 58 | Male |

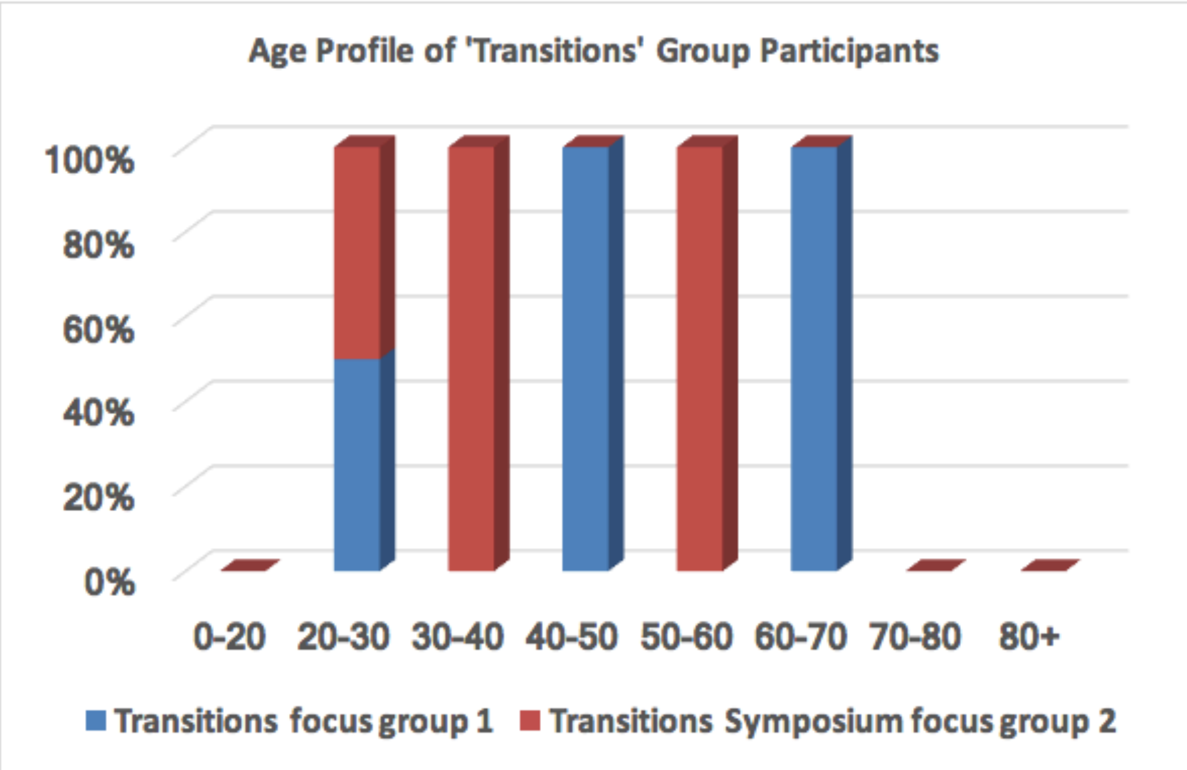


**Figure 5: Age Profile of D6.1 Participants, Transition Liverpool, Community of Interest**

[3] Age not given/withheld in this instance.

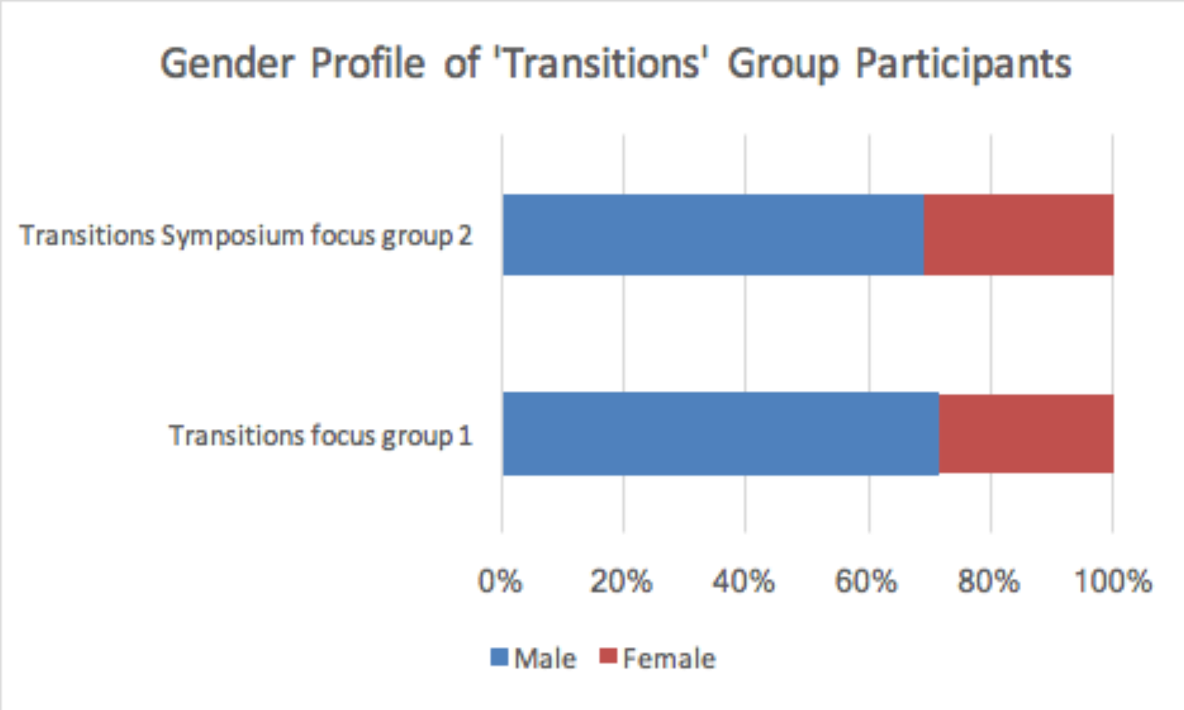


**Figure 6: Gender Profile of D6.1 Participants, Transition Liverpool, Community of Interest**

**Table 3: Summary of Key Informants for Community Energy SMEs**

| Key Informant | Professional Role | Organisation | Date of interview |
|---|---|---|---|
| SME-KI 1 | Chief Executive Officer | Social enterprise (energy generation) | 9th February 2016 |
| SME-KI 2 | Chief Executive Officer | Social enterprise (energy use reduction) | 22nd February 2016 |
| SME-KI 3 | Research Officer | Business support for social enterprise | 22nd February 2016 |
| SME-KI 4 | Project Manager | Public-Private Partnership | 23rd February 2016 |
| SME-KI 5 | Company Director | Social enterprise (energy generation) | 21st October 2016 |
| SME-KI 6 | Company Director | Social enterprise (energy generation) | 26th October 2016 |
| SME-KI 7 | Company Director | Social enterprise (energy generation) | 28th October 2016 |

### *3.2.3 Questionnaires*

To complement the rich qualitative data from semi-structured interviews and focus group discussions, a bespoke survey was also conducted. For this, a short questionnaire was developed (Appendix 2). The primary aim of this was to provide structured and comparable responses to key targeted questions on energy system visioning. In particular, the questionnaire aimed to generate insight into enablers of, and barriers to, residents' preferred energy vision together with an identification of those actors whom they considered to be the most important leaders and influencers across the energy system. Questions on sustainability visions posed by Whitmarsh *et al.* (2007) and Whitmarsh & Nykvist (2008) were taken as a starting point for the development of questions for the ENTRUST stakeholders questionnaire. Developed questions therefore emerged from, and further developed questions asked by Nykvist and Whitmarsh (2008) and Whitmarsh *et al.* (2007) on visions for energy system sustainability[4].The goal of survey research is to acquire information about the characteristics, attitudes and behaviours of a population by administering a

[4] These papers were deemed relevant to D6.1 especially as both integrated expert and non-expert visions for system sustainability (in these cases, related to the transport system),

uniform questionnaire to a sample of individuals (Bryman, 2015; McLafferty, 2003). Survey research is particularly useful for eliciting public attitudes and perspectives regarding social, economic, political and environmental issues; and valuable for investigating complex behaviours and social interactions (McLafferty, 2003; Parfitt, 2005)[5]. Good survey design is partly achieved by attempting to anticipate and minimise various types of error that may undermine the reliability and validity of a questionnaire survey (Bryman, 2015; Parfitt, 2005). In some cases, questionnaires can constrain the responses that respondents can potentially provide. To address this limitation, this study incorporated a diversity of questions (both closed-ended and open-ended) and included space for additional comments in the questionnaire. Additionally, questions asked may not be understood in the way intended or the respondent may feel pressured into agreeing with the researcher's own ideas (Parfitt, 2005; Robinson, 1998). Addressing these limitations, face-to-face administration of the questionnaires was undertaken whereby the interviewer guided the respondent and explained terms more appropriately, when required (McLafferty, 2003). This method of administration provides better response rates than self-administered, postal and electronic survey administration (McLafferty, 2003).

In surveys, when respondents are ambiguous, there is a tendency (albeit unintentional) to fit unclear responses into ones consistent with opinions expressed earlier during a questionnaire or interview (Parfitt, 2005). Alternatively, interviewers can build up a picture of the relationship between key independent variables and the responses to question from earlier surveys. These 'expectational errors' or biases can lead to the researcher seeking information that conforms with key theories under investigation rather than that which contradicts (Parfitt, 2005). The use of a combination of semi-structured interviews, questionnaires, focus groups and community brainstorm exercises allowed a triangulation of key findings and served to enhance the robustness of those findings. In addition, all recorded and themed responses were interpreted and discussed with reference to the sustainability transitions literature. Questionnaires were distributed in three stakeholder communities: one community of practice (Stockbridge Village, Knowsley); a transitions interest group in Liverpool; and at a public engagement event at Manchester Museum involving members of the general public. These questionnaires were largely given to individuals through a face-to-face approach so that researchers could go through the questions with each respondent, to support any difficulties any individual may have had with progressing through the questionnaire. A total of 96 respondents were surveyed by the questionnaire: 48 in Stockbridge, 26 from the Transitions interest group, and 22 from the event at Manchester Museum. Questionnaires were distributed across these groups from July 2016 to January 2017. The numbers distributed and overall response rates are shown in Table 4. The socio-demographic profile of returned samples for each community and the overall survey total is illustrated in Table 5. A full table describing these attributes, per returned questionnaire, is presented in the Appendix.

[5] Robinson (1998), Parfitt (2005), and McLafferty (2003) present detailed critical overview of the use of questionnaires and surveys in social science research.

**Table 4: Questionnaires Distributed and Overall Response Rates**

| Date | Questionnaires distributed | Completed / Returned Questionnaires | Response rate |
|---|---|---|---|
| **Stockbridge Village** | | | |
| 07/06/16 | 20 | 3 | 15.0% |
| 14/06/16 | 16 | 2 | 12.5% |
| 22/07/16 | 18 | 4 | 22.2% |
| 29/07/16 | 24 | 5 | 20.8% |
| 13/09/16 | 22 | 4 | 18.2% |
| 23/11/16 | 10 | 5 | 50.0% |
| 16/01/17 | 50 (+30)[6] | 15 | 18.8% |
| 27/02/17 | 15 | 10 | 66.7% |
| **Total Stockbridge** | **205** | **48** | **23.4%** |
| **Manchester Museum**[7] | | | |
| 30/07/2016 | **26** | **26** | **-** |
| **Transition Liverpool Symposium** | | | |
| 15/10/2016 | **22** | **22** | **-** |
| **Overall Total** | | | |
| **Overall Total** | **253** | **96** | **37.94%** |

**Table 5: Socio-Demographic Profile of Questionnaire-Survey Respondents**

| **Gender** | **Stockbridge** | **Transitions** | **Manchester** | **Overall** |
|---|---|---|---|---|
| Male | 17 | 13 | 10 | 40 |
| Female | 31 | 10 | 12 | 43 |
| Other | 0 | 1 | 0 | 1 |
| Not known | 0 | 2 | 0 | 2 |
| *Total* | *48* | *26* | *22* | *96* |
| **Age** | **Stockbridge** | **Transitions** | **Manchester** | **Overall** |
| 18-25 | 5 | 2 | 12 | 19 |
| 26-35 | 7 | 3 | 8 | 18 |
| 36-45 | 11 | 7 | 1 | 19 |
| 46-55 | 12 | 4 | 1 | 17 |
| 56-65 | 6 | 5 | 0 | 11 |
| 66-75 | 2 | 2 | 0 | 4 |
| 76+ | 3 | 0 | 0 | 3 |
| Not known | 2 | 2 | 0 | 4 |
| *Total* | *48* | *26* | *22* | *96* |
| **Ethnicity** | **Stockbridge** | **Transitions** | **Manchester** | **Overall** |
| White British | 46 | 20 | 14 | 80 |
| White European | 0 | 2 | 3 | 5 |
| Asian | 0 | 0 | 3 | 3 |
| Arabic | 0 | 2 | 1 | 3 |
| Black African | 2 | 0 | 0 | 2 |
| Mixed white | 0 | 0 | 1 | 1 |
| Not known | 0 | 2 | 0 | 2 |
| *Total* | *48* | *26* | *22* | *96* |

[6] Questionnaires were distributed by hand outside of School premises in Stockbridge Village (50). An additional (30) questionnaires were distributed by the School to parents, after this date.
[7] For events in Manchester Museum and Transition Liverpool, visitors / event participants were offered to complete a questionnaire on site, at that time. Those that accepted completed the questionnaire, i.e. Questionnaires were only distributed to those who agreed to complete the form 'there and then'. Total visitor numbers to these events are indicated in Table 7.

Questionnaires were also distributed to SMEs and community energy social enterprises. For this, ENTRUST partner organisations were asked to circulate a 'Survey Monkey' link to an online version of the questionnaire, together with an electronic word document of the questionnaire form. It is estimated that up to 100 organisations were contacted through this snowball approach (giving a ~15% response rate). A summary of questionnaire respondents for the returned SME questionnaires is presented in Table 6.

**Table 6: Summary of SME Questionnaire Respondents**

| Respondent Number | Country | Employees | Sector | Respondent Role |
|---|---|---|---|---|
| SME-R1 | UK | 21 | Engineering | Managing Director |
| SME-R2 | UK | 12 | Entertainment | Manager |
| SME-R3 | UK | 1 | Architect | Managing Director |
| SME-R4 | UK | 30 | Medical/Aerospace | Managing Director |
| SME-R5 | Italy | 5 | Energy Management | General Manager |
| SME-R6 | Lithuania | 2000 | Education | Employee |
| SME-R7 | UK | 8 | Consultancy | Project Manager |
| SME-R8 | Italy | 1 | Consulting | -Manager |
| SME-R9 | Netherlands | 2.5 | Energy R&D | Director |
| SME-R10 | Catalonia | 3 | Engineering | Manager |
| SME-R11 | France | 18 | Consulting | BU Manager |
| SME-R12 | France | N/A | Energy | Project Manager |
| SME-R13 | France | 1600 | Construction | Marketing Manager |
| SME-R14 | France | 6 | Env. Consultancy | Consultant |
| SME-R15 | UK | 2 | Energy/Environmental | Director |
| | | | | |

### *3.2.4 'Energy Visions' Community Brain-Storm Exercise*

Meaningful public participation must support the establishment of relationships through involving, collaborating with, or empowering public participants in such a way that they can contribute their knowledge (Morrison & Dearden 2013). At community level, innovative approaches can foster more effective engagement (Axon, 2016; Morrison & Dearden, 2013). A community 'Energy Visions' brain-storm exercise was conducted as part of a number of community engagements for ENTRUST WP5 'Community Engagement', as well as during outreach events. This exercise was useful for both WP5 and WP6. For WP6, this was an alternative means to elicit quick and immediate responses from community members on their vision(s) for the future of the energy system. For the purposes of WP5, the exercise served as a means to start a conversation on energy more broadly, to discuss the ENTRUST project and the local community of practice, and to recruit interested parties as interviewees or focus group participants. The brainstorm exercise was applied at the locations presented in Table 7.

**Table 7: Summary of Energy Visions' Community Brainstorm Exercise Activities**

| Event | Location | Date | No. of participants |
|---|---|---|---|
| 'Climate Control' Community Outreach Event | Manchester Museum | 30th July 2016 | 765 visitors to the museum for 'Climate Control'<br><br>**68 direct engagements with the ENTRUST brain-storm exercise** |
| Community Gala Day | Stockbridge Village, Knowsley (UK) | 18th August 2016 | ~300 attendees at event<br><br>**41 direct engagements with the ENTRUST brain-storm exercise** |
| Transitions Symposium | Liverpool City Centre | 15th October, 2016 | ~65 attendees<br><br>**41 direct engagements with the ENTRUST brain-storm exercise** |

The exercise consisted of a canvas with the heading "what do you want the energy system to look like in the next 20 years?" The canvas is comprised of 6 'bubbles' which participants were asked to respond to. They achieved this by writing their ideas on post-it notes and sticking these at the relevant location on the brainstorm canvas. The 6 'bubbles' of the canvas corresponded to broad systems and industries of importance from an energy perspective, including: (1) energy production; (2) communities; (3) cities; (4) agriculture; (5) businesses; and (6) transport (see Figure 7).

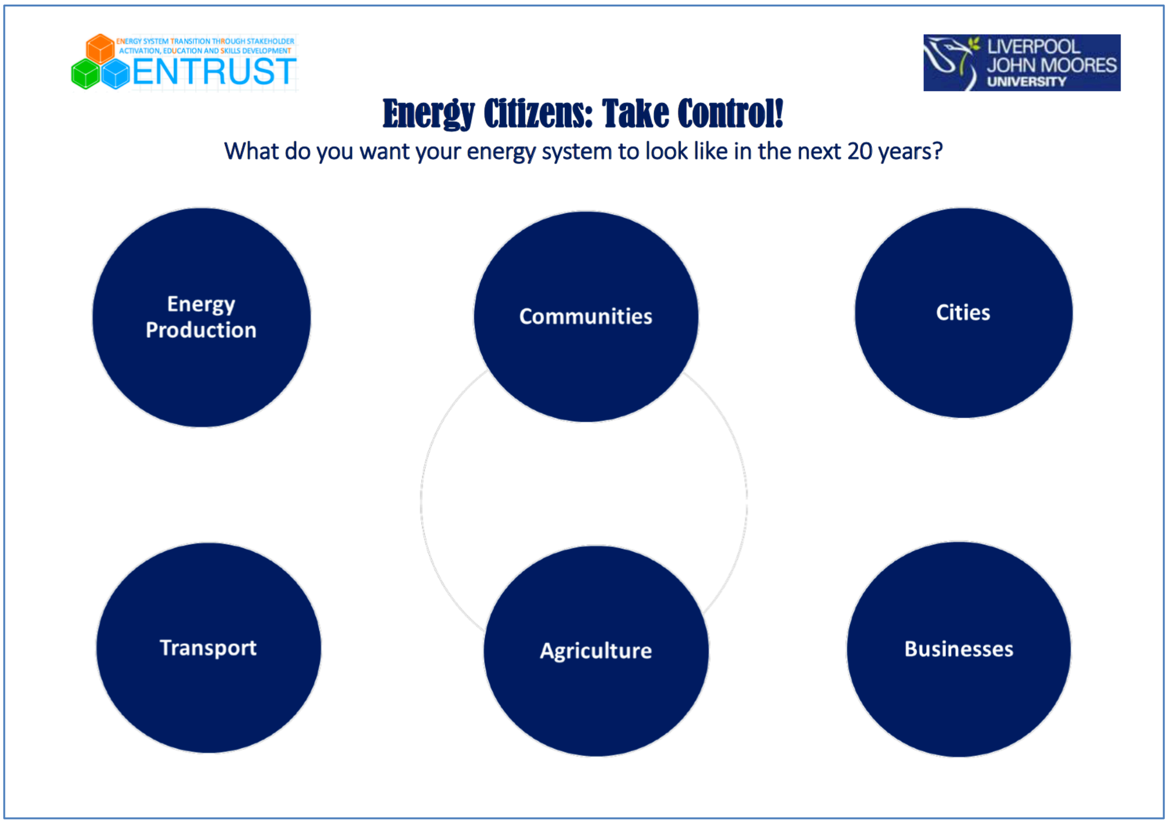


**Figure 7: 'Energy Visions' Community Brain-Storm Canvas**

This interactive exercise, allowing participants to articulate their visions at community events, provides an alternative to group-discussion based engagement approaches.

The brainstorm exercise provided a more interactive dimension that supported the scoping of themes of investigation, data collection and helped with participant recruitment for further engagement exercises. The use of a range and diversity of approaches also helped to reach a broader and more challenging to reach demographic than would have been the case with use of a single engagement technique, such as questionnaires alone.

The exercise allowed residents to articulate what they wanted the future to look like for the main 6 energy themed 'bubbles'. This exercise allowed residents in the communities to share their own vision and also to engage with the vision of others in the community (frequently respondents reviewed existing post-it notes, before responding). The exercise therefore had an element of social learning where residents could envisage how other residents and actors view future energy transitions and how changes in each area could be implemented.

### *3.2.5 'Transition Liverpool' Interest Group Workshop & Focus Group*

The 'Transition Liverpool' Interest Group was engaged for T6.1 to elicit responses from a demographic with a stated interest in low-carbon transitions. Visions from this group were deemed to be an important reference point when analysing visions from the Stockbridge community of practice. Namely, the commonalities and differences between a community with a mix of views on energy and a self-selecting community of interest were useful for D6.1 analysis. Data from the Transition Liverpool Interest group were derived from two interlinked engagements; a transition workshop and focus group discussion with key informants. The two engagements were undertaken to gain a broad overview of the viewpoints of this particular demographic on energy system change over a future 20-year time-horizon. The same questions used for the survey and workshop at the Stockbridge community of practice was applied for these engagements also (see Appendix 2 for full questionnaire).

**Table 8: Questions on energy system change over a future 20-year time-horizon**

| |
|---|
| 1) What do you want the energy system to look like in the next 20 years? |
| 2) What do you expect it to look like in 20 years and why? |
| 3) What role should various actors play in the future energy system? |
| 4) What actions could help deliver the preferred vision? |
| 5) What are the barriers? |
| 6) What are the most important action(s) to prioritise? |

#### *3.2.5.1 Transitions Interest Group Method 1: 'Transition Liverpool' Focus Group*

The aim of using focus groups was to generate rich qualitative data on the theme of energy system change. This was conducted with citizens with prior interest in, and engagement with, the concept of transitions.

Focus group participants were selected via a local community NGO called 'Transition Liverpool' (TL) which operates across a large Liverpool city region catchment, and consists of networks of individuals and organisations that 'follow' TL through email newsletters the activities of TL. TL facilitated access to their network in order to promote the focus group, and to assist with recruitment for this data generation activity. The self-selecting participants represented a diverse socio-economic group. In particular, as many of the participants were already engaged in energy transitions related issues through their professional capacities they also provided a practitioner's point of view (e.g. a social enterprise manager that delivers and promotes renewable technologies). Thus, the sample represented a mix of gender, ages, and professions (a full breakdown is available in Table 2).

The focus group was held with 7 participants. A semi-structured approach was used using the broad and open-ended questions to prompt discussion (see Table 2). Participants were also invited to raise and discuss other themes that they felt were important to the debate of energy system change (not already considered by the research team). The session lasted approximately 1.5 hours and was facilitated by one member of the research team. The focus group discussion was audio recorded and transcribed.

##### *3.2.5.2 Transitions Interest Group Method 2: 'Transition Liverpool' Symposium Workshop*

The Transitions Interest Group workshop was held as part of a one-day symposium event organised by Transition Liverpool. The Symposium is an annual event and is open to the public and practitioners (*e.g.,* NGO community and civil society organisations, local politicians, researchers, educators, *etc.*). The Symposium aims to promote sustainable development including energy issues in local communities. The event is widely promoted by all of the collaborators of the Symposium via local newspapers, leaflets and online social marketing mainly within the Liverpool City Region. The rationale for the implementation of the workshop

The LJMU ENTRUST research team took part in the symposium by invitation of the Transition Liverpool group in two capacities: as symposium participants and as researchers conducting data collection. In this way, data were collected by 'piggybacking' on this event, which provided a unique opportunity to capture a broad sample of participants with different life and professional experiences yet also those interested in the broader themes of sustainability. In essence, the ENTRUST team targeted a 'captive-audience'. Thus, the participants for the dedicated ENTRUST workshop session within the Symposium were self-selecting (pre-booked their attendance) and reflected a range of diverse socio-economic and demographic backgrounds (Table 2).

Within the Symposium, the LJMU ENTRUST team utilised a number of approaches to gather insights from members of the Transitions Interest Group, these are as follows:

Questionnaire: The workshop comprised a small group of 13 participants. Each participant after a brief introduction was encouraged to fill in the ENTRUST questionnaire on energy system change (Table 6 & Appendix 2) about what they thought the energy system could look like in the next 20 years. This helped to stimulate interest and develop an outline of the themes of interest to the research;

Mini-group brainstorm: As a follow-on from the questionnaire, the group was broken into smaller mini-groups (3 to 4 participants) and asked to brainstorm responses on blank paper to the key questions posted by the researchers. The six questions from the questionnaire helped to guide the discussions.

Group discussion: The final element included a group discussion as each mini-group 'fed-back' their responses to the key questions, these were written up on a board for everyone to see and to discuss as part of a wider group debate. The group session discussion was audio recorded and then transcribed. The transcriptions were thematically analysed using NVivo software.

## 3.3 *Expert 'Top-down' Methods*

### *3.3.1 Delphi Panel-like Expert Review*

The Delphi Technique of data collection seeks to elicit and refine anonymous group judgements. It is based on the assertion that a group of experts is better than one expert or that anonymous group judgments are more valid than individual ones (Paliwoda, 1983). It is particularly useful when exact knowledge is not available (Paliwoda, 1983) and can be used to provide an estimate or forecast on the likelihood and/or outcome of future events. The Delphi Technique is generally applied as an iterative and reflexive process which often seeks to create consensus on a set of issues or questions

(Skulmoski *et al.*, 2007). A derivation of the Delphi Technique was deemed an appropriate method for D6.1, useful to improve current understandings of the specific problem of energy system change, and in identifying opportunities and solutions for achieving change. Delphi is well suited for interdisciplinary and mixed methods approaches as it can be combined with a series of data collection, analysis and feedback methodological tools (Skulmoski *et al.*, 2007).

As described, a mixed methods approach was applied for D6.1 to investigate what people wanted and expected their future energy system would look like. The Delphi-like method is the final phase of the research methodology employed for 6.1 following one-to-one interviews, questionnaire surveys, focus groups and workshops. Breaking from the traditional Delphi approach[8] of seeking to gather consensus, the main objective of applying a Delphi-like approach was to "condense the views of the expert panels into a small number of different views about the future", following Järvi *et al.* (2015, p118). A modified Delphi-like approach was applied, to gather the viewpoints of a range of expert stakeholders on how they envisaged the energy system of the future. Actors included policymakers, industry practitioners, business leaders, academics and others. A full breakdown of the Expert Informants is provided in Table 9. In total, 23 expert participants were invited, with 11 having responded at the time of writing this report. Expert views were elicited using a version of the energy system change questionnaire that was distributed to other surveyed groups (Appendix 2). Whereas previously the research recruited individuals from specific communities (Stockbridge community of practice and Transition Liverpool community of interest), the experts come from a very diverse range of backgrounds and expertise. However, it is acknowledged that this group of experts can also be described as a community group of a sort. They also served the role of key informants on the topic of interest, as well as providing a unique perspective as key stakeholders of the energy sector. The Expert Informants were selected based on their expertise and via convenience, purposive and snowball sampling methods.

**Table 9: Summary of Expert Informants**

| Gender | Professional role | Area of expertise | Code (Expert Informant-x) |
|---|---|---|---|
| Male | Academic and practitioner | Low Carbon Business Development Sector | EI-1 |
| Male | Practitioner | Energy Sector Consultant; Housing Energy Efficiency Retrofitting Delivery (Liverpool Based) | EI-2 |
| Male | Practitioner | Housing Retrofitting Business Director | EI-3 |
| Male | Practitioner | Energy Consultant<br>European Commission Senior Expert | EI-4 |
| Female | Academic and practitioner | Renewable Energy Sector Consultant | EI-5 |
| Female | Practitioner | Local Authority Policymaker, Decision-Maker | EI-6 |
| Male | Practitioner | Economist<br>Financial Risk Manager In The Banking System | EI-7 |
| Male | Practitioner | Energy Policy, Building Services Engineering, Sustainable Energy Technologies. | EI-8 |
| Male | Practitioner | Renewable Energy And Building Efficiency | EI-9 |
| Male | Practitioner | Energy Investment | EI-10 |
| Female | Practitioner | Energy and Sustainability | EI-11 |

[8] For an example see Linstone and Turoff (2002)

The questionnaires were devised to contain both closed and open-ended questions that could potentially provide both quantitative and qualitative data. The closed ended questions with Likert scale enabled ranking of responses and enabled structured comparisons between datasets, whilst the open-ended questions enabled a qualitative dimension and enabled clarification, and contextual commentary on key themes. This helped to identify areas of convergence or divergence even though the aim was not expressly to achieve consensus. Furthermore, the emphasis and aim of the modified Delphi approach and type of data generated were also distinct from the aims and data emerging from the focus groups where participants would respond face-to-face to questions. Although focus groups have been used to scope the key issues in this research, an obvious weakness of focus groups is an inability to manage or account for power dynamics between individuals which means that some participants may have a greater voice than others, or people may not express their true feelings in a group setting and in view of peer pressures. The anonymity of the Delphi method means that individuals can 'remotely' voice their personal opinions – free of the judgements of others - based on their professional experiences without the biases of a group setting. An advantage of this process is that it can be managed electronically without the need for everyone to sit in the same room. Furthermore, when combined with other data findings, Delphi can add very specific understanding to the research problem (i.e. zooming in or out from the topic) and related to this research interest in forwarding a top-down and bottom-up perspective of the problem and solutions.

It is envisaged that the modified Delphi approach will comprise two rounds of data collection, where two different types of questionnaires are anonymously emailed to experts.

**In the first round, applied for D6.1** and reported herein, an on-line questionnaire (via survey monkey) comprised of open and closed ended questions was sent to the pre-selected expert group via email. Collated responses were summarised and will be later applied to inform development of the second-round questionnaire design. In particular, the emphasis will be on understanding 'the problem', in this case visions for future energy system change.

**In the second round, planned for application in T6.3 & T6.4, and to be reported in D6.3,** the information gathered from the first round will be processed and fed back to all participants anonymously and each person will be asked if they could reach a consensus, perhaps through changing their stance on a topic. The questionnaires are a suitable and accessible way to convey this information and may seek consensus and or judgements in the perceived course of future events. In particular, emphasis will be on developing solutions. These future visions will be expanded upon in the next areas of research in T6.3 and T6.4.

## 3.4 *Methodological Approach Reflection*

For this Deliverable, a number of methodological approaches have been applied to understand the diverse range of energy system visions and low-carbon configurations from numerous stakeholder groups. Applying a mixed methodological approach, specifically qualitative data collection and analysis techniques have been invaluable to this study as their ability to provide insights into the reasons *why* stakeholders hold such views towards the energy system and the ways in which they want them to change. Consequently, the findings from this Deliverable contribute substantially insights into the complex understandings, expectations and feelings on energy practices, the energy system, and its future.

Given that the sustainability literature has been dominated by studies focusing on identifying events and actors that have contributed to historical transitions of the energy system (e.g. Foxon *et al.*, 2010; Foxon *et al.*, 2013), this Deliverable has shed light on how various groups of stakeholders *want* and *expect* the energy system to transition to; the types of interventions that should be applied; as well as other supporting actors, institutions and organisations, that can support these visions. Therefore, the analysis and discussion sections in this Deliverable provide both breadth and depth of understanding around the 5 energy visions identified (these are 'Continuity Vision', 'Directed Decentralisation Vision', 'Gradual Path Reduction Vision', 'Accelerated Emissions Reduction Vision', and 'Deep Green Vision'). Consequently, the value of this approach has served to highlight individual considerations, decisions and choices on the future of the energy system, while also beginning to address a knowledge gap in the sustainability transitions literature. Future studies that choose to focus on current transitions; emerging transitions; or transitions 'in progress', now have, and should make, a choice around the methodological techniques applied to sustainability transitions related research.

This research also has practical applications. Namely, research of this nature that demands interviewing stakeholders also serves as public engagement whereby individual considerations are understood and, in some (if not all) cases, should be taken into consideration to inform participatory approaches that support participation with energy transitions and low-carbon configurations.

# 4 Portfolio of Community (Bottom-up) Future Vision Scenarios

## 4.1 *Outputs from Questionnaires*

Questionnaire outputs provide additional robust evidence to support the primary data collected in semi-structured interviews and focus groups investigating the same themes.

### *4.1.1 Preferences and Expectations for the Future of the Energy System*

All survey respondents were asked about their visions for the future of the energy system. This included their preferences i.e. what they want for the future of the energy system, and their expectations i.e. what they think it will realistically look like in the next 20-30 years. With respect to their preferences, respondents provided insights into the diverse ideals that they believed should comprise the future of the energy system. These preferences are demonstrated in the following quotes:

> "Keep it the way it is, gas central heating and electricity" (QR8),
>
> "Municipal and local production and control of energy, 100% renewables and zero carbon, increased efficiency of energy production tech and of end-users, and reduced demand, particularly in transport and industrial sectors" (QR12),
>
> "I would like to see nationwide, community owned, sustainable energy system" (QR16),
>
> "I think there should be much development needed of nuclear energy and renewable energy. So that we can use it after 20 years and we can provide security to our next generation" (QR37).

While there were some respondents who indicated that the provision of energy through gas should remain the same, other respondents considered how energy should be generated and produced. Within responses, idealised systems were forwarded that respondents considered should be comprised of a substantial proportion of renewable energy and that nuclear energy should also be used as part of the transition process. Respondents indicated a preference for a system of generation that relied on more local production and community-owned sustainable energy systems. Additionally, some respondents also considered that reducing demand for energy as well as improving the overall efficiency of such systems was key to providing energy security in the future. However, some of these visions contradicted what respondents indicated as their expectations on what the energy system would realistically look like given current viewpoints and perspectives. Survey respondents' expectations are outlined in the following quotes:

> "Greater role of renewables but not total supply and continued role of fossil fuels but mainly with transition fuels e.g. shale gas" (QR12),
>
> "Maybe 30% renewables, still a mix of coal, gas (including some fracked unless there's a dramatic failure or legal challenge) and probably new nuclear. Why? Because the vested interests have the political and communicative clout to override any political questioning and their self-interest is based on conservative "what they know" instincts" (QR24),
>
> "30% renewable and biomass, 10% nuclear, 60% still based on fossil fuels" (QR25)
>
> "A mix of fossil fuels and nuclear as that is what the current government is promoting and financing" (QR39),
>
> "I think perhaps a shift towards nuclear as a stepping point and green energy still being optimised due to slow development and funding" (QR52),

> "Same as now because politicians and your average person are very much removed and have other more important concerns" (QR57).

In this visioning exercise, respondents had a less positive view of what they expect the future of the energy system to look like, given a number of stated barriers to their preferred vision. While some respondents indicated that the role of renewables would increase in the future, the speculation was that potential contribution towards total energy produced would only amount to 30% with the remainder coming from nuclear, fossil fuels and fracking of shale gas. This was suggested as being part of a longer-term process with energy coming from shale gas acting as a "transition fuel". Others were more sceptical of the reasons why fossil fuels and nuclear energy would still comprise the majority of the energy mix, with some respondents indicating this to be as a result of a lack of political will and funding to support the growth of the renewable energy industry. There was a view that the current stance from the government in the UK is predicated on fossil fuels and nuclear energy, a view in fact supported by a recent energy policy review from the UK Government (DECC, 2013, 2015). Other respondents suggested that there would be a limited role for renewables because of vested interests and that politicians and the public are "removed" from the issues of energy production, climate change and sustainability. This finding echoes previous studies that suggest a "psychological distance" in the ways in which individuals hold particular attitudes towards climate change and sustainability (Devine-wright, 2013; Spence *et al.*, 2012).

### *4.1.2 Energy Sources In Future Systems*

Respondents were asked to rank which sources of energy they believed would/should play a role in the future of the energy system. Survey respondents were asked to choose whether fossil fuels, fracking of shale, solar energy, wind energy, biomass energy, nuclear energy, and other sources should play a greater role, the same role as currently, or a lesser role in the future. Responses to this question illustrate that overall, renewable sources of energy should play a greater role according to questionnaire respondents, yet there were also some distinctions between each community surveyed as illustrated in Table 10.

**Table 10: Survey Respondents Preferred Energy Visions for the Energy System**

| **Total Survey Respondents preferred energy visions for the future of the energy system** | | | | |
|---|---|---|---|---|
| **Energy Source** | **Greater role** | **Same role as currently** | **Lesser role** | **No response** |
| Fossil fuels | 6.2% | 19.8% | 69.8% | 4.2% |
| Shale Gas | 7.3% | 18.8% | 67.7% | 6.2% |
| Wind energy | 85.4% | 9.36% | 4.16% | 1.0% |
| Solar energy | 89.4% | 6.25% | 2.08% | 2.1% |
| Biomass energy | 53.1% | 25.0% | 17.7% | 4.2% |
| Nuclear energy | 20.8% | 25.0% | 44.8% | 9.4% |
| Other sources | 35.4% | 16.7% | 8.3% | 39.6% |
| **Stockbridge Village Respondents preferred energy visions for the future of the energy system** | | | | |
| **Energy Source** | **Greater role** | **Same role as currently** | **Lesser role** | **No response** |
| Fossil fuels | 8.3% | 37.5% | 45.8% | 8.3% |
| Shale Gas | 10.4% | 22.9% | 56.3% | 10.4% |
| Wind energy | 75% | 14.6% | 8.3% | 2.1% |
| Solar energy | 83% | 8.3% | 4.2% | 4.2% |
| Biomass energy | 45.8% | 25% | 20.8% | 8.3% |
| Nuclear energy | 16.6% | 25% | 45.8% | 12.5% |
| Other sources | 22.9% | 16.6% | 16.6% | 43.8% |
| **Transitions Group Respondents preferred energy visions for the future of the energy system** | | | | |
| **Energy Source** | **Greater role** | **Same role as currently** | **Lesser role** | **No response** |

| | | | | |
|---|---|---|---|---|
| Fossil fuels | 7.7% | 3.8% | 88.5% | 0% |
| Shale Gas | 3.8% | 3.8% | 88.5% | 3.8% |
| Wind energy | 100% | 0% | 0% | 0% |
| Solar energy | 96.2% | 3.8% | 0% | 0% |
| Biomass energy | 53.8% | 26.9% | 19.2% | 0% |
| Nuclear energy | 3.8% | 11.5% | 73.2% | 11.5% |
| Other sources | 50.0% | 7.7% | 0% | 42.3% |
| **Manchester Museum Respondents preferred energy visions for the future of the energy system** | | | | |
| **Energy Source** | **Greater role** | **Same role as currently** | **Lesser role** | **No response** |
| Fossil fuels | 0% | 0% | 100% | 0% |
| Shale Gas | 4.5% | 27.3% | 68.2% | 0% |
| Wind energy | 90.9% | 9.1% | 0% | 0% |
| Solar energy | 95.4% | 4.6% | 0% | 0% |
| Biomass energy | 68.2% | 22.7% | 9.1% | 0% |
| Nuclear energy | 50.0% | 40.9% | 9.1% | 0% |
| Other sources | 45.5% | 27.3% | 0% | 27.3% |

Overall, respondents suggested that fossil fuels and shale gas should have a lesser role in the future of the energy system. This is unsurprising given that fracking/shale gas is widely viewed as being socially unacceptable and environmentally damaging (Whitmarsh *et al.*, 2015). Yet one-sixth of respondents suggest that fracking could have the same role as currently occupies. While this role may be small in comparison to other energy sources, current predictions are that the fracking industry will continue to grow over the coming decade and a half in the UK (Gov.uk, 2016). Conversely, there is overwhelming support for renewable energy, particularly solar and wind energy. Biomass energy receives positive support overall, yet respondents were less certain of the role that this technology could play in the future of the energy system. Nuclear energy is seen as the most controversial energy source, with half of respondents indicating that nuclear energy will play a lesser role in the energy system as part of their energy vision. This is substantiated by comments in previous studies indicating that the majority of the UK public do not prefer nuclear energy in comparison to renewables (Corner *et al.*, 2011; Pidgeon *et al.*, 2008). The remaining half of respondents suggested that nuclear may play some role, either at the same level as currently or a greater role. Given responses on nuclear energy presented as quotes previously, a view is evident that nuclear energy may only be useful as a “transition fuel” to support the transformation of the energy system towards a more sustainable avenue.

There are distinctions between each community that suggest the identification of 3 separate visions amongst the communities surveyed. These are as follows:

**Stockbridge Village Energy Vision**: While the majority of individuals stated that renewable energy should play a greater role in the future of the energy system, nearly half of respondents indicated that fossil fuels should also have the same role as it does currently. Conversely, over half of respondents suggested that fracking should have a lesser role, with similar proportions of respondents indicating a lesser role for nuclear energy also. Biomass energy received a polarised ranking. With just under a half of respondents indicating a greater role, the remaining half of residents suggested that biomass would have the same role as it does currently or a lesser role. Consequently, biomass energy is considered to be a mixed choice for the future of the energy system in Stockbridge. This could be a result of the implementation of a biomass energy system in some residential buildings in the village, which encountered significant implementation challenges. Given its poor implementation, there has been a considerable backlash against this system locally (Liverpool Echo, 2017), which could account for the ranking suggested here.

**Transitions Interest Group Energy Vision:** As expected from an interest group, which has a specific pro-environment mission, the majority of respondents indicated a greater role for all renewables including solar, wind and biomass energy. Conversely, almost all respondents were opposed to fossil fuels and fracking of shale gas indicating a lesser role for both energy sources. Nuclear energy was also suggested as playing a lesser role in the future of the energy system.

**Manchester Museum Visitor Energy Vision:** Survey respondents in this community indicated that their energy vision preferences were predicated on greater roles for all types of renewable energy including solar, wind and biomass energy. Nuclear energy was also indicated as having a greater role, but not to the same extent as renewables. In this group, 100% of respondents indicated that fossil fuels had a lesser role in the future of the energy system, with a large majority also suggesting the same for fracking of shale gas.

### *4.1.3 Enablers and Barriers to Energy Visions*

Survey respondents outlined a number of barriers to their energy visions. These barriers ranged from infrastructural barriers at the local level to lack of knowledge and a reliance on fossil fuels. The barriers to respondents' preferred energy visions were mainly blamed on other actors and processes, particularly at a national level:

> "The government won't pay [, they would] rather pay billions for nuclear, better for us to use oil fuel, coal than nuclear. Political will [is] not there" (QR9),

> "Lack of knowledge by the general public, special interests of government and energy providers and efficient, inexpensive alternatives that can provide equivalent levels of energy" (QR11),

> "Existing infrastructure and difficulty of incorporating small scale energy to national grid, and declining government support mechanisms for micro-generation and distributed generation" (QR12),

> "Static thinking, reliance on fossil fuels and wealth of fossil fuel companies (divest). People don't want to change their lifestyles" (QR31),

> "Economy wanting to grow, central (money of big business e.g. oil and gas industry). Fear of taking a step back and government visions for economic growth" (QR49),

> "The government - there needs to be a top-down implementation if we are to truly change attitudes on a national scale" (QR56).

Overwhelmingly, a substantial number of statements related barriers to energy transitions to the government. Such criticism was directed towards the government because of the lack of funding provided to renewable energy infrastructures, vested interests in the use of fossil fuels and nuclear energy, and that there may be 'static thinking' around investments in renewable energy equating to a lack of return on investment. These considerations of the barriers to energy visions places significant weight on the decisions made at a national level. Conversely, politicians and local councils are not frequently mentioned to be as important as other stakeholders. While seemingly dissonant viewpoints, responses would suggest a lack of trust in, or respect for, national or local politics. However, with respect to the enablers to their preferred energy visions, respondents outlined that there were multiple actions that could be taken. While some actions related to political decisions such as legislation, other actions identified more social approaches such as energy democracy and provide more information on how to tackle climate change for individuals:

> "Legislation to force better and more cleaner fuels, more resources" (QR7),
>
> "Renewables growth, energy democracy, get trade unions on side, agro-ecology, and divestment from fossil fuels" (QR13),
>
> "Take action, power down demand and power up renewables, form groups locally, talk to people about positive visions" (QR15),
>
> "Phase out fossil fuels and radical amount of renewable capacity - in line with climate science and commitments (1.5C)" (QR17),
>
> "Spend whatever it takes to fit solar panels literally everywhere they will generate a net gain of energy" (QR45),
>
> "More info about climate change and renewable energy integrated into school teaching. Acceptance of climate change by government. Placing mitigation and adaptation measures at the forefront of policies (as a whole not just within designated section of government)" (QR49),
>
> "A commitment to setting (and meeting) renewable energy targets and use. More investment in renewable energy and phasing out of other energy sources" (QR56).

The strength of feeling towards particular actions is identified by these statements. For example, "spend whatever it takes" indicates that the respondent has strong positive attitudes towards the implementation of renewable energy schemes and is frustrated with the lack of development to date. Interestingly, it is noted that an acceptance of climate change by the government could go hand-in-hand with phasing out fossil fuels and that commercial organisations could divest from oil-related investments. This growing movement of divesting from fossil fuel companies appears to have become part of the discourse when identifying solutions to reducing the reliance on fossil fuels for energy production. In addition, divesting from fossil fuels is met with numerous comments to increase investments in renewable energy generation schemes that are supported by legislation to produce more sustainable fuel sources. One comment identifies that talking to individuals about more "positive visions" would support energy transitions.

### *4.1.4 Interventions Supporting Energy Transitions*

Respondents were asked to indicate their preference for what actions they believe would help to deliver their preferred energy vision. Responses (illustrated in Table 11) indicate that, overall, individuals are supportive of all listed measures, yet some differences were evident. Overall, behavioural change, education, and direct government action receive the strongest support with the largest proportion of responses noting these measures were "very important" to support their preferred energy vision. Yet, while local ownership of energy and tax measures received strong support, the proportion of importance was not as high for these options.

**Table 11: Respondents Preferred Interventions Supporting Energy Transitions**

| **Total Survey Respondents preferred interventions supporting energy transitions** | | | | | | |
|---|---|---|---|---|---|---|
| **Intervention** | **Very Important** | **Important** | **Moderately Important** | **Not very important** | **Not at all important** | **No response** |
| New and better technology | 63.5% | 20.8% | 8.3% | 1.0% | 3.1% | 3.1% |
| Tax measures | 44.8% | 34.4% | 13.5% | 2.1% | 2.1% | 3.1% |
| Education and information | 69.8% | 21.9% | 5.2% | 0% | 0% | 3.1% |
| Direct government | 68.8% | 16.7% | 9.4% | 1.0% | 2.1% | 2.1% |

| | | | | | | |
|---|---|---|---|---|---|---|
| action | | | | | | |
| Local ownership of energy | 55.2% | 22.9% | 16.7% | 2.1% | 0% | 3.1% |
| Behavioural change | 67.7% | 27.1% | 5.2% | 0% | 0% | 0% |
| **Stockbridge Village Respondents preferred interventions supporting energy transitions** | | | | | | |
| **Intervention** | **Very Important** | **Important** | **Moderately Important** | **Not very important** | **Not at all important** | **No response** |
| New and better technology | 70.8% | 14.6% | 8.3% | 0% | 4.2% | 2.1% |
| Tax measures | 60.4% | 22.9% | 10.4% | 2.1% | 4.2% | 0% |
| Education and information | 70.8% | 20.8% | 8.3% | 0% | 0% | 0% |
| Direct government action | 68.8% | 14.6% | 10.4% | 0% | 4.1% | 2.1% |
| Local ownership of energy | 58.3% | 20.8% | 16.7% | 2.1% | 0% | 2.1% |
| Behavioural change | 64.6% | 25.0% | 10.4% | 0% | 0% | 0% |
| **Transitions interest group preferred interventions supporting energy transitions** | | | | | | |
| **Intervention** | **Very Important** | **Important** | **Moderately Important** | **Not very important** | **Not at all important** | **No response** |
| New and better technology | 42.3% | 26.9% | 15.4% | 3.8% | 3.8% | 7.7% |
| Tax measures | 26.9% | 50.0% | 11,5% | 0% | 0% | 11.5% |
| Education and information | 57.7% | 26.9% | 3.8% | 0% | 0% | 11.5% |
| Direct government action | 65.4% | 26.9% | 11.5% | 0% | 0% | 3.8% |
| Local ownership of energy | 73.1% | 19.2% | 3.8% | 0% | 0% | 7.7% |
| Behavioural change | 65.4% | 34.6% | 0% | 0% | 0% | 0% |
| **Manchester Museum visitors preferred interventions supporting energy transitions** | | | | | | |
| **Intervention** | **Very Important** | **Important** | **Moderately Important** | **Not very important** | **Not at all important** | **No response** |
| New and better technology | 72.7% | 27.3% | 0% | 0% | 0% | 0% |
| Tax measures | 31.8% | 40.9% | 22.7% | 4.5% | 0% | 0% |
| Education and information | 81.8% | 18.2% | 0% | 0% | 0% | 0% |
| Direct government action | 72.7% | 18.2% | 4.5% | 4.5% | 0% | 0% |
| Local ownership of energy | 27.3% | 36.4% | 31.8% | 4.5% | 0% | 0% |
| Behavioural change | 77.3% | 22.3% | 0% | 0% | 0% | 0% |

Results in Table 11 also illustrate that there are differences between each community surveyed. Different visions for each group are accompanied with preference for different interventions, or various complimentary combinations of interventions, predicated on the importance ascribed by respondents. These distinctions are clarified as follows:

**Stockbridge Village:** Respondents indicated that they favoured education and information, direct government action, and behavioural change approaches to support their preferred energy vision. Tax measures (including financial incentives and tax rebates) were also favoured by this community, but not as strongly as direct government action and education. The reasons for this choice may be explained to some degree by the socio-demographic characteristics of the community. Given that Stockbridge Village is a socio-economically deprived area, financial support to alleviate the burden of energy costs receives support while education and information can help to support people making better choices about their energy consumption (Abrahamse & Steg, 2009; Abrahamse *et al.*, 2005; Steg & Vlek, 2009). Local ownership of energy receives broadly positive support, yet a higher proportion of residents suggest that this is only considered to be "important" or "moderately important.

**Transition Liverpool:** The Transitions Interest Group favoured a more direct approach with the emphasis of interventions focused primarily on everyday users of energy i.e. homeowners. As part of this, the interventions receiving the most support include education and information, direct government action, behavioural change, and local ownership of energy. Interestingly, this community overwhelmingly favours local ownership of energy more so than the other two communities. This finding reinforces earlier results that "local production of energy" and a "community owned, sustainable energy system" is the favoured approach[9].

**Manchester Museum:** The Manchester Museum visitor survey respondents favoured an eclectic mix of interventions to support their energy vision. Consequently, new and better technology, education and information, direct government action, and behavioural change were viewed as actions that would support their preferred energy vision. Surprisingly, tax measures were not accorded a similar level of importance. This contradicts previous research indicating that financial measures are a commonly-cited instrument to enact change and requested by individuals to support pro-environmental actions (Abrahamse *et al.*, 2005). For these respondents, this is not the case

### *4.1.5 The Role of Stakeholders in Energy Transitions*

Respondents were also asked about who the most influential leaders and organisations were with respect to energy issues. In response to this question, respondents identified that particular stakeholders were of importance in how they are involved with, and influenced by, energy system changes. Table 12 indicates that, overall, survey respondents noted that energy suppliers, researchers and universities were of considerable importance with the majority indicating that these stakeholders were "very important" in influencing the energy system. Conversely, local traders and local councils received less support in terms of their ranked importance and their ability to influence energy system changes. Teachers, politicians and community leaders also receive positive support from respondents, but not to the same extent as energy suppliers, researchers and universities.

[9] Decentralised renewable energy systems lend themselves to a sustainable energy future where energy production and consumption becomes more community-centric (Bridge *et al.*, 2013).

**Table 12: Respondents Preferred Involvement from Stakeholders in Energy Transitions**

| Total Survey Respondents preferred involvement from stakeholders in energy transitions | | | | | | |
|---|---|---|---|---|---|---|
| **Intervention** | **Very Important** | **Important** | **Moderately Important** | **Not very important** | **Not at all important** | **No response** |
| Teachers | 32.3% | 35.4% | 14.6% | 8.3% | 0% | 9.4% |
| Politicians | 45.8% | 27.1% | 3.1% | 7.3% | 10.4% | 6.3% |
| Local council | 26.0% | 40.6% | 9.4% | 9.4% | 7.3% | 7.3% |
| Researchers and universities | 57.3% | 24.0% | 10.4% | 0% | 0% | 8.3% |
| Energy Suppliers | 59.4% | 29.2% | 5.2% | 1.0% | 0% | 5.2% |
| Local Traders | 24.0% | 39.6% | 18.6% | 7.3% | 3.1% | 7.3% |
| Community Leaders | 37.5% | 36.5% | 12.5% | 4.2% | 1.0% | 8.3% |
| **Stockbridge Village Respondents involvement from stakeholders in energy transitions** | | | | | | |
| **Intervention** | **Very Important** | **Important** | **Moderately Important** | **Not very important** | **Not at all important** | **No response** |
| Teachers | 35.4% | 33.3% | 12.5% | 12.5% | 0% | 6.3% |
| Politicians | 47.9% | 16.7% | 2.1% | 14.2% | 16.7% | 2.1% |
| Local council | 39.6% | 22.9% | 8.3% | 14.3% | 12.5% | 2.1% |
| Researchers and universities | 58.3% | 22.9% | 14.6% | 0% | 0% | 4.2% |
| Energy Suppliers | 58.3% | 29.2% | 8.3% | 2.1% | 0% | 2.1% |
| Local Traders | 29.2% | 39.6% | 14.6% | 8.3% | 4.2% | 4.2% |
| Community Leaders | 43.8% | 25.0% | 20.8% | 4.2% | 0% | 6.3% |
| **Transitions interest group preferred involvement from stakeholders in energy transitions** | | | | | | |
| **Intervention** | **Very Important** | **Important** | **Moderately Important** | **Not very important** | **Not at all important** | **No response** |
| Teachers | 19.2% | 38.5% | 15.4% | 3.8% | 0% | 23.1% |
| Politicians | 26.9% | 46.2% | 3.8% | 0% | 3.8% | 19.2% |
| Local council | 15.4% | 50% | 3.8% | 3.8% | 3.8% | 23.1% |
| Researchers and universities | 34.6% | 34.6% | 7.7% | 0% | 0% | 23.1% |
| Energy Suppliers | 50.0% | 30.8% | 3.8% | 0% | 0% | 15.4% |
| Local Traders | 15.4% | 42.3% | 19.2% | 0% | 3.8% | 19.2% |
| Community Leaders | 30.8% | 46.2% | 0% | 3.8% | 0% | 19.2% |
| **Manchester Museum visitors preferred involvement from stakeholders in energy transitions** | | | | | | |
| **Intervention** | **Very Important** | **Important** | **Moderately Important** | **Not very important** | **Not at all important** | **No response** |
| Teachers | 40.9% | 40.9% | 13.6% | 4.5% | 0% | 0% |
| Politicians | 63.6% | 27.3% | 4.5% | 0% | 4.5% | 0% |
| Local council | 9.1% | 68.2% | 18.2% | 4.5% | 0% | 0% |
| Researchers and universities | 81.8% | 13.6% | 4.5% | 0% | 0% | 0% |
| Energy Suppliers | 72.3% | 27.3% | 0% | 0% | 0% | 0% |
| Local Traders | 22.7% | 36.4% | 27.3% | 13.6% | 0% | 0% |
| Community Leaders | 27.3% | 54.5% | 9.1& | 4.5% | 4.5% | 0% |

Results in Table 12 indicate that there are differences between each community surveyed with regard to the stakeholders deemed of most importance. These distinctions can be described as follows:

**Stockbridge Village:** Survey respondents from Stockbridge Village indicated the importance of almost all stakeholders that could be involved in energy transitions. Yet the results illustrate that there appear to be some respondents who identify politicians and local councillors as "not very important" in such transitions. This maybe the result of a distrust towards both local and national government. Overall, researchers and universities, energy suppliers, and community leaders were considered to be more influential leaders on energy issues. Community leaders and local traders received broadly positive support, yet this was more varied in comparison to researchers and universities and energy suppliers. Additionally, support for teachers, while receiving positive support, did not reach the same proportions of importance, as did other groups.

**Transition Liverpool:** The Transitions Interest Group, were surprisingly, less committed to the concept of importance when identifying the most influential leaders and organisations on energy. All stakeholders were deemed to be important in responses; survey respondents from this group identified especially that energy suppliers and researchers and universities were "very important" to energy transition. From this group of respondents, there is an overall consistent use of importance for each stakeholder that suggests an equal amount of influence among all categories.

**Manchester Museum:** The Manchester Museum visitor group favoured one specific group in particular, overwhelmingly classified as being "very important" to energy transitions, researchers and universities. Energy suppliers, politicians and teachers also scored in the majority for the 'very important' category. Conversely, local councils, community leaders and local traders were viewed as not being as influential. This may suggest that these survey respondents favour the role of actors in the energy system at a national level or those who may influence wider-scale efforts to influence energy transitions.

#### *4.1.6 Summary of Survey Findings: Three Distinct Visions*

From the results of the questionnaire data it is clear that there are three substantive visions that emerge from each community. An overview of these visions is outlined in Figures 8-10. "Visions" of the future of the energy system are comprised of what individuals consider what energy sources should be used, what interventions and actions should accompany changes to the energy system, and what stakeholders could be involved in such a transition. Figures 8-10 outline that the visions of each community group surveyed are not similar, rather they are distinctive owing to the specific socio-demographic characteristics, environmental attitudes, and life experiences to date of the respondents. Consequently, three distinct visions emerge. Figures 8-10 outline each offer a distinct vision corresponding to the particular community group in question:

"Continuity Vision" (Figure 8): In this vision, the status quo of energy sources remains largely the same as current energy production and consumption. While renewable sources of energy are identified, the reliance on fossil fuels is maintained and this energy source is largely viewed to comprise the majority of future energy production. Nuclear energy and fracking of shale gas are deeply opposed to. In terms of interventions, all but local ownership of energy is proposed as favoured methods of approach.

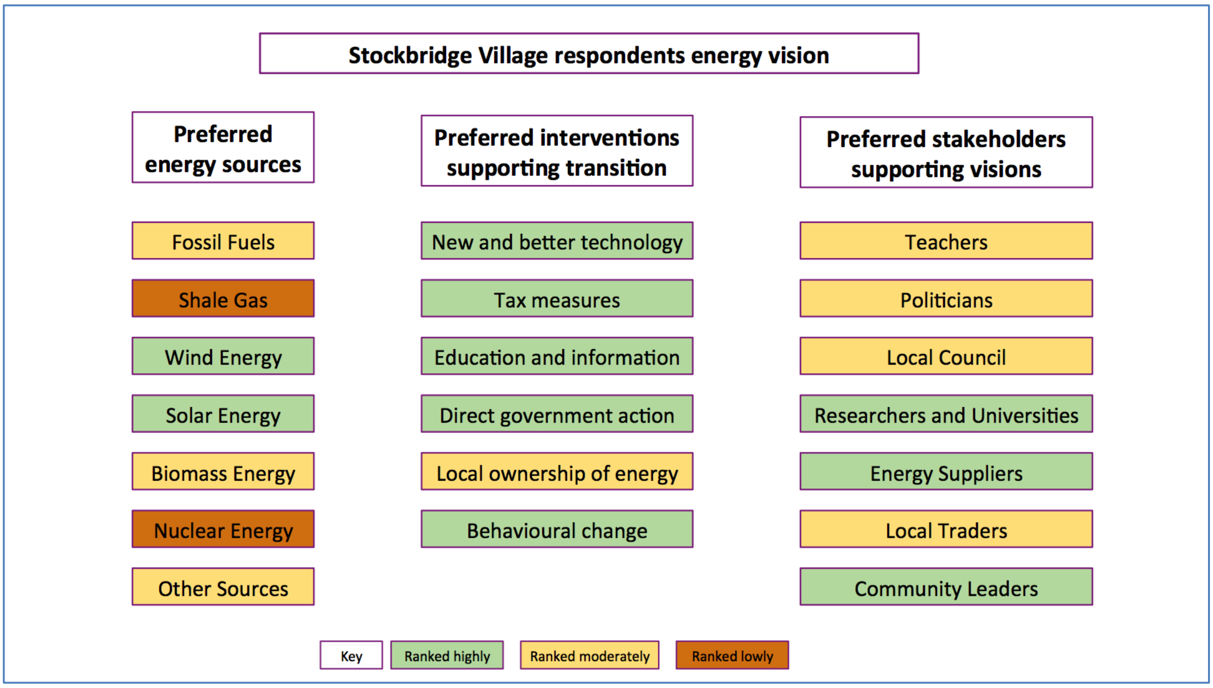


**Figure 8: "Continuity Vision"**

While decentralised systems are present in this vision, individuals largely wish to remain removed (psychologically rather than geographically) to energy production. This indicates that 'citizen control' as identified by Arnstein's (1969) ladder of citizen participation is a level of involvement that individuals are not willing to take on, in the case of the Stockbridge village community. This may have implications for energy citizenship in the future should this vision remain unchanged. With respect to the stakeholders involved in the "continuity vision", energy suppliers, researchers and universities, and community leaders are deemed to be more influential. In contrast, there appears to be a discrepancy between the interventions and stakeholders identified to support this energy system vision. Here, politicians and local councils are deemed to be of moderate importance yet tax measures and direct government action are preferred interventions. This may suggest this vision may be predicated on distrust of politicians yet favour certain financial approaches that policies outline.

**"Deep Green Vision" (Figure 9):** It is clear from this vision that traditional methods of producing and consuming energy through fossil fuels are unacceptable. This community also indicated that specific energy sources such as fracking of shale gas and nuclear energy are also not compatible with a view to a sustainable energy system. The "deep green vision" is therefore solely in favour of renewable energy at a national and at a local level.

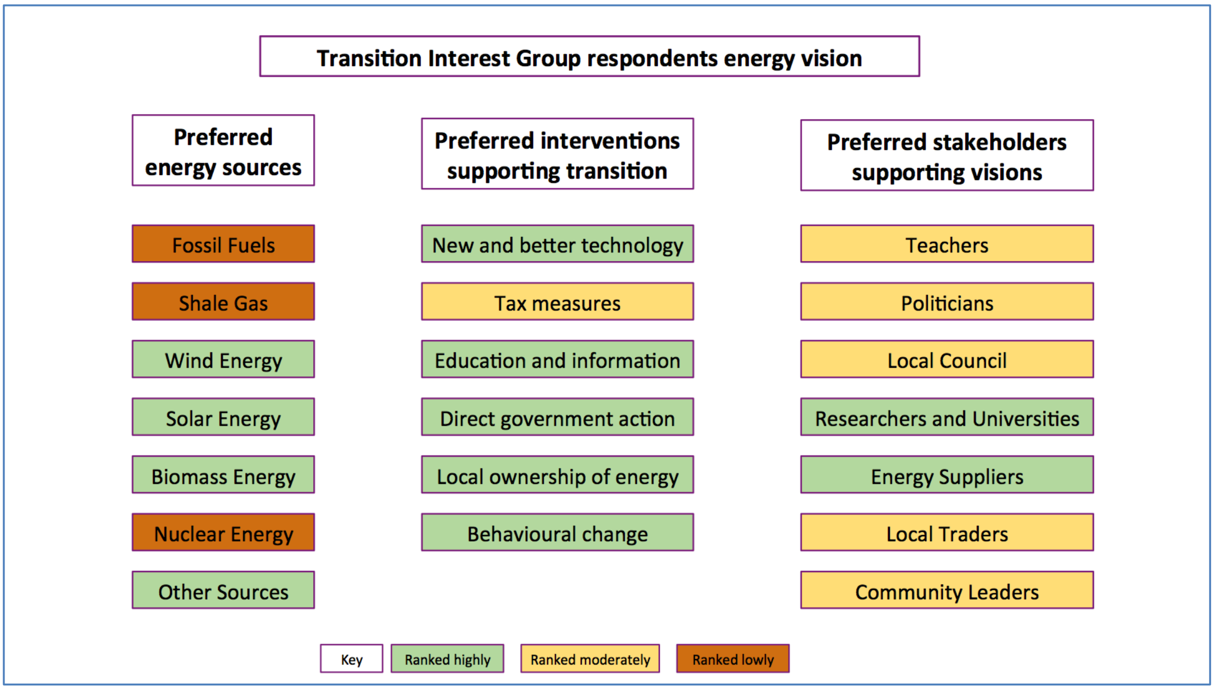


**Figure 9: "Deep Green Vision"**

With respect to interventions, all approaches aside from tax measures were deemed to be of importance. Local ownership of energy, education and information, and behavioural change supports a multifaceted approach to changing energy systems at local and national level in terms of production alongside energy consumption at a household and community scale. This vision is predicated on informing better choices where energy consumption is concerned at an individual and community level, as well as transforming the ways in which energy is produced nationally. Yet, this vision outlines that energy suppliers and researchers and universities were of more importance than any other stakeholder group. Given the interventions outlined, the "deep green vision" indicates that researchers and universities may provide education, information and approaches to behavioural change while energy suppliers may support radical transformations in the ways in which energy is produced.

**"Gradual Path Reduction Vision" (Figure 10):** This vision may reflect a 'middle-ground' approach whereby fossil fuels and fracking of shale gas are opposed, yet nuclear energy receives moderate support in order to maintain current levels of energy production until further gains in renewable energy are achieved. Interestingly, the "gradual path reduction vision" also reflects the interventions least likely to be preferred by the "continuity vision" and the "deep green vision" – local ownership of energy and tax measures, respectively, neither of which is overly favoured by the Gradual Path Reduction Vision.

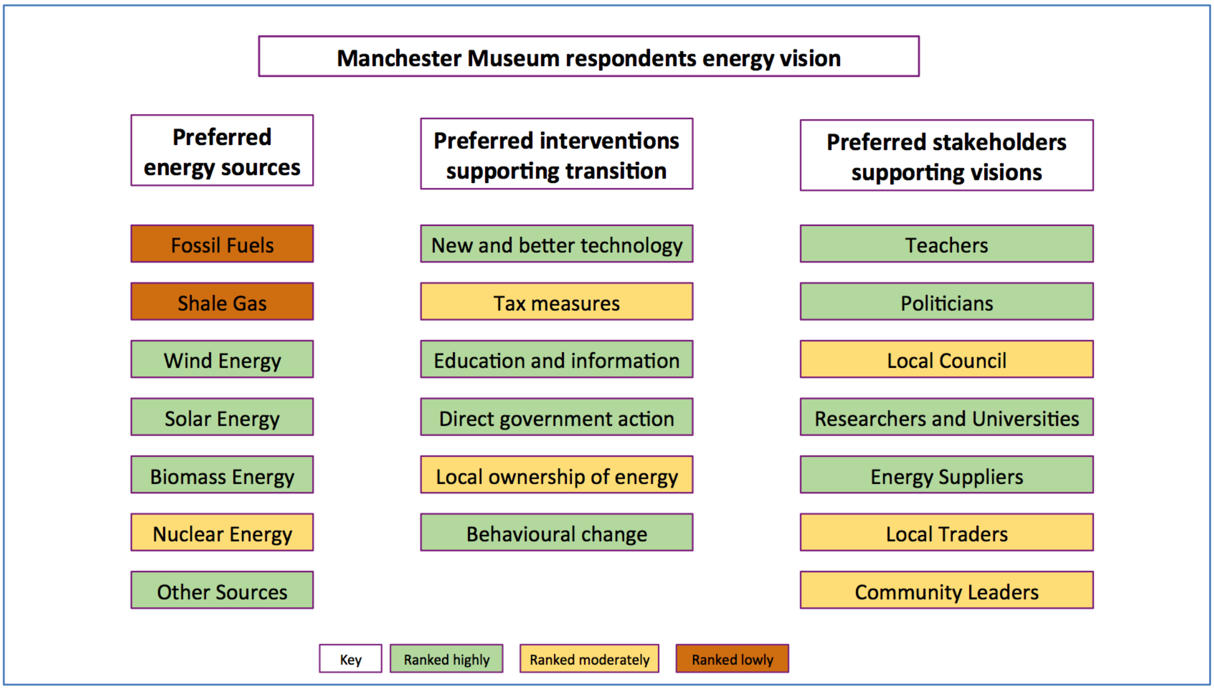


**Figure 10: "Gradual Path Reduction Vision"**

In this vision, wider technological and behavioural changes are considered with greater priority. These interventions are supported with the preferred stakeholders influencing the "gradual path reduction vision". Here, more local individuals and organisations such as local councils, traders and community leaders are not identified to be as important as wider scale actors such as politicians, researchers and universities, and energy suppliers.

## 4.2 *SME and Community Social Enterprise Visioning Of The Energy System*

### 4.2.1 *SME Questionnaires*

#### ***4.2.1.1 The Salience of Sustainability Issues***

SME respondents were asked to rate the importance of a number of sustainability and energy-related issues. The responses (see Table 13) indicate that, overall, issues relating to sustainability and energy were considered of most importance, with degrees of difference also alluded to.

**Table 13: Importance of Sustainability and Energy-Related Issues to SMEs**

| Sustainability Issue | Very Important | Important | Moderately Important | Not very important | Not at all important | No response |
|---|---|---|---|---|---|---|
| Sustainability issues | 53.3% | 26.6% | 13.3% | 0% | 6.6% | 0% |
| Long term energy planning | 20.0% | 46.6% | 13.3% | 6.6% | 13.3% | 0% |
| Certainty of energy pricing | 13.3% | 46.6% | 13.3% | 13.3% | 13.3% | 0% |
| Clear regulations on energy | 46.6% | 20.0% | 6.6% | 6.6% | 13.3% | 0% |
| Policy support on energy | 40% | 33.3% | 6.6% | 6.6% | 13.3% | 0% |
| Low-carbon energy sources | 26.6% | 46.6% | 6.6% | 6.6% | 13.3% | 0% |
| 'Green' image amongst customers | 73.3% | 13.3% | 6.6% | 0% | 6.6% | 0% |

While all issues were broadly considered to be of importance, having a 'green' image amongst customers was rated as the issue with the highest level of importance for SMEs. This may be a result of SMEs attempting to re-orientate their branding and organisation towards an audience that considers 'green' and environmental issues to be of concern and who are more receptive to such messages (Dangelico, 2010; Fineman, 2001; Ginsberg & Bloom, 2004; Meyer, 2001). Sustainability issues, more broadly, were also considered to be of high importance. This may reflect that sustainability, encompassing many different aspects and practices, is becoming well-embedded within the everyday policies and practices of businesses and SMEs (Dangelico, 2010). Additionally, clear regulations on energy, policy support for energy and low-carbon sources of energy production were also considered to be of importance, with the majority of respondents indicating that these issues were "very important" or "important", acknowledging that changes in policies can dramatically affect the business practices of SMEs (Dupont & Oberthür, 2012; Wood, 2010).

#### *4.2.1.2 Energy System Transitions and Impacts on SMEs*

SME respondents were also asked what they think the energy system will change to in the next 20 years; what energy system changes would be beneficial for their organisation; and how will their organisation use energy in the next 20 years. While some respondents were unsure of what the future of the energy system would be, other respondents had clearer views of how energy would evolve over the medium-term (next 10-20 years):

> "More people will generate their own energy" (SME-R3),
>
> "Heavy increase in local RES and EV working together in a system" (SME-R9),
>
> "Decentralisation and new renewable sources" (SME-R11),
>
> "Will still be using nuclear and thermal energy sources. Sustainable energies will be more developed but not yet enough to completely subsist to world needs. However, the way we all use the energy must be improved and the way every people use the energy will be smarter (thanks to smart grid and technologies and strategies linked)" (SME-R12),
>
> "(Can't see) any revolution the next 10 years but rather an energy system with more and more multiplied and diversified sources of energy that needs to be managed differently" (SME-R13),
>
> "I believe that steering the direction of renewable sources will become a 'given' in the future. We feel that warmth, energy, fuel and electricity can all be 100% and should be right now. Thankfully it is happening" (SME-R15).

SME respondents clearly identified that a transition to more sustainable forms of energy production would occur in the next 20 years. As part of this transition, SMEs identified that while nuclear energy sources would still be used, renewable energy systems would not yet be sufficiently prevalent to fulfil total energy demand. Yet, SMEs indicated that the future for energy production and consumption would be more intricately linked. A more decentralised energy system was envisaged, with individuals becoming "smarter" and more informed about the impacts of their behaviours and everyday technology use[10]. Survey respondents also indicated what they believed would be most beneficial for their organisation as a result of transformations in the energy sector:

[10] Decentralised energy systems, characterised by an obscuring of boundaries between producer and consumer (Bridge *et al.*, 2013) may serve to remove "psychological distance" barriers (Devine-wright, 2013; Spence *et al.*, 2012).

"Client awareness of sustainable alternatives and products" (SME-R3),

"Cheaper costs" (SME-R4),

"Increase in energy efficiency would help save costs" (SME-R6),

"The possibility to use equipment that allow to save energy" (SME-R8),

"Fair energy pricing taking pollution and climate change into account" (SME-R9),

"Won't be that impacted, maybe better energy efficiency" (SME-R14),

"We are looking at incorporating solar into our products. So, generating energy not just saving energy is a good move. The feed-in-tariff could be greatly improved" (SME-R15).

Respondents speculated that energy system changes could be beneficial for SMEs in a number of ways. Many indicated that the switch to renewable energy systems would result in cheaper energy prices. However, some respondents indicated that energy system changes would have substantial benefits for client awareness of sustainable products and innovations which may prompt some SMEs to incorporate renewable energy systems for their own office space. What is interesting about this point is that the language used by respondents indicates that generating as well as saving energy is "a good move". SMEs recognise "win-win" outcomes of generating their own energy and reducing their own consumption (Hillman *et al.*, 2016). With respect to how SMEs will use energy in their organisation in the future, respondents suggested that one of three possible (predictable) outcomes may occur; either: energy use will (1) remain at current levels; (2) increase or (3) decrease:

"Increased with growth of company would be expected**"** (SME-R4),

"All electricity is generated by solar, heat, and biogas. Improved monitoring, storage and DSM will increase the share of RES and decrease consumption overall" (SME-R9),

"Very little. We are not very energy consumption intensive" (SME-R10),

"Energy use has been reducing through: general principle of conduct and action that includes energy use matter = changes in employees' behaviour, and increase the recycled rate of raw material in our product to reduce energy use" (SME-R13),

"Over time we will always strive to improve on the energy we use as an organisation and most definitely want to reflect this in our products. We will be moving with modern day technology and constantly looking for ways to renew more, waste and consume less" (SME-R14).

While some SMEs indicated that their energy consumption would remain at current levels given that they are not very energy intensive, the majority of respondents indicated that their use of energy would either decrease or increase. The reasons for increase were predicated on an increase in the amount of business growth over the next 10 years that would potentially result in energy consumption increasing. However, those that indicated that energy use would decrease over time suggested that this would occur because of several actions being undertaken. Firstly, SMEs would become more dependent on renewable energy technologies. Secondly, reducing energy consumption through behaviour change of employees was highlighted as a measure of reducing energy use. Thirdly, changes in strategic management and innovation of products using less energy through the supply chain was also suggested as an action to reduce energy use across organisational activities.

#### 4.2.1.3 Organisational Energy-Related Training

SMEs were asked about whether their organisation had delivered any energy-related training to staff and employees in their business. The findings show that only 20% (n=3) had delivered any energy-related training to staff. Those SMEs that had delivered training suggested that an individual from the senior management team (either "director" or "general manager") had delivered the training. Additionally, respondents indicated that this training was only delivered once or twice a year, with one SME indicating that training was delivered at various times dependent upon the number of EU funded research and development projects they were engaged with. All SMEs that delivered training suggested that this training had positively affected the staff at their organisation.

#### 4.2.1.4 Stakeholder Influences on Energy Management

Respondents were also asked about which stakeholders they considered to be important influences on their energy management practices. Survey responses, illustrated in Table 14, indicate that SMEs consider multiple organisations to have varying levels of impact on energy management practices.

**Table 14: Salience of Stakeholder Influences Towards Energy Management for SMEs**

| Sustainability Issue | Very Important | Important | Moderately Important | Not very important | Not at all important | No response |
|---|---|---|---|---|---|---|
| 6.6%Central government | 40.0% | 33.3% | 20.0% | 0% | 0% | 6.6% |
| Local council | 20.0% | 53.3% | 13.3% | 6.6% | 0% | 6.6% |
| Customers | 33.3% | 33.3% | 6.6% | 0% | 13.3% | 13.3% |
| Suppliers | 13.3% | 20.0% | 40.0% | 6.6% | 13.3% | 6.6% |
| Senior management | 13.3% | 40.0% | 6.6% | 20.0% | 0% | 20.0% |
| Civil society | 20.0% | 20.0% | 20.0% | 13.3% | 6.6% | 20.0% |
| Employees | 13.3% | 26.6% | 40.0% | 6.6% | 0% | 13.3% |
| Regulatory bodies | 26.6% | 40.0% | 13.3% | 0% | 0% | 20.0% |
| Market demands | 26.6% | 26.6% | 0% | 20.0% | 6.6% | 20.0% |
| European Union | 13.3% | 40.0% | 26.6% | 13.3% | 0% | 6.6% |
| Other | 0% | 13.3% | 20.0% | 0% | 6.6% | 60% |

Most notably, SMEs considered central government, customers, regulatory bodies and market demands to be the most important influencers on energy management practices. This result suggests that SMEs are responsive to policies (top-down influences), as well as to market demands and consumers (bottom-up influences). Results could suggest that SMEs are influenced by these 4 stakeholder groups in particular, more so than others, reflecting pressures to comply with regulation as well as market pressure and a requirement to appeal to more environmentally-conscious consumers (Dangelico, 2010). The latter reflects a trend of increased awareness and engagement of individuals, beyond simple and passive consumer roles. The literature reports on households and individuals who are no longer content to act as simply passive actors in the energy system, with increasing evidence of active participants seeking to become involved with sustainability transitions (Boscan & Poudineh, 2016). Stakeholders that were considered to be "important" in influencing SME energy management practices were local councils, senior management and the European Union. Once again, these stakeholders may also exert a top-down influence on energy management practices but may be considered more removed than the influence of national level politicians. Interestingly, employees were more likely to be ranked as "moderately important", suggesting that staff may not overtly influence energy management decision-making or may exert only moderate levels of influence on energy management performance and practices.

#### *4.2.1.5 The 'Energy Vision' of Surveyed SMEs*

In addition to the three 'energy visions' identified in the questionnaire to residents, it is clear that the surveyed SMEs also hold a distinct vision of the future of the energy system. This energy vision appears to represent a mid-point between the "gradual path reduction vision" and the "deep green vision" identified previously. This vision goes further to address issues of sustainability than the "gradual path reduction vision" but not as far as the "deep green vision". Consequently, SME's hold an "Accelerated Emissions Reduction Vision" (illustrated in Figure 11) that is predicated on the following understandings about the future of the energy system:

- Renewable energy sources are the preferred method of energy generation, with the majority of SMEs aiming to generate their own energy, and enact energy savings
- Nuclear energy is viewed as a transition energy source given that renewable sources will not be developed to produce 100% of total supply of energy,
- Decentralised renewable energy systems are viewed as being an integral component of this energy vision, owned by local communities,
- Improved energy efficiency, behavioural change, innovation in the supply chain to improve the energy rating of products, and storage of renewable energy are preferred interventions in this vision (all optional interventions were ranked highly by SME respondents)
- This vision is dependent upon an integrated top-down and bottom-up approach, with a range of stakeholders involved in future changes to the energy system including central government, regulatory bodies, customers and market demand,
- Yet, local councils and the European Union were only viewed as moderately important and not seen as having a direct influence on energy practices and visions of SMEs.

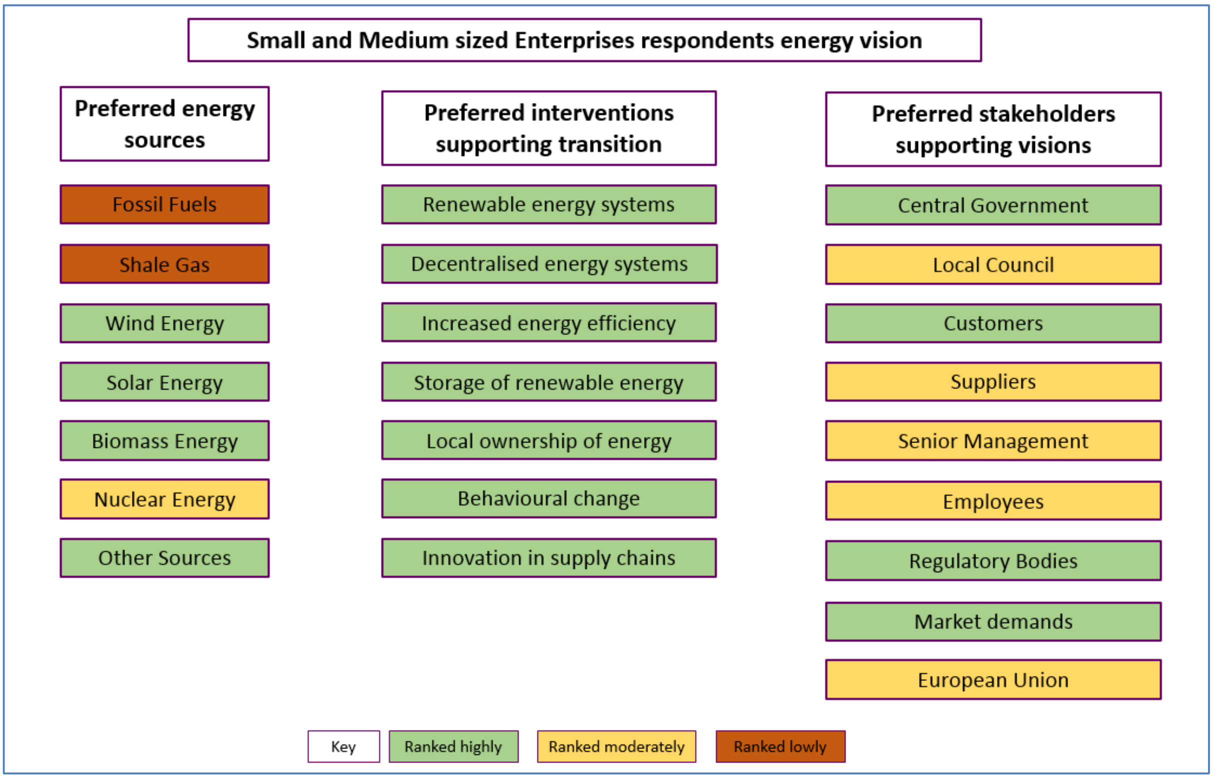


**Figure 11: "Accelerated Emissions Reduction Vision"**

### *4.2.2 SME Semi-Structured Interviews*

In addition to the questionnaires, a series of semi-structured interviews was carried out with 8 organisations in the North West of England (Feb 2016 – Oct 2016), all of which were from or linked to the energy sector in some capacity (Table 3). This Section summarises findings on the visions and expectations of the future energy system according to these organisations. The common unifying vision was of an energy system that does not just deliver energy but also benefits communities, which is not surprising given the core activities of these organisations. A strong concern for the triple-bottom-line of economy-society-environment, with overt social and environmental values was evident.

> "But there's also the other equally important aspects and its link currently to fuel poverty, but ultimately it will be linked to climate change as well and that's health and well-being." (SME-KI2).

A reoccurring vision across the interviews is one of a decentralised energy system, based on the concept that energy is generated locally and sold back to the local communities.

> "From a blue-sky point of view, I would say that in other parts of Europe, municipal energy ownership has come to the fore, where groups of communities, neighbourhoods and councils have put together a large-scale project and are selling themselves energy locally." (SME-KI2),

> "In the future energy grid, rather than a few small power stations the agenda is anyway going to go towards decentralised generation." (SME-KI4).

However, there was acknowledgement that there is a need for community energy groups to focus on energy generation and to have a larger organisation who could act as a mediator between the small groups and the larger actors active within the sector.

> "My idealised world…you need an umbrella organisation which provides a lot of that support… clearly it then becomes a conduit for the larger players to engage at the true community level. So rather than an organisation going to 10 different community organisations they can come through the umbrella. Then we can almost engage and pick out the most effective or constructive groups for them." (SME-KI2).

Technological advancement and innovation constituted a large proportion of the discussion on the future of the energy system. Unanimously, the view was that technology advancements will have a role to play in the future energy system.

> "Another one called solar windows…the coating can generate electricity through glass" (SME-KI5).

These technological advancements also come in the form of organisational innovation and the improvement of the energy infrastructure itself.

> "If you could sort out how to sell energy to each other in a market, any project that is able to do that and balance out grids, capacity, store, intermittent power, heat and power at the same time with CHP, there will be opportunities to do that in future if we move to a smarter grid system." (SME-KI4).

A key idea that emerged was a need for people to be able to see, touch and feel new technologies in order for them to consider them for use within their own homes, through the use of demonstration centres or eco hubs.

> "We need a true demonstration venue which will showcase what the opportunities available for people to improve their properties and also this is the business opportunity" (SME-KI2),

> "You need locations where people can see and feel and touch the technologies that were talking about and then discuss the issues that accrue from that." (SME-KI2).

A secondary purpose of the proposed hubs would also allow for community engagement on energy issues and education on energy reduction with respondents intimating that they

> "Also, would like to engage with the community as well around the school because clearly schools are community hubs…it would be great to have the schools as little eco hubs where people can get information and be inspired to do more" (SME-KI7).

For social enterprise as a niche innovation, the needs for the protected space to be revitalised was identified in order for community energy to flourish due to the many different barriers to start-up.

> "I think the failure rate is going to be enormously high, simply because people don't have the kind of capacity, it's a very steep learning curve, there is no timing for it in that respect.

There was acknowledgement that social enterprise does have a role to play within the future energy system, however, social enterprise alone cannot create a viable energy system.

> "So, I think there is potentially huge opportunity but I see it as being incredibly fragile" (SME-KI6),

> "I think that sadly social enterprise can only chip away at the margins" (SME-KI6).

Money is a big barrier to the sectors and in a post feed-in tariff policy landscape (UK) social enterprises have been left considering what happens now that the protected space has been removed.

> "The question about how we fund future bits of work to get to a point where we can deliver them" (SME-KI7).

As a sector in its own right, social enterprises have started to look to themselves for support and network and capacity building is seen as a big positive step forward in recent years.

> "They've taken an empty building in a former industrial estate, so it's this kind of late 19th century brick and iron building that was empty. They've fitted it out to house dozens, may be able over 100, new organisations. They charge membership fees and they have members who come and have an office space within the building itself." (SME-KI3).

## 4.3 *'Energy Visions' Community Brain-Storm Outputs*

'Energy Visions' brainstorm exercises were carried out in three locations, described in Table 7. Overall, 150 comments were obtained across all three engagement exercises: 41 from Stockbridge Village residents at the Gala Day, 68 from the Manchester Museum visitor group and 41 from the Transition Liverpool Interest Group. All of the comments from each of the individual engagement exercises were collated and transcribed verbatim. These quotes illustrate what participants from each of the three groups (Stockbridge Village, Manchester Museum visitors, and the Transitions Interest Group) consider about energy production, communities, cities, transport, agriculture and business, specifically relating to immediate impressions and brainstorm ideas that these groups had on the future of the energy system.

### *4.3.1 Stockbridge Village Residents*

Residents from Stockbridge Village participated in the energy visioning engagement exercise during a 'Gala Day', a full day of community activities that took place in the centre of the community during August 2016. Individuals placed their responses on post-it notes around the six key themes; their ideas (and innovations) are outlined in Table 15 with each statement reflecting the quotes and terminologies used by each participant.

**Table 15: Energy visions of Stockbridge Village Residents**

| | | |
|---|---|---|
| ***Energy Production*** | | |
| Solar power to store electricity for use in the winter | Greener energy and a lower carbon footprint | Energy should be cheaper for future generations |
| More wind energy and wave energy | Cheaper energy prices and less profits for bosses | Use less high-carbon energy and use clean energy |
| Green energy – no or low carbon energy | Cheaper bills, solar and recycle more | Water/heat and solar pumps |
| Solar energy | Use energy from moon light | |
| ***Communities*** | | |
| Buy equipment to make electricity when used such as cross-trainer | Cheap energy, easy to switch and cost the same on direct debit or prepay meter | Use passive lights in buildings and solar energy in schools |
| Routine checks for all the housing in the local area | Bike/rowing machine to create energy in own home | Free energy advice for everyone |
| Solar energy on houses | Recycle more of our rubbish | Wind powered houses |
| Recycle more and stop dumping waste. Save money | More recycling of waste and food | |
| ***Cities*** | | |
| More biking around cities and less buses | Less cars on the road | More walking tracks for the public |
| Solar panels on roofs | | |
| ***Transport*** | | |
| Biofuels instead of fossil fuels | Larger solar panels | Cycle or walk more |
| Power trains from solar energy | Tram system for Merseyside | Space cars |
| Chip fat powered planes | Fast trains | Hydrogen cars and buses |
| ***Agriculture*** | | |
| Encourage people to eat less foreign meat | Biofuels being produced in the UK | |
| ***Businesses*** | | |
| Free energy advice for businesses | Ozone friendly – no greenhouse gases | Apprenticeships that pay a decent wage |
| Adopt a greener footprint in manufacturing | | |

Represented another way, these quotes can be illustrated as a word cloud that highlights the predominant themes and ideas suggested by participants in Stockbridge Village. As shown in Figure 12, key words which were favoured across the participant group were "solar power" and "biofuels" as well as specific localities, activities and methods of transport that use energy such as "houses", "waste", "cars", "trains" and "buses". The high frequency of words such as "use", "cheaper" and "free" is noteworthy. These words reinforce earlier findings from resident questionnaires that specific types of renewable energy such as solar power are identified as a preferred method of energy generation yet references to "cheap" and "free" reflect residents' perception that the cost of energy is too high. Given that Stockbridge Village is a socio-economically deprived area, these findings reflect the overall sense that reducing the economic burden of energy consumption is a priority for residents.


**Figure 12: Stockbridge Village Residents Energy Vision Engagement Word Cloud**

### *4.3.2 Manchester Museum Visitor Group*

Visitors to Manchester Museum took part in the energy visioning engagement exercise as part of an event during "Climate Control", a series of exhibitions and events at Manchester Museum from 11 May – 4 September 2016. As previously, visitors placed their responses to the six key themes on post-it notes that reflected their ideas (and innovations) regarding what they want the future of the energy system to look like in the next 20 years. These ideas are shown in Table 16 with each statement reflecting the quotes and terminologies used by each participant.

**Table 16: Energy visions of the Manchester Museum Visitor Group**

| | | |
|---|---|---|
| | ***Communities*** | |
| Increase energy education in schools and organise workshops and open days for children in public institutions e.g. museums and university | Promote self-generation of electricity at home e.g. solar panels and batteries | Promote use of composting toilets to reduce water wastage. Promote grey water use |
| Solar panelled roof tiles in one. Roof made of solar panel tiles | Formal integration of climate change into school education | Government should create easier cheaper access to renewable energy (e.g. solar) |
| Place a wind turbine in each neighbourhood | Eco-communities e.g. BedZed – shared biofuel generators | Use of nuclear energy |
| Focus on co-ops and grassroots communities | Solar panels for schools | Use of wind energy |
| | ***Cities*** | |

| | | |
|---|---|---|
| More pedestrian areas/public transport as opposed to individual cars | No more nuclear energy as dealing with the waste is a massive issue | Don't allow trucks/large vehicles to drive through the city centres during the day to avoid pollution |
| Invest in fusion reactors | Positive energy savings and building design | Roof gardens – absorb carbon |
| Wind power – how does it affect bird populations? | What are they going to do with nuclear waste long-term? | Retrofit solar panels to all sky-facing surfaces |
| Global consequences of energy considered at all times | Solar energy to provide power to businesses | Local energy to reduce energy use |
| More green space | More trees | Much, much less coal and oil |
| Use of solar energy | Solar energy | More wind turbines |
| | ***Transport*** | |
| Lithium batteries give off hydrogen when reacting with water, and when put into car engines can give off energy efficiently and safely | Take all fuel cars off the road and replace for electrical and battery powered cars | Increase city bike services and create more cycle paths in the city |
| Decrease the cost of public transport | Use public transport when possible and try to walk more | Electric cars for cleaner air |
| Build more train lines | Electric cars for cleaner air | Floating (hover) cars |
| Transport links better in smaller towns and villages | Use battery powered cars instead of fuel | Efficient public transport systems powered by electricity |
| Electric transport | Walk to school or get on a bike | |
| | ***Agriculture*** | |
| Wave power – how is it affecting sea life and coastal regions? | Biowaste – such as food biomass, solar power and wave power | Buy local – farm gate – prices and locality – lower carbon footprint |
| Increase seasonal food consumption | Reduce meat and dairy products | Increase fruit and vegetable consumption |
| Decrease meat and dairy consumption | Sustainable food and farming systems | Organic food systems and energy from waste - bioenergy |
| Globalised veganism | Use natural fertilisers | Promoting vegetarianism |
| Eat more fruit - bananas | Reduce food waste | Organic produce |
| | ***Businesses*** | |
| Have 'green' policies in university e.g. switch off all the computers when leaving the building | Economic re-think! Shift to promoting environmentally sustainable policies rather than growth | Stricter regulations on energy usage – more renewables should be used than fossil fuels |
| Circular economy – making new products from waste materials | Responsibility for the disposal of products at end-of-life | Carbon tax on fast food |
| Wave power | Stricter regulations on energy | Environmental tax system |

Illustrated in the word cloud diagram shown in Figure 13, "energy" was the most frequently mentioned word. A range of energy sources such as "nuclear", "wind" and "solar" were mentioned, reinforcing findings from the questionnaire responses that these methods of generation are preferred sources of energy. Additionally, "transport" and "cars" were mentioned as being substantive contributors to carbon emissions, suggested as being something that needed to be addressed in the future energy system. Simultaneously, participants identified that "food", "waste", and "consumption" were elements that related to lifestyles that also need to be changed. These findings complement findings from the literature on sustainable lifestyles suggesting that food, waste, and consumption are integral to changing individual lifestyles to support a transition towards sustainable low-carbon living (Gorissen & Weijters, 2016; Mont *et al.*, 2014; Verplanken & Roy, 2016).


Figure 13: Manchester Museum Visitors Energy Vision Engagement Word Cloud

## 4.3.3 Transitions Interest Group

Members of "Transition Liverpool" also took part in the energy visioning engagement exercise. Members of the Transitions Interest Group identified their ideas (and innovations) regarding what they want the future of the energy system to look like in the next 20 years for the six key themes on post-it notes. These ideas are shown in Table 17 with each statement reflecting the quotes and terminologies used by each participant.

**Table 17: Energy visions of the Transitions Interest Group**

| | | |
|---|---|---|
| | ***Energy Production*** | |
| Pension funds invest in renewable and divest fossil fuels | Offshore/onshore wind | Tidal? (different types of energy for different environments |
| No fracking! (Frack under Downing Street!) | Marrying up political will with the UK's climate obligations | Re-nationalise the grid and energy for profit |
| Low/zero carbon | Smart energy saving devices of materials | |
| | ***Communities*** | |
| Behaviour change (households) | More communal living = less energy production | Give people a low-cost energy allowance. Higher tariff for extra |
| Community owned renewables | Bottom-up community approach | 3R's – reduce, reuse, recycle |
| | ***Cities*** | |
| Live and work more locally | Is there any urgent action needed regarding current plans e.g. airport expansion | Making sustainability a part of building regulations (house specifications |

| | | |
|---|---|---|
| Solar City model for PV | More communal space | Devolution of energy |
| Universities, hospitals, LCC investment – move to clean | Robin Hood (not for profit energy firm) | |
| | ***Transport*** | |
| Public transport system that works properly | Municipally owned so citizens/councils make decisions | Reduce air pollution – high quality air |
| Affordable and clean | Public transport and walkable/cyclable planning | |
| | ***Agriculture*** | |
| No pesticides | Fewer food miles, local growing | Save the bees |
| Food growing everywhere e.g. train stations, schools etc. | Small scale farming | Less and better meat |
| Localised | Allotments, food producing and biodiverse | Energy efficient and conservation |
| Move to agro-ecology (localised, organic, protection of trees and soil | | |
| | ***Businesses*** | |
| Long-term critical investment in tidal energy (Severn, Mersey etc.) | Municipal/city energy companies e.g. Liverpool Leccy/Bristol Energy | Big 6 - need to take power away from them – move to Energiewande model |
| Stop “greenwashing” | | |

The word cloud in Figure 14 shows the high frequency of “energy”. Most notably, changes to the ways in which “energy” and “food” are to be consumed and different types of “transport” taken, were considered to be important for the future of the energy system. Statements also reflected envisaged changes to the energy system that prioritised “communal” ownership and “clean” energy generation.


Figure 14: Transitions Interest Group energy vision engagement word cloud

## 4.4 *Insights from 'Transition Liverpool' Engagements*

Participants were asked about their visions for the future of the energy system. Table 2 presents an overview of the participants, and includes all corresponding codes applied as identifiers.

### *4.4.1 A Greener and Renewable Energy System*

There was an overwhelming sentiment that participants favoured a greener and low carbon future energy system. This unsurprisingly meant less reliance upon fossil and nuclear energy and more renewables. For example:

> "Nuclear has got too many risks basically I think..." (FG3P6),

> "I think it needs to be a bit more greener..." (FG4P1),

> "Divestment from fossil fuels and towards renewables" (FG4P3),

> "...what we actually committed in Paris is getting to zero carbon... us in the industrialised countries have to take our fair share which means we have to go down to zero in the next two decades" (FG4PX)[11].

There appeared to be a highly idealised and multifaceted concept of what the future energy could look like, as expressed by one participant:

> "...our visions were around having ...100% community owned democratic energy and zero carbon affordable no fossil fuels..." (FG4PX).

### *4.4.2 Devolved and Decentralised Community Generation*

Moreover, participants also not only wanted more renewables, they wanted renewables to be the dominant energy source, eventually replacing fossil and nuclear sources. In relation to the semantics used in energy discourse, the terms 'zero carbon', 'low carbon', and 'sustainable energy' were often used interchangeably to convey a desire for a greener energy system with an inherent assumption that these would constitute sources of energy with less environmental impact.

> "Change language… low carbon to zero carbon and move away from the use of the word sustainability" (FG4PX).

Only a few respondents specified what their vision clearly constituted in terms of what the future energy mix should look like, with limited attempts at quantification. Opinions ranged from very specific percentages of RE within the energy mix to more general views on wanting more renewables. For example:

> "The vision is more or less the same, 100% renewables and biomass..." (FG4PX).

> "Let's say an 80/20 at least an 80/20 mix, 80% from low carbon renewable sources and 20%... if you don't set a target it will never happen..." (FG3PX).

### *4.4.3 Need to 'Power Up' Renewables*

It was suggested that that new energy sources could fill in gaps or any shortfalls in energy supply and demand from renewable sources could be met with some of the new emerging renewable or bio-energy sources:

[11] Where the individual respondent is not identifiable in audio recording of the focus group (for example, multiple speakers at once etc.) the identifier FG3/4 X is used to signify that this contribution comes from a participant in either FG3 or FG4.

> "...Very simple energy ...to fill the gaps in renewables because we can't... renewables can do 8% of the time ...12 to 15% of the time and energy shortfalls... it's the middle of winter and it's -14 and the wind has completely drop around Britain you have to be ... combine gas turbines ... and use synthetic methane made with your surplus renewables so that you can fill in the gap in renewables…(FG4PX).

This greater role for renewables for some could only be facilitated through greater investment, and by a decentralised form of community energy generation moving away from the "lock-in of a centralised system". In addition, greater renewable energy generation should also be accompanied by increased energy storage and efficiency capacities. For example:

> "...Probably more emphasis on…control and energy systems that benefit the community so generation where possible with storage you know energy-saving is one..." (FG3P2),

> "...Community energy in general so that will be generation storage and retrofit... the tidal barrage is needed now... (FG4PX).

### *4.4.4 Municipal Energy Generation*

The role of community energy generation was emphasised by many, and expressed as a desire to see the local development of a municipal renewable energy provider in Liverpool City or across the Liverpool City Region. Notable examples of this from other cities in the UK and across Europe were cited, e.g.: Bristol, Nottingham, Hamburg etc.:

> "I think we … can have the Hamburg option we can say we're gonna be energy sufficient yeah we're gonna supply all the energy we use in Liverpool from locally produced energy and I think personally think it can be perfectly possible …" (FG3PX),

> "Our main ideas were looking at a municipal energy.... Bristol Energy Company... but then we also want to see ... commitment from a city region Mayor..." (FG4PX),

> "There were suggestions that the municipal energy provider should operate as a local energy provider and a not-for-profit organisation and be able to become a "net energy exporter" if feasible." (FG4PX).

The desire for a decentralised and community generated power source aligned with participants wishes to see more devolved local governance and power, in particular the forthcoming 'metro mayor' elections (UK city-regions) and the proposed regional devolution agenda in the UK that many of the participants were already engaged with.

### *4.4.5 Challenges to energy system transitions*

Participants highlighted numerous barriers to their energy visions. These barriers ranged from socio-political, economic, technological and behavioural aspects that originated from the national to local levels and which challenged energy system change. Some of the key points are highlighted here.

#### ***4.4.5.1 Lack of Political Will and Support***

A perceived lack of political will and support from national level government was considered to be a significant obstacle. There was a general perception of misalignment of political priorities where national government appeared to favour corporate interests over those of citizens:

> "Barriers are existing political and economic imperatives so it's not just the politics and structures..." (FG4PX),

> "At the minute with our current government and the politics and ideology you going everything against this so it's the politics that's a barrier and their working for the interests of the corporates not citizens. I guess that's the biggest barrier isn't it..." (FG4PX),

> "The question about that is the devolution agenda is their scope within that do you think to pull on the grassroots may be more community level power away from the corporate interests or do you think the corporate interests will find a way to reassert themselves even at the regional level." (FG4PX).

These examples further highlight the prevalence of conflicts of interests between differing stakeholders. It was proposed that a lack of political support and conflict of interest may filter down and be reflected in the practices, policies and politics at the local government level. There was a sense of a disconnect between what local authorities wanted to achieve (through plans and policy) with what national representations (MPs) for local constituencies were willing to engage in and help deliver in practice. For example:

> "We've always tried to engage with the council in ways umm and with limited success... I think its political demoralisation to be honest [laughs] umm we've tried things." (FG3P6),

> "Local authority are interested ... our local MP isn't interested I spent a whole year sending out letters - all the green organisations they say lobby your MP - so we had ... them saying we take this very seriously ... when she produced her end of term report looked at her record she didn't involve herself in a single debate anything remotely green or sustainable..." (FG3P7).

A further dimension of this political misalignment was a perception of policy 'short-termism' found in national to local policy delivery. For example:

> "Small-scale short-term ism so you know this year it's smart meters, next year its insulation, the year after is renewables, the year after its back to smart meters. You know so nobody is really setting targets..." (FG3P4),

> "I think we have the solutions the problem we have is short termism..." (FG3PX),

> "Our barriers were, the first one was funding and regulation... providing funding on action on energy... again the vested interests of the corporates... we're locked into a potential centralised system..." (FG4PX).

There was a perception of a lack of joined-up thinking on energy system change as well as weaknesses in the local decision-making processes. According to participants, nobody appeared to be taking the lead or to be accountable. Furthermore, a lack of funding and relevant regulations appears to be holding back energy system change. Weaknesses in the policy process can mean that energy companies can cherry pick segments of policy (e.g. CESP, ECO) when it comes to their implementation and in a way to best suit their interests. This can then reinforce "lock-in" features of a centralised system. This implicitly is also related to the extent to which existing energy direction and visioning comes from national government itself and where energy supply still predominantly comes through a nationalised energy supply system, the national grid. These aspects were likely to hold back the potential of the desired vision of a decentralised energy system from developing (as highlighted above).

Linked to the theme of policy weakness and lack of political support, participants cited mistrust and 'demoralisation' when trying engage with key local actors such local councillors and MPs who do not ultimately hold the same visions of change. This has resulted in a sense of disenfranchisement in the role of local politicians. The wider sense of a lack of political leadership and dearth of actors taking responsibility for delivering a shared vision of change emerged as a key theme from respondents.

##### *4.4.5.2 Individual Lifestyles, Consumption and Public Awareness*

Participants highlighted that individual lifestyles and consumption practices, and a lack of public or societal awareness as well as a dearth of curtailment measures for energy use in everyday lives poses a significant barrier. Only through greater awareness of energy consumption and in particular aided by the right technological support can energy transition process be facilitated. For example:

> "One of the other barriers is individualised lifestyles..." (FG4PX),

> "The barriers were ...that it's not accessible to people as an issue it's a bit too big it's a system issue so it's quite difficult to get your head round it... and engaging more people we need to take control and get more people interested in how they consume energy..." (FG4PX),

> "I think at the moment the way we use energy we're very disconnected from it. I think that's a huge barrier to getting anything to change people are consumers of it - of a product that they buy. So, I do think technologies coming in the future could make people more aware of what they're using...." (FG3PX).

There is a suggestion here that technologies could play a role in making people more aware of their everyday energy consumption, in terms of energy use control and potential for greater ownership over consumption patterns and particularly in the case of 'prosumers', generating and stored energy themselves.

### *4.4.6 Expectations for the future of the energy system*

In the discussion of how the desired vision of the energy system could be achieved, a number of complex interrelated themes emerged. Despite the acknowledged challenges (Section 4.4.2) there was also a sense of optimism conveyed of the likelihood of achieving the desired vision. For example:

> "... within limits we're hopeful" (FG4PX)

> "There are a lot of other factors... the main one is Brexit ... government agreement there are so many factors which might affect this... with China, France, UK... Germany..." (FG4PX),

> "It enables humans to do the innate trick where we begin to imagine the world where it's never been before and then fill in the details through a play through a film or through a... once we can imagine it as being live we can step into it being real.... calculating that you can actually keep the lights on is a powerful tool that helps to have the confidence... the science and technology says we can..." (FG4PX).

Thus, the vision could only be brought to life with confidence in the desired change. Observing and learning from examples of places that have achieved or close to a low carbon transition was forwarded as one means to generate this confidence. Confidence also is associated with the fact that some of the enablers can emerge through technological and scientific developments:

> "I think the key thing to think here is what would it be like here what would a zero carbon Liverpool be like and once we can get that vision out there .... Bring it to life then it's more likely to become real." (FG4PX).

The development and emergence of innovative and cheaper energy generation technologies and storage capacities supports the view that the vision could be achieved or developed now. For example:

> "The message is that we have all the technologies as we have the new ones are appearing all the time batteries are getting cheaper electric vehicles are getting cheaper the price of solar PV has come down and down and down so it's all actually getting easier and cheaper to do..." (FG4PX).

> "The technology's all there, the solutions all there but where does the political will come from? That is in the nudge and that nudge has to be lobbied for as a nudging process..." (FG4PX).

Despite the optimism around the likelihood of achieving the desired energy vision, there was also a fear that some obstacles – mainly around political will – could still stifle its materialisation.

There was a sense conveyed that people needed to change by 'powering down' energy consumption through changes in their lifestyles; the challenge of finding a balance between a less energy intensive lifestyle while maintaining good quality of life was articulated.

> "... even compared with the 70s we're using far more energy than we've ever used before we need to be in a process of powering down, back down to a more sensible amount of energy but we still can have personal mobility food, warm houses but can do that on about 60% of the energy that we're using today so we call that a process of power-down" (FG4PX).

### *4.4.7 Solutions with Policy Implications*

Participants highlighted a number of ways in which they thought that energy transition could be aided. This ranged from financial incentives to behavioural nudge approaches. For example, offering a low council tax for homes for retrofitting energy efficiency measures into existing housing. Second, offer reduced or no tax for those implementing or buying renewable technologies. Third, offer preferential VAT rates for green energy. Fourth, invest in renewables by offering subsidies or re-directing them from other energy sources (e.g. nuclear and fossil fuels) and in to the renewable energy sector. A summary of these is presented in Table 18:

**Table 18: Forwarded Policy Options from Respondents**

| Forwarded Policy Options from Respondents | Description | Key Quotations |
|---|---|---|
| **Reduced council tax** | For example, offer lower or reduced council tax for those that have improved the energy efficiency of their home to certain existing standards: | "...or with council tax you could say this is in a band with super insulation so we're going to push it down and pay less council tax..." (FG3P4) |
| **Reduce tax or VAT on renewables** | For example, offer favourable taxing or subsidies to galvanise the renewables sector: | "Arguably if you want a strong renewable energy particularly... take off any tax on it. Make it utterly competitive over everything ……there are models there that do that and why on earth is green energy paying the same rate of VAT?" (FG3PX) |
| **Subsidies and investment in renewables** | Linked to the above example, more specifically, divert investment from nuclear into solar energy: | "It's [nuclear] subsidised phenomenally you know if those subsidies were swapped into renewables that sector would leap away..." (FG3P7) |

| | | |
|---|---|---|
| **Different pricing mechanisms for differing uses** | Offer more differential pricing or tariffs which meet differing consumers' needs and at different times of day | "Do differential pricing for electricity depending on what time of day when you've got the middle of the day middle of a sunny windy day you've got far too much power so you reduce the price of the electricity and then people charge their cars up you know or do their washing or whatever..." (FG3P6) |

Some respondents favoured 'nudges' as an essential behaviour change strategy in energy transitioning. A practical interim nudge solution could mean making small changes such as switching to a green and renewable energy provider. For example:

> "...The big thing I'm interested in is behaviour change… how to change people's behaviour how to nudge people's behaviour is something that we should be been engaged in at the moment... there must be ways of enabling people to shift their attitudes and use less..." (FG3P7),

> "Good Energy is good, they say if you can persuade a friend to join with us you can get a £125 probably quite a good incentive... so being able to publicise offers like that is part of nudging people really" (FG3P6).

Participants highlighted that new and emerging technologies should provide some of the solutions, especially around changing people's behaviours. In particular, technologies (e.g. smart meters) to be used as a way to nudge people to think about their energy use and then change how they consume and manage energy. For example:

> "I think what's interesting is if you can use technology to make people think too, nudge people to think... I think it is possible I think a beeping smart meter if that's going to connect to your mobile phone or app or something like that would be things that are very, very possible..." (FG3PX),

> **"**…how many households have got smart meters and even if you got smart meters how many of those households know how to use a smart meter..." (FG3PX).

There were concerns that not everyone had smart meters or equivalent systems and particularly those with high-energy use who could benefit more. For example, smart meters may be ineffective with users that were relatively affluent and could 'afford to pay' their bills. Whereas those who could benefit from smart meter technology were poorer, did not necessarily have a smart meter and did not possess the means to invest in this technology. For example:

> "... my dad just got one…I don't know what he's bills are like he can afford to pay them so it's like it doesn't really engaged him as he's got no motivator you know that's quite interesting I thought he'd be quite interested to look oh look its doing this you know it's doing that but he's not interested [laughs]" (FG3P2),

> "...it's the people that are really keen the interested will use it but they tend to be people who are not using much energy anyway..." (FG3P7).

### *4.4.8 Involvement of stakeholders in energy system transitions*

Discussion of the potential solutions, lead to questions of who should play a key role in helping the transition process. There was a whole range of actors identified and the general consensus was that no one person alone could tackle the issue. This included 'green' minded individuals, housing providers, local councillors and MPs. For example:

"I suppose the key stakeholders are committed green individuals like ourselves, social housing providers that's it really..." (FG3P6),

"Local authority are interested in, our local MP isn't interested I spent a whole year sending out letters all the green organisations they say lobby your MP so we had a house in common that saying we take this very seriously ... when she produced her end of term report looked at her record she didn't involve herself in a single debate anything remotely green or sustainable so it was complete ...? Made me really, really angry…" (FG3P7).

Whilst participants understood that having local councillor and MP support was important, they found from personal experiences of engaging with them that they had varying responses and levels of success with them:

"Some are, XX has certainly - he is on the environment committee. He supported this whole process..." (FG3P6),

"But you've got a one-party state you know and that's only happened in the last couple of years really so there are no alternative channels." (FG3P4).

Participants also highlighted that from personal experiences that individual politicians taking the lead on green issues can be stifled by local politics and practices. Local level inertia served to discourage those who may want to take more radical shifts in policy and decision-making. Finally, there was a consensus that schools were an integral part of the solution.

"...Stakeholders I'd say children are the stakeholders as well ...I'd influence the schools and teachers and maybe make it a requirement that set a good example and also teach it……" (FG3P2).

## 4.5 *Stockbridge Village Resident Interviews*

### *4.5.1 Energy System Visions*

In terms of a desired vision of a future energy system, many Stockbridge Village interviewees articulated in various ways that they wanted a more 'cleaner and greener' energy system in the future. This meant most favoured more renewables such as solar, wind and tidal sources and less fossil fuel, less fracking and nuclear sources.

"...Prioritise clean energy I really would because we don't wanna to be burnin' more and more gas an coal and stuff like that to produce our energy. We need to find cleaner ways of doing it and we need to find cheaper ways of making it cheaper energy so it's more accessible for people..." (IP13),

"I think it needs to be a bit more greener in the respect that a lot of places in the UK I mean abroad have windfarms wind-farms in the sea and imagine generating enough electricity for so many thousands hundreds of thousands of homes... I'd like to receive it from a renewable source really either wind farm or fossil..." (IP6).

At the household level, this would mean greater self-sufficiency:

"I mean every house should be really self-sufficient power wise that would be a lot of help wouldn't it... your own way of generating fuel" (IP6).

However, the expectation of such change was also muted and there was a widespread view that in reality this could take time to materialise:

> "...If I'm absolutely honest it might change gradually but it won't. It will take years and years and it won't change overnight ... I think it will be another 20-30 years before you know..." (IP13).

> "... I don't think things will change that drastically in 20 years myself I think there will be a lot more people driving ..." (IP10).

However, as shown in Stockbridge Village responses to questionnaires, there remains a commitment to conventional, fossil fuel energy sources. Firstly, some participants expressed views in favour of fracking and fossil fuels whilst conflating the two as being more 'natural', similar to solar energy:

> "Well coal's natural isn't it? It's a natural resource and you get it out of the ground. And solar energy that's natural because it comes from the sun doesn't it" (IP12).

This desire for more natural energy sources lead two participants to suggest greater use of more wood for home heating and peat as an alternative energy source in the future. However, these respondents also acknowledged that these latter two options could be more viable in rural settings than in urban communities such as Stockbridge.

> "I'd like everything to go back to being a little bit simpler. Natural...like now we have central heating... there was a time when we had a fire to keep you warm I know that sounds like [laughs] back in the day you know but it does work I seen it work" (IP7),

> "I think I'm very optimistic we could change I think we could make a small dent if we went for what's within our own country some people who live in rural areas use peat fires n things like that it occurs naturally in the ground ... n things like that which they can burn on the fires a lot of people are going for old traditional fire where the wood the wood and it heats the house " (IP10).

There was a particular dichotomy in the viewpoints around specific energy source development. This meant that some sources were seen as 'good' energy sources such as solar whilst others were framed by a narrative of fear, such as nuclear. It seemed that most participants were particularly in favour of solar energy. This seemed to be related to its familiarity and presence in the public domain. Many had seen solar panels on roofs in houses in their neighbourhood, or they knew a neighbour, friend or family member who had had solar energy installed in their homes. In one case, a participant had installed solar panels largely to save on energy costs, to increase self-sufficiency and for income generation via the Feed-In-Tariff. In contrast, there was a narrative of fear evident against specifically fracking and nuclear energy:

> "...It's always a worry nuclear umm I'd like to rely on less in the future. We can explore the renewable more, then we would have to rely on nuclear less ...it's a clean way of getting power although there's waste to be got rid of..." (IP13),

> "There's also this big issue about fracking and whether it disturbs the Earth's crust, and is there a great danger in it. It's like an unused energy… untapped too I think it should be given a fair chance really...I know there's a lot of protest against it..." (IP6).

Thus, nuclear energy in its current form of processing was unacceptable due to the perceived volatility of power generation from this process and risks from waste bi-products. For one participant, the history of nuclear energy disasters and problems deters further development of it in the future.

> "...Because of all the risks involved and all the waste involved and what do with it. It's just something that goes on for too long... we've had Chernobyl haven't we and we've had a few incidents in our nuclear plants over the years... I'd rather have something that's a bit cleaner and a bit more manageable" (IP10).

These experiences and viewpoints emerge from a community setting characterised by high rates of socio-economic deprivation, fuel poverty and a history of a range of local area based initiatives aimed at increasing energy efficiency of homes.

### *4.5.2 Challenges for energy transitions*

Stockbridge Village Respondents echoed viewpoints expressed by other stakeholder groups on challenges to energy system change. For example, costs, lack of political will and the dominance of economic interests were perceived to hold back change. In particular, the cost dimension to moving away from the conventional mode of energy production and supply to greater use of renewables could manifest in differing ways: at the macro level, it could mean a loss of income or profitability for big energy providers should they divert investment into renewables. At the micro-household level this could mean individuals would be unable to afford energy costs or unable to purchase renewable technologies such as solar.

> "I think its cost a lot of cost... it's not just costs I think there's vested interests and they've got big power companies obviously they don't want lose that income they've got coming in from more renewable resources. I think that's a big barrier..." (IP10),

> "But its cost everything comes down to the cost in the end... It's the initial outlay isn't it? I mean you could get solar panels but it's that initial outlay" (IP10).

There was a sense of disillusionment with local politicians who looked after their personal political interests and did not appear to lead on such issues and were perceived to be far too removed from the social problems of the local community and their critical relationships with energy.

> "They're an absolute joke... they're only interested in getting votes to getting their seat ...although the challenge in parliament is they take on board what they're constituency is saying. They don't really believe it. They're only trying to make themselves look good" (IP9).

However, the government is nevertheless perceived to be a key player in delivering change in the energy system and moving all the relevant actors.

> "...There needs to be a bit more of a government campaign to empower each town or city to look more into solar panels for houses or umm windfarms or reusable fuels..." (IP6),

> "... and the only ones who can change what's happening with all the energy and renewable energy in the energy companies they've got to invest more" (IP13).

Many local residents in the area live in fuel poverty and struggle to meet the costs of energy in their homes. In some cases, residents face choices between eating and heating their home.

> "The big companies and their profit margins cus its greed. It is greed. They're paid mega-bucks and give themselves big bonuses and there's people out there who can't even afford to put their heating on to keep themselves warm. And it is, it's greed" (IP9).

> Interestingly, there seemed to be mixed views on community empowerment and community driven change.

> "I think individuals yeah can make a difference to their own family unit yeah very much... I think if it's a collective of individuals who've got the same ideology yeah they can... I think if we can empower upskill our friend or neighbour family member I think that's something that's really important..." (IP10),

> "…But in a bog-standard estate like this it would be really difficult to do that because the houses have got specific issues..." (IP10).

Interviewees highlighted the need to find more innovative and imaginative technological solutions to some of the existing barriers in the development of some forms of energy, such as how to make nuclear cleaner and/or invest in underexploited resources such as fracking and generating hydro-electric power from the sea.

> "...Maybe they could explore shuttling it to the moon or something [laughs] and they would find a cheap way of doing that obviously, space flight is expensive isn't it ... trying to find a way of cutting costs. May be finding a way to send it in pods unmanned... so when it's in space they could blow it up..." (IP13),

> "There's also this big issue about fracking ... It's like an unused energy... untapped too. I think it should be given a fair chance really...I know there's a lot of protest against it..." (IP6),

> "... Changes there's a lot of things we could do... get power from hydroelectric power from that... we're surrounded by sea why don't we do more of that?" (IP6).

Finally, residents did exhibit some hope for positive future change.

> "...Well I try not to be wasteful in anything and I really do you know and every person can do their little bit their contribution... even in things like turning your heating down. If everyone does it ..." (IP7).

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 less nuclear energy. Some sources were seen as 'good' energy sources such as solar or 'bad' sources such as nuclear. 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 tackling climate change. Many identified the need for both technological and behavioural solutions e.g. re-thinking of our lifestyles to pave the way for change. In a community beset with many challenges on energy (specifically fuel poverty) the proportion of respondents with informed, positive and hopeful views of the future of the energy systems was particularly noteworthy.

# 5 Portfolio of Expert (Top-down) Future Vision Scenarios

## 5.1 *Review of Published Visions Reports*

Table 20 presents a summary of a detailed review of reports sourced from academic and grey literature. These reports consider the development of visions for zero or low carbon futures. Reports presented were authored by a wider range of different actor types at national, regional and city levels. The reviewed reports show some commonalities, but also key differences into how energy futures are being imagined, presented and ultimately, planned for. The scenario mapping presented in Table 20 was developed following the approach reported in Allen *et al.* (2015). In this deliverable, we build on and expand Allen *et al.*'s (2015) work to provide a comprehensive and state-of-the-art review of current visioning work. Table 19 presents a key to the interpretation of the mapping of scenarios across the visions reported in each of the presented reports.

**Table 19: Key to acronyms for applied in Table 19, after (Allen *et al.*, 2015).**

| Key | Scenario Description |
|---|---|
| ZERO | • Zero emissions scenario |
| LOW | • Low emissions scenario |
| $CO_2$ | • Includes $CO_2$ emissions only |
| GHG | • Scenario includes all greenhouse gases |
| OFF-SET | • Scenario includes carbon offsetting |
| 1-SECTOR | • Scenario addresses a single sector |
| MULTI-SEC | • Scenario addresses multiple sectors |
| GOV | • Governmental author |
| NON-GOV | • Non-governmental author |
| VISION | • Scenario offers a vision for the future |
| PLAN | • Agreed action plan |
| 50% RE | • Scenario uses 50% renewable energy or more |
| 100% RE | • Scenario uses 100% renewable energy |
| ### | • Most ambitious scenario combining zero-carbon, full range of GHG focus and 100% renewable energy target. |

**Table 20: Review of Visions Reports, after Allen *et al.* (2015)[12]**

| Organisation/Authors | Scope | Report Title | ZERO | LOW | $CO_2$ | GHG | OFF-SET | MULTI-SEC | GOV | 50% RE | 100% RE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| WWF, Ecofys & OMA (WWF, ECOFYS, & OMA, 2011) | Global | The Energy Report – 100% Renewable Energy by 2050 | | √ | √ | | | √ | X | | √ |
| ACT 2015 (ACT 2015 - World Resources Institute, 2015) | Global | The Three Propositions | √ | √ | | √ | √ | √ | X | | |
| Pascala and Socolow, (2004) | Global | Stabilisation wedges: solving the climate problem… | | √ | √ | | √ | √ | X | | |
| Hatfield-Dodds *et al.*, (2017) | Global | Assessing global resource use and greenhouse emissions to 2050… | | √ | | √ | | √ | X | √ | |
| Nordic Energy Research & IEA (IEA, 2016) | Multi-nation (4 Countries) | Nordic Energy Technology Perspectives 2016: Cities, flexibility and pathways to carbon-neutrality | √ | | | √ | | √ | X | √ | |
| Deep Decarbonisation Pathways Project (2015) | Multi-nation (16 countries with combined 74% of global emissions) | Pathways to Deep De-carbonisation | | √ | √ | | | √ | X | | |
| European Commission (2011) | Multi-nation (28 Countries at time of writing) | Energy Roadmap 2050 | | √ | | √ | | √ | √ | √ | |
| Pleßmann and Blechinger (2017) | Multi-nation (28 Countries) | How to meet EU GHG emission reduction targets? | | √ | | √ | | √ | X | √ | |
| Jägemann *et al.* (2013) | Multi-nation (27 Countries) | Decarbonising Europe's power sector by 2050 | | √ | √ | | | √ | X | √ | |

[12] The analysis presented here is developed from the framework reported in 'who is getting ready for zero' reported in Allen *et al.* (2015)

| **Organisation/Authors** | **Scope** | **Report Title** | **ZERO** | **LOW** | **$CO_2$** | **GHG** | **OFF-SET** | **MULTI-SEC** | **GOV** | **50% RE** | **100% RE** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Child and Breyer (2016)[###] | National - Finland | …recarbonised Finnish energy system for 2050 | √ | | | √ | | √ | X | | √ |
| Järvi *et al.* (2015) | National - Finland | A transport policy tool for reduction of $CO_2$ emissions in Finland | | √ | | √ | | X | X | | |
| Budzianowski, (2012) | | Target for national carbon intensity of energy by 2050 | | √ | | √ | | X | X | | √ |
| Danish Climate Commission & Energy Agency (2010) | National - Denmark | The Road to a Danish Energy System Without Fossil Fuels… | | √ | | √ | | √ | √ | | √ |
| Lund and Mathiesen (2009) | National - Denmark | Energy system analysis of 100% renewable systems | | √ | √ | | | √ | X | | √ |
| Vedvarende Energi & INFORSE (Denmark) (Olesen, 2000) | National - Denmark | Fast Transition to Renewable Energy by 2030 | | √ | | √ | | √ | X | | √ |
| Gov. Offices of Sweden (2012) | National - Sweden | Sweden - an emissions-neutral country by 2050 (in Swedish) | √ | | | √ | √ | √ | √ | | |
| IVL Swedish Env. Research Institute & WWF (Gustavsson, Särnholm, Stigson, & Zetterberg, 2011) | National - Sweden | Energy Scenario for Sweden 2050… | | √ | | √ | | X | X | | √ |
| German Federal Environment Agency (Benndorf, R. *et al.*, 2014) | National - Germany | Germany in 2050 - a greenhouse gas-neutral country | | √ | | √ | √ | √ | √ | | √ |
| Deep De-carbonisation Pathways Project (Hillebrandt K. *et al.*, 2015) | National - Germany | Pathways to deep de-carbonisation in Germany | | √ | √ | | | √ | X | | |
| Centre for Alternative Technology (Allen *et al.*, 2013)[###] | National - UK | Re-thinking the Future - Zero Carbon Britain | √ | | | √ | | √ | X | | √ |
| Deep De-carbonisation Pathways Project (Pye, Anandarajah, Fais, McGlade, & Strachan, 2015) | National - UK | Pathways to deep de-carbonisation in the United Kingdom | | √ | √ | | | √ | X | | |

| Organisation/Authors | Scope | Report Title | ZERO | LOW | $CO_2$ | GHG | OFF-SET | MULTI-SEC | GOV | 50% RE | 100% RE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| UK Government (Department of Energy and Climate Change (UK), 2011) | National - UK | The Carbon Plan: Delivering our low carbon future | | √ | | √ | √ | √ | √ | | |
| Foxon (2013) | National - UK | Transition pathways for a UK low carbon electricity future | | √ | √ | | √ | *X* | X | √ | |
| UK Energy Research Centre (UKERC)<br>Winskel *et al.* (2009) | National - UK | Decarbonising the UK energy system: Accelerated development of low carbon energy supply technologies | √ | | | √ | | √ | X | √ | |
| Deep De-carbonisation Pathways Project (Criqui P. *et al.*, 2015) | National - France | Pathways to deep de-carbonisation in France | | √ | √ | | | √ | X | | |
| Deep De-carbonisation Pathways Project (Virdis *et al.*, 2015) | National - Italy | Pathways to deep de-carbonisation in Italy | | √ | √ | | | √ | X | | |
| Chiodi *et al.* (2013) | National - Ireland | Modelling the impacts of challenging 2050 European climate mitigation targets on Ireland's energy system | | √ | √ | | | √ | X | √ | |
| Berlin Senate (Potsdam Institute for Climate Impact Research (PIK), 2014) | City – Berlin | Climate-Neutral Berlin 2050 | | √ | | √ | | √ | √ | | |
| City of Copenhagen*<br>*Agreed action plan rather than scenarios/visions (Copenhagen City Council, 2009) | City - Copenhagen | Copenhagen 2025 Climate Plan – a Green, Smart and Carbon Neutral City | √ | | √ | | | √ | √ | √ | |
| City of Rome and the Jeremy Rifkin Group (Rifkin, Easley, Laitner, Watts, & Fitzjohn-Sykes, 2010) | City - Rome | Master Plan …Post Carbon Biosphere City | | √ | | √ | √ | √ | √ | | |

| Organisation/Authors | Scope | Report Title | ZERO | LOW | $CO_2$ | GHG | OFF-SET | MULTI-SEC | GOV | 50% RE | 100% RE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Connolly *et al.* (2012) | City-region (Limerick-Clare) | Limerick Clare Energy Plan: Climate Change Strategy | | **√** | **√** | | | ***X*** | **√** | | **√** |
| Manchester City Council (Manchester City Council, 2016) | City - Manchester | Manchester Climate Change Strategy 2017-50 | **√** | | **√** | | **√** | **√** | **√** | | ***√* 100% "clean" energy*** |
| Shell (Shell, 2016) | Commercial Organisation – Global Scope | Energy Scenarios to 2050 | **√** | | **√** | | **√** | **√** | ***X*** | **√** | |
| Trutnevyte, (2014) | COMMUNITY | The allure of energy visions: Are some visions better than others? | | **√** | **√** | | | **√** | ***X*** | | **√** |
| **TOTAL NO. VISIONS REVIEWED = 34<br>TOTAL COUNT OF EACH SCENARIO FROM 34 REPORTS** | | | **9** | **26** | **16** | **18** | **9** | **29** | **10** | **10** | **12** |
| **PERCENTAGE COVERAGE –<br>**What percentage of reviewed vision reports have this scenario present?**** | | | **26.5** | **76.5** | **47.1** | **52.9** | **26.5** | **85.3** | **29.4** | **29.4** | **35.3** |

From the review of published visions presented in Table 20, some key trends are evident:

- Low or full de-carbonisation scenarios have been undertaken for a wide range of countries, including sixteen of the world's largest emitters, which emit nearly 75% of the world's carbon emissions (Allen *et al.*, 2015); not all of these are necessarily government developed.
- The range of terminology and diversity of targets across all reviewed reports is noteworthy. (Zero vs. Low Carbon / $CO_2$ vs. GHG / Use of renewables vs. other options).
- Figure 15 presents a summary of the percentage of all reviewed reports, 34 in total, within which each scenario appears. By and large, the visions reviewed are multi-sectoral, giving scope and breadth to constituent scenarios. Conversely, this could also be interpreted as a lack of detailed and precise, sector specific visions.

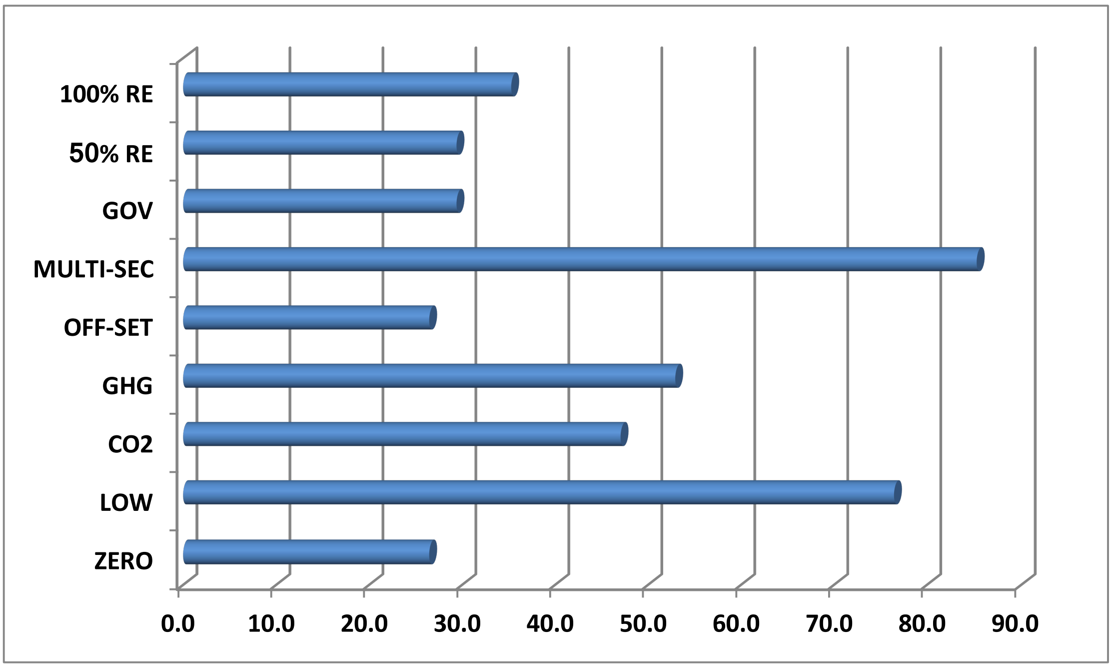


**Figure 15: Percentage of reviewed visions reports which present respective scenarios**

- Figure 15 shows that only 29.4% of all reviewed reports were from governmental sources. While Table 20 is not exhaustive in its coverage, this figure does highlight a need for more government activity in this space.
- Only two of the reports reviewed applied the most ambitious combination of scenarios, that is, zero-carbon, full range of GHG focus and 100% renewable energy target; these were Allen *et al.* (2013) and Child and Breyer (2016). This perhaps suggests an element of conservatism in scenario modelling and flags potential scope for more ambitious and radical modelling of future scenarios.
- The majority of the reviewed reports are scenario-only based. It is clear that there remains a lack of clear and tangible plans to put steps to achieve scenarios in practice. The cases of Manchester and Copenhagen are notable exceptions, and these cities would appear to be providing strong leadership, through development of clear plans and pathways for realisation of ambitious carbon reduction goals. Another way to view this apparent gap between scenarios and tangible, practical actions is a lack of clear linkages between visioning and scenario development and current and planned policy responses.
- The majority of reports also had a technocratic focus; minimal levels of community engagement were evident across the reviewed literature, The Manchester Climate Change Strategy 2017-50 is a notable exception again in this case, which was developed incorporating input from over 700 people and organisations during a public consultation over July to October 2016 (Manchester City Council, 2016).
- The paper by Whitmarsh *et al.* (2007) provides an excellent approach for the development of stakeholder visions for transition at a grass-roots level (the approach informed the stakeholder engagement processes applied for the purposes of this deliverable) but this methodology is not

widely replicated for the purposes of energy system visioning across the literature, further emphasising the importance and novelty of the methodologies being applied on ENTRUST.

**Table 21: Vision Profile: European Energy Roadmap 2050.**

| **Vision Profile: European Energy Roadmap 2050.** |
|---|
| • The EU is committed to reducing GHG emissions to 80-95% below 1990 levels by 2050. In the Energy Roadmap 2050 the European Commission explores how the EU's de-carbonisation target can be met whilst ensuring security of energy supply and competitiveness. The Energy Roadmap 2050 examines four de-carbonisation pathways. These include different combinations of energy efficiency, renewables, nuclear, and carbon capture and storage that would allow a goal of 85% $CO_2$ emission reduction by 2050 to be achieved (Allen *et al.*, 2015). |
| • The scenarios in the Energy Roadmap 2050 explore routes towards de-carbonisation of the energy system. All imply major changes in, for example, carbon prices, technology and networks. A number of scenarios to achieve an 80% reduction in greenhouse gas emissions implying some 85% decline of energy-related $CO_2$ emissions including from transport, have been examined (European Commission, 2011). |
| • The scenario analysis undertaken is of an illustrative nature, examining the impacts, challenges and opportunities of possible ways of modernising the energy system. They are not "either-or" options but focus on the common elements which are emerging and support longer-term approaches to investments (European Commission, 2011). |
| • The scenarios show that de-carbonisation of the energy system is possible using currently available technologies and that the costs of transforming the energy system do not differ substantially from the 'current policy initiatives' scenario. Exposure to energy price volatility is also reduced as well as energy import dependency (Allen *et al.*, 2015). |
| • The share of renewable energy (RES) rises substantially in all scenarios, achieving at least 55% in gross final energy consumption in 2050, up 45 percentage points from today's level at around 10% (European Commission, 2011). |
| • Decentralisation of the power system and heat generation increases due to more renewable generation. However, as the scenarios show, centralised large-scale systems such as e.g. nuclear and gas power plants and decentralised systems will increasingly have to work together (European Commission, 2011). |
| • The electricity supply will need to be almost fully decarbonised by 2050, and even in high energy efficiency scenarios the amount of electricity required will increase from today's levels (Allen *et al.*, 2015). |

## 5.2 *Expert-Informant Panel Findings*

### 5.2.1 *Expectations for the future of the energy system*

Responses from Expert Informants (EI) echoed some of the viewpoints and themes already expressed in earlier sections. There was an overwhelming sense that existing energy system change would be slow and not necessarily perceptible within the next 20 years. Moreover, the 20 years' timescale was perceived to be a relatively short period of time over which to see the desired changes. Thus, EIs suggested that transformational change would require a much longer period of time to materialise:

> "…20 years is not that far off. Likely to be some unforeseen changes, but much of the infrastructure is what it is" (EI-5),

> "Probably not a lot different from what we have now unfortunately..." (EI-3),

"It will be more diverse than in the past. Efforts will continue to decarbonize but will progress more slowly than hoped" (EI-6).

There some evidence of a dichotomy between the desired changes and the likelihood of change occurring. Therefore, in the future energy system, many expected that this would mean a continuation in the reliance on, and dominance of, fossil fuels and nuclear energy. Although many would like renewable sources to play a greater role, they felt that in reality renewable energy sources would continue to play either the same role as currently or a relatively marginal role. A greater level of investment in renewable energy, and into the technologies associated with it to aide transition, was presented as desirable, particularly through the improvements in battery storage capabilities:

"Hopefully more renewables, because it makes sense..." (EI-1),

"Renewable energy is more diffuse than fossil fuels, therefore as many opportunities will need to be exploited as possible leading to more decentralisation but more integration" (EI-6),

"...more electric heating (with heat pumps) and more use of renewables - mostly PV, solar thermal and large-scale wind. Improved battery technology is potentially transformational" (EI-3).

Although most EIs would like to see de-carbonisation efforts leading towards more renewables and decentralised power generation, they recognised the complexity and the challenges to achieving this goal:

"I believe we are slowly moving towards more decentralised energy generation and smarter management of energy (via smart meters, demand side response, etc.). However, how this will play out in the context of a growing population, aging energy infrastructure, etc., is unclear" (EI-11),

"…Certainly more decentralised generation, better integrated into the electricity grid with data management and comms. Whether this will be a truly smart grid facilitating system balancing, demand side response and energy sharing depends on the changes to regulation and £billions of investment" (EI-8).

### *5.2.2 The role of specific energy sources*

In terms of identifying what role different energy sources should play in the future energy system, EI responses again echoed sentiments conveyed previously in the focus groups and surveys. The emerging pattern suggested that most EIs wanted fossil fuels, including shale, gas to play a 'lesser role'; whilst wanting renewables such as wind, solar, biomass to play a greater role in the future energy system. In contrast the support for nuclear seemed less distinct – whilst many wanted nuclear to play a 'lesser role' there were a few that also wanted nuclear to play a 'greater role' or its role to 'stay the same'. Consequently, across the sample of Expert Informants, biomass energy and nuclear energy were on the whole determined to play a moderate role in the future of the energy system. One noteworthy finding was that most EI respondents indicated a preference for 'other sources' of energy to start playing a greater role in the future energy system (Table 22).

**Table 22: Expert Informant's Preferred Energy Sources**

| Energy Source | Greater role | Same role as currently | Lesser role | No response |
|---|---|---|---|---|
| Fossil fuels | 9.1% | 0% | 90.9% | 0% |
| Shale Gas | 27.3% | 9.1% | 63.6% | 0% |
| Wind energy | 81.8% | 9.1% | 9.1% | 0% |
| Solar energy | 90.9% | 0% | 9.1% | 0% |
| Biomass energy | 45.5% | 45.5% | 0% | 9.1% |
| Nuclear energy | 18.2% | 45.5% | 36.4% | 0% |
| Other sources | 72.7% | 18.2% | 0% | 9.1% |

### *5.2.3 Challenges to energy transitions*

A range of social, political, economic and technical reasons were cited as barriers to the delivery of expected energy visions. In particular, the participants highlighted that the existing political and governance structures were weak and overtly centralised in delivering the energy system changes. For example, EIs highlighted that politicians in central and local government lacked the political will and did not prioritise the desired change in their decision-making, amongst other reasons:

> "...Lack of leadership, competing priorities, miss-match of political timelines with decision-making timelines, lack of carbon price..." (EI-5),

> "...if we continue to have less progressive governments, this may not be the case..." (EI-1),

> "...Lack of political will..." (EI-6).

Consequently, there were issues relating to the financing and economics, regulation and policymaking surrounding the delivery mechanisms for energy system change across the various sectors and differing levels of governance:

> "No financial incentives. High capital costs for new infrastructure versus amortised existing infrastructure..." (EI-6),

> "...Lack of joined up policy on energy..." (EI-6),

> "Lack of coherent policy..." (EI-3),

> "Lack of budgets for local authorities..." (EI-6),

> "A more competitive marketplace with barriers to entry reduced and all of us able to supply and demand energy…" (EI-9).

Some cited problems with the existing building stock and the lack of skills in the construction sector, as well as lack of financial incentives for the building industry to address energy efficiency adequately:

> "...Poor building stock. Lack of land per capita. Lack of budgets for local authorities. Lack of skills among installers and knowledge among consumers..." (EI-6),

> "...lack of financial incentives for construction industry businesses to engage and take energy efficiency seriously..." (EI-3).

A few linked lack of engagement by individuals (as electorates and consumers) with lack of political interest:

> "Lack of voter understanding and consequent disinterest of politicians" (EI-2).

EI viewpoints suggest that current energy policy is problematic and contains a wide range of weaknesses which holds back the delivery of a (rapid) lower carbon transition. There is an overall sense that the politics and governance structures pose the largest challenge. The following highlights the complexity of the sociotechnical problem:

> "Incentive structures in the generation industry are broken. Grid stability is a problem with large wind and solar installations and insufficient baseload and turbine generation to enable stability at 50hz. Costs for adaptation are heavily loaded on consumers with carbon tax, rather than carbon pricing, though get emissions credits. Failed emissions trading schemes haven't helped..." (EI-7),

> "Energy market reform to tilt the playing field in support [of] de-carbonisation, and reduce the risk of energy system planning by setting long term strategy" (EI-8).

### 5.2.4 Interventions required to achieve energy visions

EI respondents were asked to prioritise the types of interventions they thought would help deliver their preferred energy system. The range of measures listed included: "new and better technology"; "tax measures"; "education and information"; "direct government action"; "local ownership of energy"; "behaviour change" and "produce my own energy". Nearly all respondents supported some form of intervention. EI respondents rated "education and information"; "direct government action"; "local ownership of energy"; and "behavioural change" as "very important", yet were more likely to rate "new and better technology" and "tax measures" to be "important" (Table 23).

**Table 23: Expert Informant Respondent's Preferred Energy Interventions**

| Intervention | Very Important | Important | Moderately Important | Not very important | Not at all important | No response |
|---|---|---|---|---|---|---|
| New and better technology | 27.3% | 45.5% | 27.3% | 0% | 0% | 0% |
| Tax measures | 18.2% | 54.5% | 18.2% | 9.1% | 0% | 0% |
| Education and information | 45.5% | 36.4% | 18.2% | 0% | 0% | 0% |
| Direct government action | 45.5% | 36.4% | 9.1% | 9.1% | 0% | 0% |
| Local ownership of energy | 45.5% | 36.4% | 9.1% | 9.1% | 0% | 0% |
| Behavioural change | 45.5% | 27.3% | 18.2% | 9.1% | 0% | 0% |

### 5.2.5 The Most Influential Leaders and Organisations on Energy

EI respondents were asked to prioritise which actors they thought could play an influential role in the delivery of the desired energy system. The range of actors listed, included: "teachers"; "politicians"; "local councillors"; "researchers and universities"; "energy suppliers"; "local trades people" and "community leaders". Almost all EIs agreed on the importance of the influential role of all the listed actors. However, some were considered more important than others. For example, politicians, energy suppliers and researchers and universities all stood out as being "very important".

**Table 24: Expert Informant Respondent's View of Influential Stakeholders in Energy Transitions**

| Intervention | Very Important | Important | Moderately Important | Not very important | Not at all important | No response |
|---|---|---|---|---|---|---|
| Teachers | 18.2% | 9.1% | 27.3% | 36.4% | 9.1% | 0% |
| Politicians | 54.5% | 18.2% | 18.2% | 9.1% | 0% | 0% |
| Local council | 9.1% | 27.3% | 36.4% | 27.3% | 0% | 0% |
| Researchers and universities | 18.2% | 45.5% | 27.3% | 9.1% | 0% | 0% |
| Energy Suppliers | 54.5% | 18.2% | 27.3% | 0% | 0% | 0% |
| Local Traders | 18.2% | 36.4% | 36.4% | 9.1% | 0% | 0% |
| Community Leaders | 27.3% | 9.1% | 45.5% | 9.1% | 9.1% | 0% |

One emergent and reoccurring theme, relates to who should or could play a greater role and influence on energy system change. In particular, a few EIs cited the important role researchers could and should play in the transition process, in particular in terms of informing and shaping policy and decision-making:

> "Researchers should have more impact than they have currently. But politicians need to be better educated to take advantage of the outcomes of research. STEM needs higher status for teachers to be effective. Other influences seem to override school input" (EI-6),

> "...And for this policy makers and the population need a greater understanding of what energy actually is, so higher requirements for scientific education" (EI-6).

### 5.2.6 *Prioritised changes required for the energy system*

EIs in response to the question of the 'most important thing' they would prioritise to change the existing energy system; the following key areas were highlighted:

> "Stop using fossil fuels for non-essential things" (EI-5),
>
> "A more holistic approach to energy across all sectors" (EI-6),
>
> "Higher requirements for scientific education" (EI-6),
>
> "Batteries" (EI-3),
>
> "Retrofit [existing] housing" (EI-2),
>
> "Bring energy production under public control" (EI-1),
>
> "Introduction of British version of the German Energiewende Project [decentralised energy production]" (EI-4),
>
> "Smart technologies and using these to provide better access to energy data and the management of usage" (EI-11).

Interestingly each EI cited different and disparate areas for prioritisation. In most cases, responses not surprisingly appear to correspond to the EI's professional and/or personal interest areas.

### 5.2.7 *Expert Informant Energy Vision*

The results from the Expert Informant engagement exercise can be characterised as another discreet energy vision. The developed vision can be characterised as being somewhat in conflict or contradiction on first viewing. Expert Informants are almost reluctant about specific elements of future energy system changes. The findings illustrate that Expert Informants suggest that there are many barriers to policy in terms of its coherence. EI respondents expressed concern about barriers to systemic change, lack of funding for renewable energy projects, poor infrastructure and a lack of appropriate public understanding of energy.

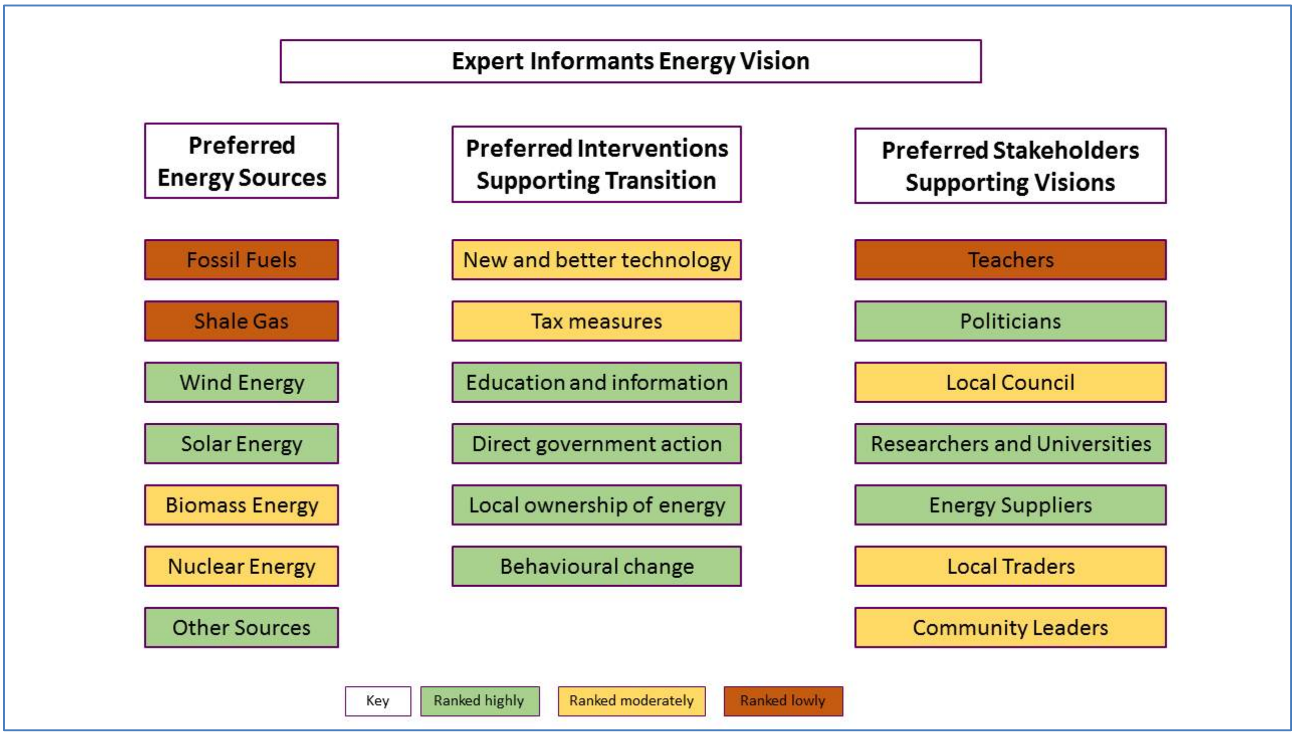


**Figure 16:"Directed-Decentralised Energy Vision"**

The “Directed Decentralised Energy Vision” can be characterised as follows:

- Current dominant sources of energy supply based upon fossil fuels and fracking of shale gas are determined to be incompatible with the future of the energy system. Nuclear energy and biomass energy have the potential to contribute in the future but not at a substantive level. Renewables such as solar and wind energy are depicted as being the key sources of energy generation in the future
- There is a clear articulation of a number of barriers to change in the paradigm in the supply and generation of energy, including issues such as political will, policy, funding, energy infrastructure and public understanding
- To address these issues, bottom-up interventions are suggested such as decentralised energy systems that are locally owned, behavioural change, and education and information. Direct government action is also viewed as instrumental in making these changes to the future of the energy system
- However, financial measures (despite financial issues being suggested as a barrier) are not viewed as favourably as other interventions, including social changes
- Stakeholders at the national level and those traditionally seen as influencing energy systems from the “top-down” were perceived as being of more importance to this energy vision, rather than local stakeholders such as local councils, traders and community leaders. Interestingly, teachers were viewed negatively and as not being able to influence the future of the energy system in questionnaire responses. However, in semi-structured interviews, a more nuanced view of teachers and their role in the community was evident.

# 6 Derived Future Energy System Configurations

## 6.1 *A Transitions Perspective on Energy Visioning*

De-carbonisation of Europe's energy sector while ensuring reliability, availability and cost-competitiveness of supply is a highly complex task. This transition requires a well-designed transition pathway to meet social, political, ecological and economic expectations (Van den Bergh & Bruinsma, 2008) cited in (Pleßmann & Blechinger, 2017). However, an evolutionary transitions approach will be inadequate unless strategically accelerated, according to Wiseman *et al.* (2013). The role of informed, forward-looking policy-making to shape large-scale transitions and "decisive interventions from state and non-state actors" in order to overcome the inertia and lock-in that characterises prevailing sociotechnical systems will be particularly important (Markard *et al.*, 2012; Wiseman *et al.*, 2013). The challenge is multi-faceted and complex. Reaching emission targets requires strong actions, the active co-operation and commitment from across sector(s) and related stakeholders, as well as more environmentally aware choices from citizens (Tuominen *et al.*, 2014).

Scenarios provide useful heuristic tools, permitting the envisioning of scenarios of radical system innovation and the unfolding of political and social contexts under which such changes may occur (Söderholm *et al.*, 2011). The sharing of energy visions, scenarios and strategy plans by organisations, corporations and states can contribute to establishing a common knowledge base for optimising future energy choices. Given the scale of the transitions challenge, knowledge advancement and exchange are critical, and are urgently needed to stimulate and optimize vision sharing and further integration of the plethora of existing diverse energy strategies (Weijermars *et al.*, 2012). The identification of the overlaps of several visions provides the opportunity for aiding consensus building among multiple societal actors, especially if they have conflicting interests (Trutnevyte, 2014). Further to this, Mont *et al.* (2014) argue that the engagement of stakeholders in experimentation, testing and evaluations might enable and facilitate behavioural and value changes that are of high importance for a transition to sustainability.

The transition has to start with practical actions, empowering key actors in the short-term, while targeting long-term trajectories toward sustainability (Wang *et al.*, 2017) and a low-carbon, low-emissions society. However, providing the enabling conditions for energy system transformations while stimulating, coordinating and steering transitions in particular, desired directions while balancing various interests and perspectives (Söderholm *et al.*, 2011) presents a fundamental challenge to Europe's governance regime. While energy scenario studies contribute to envisage possible low-carbon futures it is equally important to address the societal transitions implied by these futures, and investigate how these can be governed, implemented and achieved (Söderholm *et al.*, 2011).

As a first step, the generation and exchange of knowledge is key (Weijermars *et al.*, 2012). Tuominen *et al.* (2014) argue that at the policy development level, there is presently a lack of information on issues relating to synergies of policies and policy packages, as well as on the risks of alternative transitions or development pathways. This is important from a transitions perspective. For instance, governments may introduce temporary policies and subsidies to support some energy technologies, which can lead to severe technological lock-in effects in the long run (Wang *et al.*, 2017), potentially even undermining capacity for achievement of low-carbon goals. When energy visions are developed, incomplete knowledge of complex energy systems may lead to suboptimum solutions from a systems engineering model perspective (Weijermars *et al.*, 2012). The logic or framing that dominates a pathway (dependent on the actors involved) will have a crucial influence on energy choices made and the shape of any future low-carbon energy (Foxon, 2013). It is therefore critical that such visions and pathways to achieve these visions are informed by as full and complete an evidence base as is possible.

According to Söderholm *et al.* (2011) scenarios need to better take into account political and economic realities to ensure applicability and instrumentality in supporting policy-making processes. As a key element of this, any visioning and pathway development process must incorporate the views, engagement and buy-in of the general public. Reporting on the Greater Helsinki Vision 2050 (GHV2050), Neuvonen and Ache (2017) state that stakeholder involvement was intense but focused strongly on a narrow group of experts whilst not paying very much attention on engaging the wider public. The work resulted in a single, technically focused vision (Neuvonen & Ache, 2017). Individuals and households need to be engaged to fully realise any low-carbon vision. For example, energy choices at home are embedded in behavioural practices or routines that have cultural meanings and may be hard to change (Foxon, 2013; Hargreaves *et al.*, 2010). A good public understanding of the supply security issue is crucial, according to (Frei, 2004). Individuals and households have largely had a passive role as energy consumers to date (Foxon, 2013; Hargreaves *et al.*, 2010). This role is now rapidly changing. A successful energy vision for the future must anticipate, stimulate and support the development of relevant innovations and paradigm shifts that can change the future energy landscape (Weijermars *et al.*, 2012). Changing roles of stakeholders, including behavioural and practice related changes constitute just such a shift.

## 6.2 *Distinct Visions of the Future*

From the extensive stakeholder engagement carried out with local community residents, transition interest group members, SME employees, and expert 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)
- Deep Green Vision (DG)

These five distinct visions are predicated on an "…ideal, desirable future state of the energy system" (Trutnevyte 2014: 111) 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 coming years. These visions are constructed from different components, and are not necessarily an attitude towards energy in its generic sense. Specifically, these energy visions are comprised of a number of interrelated components, outlined as follows:

- What individuals consider to be the role of specific **energy sources** (e.g. are fossil fuels, fracking, renewable sources, nuclear energy, or other sources given preference in the future of the energy system);
- What are the specific **support measures and interventions** that individuals consider would support their particular vision for the future of the energy system (e.g. specific infrastructural changes, policy measures and social changes – including behaviour change and local ownership of energy);
- What **stakeholders** do individuals consider to play an important part in their energy vision, and are there some stakeholders that individuals prioritise over others to implement, and support, their visions of future energy transitions (top-down approaches vs. bottom-up approaches and the stakeholders involved at these levels).

While each of the energy visions are discussed in the relevant sections, Table 25 provides a summary overview of each vision indicating the key features of each. Each category is ranked in terms of its importance for each vision (e.g. high, moderate and low).

**Table 25: Summary table of the five distinct visions for energy system transitions**

| ***Energy Vision Priorities*** | | | | | |
|---|---|---|---|---|---|
| | CONT | DD | GPR | AER | DG |
| ***Role Of Energy Sources*** | | | | | |
| Fossil fuels | Moderate | Low | Low | Low | Low |
| Fracking | Low | Low | Low | Low | Low |
| Wind power | High | High | High | High | High |
| Solar power | High | High | High | High | High |
| Biomass | Moderate | Moderate | High | High | High |
| Nuclear energy | Low | Moderate | Moderate | Moderate | Low |
| Other sources | Moderate | High | High | High | High |
| ***Preferred Interventions*** | | | | | |
| Hard infrastructure measures | High | Low | Moderate | High | Moderate |
| Local technology changes | Moderate | Low | Moderate | High | High |
| Social changes | Low | High | Low | High | High |
| ***Role Of Stakeholders Supporting Energy Transitions*** | | | | | |
| Top-down stakeholders | Moderate | High | High | High | High |
| Bottom-up stakeholders | Moderate | Moderate | Moderate | High | Moderate |

It should be acknowledged that the views expressed in these visions may not be static, and they may fluctuate over time, both with stakeholders themselves, and across stakeholder groups. These visions may also be influenced by wider political, economic, social and environmental issues, which may potentially play a role in framing energy issues differently. Individual positionalities may change as a result of how such issues are debated, framed, and responded to. Consequently, there is also the potential, now that these visions have been identified, for individuals to move between different visions. While much research has stated that individuals need to live more sustainably, the process of articulating and debating different energy visions may in fact support more direct, active, and meaningful engagement with energy, potentially accompanied by shifting stakeholder roles (such as a change from passive consumers towards a rights-based energy citizenship). The deliberation on how specific energy sources, interventions that individuals consider to be acceptable or unimportant, as well as the various stakeholders can contribute towards energy system change represents a key element of the emergent energy system transition. While it is beyond the scope of this deliverable to determine if there are some visions that are better than others, it is acknowledged that a "…good vision needs to be both socially viable and analytically sound" (Trutnevyte, 2014: 218).

The five distinct visions that are identified here are presented diagrammatically with respect to four different characteristics. These categories are:

1. Top-down vs. bottom-up approaches
2. Extent of hard-infrastructure changes
3. Extent of local technology changes
4. Extent of social changes

All of these categories are 'mapped' (on the X-axis) to indicate the extent to which each vision advocated a decarbonised energy future as opposed to a business-as-usual/carbon intensive future. All maps are developed on the basis of a 3x3 matrix, ranging from low-med-high on each axis. For example, Figure 17 presents the *Continuity Vision* as "Carbon Intensive" (low) on the X-axis and mid-way between top-down and bottom-up (med) on the Y-axis[13]. Conversely, the *Accelerated Emissions Reduction Vision* and the *Deep Green Vision* represent a "decarbonized energy future" on the X-axis, yet differ in their approach to top-down versus bottom-up influence (Y-axis). The *Accelerated Emissions Reduction Vision* suggests a combination of top-down and bottom-up approaches while the *Deep Green Vision* indicates that bottom-up approaches hold the key to energy system transitions, with a more limited role for top-down approaches. The *Directed Decentralisation Vision* posits that top-down approaches are required to facilitate a transition in the energy system, more so than bottom-up approaches. Key attributes of these five distinct visions are further unpacked in detail in the following section.

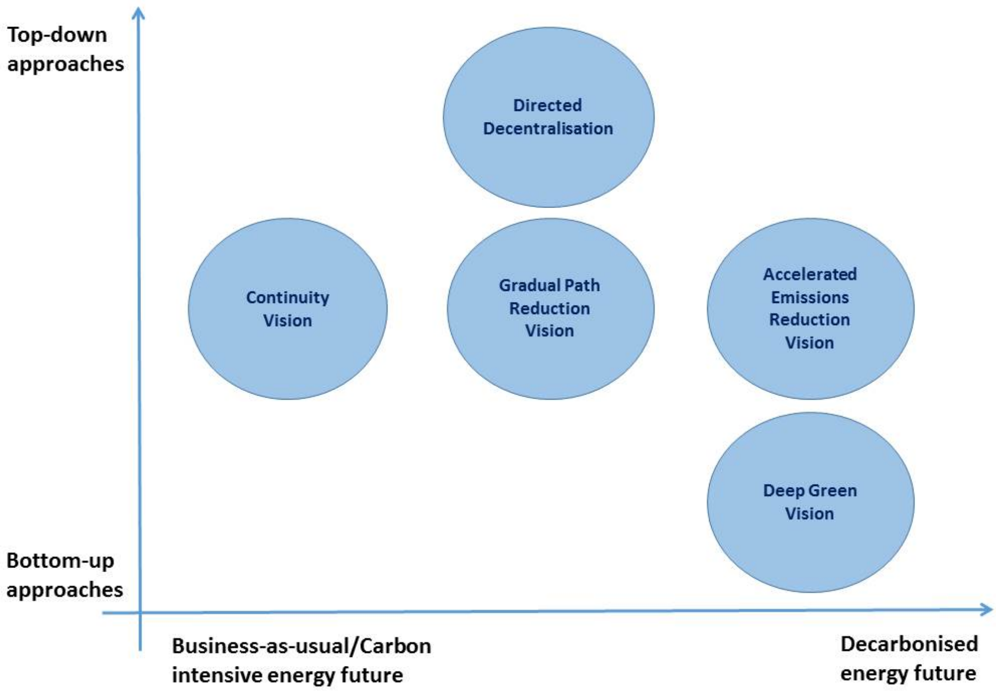


**Figure 17: Five energy visions, mapped by top-down vs. bottom up approaches**

The visions also differ on the extent to which hard-infrastructure interventions are favoured (Figure 18)[14]. While on the opposite ends of the X-axis with respect to a business-as-usual/carbon intensive energy future versus a decarbonised energy future, the *Continuity Vision* and the *Accelerated Emissions Reduction Vision* both support hard-infrastructure changes. Conversely, *the Directed Decentralisation Vision* supports minimal hard-infrastructure interventions, preferring radical social changes to facilitate and support energy transitions (see Figure 20). The *Gradual Path Reduction Vision* and the *Deep Green Vision* support an intermediate approach that does not utilise extensive hard-infrastructure interventions.

[13] Figure 17 illustrates distinctions between each vision with respect to top-down and bottom-up approaches. These were classified based upon the stakeholders chosen to contribute towards each vision. For example, if politicians and energy suppliers were ranked highly, this would indicate a top-down approach, yet if local councils, local traders and community leaders were ranked highly, this would indicate a preference for a bottom-up approach.

[14] [14] Figure 18 illustrates distinctions between each vision with respect to whether hard-infrastructure changes were proposed as part of each vision. For example, if new and better technology, storage of renewable energy, and improved renewable energy were ranked highly, this was classified as substantive hard-infrastructure interventions.

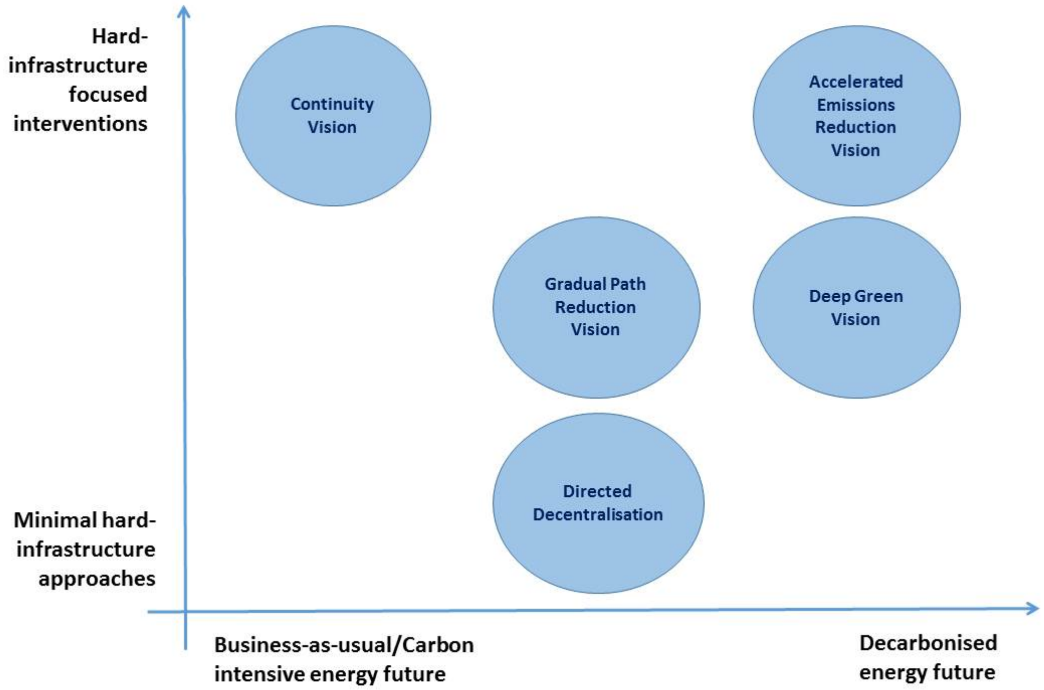


**Figure 18: Five energy visions, mapped by preference for hard infrastructure interventions**

Moreover, the visions also differed when advocating changes to local technology (Figure 19)[15]. The *Directed Decentralisation Vision*, while advocating a top-down vision and enforcing changes to local energy consumption, advocated minimal changes to local technology. Conversely, those visions advocating for substantive decarbonisation of the energy system such as the *Accelerated Emissions Reduction Vision* and the *Deep Green Vision* were more likely to suggest that changes to local technology were an essential intervention to support these types of energy transitions, particularly at a local level. The *Continuity Vision* and *Gradual Path Reduction Vision* outlined moderate changes to local technology that may be more appealing to the public i.e. those that want change in the energy system yet do not want transformations to be too radical.

[15] [15] Figure 19 illustrates distinctions between each vision with respect to advocated changes in local technology. Substantive changes local technology was classified whether aspects such as local ownership of energy, new and better technology and improved energy efficiency were ranked highly.

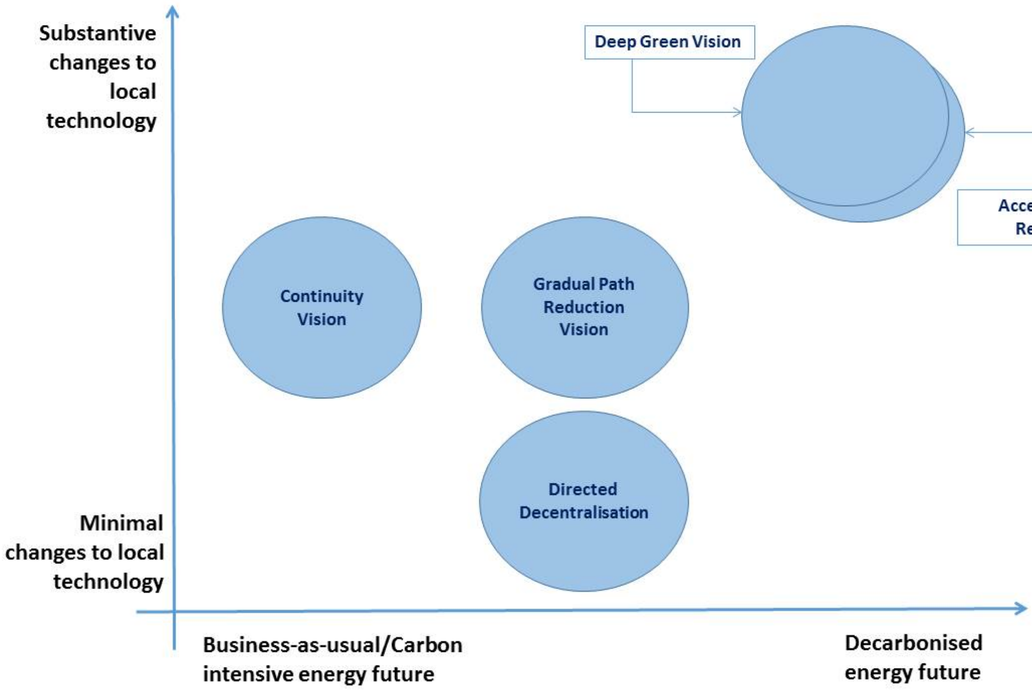


**Figure 19: Five energy visions, mapped by preference for local technology changes**

Finally, each of the visions differed with respect to advocating social changes (Figure 20)[16]. The *Continuity Vision* and the *Gradual Path Reduction Vision* advocated minimal social changes while the *Directed Decentralisation Vision*, the *Accelerated Emissions Reduction Vision* and the *Deep Green Vision* advocated radical social changes as a means to support energy transitions. The *Directed Decentralisation Vision* advocates minimal changes to infrastructure and technology (see Figures 18 and 19), yet recognises that changes in society would support energy transitions. On first viewing, it appears this vision has some internal contradictions, with a preference for a top-down approach, but also emphasis on social change; however, the evidence supports the characterisation of the *Directed Decentralisation* vision as one advocating clear direction of how decentralisation approaches should be facilitated. In opposition to this, the *Accelerated Emissions Reduction Vision* advocates for substantial and radical changes to hard-infrastructure, local technology and social change. Consequently, this vision appears to be one that is a strong proponent of using multiple interventions to address energy transitions in multiple ways and by engaging multiple stakeholders.

[16] [16] Figure 20 illustrates distinctions between each vision with respect to social change. Radical social changes were classified upon whether aspects of energy transitions such as behavioural change, local ownership of energy, decentralized energy systems and education and information were ranked highly as part of each individual vision.

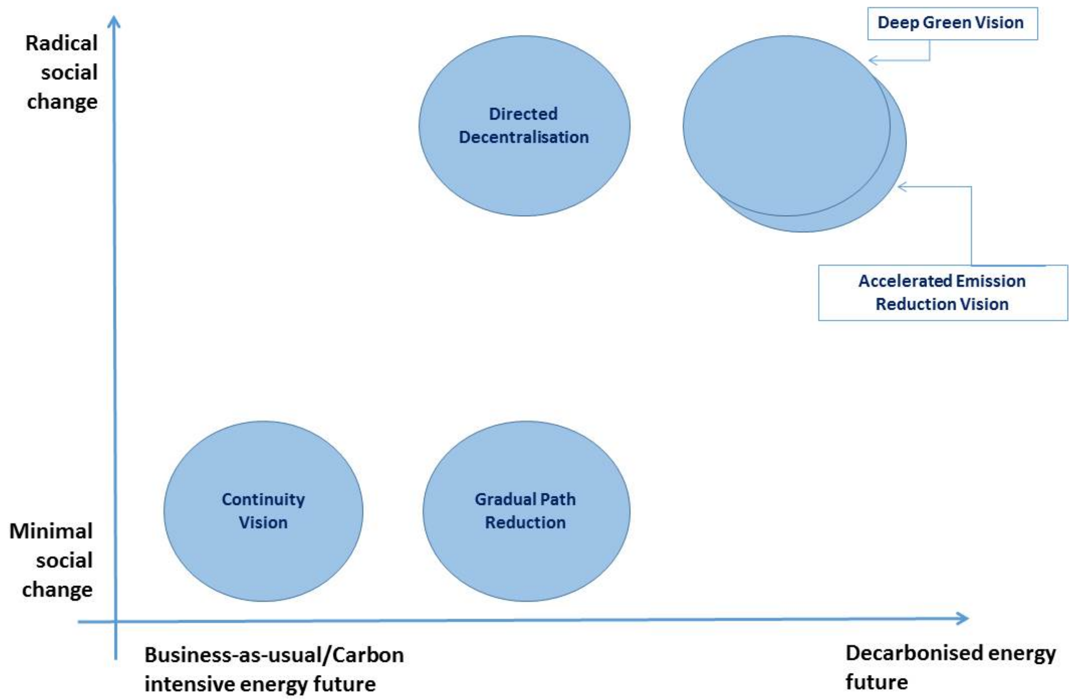


**Figure 20: Five energy visions, mapped by preference for social change**

The presence and strength of narratives of stasis, along with the evidence of highly carbonised lifestyles, suggest that there are major challenges to facilitating transitions towards low-carbon futures (Phillips & Dickie, 2014). The narratives here, characterised by five distinct visions of the energy system, illustrate that multiple 'transitions' are identified dependent upon the role of various energy sources, interventions and stakeholders. Indeed, many of the narratives of stasis can be seen as being ways to make futures absent from the present (Phillips & Dickie, 2014). The narratives of 'denial' and 'keep things as they are', for example, both seek to keep absent from the present concerns for the future related to climate change and energy shortage. They do this, however, in quite different ways: in the first instance by direct rejection of the anticipation of such futures, whilst in the second a focus on the present is used to displace concerns for the future (Phillips & Dickie, 2014).

From the Stockbridge Village engagements, a strong dichotomy in experiences is observable. On the one hand there are some participants who appear to be quite engaged with, and understanding of wider energy related issues; and on the other, there are those who do not seem to either understand energy at a broader macro level, and/or they may have a very fragmented knowledge of the energy system. However, nearly all participants could understand their energy consumption from the point of view of their everyday lives. There was also the expression of more pressing issues relating to social inequality and fuel poverty that manifested very evidently in the way in which local residents consume and interact with energy. The narratives from the Stockbridge Village engagements, as well as from other stakeholders, supports the conclusions drawn particularly in relation to the fragmented nature of the experiences, and knowledge of the energy system that individuals hold. These observations can be applied more broadly to illuminate some of the range of attitudes, concerns, and opinions held by members of the public in wider society more generally. The complexity of energy system visioning highlights often multiple and competing visions or narratives for a desired future; and raises the question of how these visions can be reconciled in a manner to deliver viable and timely low-carbon transitions. This important issue will be further explored in ENTRUST Task 6.3 and Task 6.4.

## 6.3 *Analysis of Identified Low-Carbon Configurations*

### *6.3.1 Analysis of Strengths, Weaknesses, Opportunities, and Threats*

In this section of the Deliverable, each of the 5 distinct visions highlighted as part of this study are further analysed within a SWOT (Strengths, Weaknesses, Opportunities, and Threats framework). Each vision is analysed within the context of how likely it is to achieve substantive decarbonisation as part of a transition to a low-carbon society and future. The following tables (Tables 26 through to 30) provide the findings from the SWOT analysis.

**Table 26: SWOT Analysis of the "Continuity Vision"**

| ***Strengths*** | ***Weaknesses*** |
|---|---|
| • Minimal transformations may appeal to those sceptical of changes<br>• Vision more acceptable to those from communities of low socioeconomic status<br>• Desires changes to infrastructure to address multiple energy issues<br>• Opposition to shale gas deemed to be central to local community values<br>• Supportive of numerous incremental interventions to encourage small-scale changes in opposition to other visions<br>• Opposition to certain energy sources reflected in understandings and experiences of current changes in supply | • Not radical enough to support rapid decarbonisation<br>• Some support for continuation of fossil fuel usage<br>• Based on a pro-consumer perspective<br>• Based on the maintenance of the status quo of energy sources, and consumption practices<br>• Rejects substantive social and behavioural changes as methods to minimise consumption<br>• Top level stakeholders such as politicians viewed as barriers to action<br>• Inconsistency between interventions and stakeholders e.g. supportive of government action but politicians not prioritised as an important stakeholder |
| ***Opportunities*** | ***Threats*** |
| • Potential to 'recruit' sceptical individuals to then move towards another vision<br>• Multiple methods of intervention make this vision more appealable to individuals<br>• Desire to improve local socioeconomic factors could provide impetus for change | • Easily overcome by stronger visions advocating more radical change<br>• Decarbonisation impossible to reach in required time-frames with this vision<br>• Social fear of change can immobilise e.g. politicians not wanting to upset electorates. |

**Table 27: SWOT Analysis of the "Directed Decentralisation Vision"**

| ***Strengths*** | ***Weaknesses*** |
|---|---|
| • Changes at a local level are enforced to maintain momentum<br>• Encourages local ownership of energy and behaviour change to encourage a locally based and owned energy transition<br>• Potentially acceptable to local communities seeking to 'take control' of transitions<br>• Seeks to replace fossil fuels with decentralised energy systems<br>• Possibility of using nuclear energy and biomass as transitions fuels e.g. where nuclear system is already present. | • Dissonance between preference for decentralised system and top-down intervention strategies<br>• Devolution of national energy policy, e.g. so local and regional governments can create their own locally specific energy policy<br>• Enforcing changes at a local level rather than at the top may result in backlash<br>• Reluctance to commit to other interventions<br>• May marginalise some (local) individual stakeholders in preference for others<br>• Reluctance to change at the top inhibits further changes and may result in unsustainable 'lock-ins' |
| ***Opportunities*** | ***Threats*** |
| • Social changes are enforced from the top to support participation in transition<br>• May be viewed as a 'transition vision' to promote moving from one vision to another<br>• Limited interventions may support those who do not consider substantive policy changes as necessary<br>• Could be used by government to lead the way and signal changes to the wider energy sector | • May be seen as a hesitant and top heavy approach to transitions<br>• Enforcing changes at local level rather than top suggests inequality of participation in transition<br>• Marginalising some stakeholders may impede practicality of this vision |

**Table 28: SWOT Analysis of the "Gradual Path Reduction Vision"**

| ***Strengths*** | ***Weaknesses*** |
|---|---|
| • Advocates change, but not radical changes<br>• May appeal to broad sections of society – very generic vision<br>• Idea of nuclear energy as a transition fuel may be viewed positively to move towards low-carbon economy<br>• Breadth of appeal may allow this vision to be seen as a 'halfway house' perspective<br>• Appeal of vision predicated on moderate changes that are not excessive<br>• Promotes the use of widespread renewable energy | • Changes may not go far enough to support low-carbon energy future<br>• Local ownership of energy and tax measures receive only moderate support<br>• Local councils, traders and community leaders not seen to play a substantive role<br>• Policy appears ineffective and tokenistic<br>• Desire for renewables remains more of an aspiration for the future than for the present |
| ***Opportunities*** | ***Threats*** |
| • The moderate interventions supported along with those stakeholders' contributions place this vision as an acceptable energy vision that is not excessive<br>• Appears to offer a more 'palatable' transition vision option | • Reluctance to include tax measures and local ownership of energy limits opportunities for substantive decarbonisation<br>• The gradual path may not disrupt the status quo sufficiently to achieve sufficient decarbonisation. |

**Table 29: SWOT Analysis of the "Accelerated Emissions Reduction Vision"**

| ***Strengths*** | ***Weaknesses*** |
|---|---|
| • Radical approach to reducing emissions to meet carbon reduction objectives<br>• Identifies, and seeks to address, a series of political, economic and social barriers<br>• Very pragmatic approach to transitions<br>• Takes a hybrid top-down and bottom-up approach<br>• Supports a wide variety of interventions used in conjunction with one another<br>• Reactive to sustainable trends, consumer focused and market demands for energy efficiency<br>• Decentralised renewable systems and innovation in supply chains identified as substantive intervention<br>• Potential big step that is needed to make a dent on tackling climate change | • Hesitant towards international calls for transitions<br>• Identifies that not all stakeholders have an important role to play<br>• May be guided by market demands and regulatory bodies, should changes in these areas switch to unsustainable paradigms<br>• This vision could be of limited impact should certain stakeholders such as EU and local councils not be sufficiently acknowledged<br>• Elements of this vision may be too susceptible to policy changes that influence demands |
| ***Opportunities*** | ***Threats*** |
| • Scope for multi-intervention approaches to be implemented<br>• Pragmatic approach for energy transitions would find favour with many environmentalists<br>• Innovation identified as potential intervention to support sustainability in wider areas of supply chains and business<br>• Strong support for bottom-up innovations with strong support mechanism and interventions in place | • Market demands and consumer trends may facilitate unexpected changes in demands<br>• Not recognising the importance of some stakeholders e.g. EU, may fail to take into account influencing factors from higher levels<br>• The finite financial resources available may limit the big steps required<br>• Dominant political and market models/paradigms may stifle radical shift in status quo |

**Table 30: SWOT Analysis of the "Deep Green Vision"**

| ***Strengths*** | ***Weaknesses*** |
|---|---|
| • Very radical approach to transition to meet carbon reduction objectives<br>• Supportive of community-based activities<br>• Encourages local ownership and generation<br>• Strong opposition to carbon intensive sources of energy generation<br>• Strong support for renewables to be implemented quickly for immediate energy transition<br>• Support for research and energy suppliers as integral stakeholders for new pathways to be developed<br>• Requires behavioural changes e.g. adoption of a sustainable lifestyles | • May only appeal to those already interested in environmental issues<br>• May marginalise some actors in the energy system should some interventions not be compatible with existing frameworks<br>• Reliance on renewable sources without support of 'transition fuels' may make this vision impractical<br>• Some top level and community level stakeholders determined to be moderately important<br>• Focused on addressing peak oil and climate change rather than wider issues |
| ***Opportunities*** | ***Threats*** |
| • Supports bottom-up innovations with strong support mechanisms<br>• Encourages community-based projects<br>• Support for multiple interventions allows for numerous approaches to be implemented<br>• Focused movement on energy transitions | • Reliance on renewables without transition fuels may lead to transition failing in short term<br>• Potentially too supportive of bottom-up approach; may fail to take into account changes at higher levels of governance<br>• May only appeal to certain demographics, for example, potentially the more affluent. |

### 6.3.2 Cost-Benefit and Lifecycle Perspectives

The following tables (Tables 31 through to 34) provide a cost-benefit and lifelcycle perspective to the data.

**Table 31: Lifecycle and Cost-Benefit Implications of "Continuity Vision"**

| Vision | "Continuity Vision" |
|---|---|
| Characterisation | "Keep it the way it is, gas central heating and electricity" (QR8),<br>"Don't think it will change that quickly from what we have now" (QR44)<br>**Support for renewable energy sources, but continued reliance on fossil fuel sources. General Opposition to Nuclear and Shale Gas.** |
| Life-Cycle Features – Selected Technology:<br>Fossil Fuel Sources | According to Ding *et al.* (2016) thermal power (from coal, oil, and natural gas) discharges 19, 66, 123, and 164 times more emissions than solar power, hydropower, wind power, and nuclear power, respectively. Of fossil fuel options, lignite is the worst option overall, with a multitude of impacts higher than for hard coal, ranging from 11% higher fossil fuel depletion to six times greater fresh water eco-toxicity. Most impacts are mainly caused by the operation of power plants and transportation of imported fuels (Atilgan & Azapagic, 2015). |
| Cost-Benefit Implications[17] | It is expected that, once cost parity with fossil fuel generation is achieved, a transition towards renewable power should continue without the need for further renewable energy subsidies (Foster *et al.*, 2017). However, this reasoning implicitly assumes that the cost of fossil fuel power generation does not respond to the large-scale penetration of renewable power. Foster *et al.* (2017) report that it is likely that the cost of fossil fuel power generation will respond to the large-scale penetration of renewables, thus making the renewable energy transition slower or more costly than anticipated. At present, the externality issue is of central importance in the cost-benefit discussion on fossil fuels, whereby generating electricity, especially from fossil fuels, creates environmental and socioeconomic impacts on third parties, which are not included in the electricity price (Ortega-Izquierdo & Del Rio, 2016) |

[17] Cost-benefit analysis involves the comparison of total costs and benefits associated with a project or policy, namely those reflected in market prices (private cost or benefit) and those experienced by the external economic and natural environment without directly influencing the market mechanism (external cost or benefit) (Strantzali & Aravossis, 2016)

**Table 32: Lifecycle and Cost-Benefit Implications of "Directed Decentralisation Vision"**

| Vision | "Directed Decentralisation Vision" |
|---|---|
| Characterisation | "I expect small, localised energy production to become more popular [to] complement centralised power generation. I see various types of technology achieving this" (EI9)<br>**Localised energy production, with strong direction and intervention from top-down to achieve this. Opposition to Nuclear and Shale Gas.** |
| Life-Cycle Features – Selected Technology: Wind Energy | The life cycle of wind power includes infrastructure construction (production of steel and cement) and production of other wind power equipment, such as towers, nacelle and blades, hubs, nacelle chassis, generators, and gearboxes. The design life of wind power equipment is 20 years, with an annual operation time of 4500 h and electricity generation of 81.54 GWh (Ding *et al.*, 2016). The environmental impact of offshore wind power systems is based primarily on ferrous metal, which is used to install the foundations, towers, and nacelles. The impact categories with the greatest relevance were fossil fuels and respiratory inorganics (Huang, Gan, & Chiueh, 2017). In a life-cycle analysis of environmental impacts of various RE sources, Atilgan and Azapagic (2016) report that onshore wind is the worst option overall, with nine out of 11 impacts higher than for hydropower and geothermal. However, the global warming potential (GWP) for onshore wind is 9 times and 11% lower than for geothermal and large reservoir hydropower. These figures illustrate the complexity of assessing life cycle impacts for RE technologies and further emphasise the argument by Strantzali and Aravossis (2016) that the problem of selecting an energy resource requires a detailed multi-dimensional analysis. |
| Cost-Benefit Implications | This vision advocates a more decentralized paradigm, where a large number of small energy prosumers (i.e. both producers and consumers) generate energy and may participate in the energy market. Vergados *et al.* (2016) report that significant cost reduction may be achieved, through the association of the prosumers into groups, with prosumer clustering into virtual micro-grids to deliver significant financial benefits. |

**Table 33: Lifecycle and Cost-Benefit Implications of "Gradual Path Reduction Vision" & "Accelerated Emissions Reduction Vision"**

| **Vision** | **"Gradual Path Reduction Vision"** |
|---|---|
| Characterisation | "I think perhaps a shift towards nuclear as a stepping point and green energy still being optimised due to slow development and funding" (QR52).<br>**Transition to low-carbon model, but with reliance of nuclear as bridging source in the interim to minimise disruption and adverse economic consequences. Opposition to Shale Gas.** |
| **Vision** | **"Accelerated Emissions Reduction Vision"** |
| Characterisation | "Heavy increase in local RES and EV working together in a system" (SME-R9)<br>**As with GPR vision, transition to low carbon model, but with reliance of nuclear as bridging source in the interim to minimise disruption and adverse economic consequences. Uptake of RE more rapid and widespread in this vision.** |
| Life-Cycle Features – Selected Technology Nuclear | The life cycle of nuclear power includes infrastructure construction, nuclear fuel preparation, and station operation (Ding *et al.*, 2016). Electricity generated from operating nuclear power plants is generally associated with low emissions per kWh generated (Ashley *et al.*, 2015). Average GHG emissions are around two orders of magnitude lower for nuclear energy than for conventional coal-based power production, according to van der Zwaan (2013). For nuclear energy, the requirement for mined or recovered uranium (and thorium) ore is the greatest overall contributor to emissions, with the possible exception of nuclear energy systems that require heavy water (Ashley *et al.*, 2015). However, a common value of carbon emission factor, t-CO2/GWh, in nuclear power generation reported in the literature varies by more than a factor of 100. Such a variation suggests a large margin of uncertainty and reliability (Nian *et al.*, 2014). |
| Cost-Benefit Implications | Significant side effects of nuclear power include nuclear accidents, radioactive waste, nuclear proliferation, and fear of radiation being used in acts of terror (Choi *et al.*, 2016). In addition, cost estimates for construction of power plants may be underestimated. Harris *et al.* (2013) report that levelised cost may turn out to be significantly higher than expected which in turn has important implications for policy, both in general terms of the potential costs to consumers and more specifically for negotiations around the level of policy support and contractual arrangements offered to individual projects through the proposed contract for difference strike price. |

**Table 34: Lifecycle and Cost-Benefit Implications of "Deep Green Vision"**

| **Vision** | **"Deep Green Vision"** |
|---|---|
| Characterisation | "Take action, power down demand and power up renewables, form groups locally, talk to people about positive visions" (QR15),<br>"Phase out fossil fuels and radical amount of renewable capacity - in line with climate science and commitments (1.5C)" (QR17).<br><br>**"Deep Green Vision" advocates rapid uptake of RE technology, with strong opposition to Nuclear and Shale Gas.** |
| Life-Cycle Features – Selected Technology: Solar | The life cycle of solar power includes the entire production process of PV, from raw material extraction to PV module assembly, with this divided into six steps: silicon mining, industrial silicon manufacturing, solar-grade polysilicon manufacturing, polysilicon manufacturing, battery manufacturing, and PV module assembly (Ding *et al.*, 2016). Tsang *et al.* (2015) present results of a life-cycle assessment showing that environmental benefits for organic photovoltaics extend beyond the manufacture of the photovoltaic panels, with baseline cradle-to-grave impacts for both long-term uses (rooftop arrays) and short-term uses (portable chargers) on average 55% and 70% lower than silicon devices, respectively. |
| Cost-Benefit Implications | Solar and wind power installations require high capital expenditure per MW of rated power which does not have the same connotation as conventional plants (Stram, 2016). High upfront costs are a critical barrier for investments in clean infrastructure technologies, particularly in developing countries, but also in advanced economies (Huenteler *et al.*, 2016). The intrinsic nature of solar and wind power is likely to present greater system challenges than "conventional" sources. Within limits, those challenges can be overcome, but at a cost (Stram, 2016). While the share of renewable energy, especially wind power, increases in the energy mix, the risk of temporary energy shortage increases as well (Yang *et al.*, 2016). Munnich Vass (2017) report a net present cost of reaching the EU emissions target of approximately 225 billion Euros and a carbon price of 306 Euro/ton $CO_2$ in 2050. |

# 7 Feasibility of Collated Portfolios and Outlook

## 7.1 *Outlook*

The energy horizon for the European Union has been clearly defined. There is also a clear commitment to increase the level of energy security by reducing the risk of disruptions and increase the level of respect for the environment by means of emissions reductions up to 2030 and 2050 (DeLlano-Paz *et al.*, 2016). The main question in relation to this strategy is whether the European Union is on the right track towards an efficient design in terms of the cost and risk of its future technology portfolio (DeLlano-Paz *et al.*, 2016). If market regulation is not sufficient to generate a transition towards social and environmental sustainability, then fundamental changes to the economic system will be needed (Rogers *et al.*, 2012). Scenario building is a powerful tool that can engage stakeholders and citizens (Allen *et al.*, 2015) at multiple scales. Community initiatives can produce real benefits at local level, though they have limited impact in terms of tangible sustainability outcomes when compared to the magnitude of changes required (Forrest and Wiek, 2015). Initiatives also need to be carefully targeted. Interventions may not only fail to elicit any engagement but can also create active rejection or hostility to the concept being promoted (Phillips and Dickie, 2014). In addition, community level action alone, while a key part of a transitions response, are wholly insufficient in the absence of actions, targets, incentives and legislation at higher levels of governance (Allen *et al.*, 2015). The degree to which transformational outcomes are attained depends on targeting deeply embedded modes of mobility and consumption and tackling root political and economic drivers (Forrest and Wiek, 2015). The presence and strength of narratives of stasis, along with the evidence of highly carbonised lifestyles, suggest that there are major challenges in facilitating transitions towards low carbon futures (Phillips & Dickie, 2014).

**Table 35: Summary Overview of Community Perspectives**

| **Future energy vision: "What do we want?"** | **Perceived Challenges/Barriers** | **Expected energy future: "How could we get there?"** | **Forwarded Solutions with policy implications** |
|---|---|---|---|
| • Some support for a 'deep green' vision.<br>• Move away from fossil fuels, but widely expressed desire for stability/continuity<br>• Greater and central role for renewables<br>• Renewables supported by new emerging energy sources<br>• Support for decentralised community level energy systems<br>• Move from citizen consumers to prosumers | • Lack of political will and support<br>• Lack of coherence and continuity in energy policy<br>• contradictions between national and local policy and decision-making<br>• Lack of support from some local politicians<br>• Challenges of individual lifestyles in energy consumption reduction<br>• Challenges of retrofitting housing | • No expectations for radical change<br>• Sense of optimism about longer term<br>• Clearer and shared vision needed<br>• Solutions are already available<br>• Need to power down consumption<br>• Learning by example from others<br>• Both behaviour and technological solutions needed | • Reduced council tax<br>• Reduce tax or VAT on renewables<br>• Subsidies and investment in renewables<br>• Different pricing mechanisms for differing uses<br>• Greater use of Smart and intelligent technologies to get behaviour change<br>• Key role to be played by politicians, housing providers and schools. |

## 7.2 *Summary of Perceived Challenges/Barriers*

The overall perspective held by nearly all stakeholders is that change will not be easy and that it will face numerous challenges before any of the desired changes could 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 of fossils fuels and for alternatives to be developed, particularly more renewable energy and decentralised generation and supply. However, this type of change was being held back by an inert centralised top-down energy system of supply, dominated by and almost monopolised by the power of large energy companies.

Furthermore, it was perceived politicians in central and local government lacked the political will to prioritise the desired energy system changes in their decision-making. Stakeholders expressed 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.

## 7.3 *Summary of Perceived Energy Future 'In Reality'*

There was an overwhelming sense of expectation that the existing energy system change would be slow and not necessarily perceptible within the next 20 years. Moreover, the 20 years' timescale was perceived to be a relatively short time-frame and 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 nuclear energy. Alongside this there will be some more localised growth in renewable energy sources and the development of other energy sources, such as biomass. Some expect technological innovations could provide a boost for renewable energy generation through greater storage capacities through battery storage capabilities. The centralised system of energy production, supply and its governance will continue to dominate and will hinder the growth of decentralised energy generation and would not be expected to replace the dominance of fossil fuel or nuclear. A greater level of investment in renewable energy, and into the technologies associated with it to aide transition, was presented as desirable, particularly through the improvements in battery storage capabilities.

# 8 Conclusions

This deliverable has produced a portfolio of scenarios of what the energy system will transition to, outlining in particular **what residents in their communities *want* and *expect* the future of the system to look like.** The deliverable provides a breadth and depth of understanding of how individuals make sense of low-carbon configurations for the energy system. The role of visions in transitions is central, and we offer a summary of both 'top-down' and 'bottom-up' perspectives on a range of future visions that will determine the nature of the imminent low-carbon transition. Envisioning exercises, including scenario development, are important as they can be used to highlight the need for mechanisms for the long-term evaluation of policies and strategies, particularly in the context of preparing society, institutions, actors and infrastructure for lasting change. From the extensive stakeholder engagement carried out with local community residents, transitions interest group members, SME employees, and expert 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 coming years. The five described visions constitute a portfolio of scenarios of what the energy system will transition to, outlining in particular what residents in their communities want and expect the future of the system to look like. While 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 which underpin socio-technical transitions, this paper presents unique community perspectives on current, ongoing transitions. The paper provides breadth and depth of understanding of how individuals make sense of low-carbon configurations for the energy system. The viewpoints presented by Stockbridge Village residents reflected a particular dichotomy in the viewpoints around specific energy sources which also reflected the wider opinions expressed by other groups in this research, e.g. that people favoured more solar and less nuclear energy. Some sources were seen as 'good' energy sources such as solar or 'bad' sources such as nuclear. 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 tackling climate change. Many identified the need for both technological and behavioural solutions e.g. re-thinking of our lifestyles to pave the way for change. In a community with many challenges on energy (specifically fuel poverty) the proportion of respondents with informed, positive and hopeful views of the future of the energy systems was particularly noteworthy.

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# Appendix 1. Summary Table of Questionnaire Respondents

| Respondent | Age | Gender | Ethnicity |
|---|---|---|---|
| QR1 | 31 | Female | White British |
| QR2 | 37 | Female | Black African |
| QR3 | 24 | Female | White British |
| QR4 | 40 | Female | White British |
| QR5 | 39 | Female | White British |
| QR6 | 59 | Female | White British |
| QR7 | 67 | Male | White British |
| QR8 | 83 | Female | White British |
| QR9 | 86 | Male | White British |
| QR10 | 62 | Female | White British |
| QR11 | 38 | Female | White British |
| QR12 | 20 | Male | White British |
| QR13 | 56 | Male | White British |
| QR14 | 59 | Male | Arabic |
| QR15 | 55 | Male | White European |
| QR16 | Not known | Not known | Not known |
| QR17 | 37 | Female | White British |
| QR18 | 32 | Male | White British |
| QR19 | 31 | Female | White British |
| QR20 | 35 | Male | White British |
| QR21 | 37 | Male | White British |
| QR22 | 58 | Male | Arabic |
| QR23 | 55 | Female | White British |
| QR24 | 58 | Male | White European |
| QR25 | 68 | Male | White British |
| QR26 | 42 | Female | White British |
| QR27 | 50 | Female | White British |
| QR28 | Not known | Female | White British |
| QR29 | 65 | Male | White British |
| QR30 | 40 | Male | White British |
| QR31 | 39 | Female | White British |
| QR32 | Not known | Not known | Not known |
| QR33 | 24 | Queer | White British |
| QR34 | 43 | Female | White British |
| QR35 | 69 | Female | White British |
| QR36 | 51 | Male | White British |
| QR37 | 24 | Male | Asian |
| QR38 | 29 | Male | White British |
| QR39 | 24 | Female | White British |
| QR40 | 32 | Female | White European |
| QR41 | 30 | Male | White British |
| QR42 | 24 | Male | Asian |
| QR43 | 24 | Female | Asian |
| QR44 | 32 | Female | Mixed white |
| QR45 | 37 | Male | White British |

| | | | |
|---|---|---|---|
| QR46 | 31 | Male | Arabic |
| QR47 | 18 | Female | White British |
| QR48 | 49 | Male | White British |
| QR49 | 24 | Female | White British |
| QR50 | 22 | Male | White British |
| QR51 | 25 | Male | White British |
| QR52 | 23 | Female | White British |
| QR53 | 27 | Male | White European |
| QR54 | 18 | Female | White British |
| QR55 | 24 | Female | White British |
| QR56 | 29 | Female | White British |
| QR57 | 25 | Female | White British |
| QR58 | 28 | Female | White European |
| QR59 | 49 | Male | White British |
| QR60 | 52 | Female | White British |
| QR61 | 49 | Male | White British |
| QR62 | 42 | Female | White British |
| QR63 | 40 | Female | White British |
| QR64 | 41 | Female | White British |
| QR65 | 40 | Male | White British |
| QR66 | 29 | Female | White British |
| QR67 | 30 | Female | White British |
| QR68 | 24 | Female | White British |
| QR69 | 34 | Female | White British |
| QR70 | Not known | Male | White British |
| QR71 | 41 | Female | White British |
| QR72 | 47 | Female | White British |
| QR73 | 35 | Female | White British |
| QR74 | 42 | Female | White British |
| QR75 | 29 | Male | White British |
| QR76 | 48 | Female | Black African |
| QR77 | 55 | Female | White British |
| QR78 | 75 | Female | White British |
| QR79 | 45 | Male | White British |
| QR80 | 48 | Male | White British |
| QR81 | 24 | Female | White British |
| QR82 | 76 | Male | White British |
| QR83 | 55 | Male | White British |
| QR84 | 62 | Female | White British |
| QR85 | 48 | Male | White British |
| QR86 | 59 | Female | White British |
| QR87 | 56 | Male | White British |
| QR88 | 54 | Male | White British |
| QR89 | 41 | Male | White British |
| QR90 | 18 | Female | White British |
| QR91 | 18 | Female | White British |
| QR92 | 52 | Female | White British |

| | | | |
|---|---|---|---|
| QR93 | 50 | Female | White British |
| QR94 | Not known | Female | White British |
| QR95 | 57 | Male | White British |
| QR96 | 28 | Male | White British |

# Appendix 2. Visions Questionnaire

1. What do you want your energy system to look like in the next 20 years?

2. What do you expect it will look like in reality in 20 years' time? Why?

3. What role do you think the following should play in the future energy system?

| | Greater Role | Same Role as Currently | Lesser Role |
|---|---|---|---|
| Fossil Fuels (Coal, Gas, Oil) | ☐ | ☐ | ☐ |
| Shale Gas ('Fracking') | ☐ | ☐ | ☐ |
| Wind Energy | ☐ | ☐ | ☐ |
| Solar Energy | ☐ | ☐ | ☐ |
| Biomass Energy | ☐ | ☐ | ☐ |
| Nuclear Energy | ☐ | ☐ | ☐ |
| Other sources? | ☐ | ☐ | ☐ |

4. What actions would help to deliver your preferred vision?

| | Very Important | Important | Moderately Important | Not very important | Not at all important |
|---|---|---|---|---|---|
| New and better technology (eg. Smart Meters) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Tax measures (eg. incentives for savings/efficiency) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Education / Information | ☐ | ☐ | ☐ | ☐ | ☐ |
| Direct Government action | ☐ | ☐ | ☐ | ☐ | ☐ |
| Local Ownership of Energy | ☐ | ☐ | ☐ | ☐ | ☐ |
| Behaviour Change | ☐ | ☐ | ☐ | ☐ | ☐ |

5. What currently prevents the achievement of your preferred energy vision?

6. What is the most important thing you would prioritise to change the existing energy system?

7. Who are the most influential leaders and organisations on energy?

| | Very Important | Important | Moderately Important | Not very Important | Not at all Important |
|---|---|---|---|---|---|
| Teachers | ☐ | ☐ | ☐ | ☐ | ☐ |
| Politicians | ☐ | ☐ | ☐ | ☐ | ☐ |
| Local Councillors | ☐ | ☐ | ☐ | ☐ | ☐ |
| Researchers and Universities | ☐ | ☐ | ☐ | ☐ | ☐ |
| Energy Suppliers | ☐ | ☐ | ☐ | ☐ | ☐ |
| Local Trades People (eg. Builders) | ☐ | ☐ | ☐ | ☐ | ☐ |
| Community Leaders (eg. Energy Champions) | ☐ | ☐ | ☐ | ☐ | ☐ |

8. Your Details

Occupation: ______________________________________________

Where do you live? ____________________________________________

Age: ______________________________________________

Gender: Female ☐ Male ☐ ☐_______________

Ethnicity: ______________________________________________

Contact details (email or phone, whichever is more convenient /your preference)

______________________________________________________________