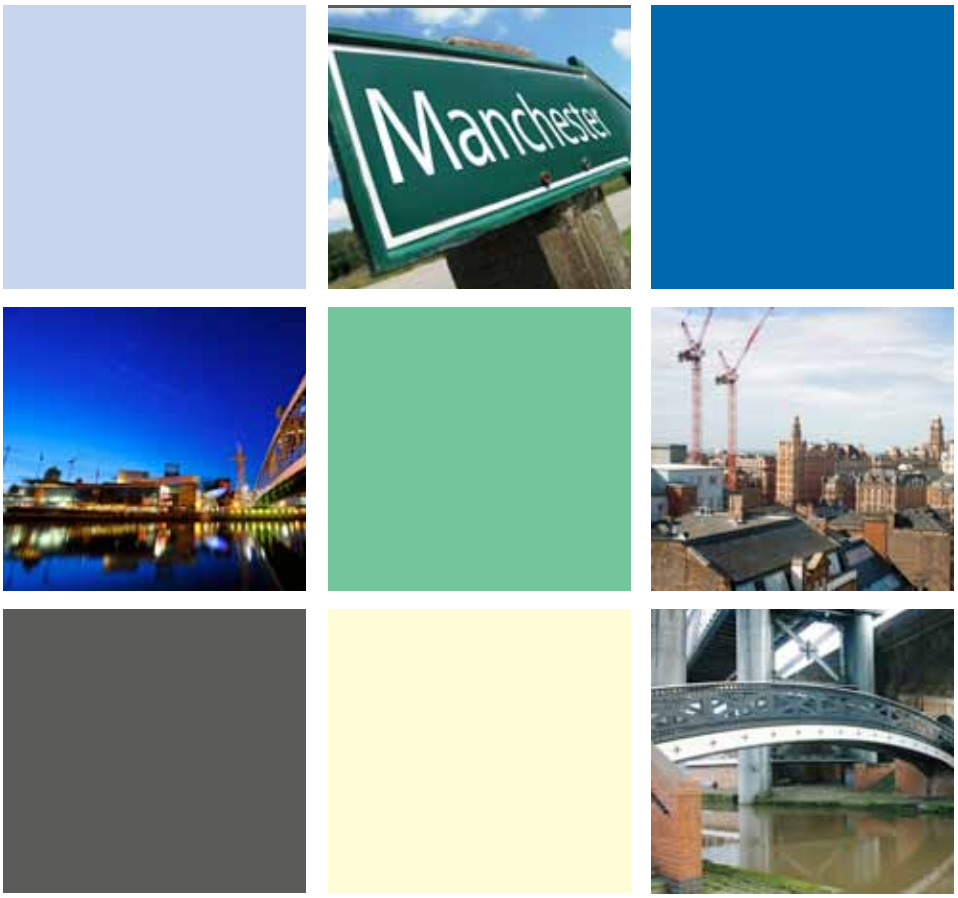
MANCHESTER 1824

The University of Manchester

UK-SHEC Plus:
Public Attitudes to City-Level Energy Options



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SUPERGEN

Executive Summary

Greater Manchester is one of the UK's "Low Carbon Economic Areas" – a flagship designation intended to help in delivering national emissions-reduction targets through technology specialisation. This report provides summary results for a collection of workshops investigating stakeholder perceptions of how Greater Manchester might meet the 2020 and 2050 CO_2 reduction targets set as part of its Low Carbon Economic Area status. Seven workshops were conducted, three with homeowners, one with landlords, and three with "traditional" stakeholders (particularly, but not only, policy makers). In addition, a detailed questionnaire was completed by 201 climate pledgers in Greater Manchester. The report is primarily descriptive and further thematic analysis will follow.

In each workshop, stakeholders were provided with an introduction to key issues relating to emissions reduction and to the scientific basis of human-caused climate change. In workshops with homeowners and landlords, views were sought on differing emissions reduction approaches at the household level, together with views on centralised electricity generation technologies.

The workshop findings highlighted stakeholder concerns regarding the cost of implementation of targets: invariably participants sought high levels of government subsidy to achieve the targets set. The workshop findings also emphasized the unfamiliarity of most micro-gen technologies for UK homeowners, together with associated scepticism of their efficacy. Nonetheless, after going through an energy-emissions learning process with the Greenhouse Gas Regional Inventory Protocol (GRIP) scenario tool and having generated low carbon scenarios, both homeowners and landlords concluded that in order for Manchester to deliver on its targets, they would need to be required through regulation to make the required changes to their homes. This is particularly for implementation of energy efficiency measures and new onsite/on home energy production. Despite being produced by separate groups of stakeholders with differing levels of initial energy expertise, the low carbon scenarios show a high level of similarity, with energy efficiency and renewable energy emphasized and approved of, and with nuclear and fossil CCS playing sometimes significant but more contested and varying roles.

Workshop outcomes are presented in some detail, together with results of the detailed questionnaire sent to environmentally concerned individuals in Greater Manchester. This survey of 201 strongly pro-environmental climate pledgers residing in Greater Manchester shows that installation cost and lengthy pay-back times are major constraints on micro-generation installations, not just for the general population but also for those with a high degree of environmental commitment. Although the microgen installation rate among this pledger group is at least 11 times higher than the national average, fewer than 20% of those who had seriously considered a microgen option went on to install it. The group contained a higher than average level of environmental concern and identity; a belief in a capacity for action nationally and locally, by self and others; and a commitment to a variety of pro-environmental behaviours.

Overall, the workshops with 'traditional' policy stakeholders highlight that the emissions reduction targets set for Greater Manchester are much more challenging than is realized by some of those tasked with implementing such change locally. The workshops with the 'lay-public' both echoed previous studies on preferences for different energy technology options but also revealed how, with appropriate learning tools, non-specialists can quickly appreciate the energy-related challenges posed by stringent climate targets. Moreover, the workshops with the public are among the first to elicit opinion on energy scenarios and systems. Finally, through their differentiation (lay public home-owners, landlords, traditional policy stakeholders and climate pledgers), the studies as a whole offer an insight into how differing groups within Manchester perceive their own roles in energy decarbonisation.

Background: reflections on the research process

For several decades research has been conducted on public attitudes towards different types of energy production technologies. The large majority of these studies have focused on energy technologies in isolation, such as nuclear power, with others more recently focusing on carbon capture and storage, as well as renewable technologies such as wind power. There have, however, been very few studies of how members of the public view energy transitions. Furthermore there have been few attempts to engage the public in energy scenario production, as this study does, not least because of the scarcity of tools with which to do this. Thus while the literature on public opinion of energy technologies is varied both methodologically and with respect to technologies considered, it has been uncommon for researchers to explore opinion of system-level change. Yet it is now axiomatic in the low carbon energy field that system-level change is exactly what is needed, urgently.

This is an applied, qualitative and quantitative study of public and other stakeholder opinion of the options for emissions contraction in a single city-region. The "public stakeholder" workshop element comprised 40 homeowners, including 10 landlords. The "traditional stakeholder" component comprised 21 participants from academia, non-governmental organizations (NGOs), as well as the public and private sectors. The questionnaire survey of climate pledgers received responses from some 200 pro-environmental citizens.

Nonetheless, the exercise was selective in its focus and was not a poll: we sought a variety of views but did not seek to sample in a formal sense. There are multiple publics with diverse views and these are very probably not reflected in our results. Moreover, the views and attitudes sought and elicited are unlikely to be static. They may also not reflect present or future behaviour by the same participants: in a workshop context, individuals may be tempted to report their views in terms of what they deem to be socially responsible, (i.e., they may be tempted to report what they believe is the "right answer") rather than what they think or how they believe they would behave. Views expressed may also be influenced by the discomfort of cognitive dissonance, resulting from holding conflicting beliefs. Participants may also come to realise that their behaviour differs relative to (is inconsistent with) the conclusions that they reach during the scenario process – potentially necessitating justification of their behaviour (Brehm and Kasin, 1996). Indeed, despite their environmental concern, there may be many reasons (often unstated) why an individual may make one choice over alternatives (Anable, 2005). These are just some of the factors that one should bear in mind when interpreting modest-scale studies. Large-scale, statistically-representative studies have their own limitations, of course.

This is a summary, empirically-oriented report with theoretical positioning to be undertaken in academic papers to follow. Nonetheless it is worth briefly considering some of the theoretical issues of relevance. Firstly, energy transitions are deeply socio-technical, a term that is variously understood, but which means at its most general that technology change is as much a social as a technological process. Technology change generally involves winners and losers – an unequal distribution of costs and benefits. Policymakers will look for co-benefit (win-win) opportunities, but in the end a low carbon, more resilient energy system will require new and initially costly infrastructure. Obtaining buy-in for this change, to some extent literally, is but one reason why an understanding of stakeholder and public attitudes is important.

Secondly, there is in science, technology and innovation studies a long tradition of argument for, and experimentation with, wider and user engagement in new technology design and assessment, well beyond commercial, near-market forms of opinion research. Such engagement may be of diverse forms, with engagement of "experts" on one end of a continuum, to the "lay" public at the other. Here we concur with Hendricks (2010) and decades of preceding argument that there is a need for direct citizen engagement in policy and technology debate, and for ensuring that engagement does not serve to simply legitimate pre-existing policy and technology commitments (Stirling, 2008). Associated psychological literatures and perspectives have explored a wide range of factors influencing opinion at different stages of technology R&D chains, including risk perception; place identity and community opposition to energy developments (van Noorden, 2010); the relationship of public trust in the science and environmental concern in relation to global warming and climate change (Pearce, 2010); the role of dissonance with currently held views (Nickerson, 1998; Smith and Mackie, 2007) and so on.

Previous studies notwithstanding, here we present and treat scenarios reflecting both "lay" and "expert" opinion equally. In terms of envisaging long-term future energy mixes, not only is the energy expert's competence constrained by factors unforeseen, but in our experience, supported by software, it is possible to quickly provide members of the public with the information necessary to express informed opinion on energy futures.

Introduction

This work was funded by the EPSRC (Engineering and Physical Research Council) through the United Kingdom Sustainable Hydrogen research Consortium (UK-SHEC). The consortium is comprised of a variety of UK partners, largely universities, including the University of Manchester, and is led by Tim Mays at the University of Bath. This report summarises the work conducted at Manchester University through two of its research centres: Tyndall Manchester (also Manchester Institute of Innovation Research) and the Centre for Urban and Regional Ecology (CURE).

Tyndall-CURE worked with Manchester Knowledge Capital (MKC) to develop a series of workshops with stakeholders to explore how Greater Manchester may deliver its emissions-reduction targets. These workshops have engaged with traditional stakeholder groups comprised of policy makers, academics, NGOs and land use planners. In partnership with MKC, Tyndall-CURE also distributed a questionnaire survey to MKC's climate pledgers. In a third strand of enquiry, homeowners and landlords within the residential sector were also engaged in focus groups for the same purpose. Taken as a whole, the workshops produced a diverse series of outputs through mixed-method approaches. Nonetheless, there are similarities between the energy-emissions scenarios generated by both "traditional stakeholder" workshops and by the workshops comprised of homeowners.

Why Greater Manchester?

Greater Manchester is identified by national government as one of the UK's "Low Carbon Economic Areas" – i.e. a flagship area of the UK intended to help in delivering national emissions-reduction targets through technology specialisation. As a consequence, a series of individuals, groups and other actors are involved in the process of exploring and implementing policies to deliver emissions reduction targets. The Association of Greater Manchester Authorities (AGMA) spearheads many initiatives and Manchester has its own set of emissions targets: a 41% reduction by 2020 and a 93% reduction by 2050, relative to 2005 levels. These reductions represent a sector-specific downscaling (translation) of a national scenario study commissioned by the Climate Change Committee (CCC). This creates a unique situation for Manchester. Tyndall-CURE's links with local policy makers, along with Manchester's history as arguably the birthplace of the Industrial Revolution make it an ideal test bed for energy and climatic change studies.

Downscaling Emissions Targets: Greater Manchester

When emissions reductions are considered sub-nationally, attention should be paid to current and perceived future economic structures, renewable resources and the climatic situations of the area under study. Whilst it may seem nominally straightforward for an area to simply adopt national emissions targets for its own region, in practice different sectors such as residential, services, transportation and industry have different capacities to deliver emissions reductions and these are distributed unequally across a country. Within the UK, mitigation policy is largely advised by the CCC, with local authorities and regional bodies tasked with delivering change. Translating national targets into feasible regional targets that are sectorally split but that sum to similar total reductions requires some level of carbon intelligence and economic awareness on the ground.

What did we do?

Firstly, Tyndall-CURE worked in partnership with Manchester Knowledge Capital to set-up three, one-day "traditional stakeholder" scenario workshops that produced three different energy emissions scenarios; this process was based on the GRIP approach to scenario formation. In total, the process engaged more than 20 stakeholders. The work produced has since been taken forward into a Strategic Energy Action Plan (SEAP) for Greater Manchester.

Secondly, a questionnaire study with climate pledgers focused primarily on attitudes towards climate change mitigation approaches. This component of the work was set up and delivered between January and April 2010, providing data from 201 pro-environmental respondents from Greater Manchester.

Thirdly, four day-long workshops, conducted in a focus group style but with each individual having access to GRIP energy-emissions software on a laptop, were conducted with homeowners in Greater Manchester, with one of these specifically targeting landlords. The workshops examined how Greater Manchester's residential sector might deliver the emissions reduction targets of 41% by 2020 and 93% by 2050. The workshops were conducted between May and September 2010.

The results of these exercises and a more complete description of the work conducted is presented over the following pages. Further thematic summarization across groups and theoretical consideration will be undertaken in subsequent publications: this report is essentially a descriptive condensation of some 40 hours of intensive workshops and questionnaire results.

Research Exercise 1: Reducing Emissions in the Residential Sector: Homeowners and Landlords

The Methodology

In total, 38 stakeholders, all home-owning members of Greater Manchester's public, including eight landlords, were engaged in four separate focus groups. There were between eight and 10 stakeholders in each of the four focus groups; three workshops for homeowners and one workshop for landlords. The stakeholders were sourced through an external agency who recruited from the street, through email and by telephone. Of the stakeholders, 34 owned a house (which varied in age and size), used as their main residence, while the remaining three owned flats.

The stakeholders were given the following hypothetical brief: "You have been appointed to a panel set-up to advise AGMA on how to deliver emissions-reduction targets in the residential sector".

The three workshops performed with homeowners (stakeholders) were divided into six sections. In the first section, stakeholders were given a standardised introduction to human-caused global warming. In the second section, stakeholders were given a set of factsheets describing different electricity generation technologies. They were asked to read the factsheets, make notes on any reactions or thoughts and then place the options in their preferred order for implementation (the table below lists the factsheets provided).

Electricity Generation Technologies	Energy in Homes
Biomass Power	Air Source Heat Pumps
Carbon Capture and Storage	Combined Heat and Power
Coal Generation	Ground Sourced Heat Pumps
Concentrated Solar Thermal	Insulation
Hydrogen	Micro Wind
Natural Gas	Reducing Energy Consumption
Solar Photovoltaics	Solar Photovoltaics
Wind Farms	Solar Water
Nuclear Power	Bio-Fuels/Mass
	Thermal Mass

In the third section, stakeholders were asked to arrive at a group consensus on which electricity generation technologies they would prefer to see implemented. During this discussion, participants were also asked where, in Greater Manchester, would be their preferred location for deployment of the different technologies. Following group discussion, they were asked to review their earlier, individual choices. The fourth and fifth sections of the workshops followed a similar structure to the second and third sections, but this time with a focus on home energy generation and usage. The general approach up until this point was based on that used by Fleishman (2009).

In section six, stakeholders were taken through an energy-emissions scenario exercise for 2050, in which the GRIP scenario tool was used to back-cast to 2020. That is, GRIP was pre-loaded with the necessary emissions reduction targets and current, region-specific emissions data, and the group was taken through a process of entering their technology choices in sections three to six, such that the consequent emissions reductions and their relationship to the targets could be observed. Stakeholder discussions were both observed and audio recorded throughout the day and subsequently transcribed.

General Comments.

The homeowners/landlords (lay public) engaged well with each component of the exercise; they were generally able to distill the information, with most stakeholders engaging well with the discussion. There was some variety in levels of pre-existing knowledge, with two stakeholders having already installed renewable energy devices in the form of solar thermal, but very few had any specialist knowledge of, or interest in, energy issues.

During the discussions, stakeholders frequently sought further information from the facilitator. This usually took the form of context-setting, such as how much electricity is consumed in the UK. Much of the discussion in respect of delivering changes to energy consumption and supply related to willingness to pay for energy efficiency measures and renewable technologies. Other themes included identification with particular places and a desire to avoid over-burdening 'natural' areas with new infrastructure; also that a more forceful approach will be needed for Manchester to deliver on its targets. Stakeholders also highlighted a need for greater levels of information provision on energy in everyday life. When asked, however, they were unsure of how this information should be provided and admitted to not reading documentation provided by their energy company and not paying much attention to adverts on TV and elsewhere about energy efficiency or renewable technologies.

Stakeholders were able to provide individual rankings for preferred home technologies and practice changes. They were also able to justify and clarify these for other participants when requested. The scenario exercise elicited new views from the stakeholders that were not present earlier in the day, as the stakeholders began to understand better the scale of change needed to deliver the targets that Manchester has set. However this meant that the energy scenario that they eventually and collectively produced did not always wholly reflect their preferred technology options. Overall, it was clear from the changing content of the discussions, from initially general preferences and reactions to a later appreciation of the emissions reduction potential of particular technologies, that the process largely succeeded as a an exercise in social learning.

Homeowner Group 1

Demographics

In workshop 1 there were 10 stakeholders: five women and five men. The level of education reached by the stakeholders varied; two stakeholders were educated to GCSE/O-Level, four to A-level, two to under-graduate level and two to Masters level. The stakeholders also varied in age; seven stakeholders were between the ages of 26-35, two stakeholders were between the ages 36-45 and the one remaining stakeholder was in the 46-55 age group.

Home Technologies

Of the 10 stakeholders, nine cited energy efficiency measures as their preferred approach to helping reduce emissions. These energy efficiency measures included reducing energy demand directly by, for example, switching off lights or through improved insulation. One of the stakeholders saw this as "non-controversial" and "the most economical way of keeping their home warm"; these were positions agreed with by the majority of the rest of the group. A focus on cost and disruption from installation partly shaped the day's discussion. Solar photovoltaic (PV), due to its perceived potential future efficiency improvements and perceived lack of visual intrusion, placed third. Solar thermal placed fourth, after PV, because several workshop stakeholders did not have water tanks and therefore needed to find space for one to make full use of the technology. Micro-wind placed fifth; this form of power generation was seen as less efficient than solar PV, with frequent concerns expressed by the stakeholders over noise.

"I would like to produce energy from natural things, but I have placed micro-wind low down on my list as I do not like to hear noise."

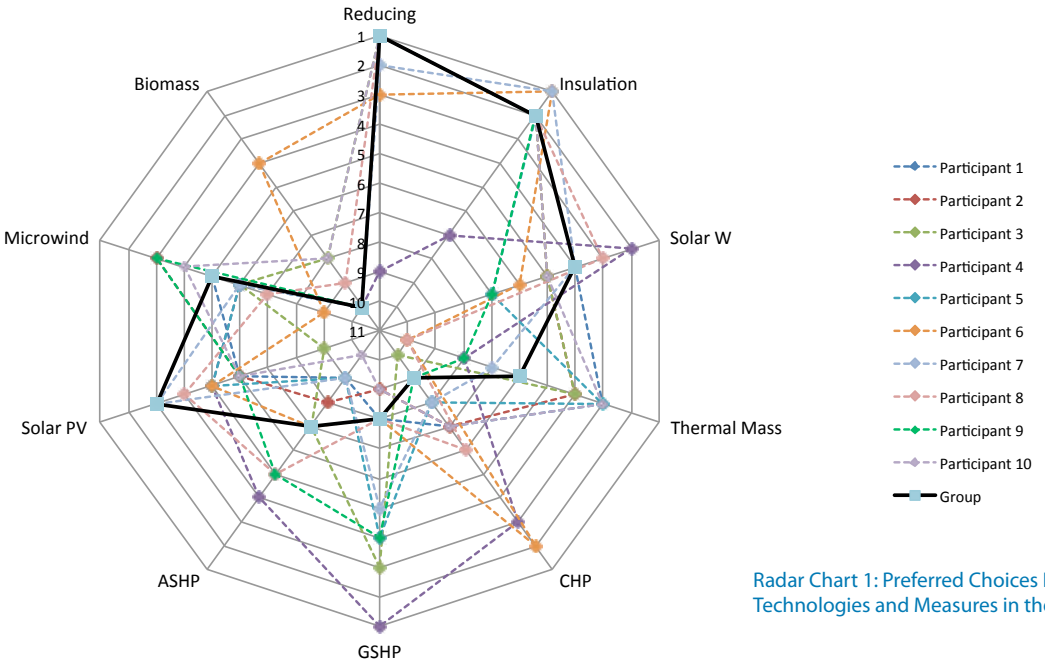
The stakeholders discussed the visual intrusion element of micro wind turbines, however it was felt that this was less of an issue; this was partly summarised by the statement "everyone has satellite dishes now." A degree of dissent occurred within the discussions, with one stakeholder saying that he felt that "wind is a preferable option as we have more wind than solar." Thermal mass placed sixth, because, whilst seen as a preferred approach, being an energy efficiency measure, it was perceived as costly, although in a new-build development, stakeholders said they would have ranked this technology higher.

A slight confusion ensued when discussing air source heat pumps (ASHP), with the confusion being around storage heaters. ASHP ranked seventh, their perceived visual intrusion causing them to be less acceptable to the stakeholders than previous technologies. Ground source heat pumps (GSHP) placed eighth, due to the perceived disruption to existing properties that their installation was deemed to create, together with their expense. However, there was general agreement that GSHPs should be fitted as standard on new-build developments. One stakeholder suggested that GSHPs should be compulsory for 'new builds.' Micro-CHP placed ninth, followed lastly by bio-fuel/mass. Bio-fuel/mass was seen as old fashioned and messy, requiring cleaning away of ash. Further concern was expressed over smoke, fumes, and local environmental impacts.

The results of the individual exercise, together with the group exercise are displayed in Chart 1 below. This chart shows how each stakeholder ranked the technologies and how each technology compared to the overall group result.

Financing

The stakeholders were provided with differing options for financing the installation of renewable technologies and efficiency measures. Stakeholders were uncomfortable with the idea of taking a loan from the



Radar Chart 1: Preferred Choices Energy Technologies and Measures in the Home

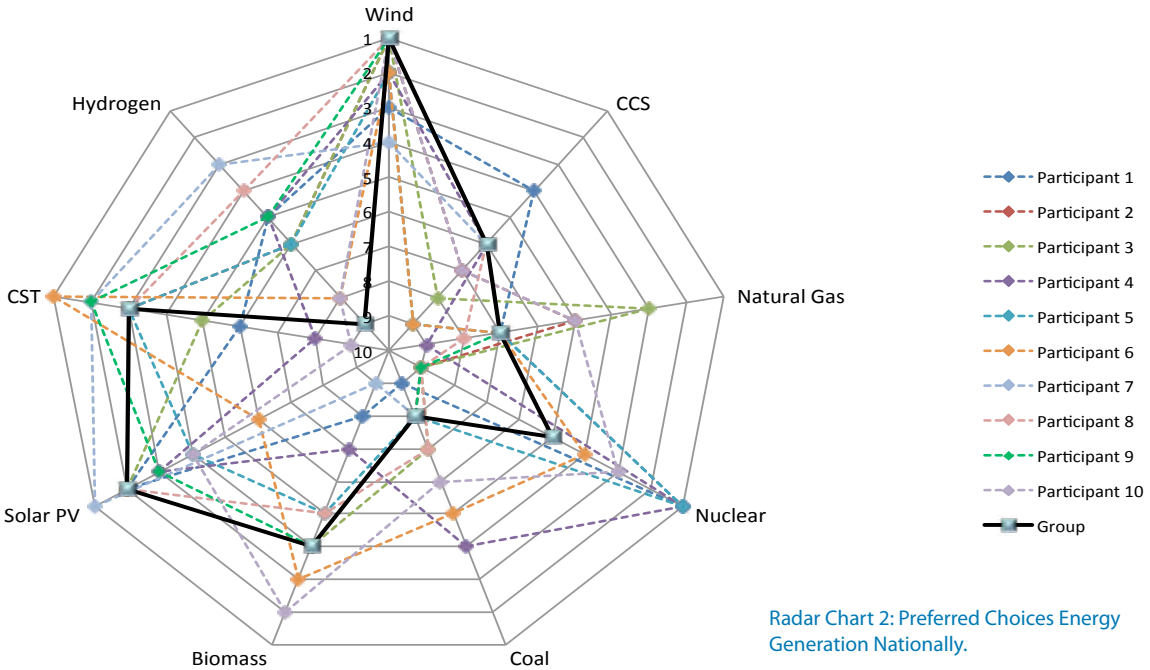
council such that the debt would stay with the property if the owners moved, as this was perceived as an additional debt linked to their home: "A house is difficult enough to sell as it is." When considering borrowing money to install either efficiency measures or new technologies, one stakeholder expressed a preference for the cost to be included as part of their mortgage. Stakeholders felt that the levels of remuneration provided by feed-in tariffs are appropriate, but presented a long pay back period and so would still not be affordable. It was felt that many options were best implemented when a home is built, whilst at the same time avoiding "crippling the business" of the builders. The policies required to bring about change, it was considered, required regulation – either from the national or European Union level – rather than by any Greater Manchester agency.

Electricity Generation

As Chart 2 below shows, initially there was little consensus over preferred electricity generation technologies, with the exception that macro wind-based generation was either the first or second choice for eight of the stakeholders in the individual exercise. Partly as a consequence of this, in the group exercise macro wind generation was the first-placed option. In contrast, micro-wind was consistently placed lower down in the domestic technology section in Chart 1. The difference in reasoning appeared to be linked to concerns over the perceived visual impact and noise that a wind farm would bring, versus a micro-wind turbine on a home. The discussions within the exercise identified wind as an abundant and clean resource. Furthermore, wind was seen to be useful, because: "as an island we can put it out to sea and we're surrounded by sea". The issue of visual intrusion was highlighted, but rebuked by one stakeholder who took the view that "I just think that if you want to live the life we live, there's a price to pay and the price is looking at wind turbines".

Stakeholders were also introduced to the concept of a European grid in the future; because of this, they envisioned some of Manchester's electricity coming from southern European solar generation through PV, and concentrated solar thermal production - placing these options second and third. Thermal generation based on bio-fuel/mass/waste was deemed to be the next preferred option despite being placed last on the domestic technology front. There continue to be concerns over what would be emitted in terms of local air pollution, but because of assumed out-of-town locations, this posed less of a problem. Advanced nuclear-based electricity generation – the power generation technology that created the largest variation in individual preference - placed fifth (the first choice of three of the stakeholders, but the last choice of four stakeholders). A wide variety of polarized views were expressed by stakeholders in relation to nuclear power. For example: "We're not going to be able to manage without them", "It's nuclear. You think futuristic/dangerous". "An accident in there? Compared to wind farms – it's a different kettle of fish".

Whilst nuclear power placed fifth overall, there was an aversion by all to having a nuclear power station near stakeholders' homes. Nearby sites for nuclear that were suggested included parts of Greater Manchester that were remote from participants' homes: "Salford seems a good bet". Carbon capture and storage (CCS) was placed sixth, with one stakeholder suggesting: "it is a case of making the best of what we have". This was followed by natural gas and then coal due to the respective efficiencies and comparative emissions – despite greater concerns for gas over security of supply. Below, Chart 2 shows the group consensus on macro-technologies.



Radar Chart 2: Preferred Choices Energy Generation Nationally.

The Scenario Exercise

Stakeholders were introduced to a distilled version of the GRIP scenario tool that focuses on domestic energy consumption and supply, together with electricity provision nationally. The scenario tool required stakeholders to convert their attitudes/ views from the morning sessions into numbers to deliver the emissions reduction targeted for both 2020 and 2050.

The stakeholders initially believed that an emissions reduction of approximately 20-25% would be possible by 2020 for heat reduction, delivered first through new build and social housing and thereafter in the wider housing stock. Some of the reductions would be aided through national government incentives to local councils and passed onto the public.

The stakeholders did not foresee CCS to be in place by 2020. They saw less of a role for coal generation, declining use of natural gas-based electricity generation and a similar amount of nuclear power as today. They expected a very substantial increase in both onshore wind and offshore wind.

Although stakeholders did not see a widespread role for electricity to produce heat in homes by 2020, they did continue to see a limited role for it: "due to new builds mostly".

The national grid was viewed by the stakeholders as universal in terms of its provision of energy services and large in scale. Stakeholders did not envisage micro generation as supplying much heat by 2020. They saw a limited role for domestic bioenergy, with one stakeholder expressing disquiet: "I think there'll be legislation about what you can burn. It might happen further down the line when we've run out of things to burn."

In terms of electricity consumption one of the stakeholders said that a new rule should be installed: "Just don't give people a choice of inefficient products."

The stakeholders saw on-site power production increasing to 10% of electricity demand by 2020. Furthermore, stakeholders suggested that in order to meet the targets, "We'll need compulsory solar panels on every house". This raised a cost concern by other stakeholders, with one suggesting that "the government would have to pay for it, as some people couldn't afford it". At this point one of the stakeholders suggested that another sector, industry, should have higher targets to enable the domestic sector to emit more. As the discussion became more authoritarian, one of the stakeholders said: "I don't want anything compulsory on my house… I don't see why anyone should tell you what to do with your own property." The stakeholders were asked: "What would make you accept these technologies?," to which the response was: "If there was some penalty." As the emissions reductions scenario process progressed, stakeholders began to get frustrated that they were not achieving the reductions needed, with one suggesting that we needed: "more air pumps – but I don't like them!" The stakeholders subsequently thus reduced energy demand further, until they reached the target of 42%.

GRIP makes the emissions reduction challenge explicit to people and this can be discomfiting. When the discussion moved towards a 90% reduction in emissions, one of the stakeholders remarked: "I'm just going to move somewhere they don't care (obviously I'm jesting)". The stakeholders continued to take a demand-oriented approach to their scenario with building heat efficiency being: "loads more efficient.... then today".

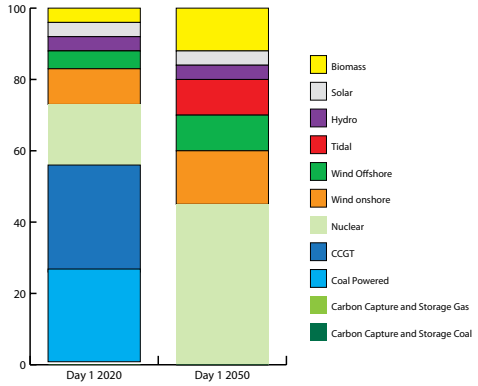
With a now fully decarbonised electricity grid, stakeholders decided to utilise electricity as one of the dominant forms of heat provision within the home. The stakeholders generally perceived installation of micro-generation to be much easier on new builds than existing properties.

Natural gas for direct heating was reduced to zero as a consequence of the choices the stakeholders made. As a result, the only emissions from the domestic sector in this scenario arose from micro-CHP using natural gas.

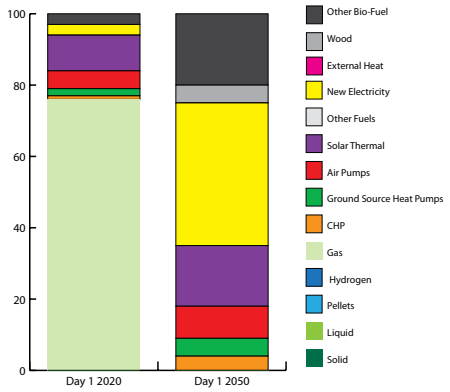
Workshop Preferred Choices and the Scenario for 2050

In both the previous exercise and the scenario exercise there was a focus on demand reduction through insulation and other technologies together with some behavioural changes. Despite featuring highly on the choice exercise, the amount of energy provided by onsite PV and solar thermal featured comparatively little in the scenario exercise. The prevalence of micro-CHP featured higher in the scenario, despite being placed second to last in the choice exercise. The use of bioenergy also featured highly in the scenario exercise as a source of heat, surpassed only by electricity, despite bioenergy being the least-preferred technology option in the choice exercise for heat production.

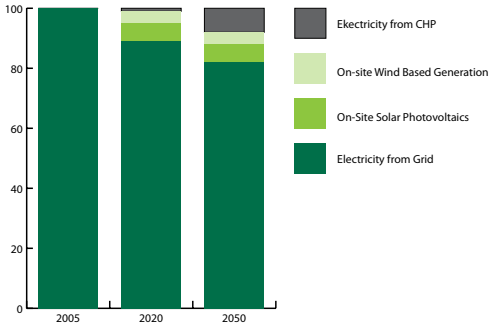
Use of wind power placed first in the choice exercise, with nuclear power being placed fifth. However in the scenario, wind generation, both on- and off-shore, was deemed to account for 25% of electricity generation, with nuclear power accounting for 45% of total electricity generation. This should be considered in comparison to solar PV and solar thermal, which placed second and third in the choice exercise but only accounted for a total of 4% of electricity generation in the scenario. There was a greater link between the choice exercise and the scenario in the case of coal, natural gas and CCS generation, which featured last in the preferred choice exercise and did not feature in the scenario. The latter is notable in particular: CCS was not seen as a low carbon technology with a long term future.



Bar Chart 1: Electricity Generation by technology in percentages.



Bar Chart 2: Energy by technology in the home in percent.



Bar Chart 3: Source of electricity consumed at home in percent.

Homeowner Group 2

Demographics

In this group there were 10 stakeholders, comprised of five women and five men (one had to leave early due to ill health). Again, the level of stakeholder education varied. One stakeholder was educated to GCSE/O-Level, three were educated to A-level, five to undergraduate level and one to Masters level. There was a smaller spread of ages in this group as compared to those in Homeowner Workshop 1. Seven stakeholders were between the ages of 36-45, one stakeholder was between the ages 46-55, one stakeholder was in the age band 55-65, and the remaining stakeholder was between the ages 26-35. Nine out of the 10 stakeholders owned houses, one owned a flat.

Home Technologies

On this day, energy efficiency measures were placed as the first choice option by nine of the stakeholders, with seven placing energy efficiency approaches second in their preferred approaches. In the group discussion, reducing energy consumption placed first, as it was viewed as a "no brainer" and as something that "everyone can do".

Thermal mass was seen positively, with simple measures such as placing reflective heat panels behind radiators being positively promoted within the group. Concern arose, however, over aesthetics, particularly "painting walls black".

Ground source heat pumps (GSHP) placed forth, but this was with a particular focus on new builds. Stakeholders were highly reluctant to have their existing gardens "dug up". Solar PV placed fifth as, "once installed it produces no emissions". The cost of this seemed to present less of a problem to the stakeholders than other technologies.

This was followed by solar water, sixth, "as it is a renewable source"; in a similar manner to Workshop1, stakeholders in Workshop 2 were reluctant to have a hot water tank put in their homes. The stakeholders were also not convinced by the value of pre-heating water through this technology, nor the technology potential for warming water overall. Two such statements that were linked to this included: "I just don't understand how it can heat enough"; "I just can't see it working. They'll all be bursting the pipes in the winter".

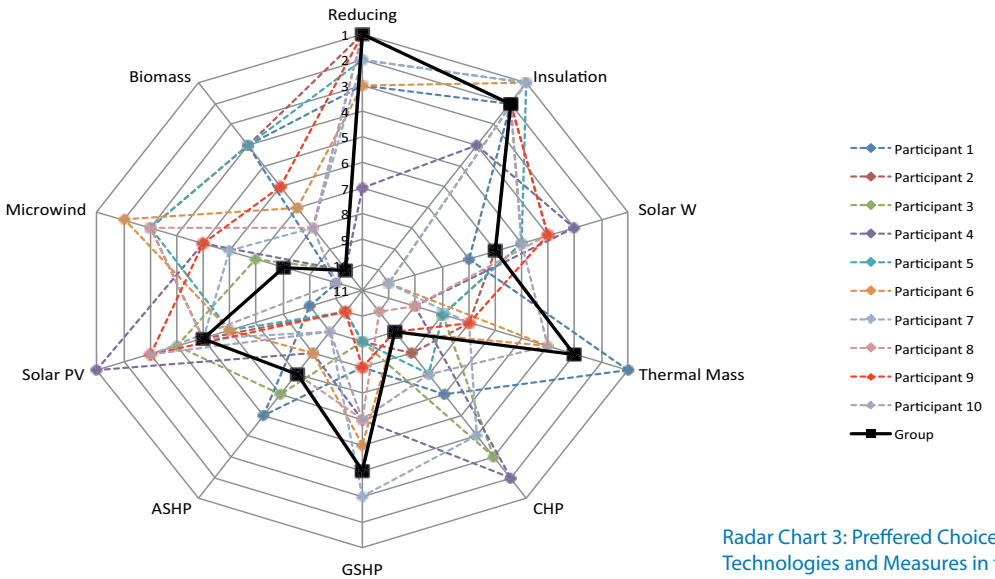
Air Source heat pumps (ASHP) placed seventh, due in part to concerns over these being unsightly, noisy and inefficient. One stakeholder expressed concern over the figures provided in the factsheets, postulating that ASHPs were not as efficient as the figures suggested.

Micro-wind turbines placed eighth, again as was discussed in Workshop 1, they were perceived to be ugly, inefficient and noisy, with one stakeholder remarking: "I spent three weeks in a pub next to a wind farm and I didn't sleep at all". Other stakeholders had a greater degree of confidence in micro-wind installations. One stakeholder referred to the pictorial representation of wind resources around Europe provided to them on the fact sheets and referred to the UK as the "windiest country in Europe".

Micro-CHP was generally not desired, as stakeholders perceived there would be less need for this in the future as buildings would be more efficient. One stakeholder felt uneasy with the concept of a mini-power station in their home, stating, "I have enough problems with my current boiler".

Bio-fuel/mass placed last in this workshop, as it was the case in the first workshop. This occurred for a variety of reasons. Unease existed over the apparent lack of control surrounding bio-fuel/mass in comparison to natural gas, in relation to both ease of delivery (natural gas being piped in, whereas pellets are delivered) and "safety in the home, especially if you have kids". Additional concerns were expressed in relation to bio-mass competing with food.

Workshop 2 stakeholder responses are summarized in Chart 3 below.



Radar Chart 3: Preffered Choices Energy Technologies and Measures in the Home

Financing

Participants expressed concern regarding the cost of the household options, primarily the upfront cost, and said that they would need government grants to install the renewable devices and to compensate for the perceived disruption. "Government grants, it all comes down to money and disruption". They also expressed concern over the timescale: "I don't want it to cost me for 4 years".

The group was keen that new-build properties should be more tightly controlled, but in general preferred positive incentives for installation to penalties. In fact there was a considerable degree of distrust and dislike of government control, with a perception that they were living in a state where "more and more rules are being piled onto people".

Similarly, there was a general view was that: "people should not be punished for the type of house they live in". Hence participants did not, for example, believe that a house should be subject to some form of charge or cost if it failed to meet efficiency standards when sold. Indeed, as in the first group, cost was a key concern. There was also concern expressed over the methodologies behind efficiency measures for products (an A-rated product that is twice the size of a B-rated product is not necessarily better) and there were anecdotal comments about home efficiency measures: "We had someone in for a minute and she wrote a report". One participant expressed dismay at being "spoiled" over the cost of energy and product availability, citing excess choice as a barrier to "helping do their bit". Further concerns were expressed over the dominant policy approach taken to emissions and cost, with one of the participants saying: "I disagree with having the option of being able to pay more to pollute more. I don't understand that. It's like countries can offset emissions – I find that absolutely ridiculous". Concerns were also expressed about the impact of measures on vulnerable groups, notably the elderly and the poor. Overall, then, this was a group with relatively heterogeneous views on policy.

Electricity Generation

In a similar manner to stakeholder in Workshop 1, there was a variation in the choice of electricity generation technologies. Once again, this was most noticeable in terms of nuclear generation, with three stakeholders placing it first and three stakeholders placing it last. However, following the group discussions, the consensus was to place it first. This was despite concerns relating to safety and placement. "It's the word nuclear. The radiation risk is a problem. Getting rid of carbon but having radiation would scare me"; "I don't have the facts to back up my case but I wouldn't want to live near one". Another stakeholder who "used to work for nuclear electric" was keen.

The second most preferred macro-technology was wind, identified as "a natural resource", although one participant did refer to wind turbines as "eyesores". Wind placed above solar power because of its perceived better efficiency, however, with a European grid in place, participants felt they would prefer to utilise solar generation from southern Europe and northern Africa. One participant considered that: "we would not be able to tap into our existing resources so we would have to import from elsewhere".

Bio-fuel/mass placed fifth, although concerns were raised about the disposal of the ash, and the impact on local air pollution. This was followed by CCS, although participants did raise concerns about the stored CO_2 "coming back to bite us" and the risk of potential inertia by going down this route, meaning that it "wouldn't do anything for things in the long term".

Relative to other technologies, hydrogen did not generate much discussion, with participants being reluctant to adopt it as a technology. They found it difficult to engage with the idea of hydrogen as a storage mechanism and failed to see its potential as an energy carrier without a substantial hydrogen supply network. The discussion was pessimistic, with a consensus that: "Hydrogen sounds great but we are a long way from doing it as a country".

The list of preferred technologies was completed by last-placed natural gas and coal-based generation due, solely, to the CO_2 emissions that they release. The preferred technologies chosen by individual participants, and in terms of the group overall, are displayed in Chart 4 below.

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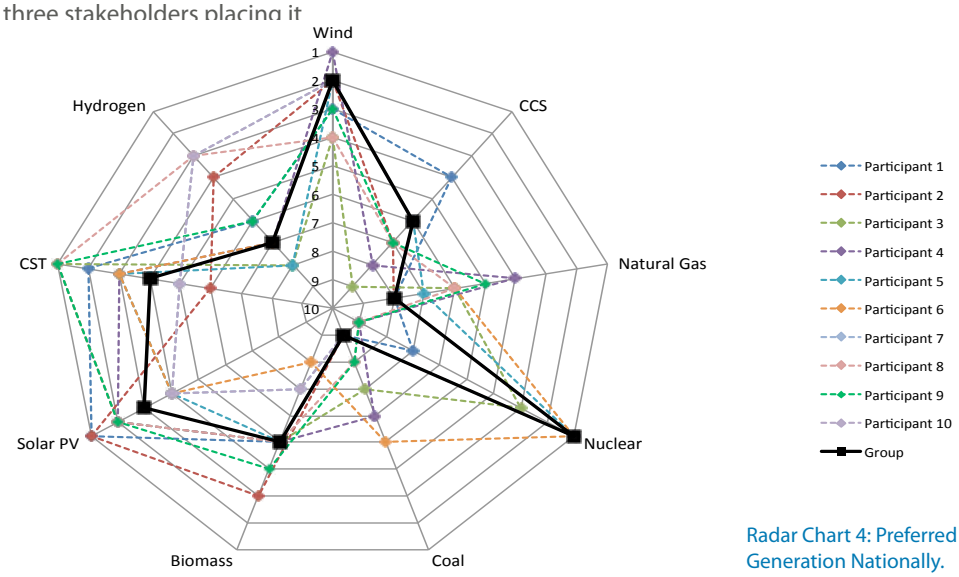


Radar Chart 4: Preferred Choices Energy Generation Nationally.

The Scenario Exercise

The stakeholders were introduced to a distilled GRIP Scenario tool that focused on domestic energy consumption and supply, together with electricity production nationally. The stakeholders were first introduced to the residential electricity consumption screen. How GRIP represented energy consumption and CO_2 emissions for the residential sector in Greater Manchester was explained to the stakeholders.

The stakeholders believed that absolute electricity consumption in Greater Manchester was likely to fall as household appliances become more efficient. This was partly balanced by people living longer, causing an increase in households and the increasing number of products purchased. Whilst the stakeholders perceived a degree of convergence on electrical equipment, for example in terms of multi-purpose entertainment devices, they also expected a net increase in the absolute number of household appliances.

Stakeholders believed that the amount of energy consumed for heating would need to decrease by at least 30% by 2020 to help realise the required reduction in emissions. Stakeholders did not, initially, see an enhanced role for electricity being utilised for heat in homes, seeing this as expensive. However, on realising that their options were limited in terms of meeting decarbonisation targets, they accepted quite a large role for heating using electricity in 2050. The stakeholders, following on from their group discussions, saw a significant role for new builds in the introduction of micro-generation, such as solar heating; micro-CHP was seen to have a limited role. They continued to express disquiet at the concept of biomass/fuel as they couldn't see "people burning stuff in their house – having an actual fire".

In the ranking exercise, this group assumed a European electrical grid and adopted the same in the scenario. They did not see a role for coal or gas without CCS by 2050, and were far more comfortable with nuclear power – with one stakeholder saying: "I don't believe the options are there to do anything other"; and with another suggesting: "I think it will be quite high but not popular with everyone. I can see it being 50% [of electrical supply]".

Onshore wind was seen in this part of the exercise as having a larger role in the electricity mix than offshore wind, with import of solar power accounting for approximately 4% of electricity consumption. Nonetheless, stakeholders maintained their stance that solar PV would contribute a larger share of electricity production than wind production; this was partly due to their belief that there would be an improvement in the technological efficiency of PV products.

The group envisaged almost complete decarbonisation of the electrical grid, with the remainder of the emissions reduction target to be delivered through changes in the utilisation of heat in the building stock. This was approached by further reducing demand and also by increasing biomass use and electricity.

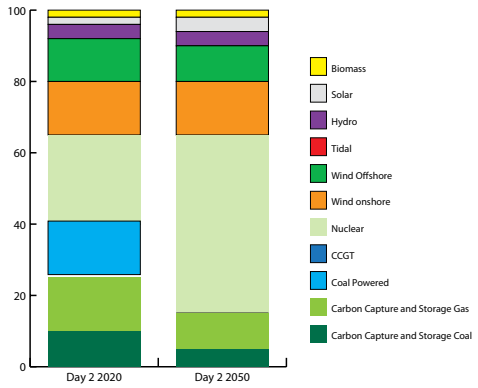
Stakeholders saw electricity consumption increasing up to 2020 before decreasing by 2050. The amount of electricity produced by on-site generation was also seen to be lower in 2050 than in 2020. This workshop was the only one to see a role for CCS in 2020. The stakeholders also saw a new nuclear power regime in place by 2020, which would remain in place until 2050. The amount of electricity produced by wind, hydro and solar was seen to be more linear in its growth from 2005 than in other groups. In order to meet the reduction targets, the stakeholders began to push boundaries of what they believed to be plausible. This included a 15% reduction in heat consumption across the residential sector by 2020, which included 30% of heating coming from electricity generation, with heating from natural gas being just over half of what it was in 2005.

One of the stakeholders discussed the concept of electricity being imported from Europe positively, saying: "Are anyone of our power companies British owned? I'm more comfortable with it being European as I don't think we'll take the right decisions as the UK".

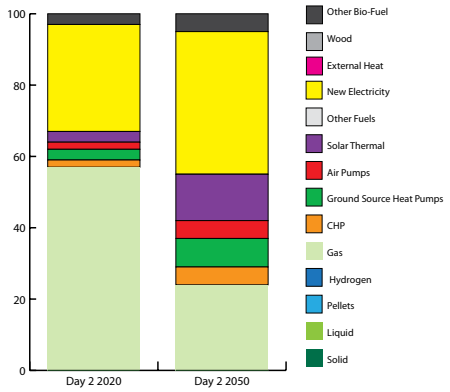
Workshop Preferred Choices and the Scenario for 2050

In both the choice exercise and the scenario exercise, there was a focus on demand-reduction through insulation and other approaches, as well as through behavioural changes. However, this achieved a lower reduction than in the first workshop despite being placed first and second. While featuring highly in the choice exercise, the amount of energy provided by onsite PV and solar water featured at a comparatively low level in the scenario exercise, though still accounting for a higher percentage of generation than that assumed by stakeholders in the first workshop. The prevalence of micro-CHP featured little in the scenario, accurately reflecting its second-to-last position in the choice exercise. Use of bioenergy for heat purposes in the home featured low in both the scenario exercise and the choice exercise.

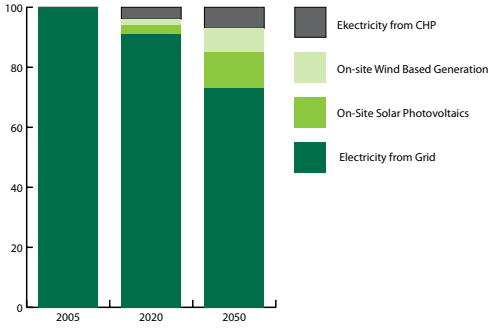
Nuclear power was placed first in the choice exercise, with wind power placing second. As reflected in the scenario with wind generation, both on- and off-shore wind were deemed to account for 25% of electricity generation, the same as in the first workshop, with nuclear power accounting for 50% of generation. In comparison, solar PV and CST were placed third and fourth in the choice exercise but only accounted a total of 4% of power and heat generation. The link between the choice exercise and the scenario in the case of CCS (which featured sixth in the preferred choice exercise) was less clear, with CCS accounting for only 15% of 2050 generation, in part due to the reliance on nuclear.



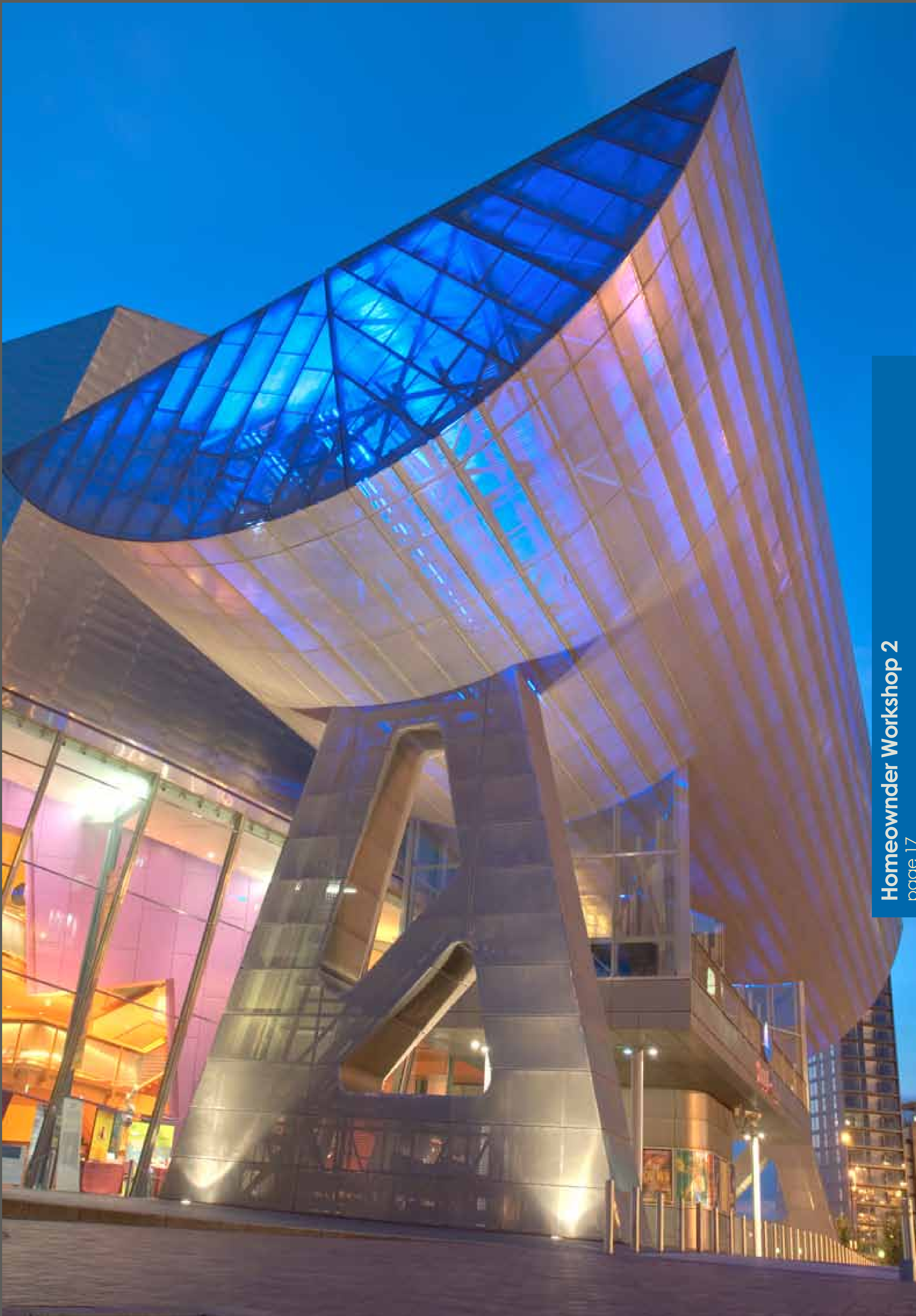
Bar Chart 4: Electricity Generation by technology in percentages.



Bar Chart 5: Energy by technology in the home in percent.



Bar Chart 6: Source of electricity consumed at home in percent.



Homeowner Group 3

Demographics

Homeowner Group 3 included nine stakeholders: six women and three men. Three stakeholders were educated to GCSE/O-Level, three had continued education to A-level, one stakeholder reached undergraduate level, one to Masters level, and one stakeholder did not disclose their education background. Stakeholders again varied in age, with five aged 46-55, one in the 56-65 age range, one aged 36-45, and the remaining two in the 66-80 age range.

Home Technologies

In a similar fashion to the previous two workshops, all but one stakeholder placed energy efficiency measures as the preferred choice, with six stakeholders placing it at as their second option. These options were mirrored in the group rankings, for example because: "wasting energy at home is a waste", and we should "insulate first and sort the rest out later". This was further backed by another participant: "Reducing energy demand doesn't cost anything, it's easy to do. And if everyone does it, it will make a big difference, less disruption". Solar PV was placed third, though there was general concern (in relation to electricity generation) that: "in winter when you need it most, it won't be available, just as in the summer when you don't need it". There was a preference for locating PV on new properties rather than existing ones and also concern about anti-social behavior associated with "kids throwing stones" at the PV systems.

Micro-wind was placed fourth and was deemed a good idea for both existing and new buildings, though, in the previous workshops, there was discontent regarding the noise associated with micro-wind, with one participant remarking: "imagine the noise if everyone had one". There was a particular demand from this group for community-based wind turbines, though some wondered how installation and use could be equitably managed. The potential benefits of a communal over an individual approach were noted: "If it is a new-build estate, they could have a bit of everything and be self sufficient. But I don't think you can stick everything on your house".

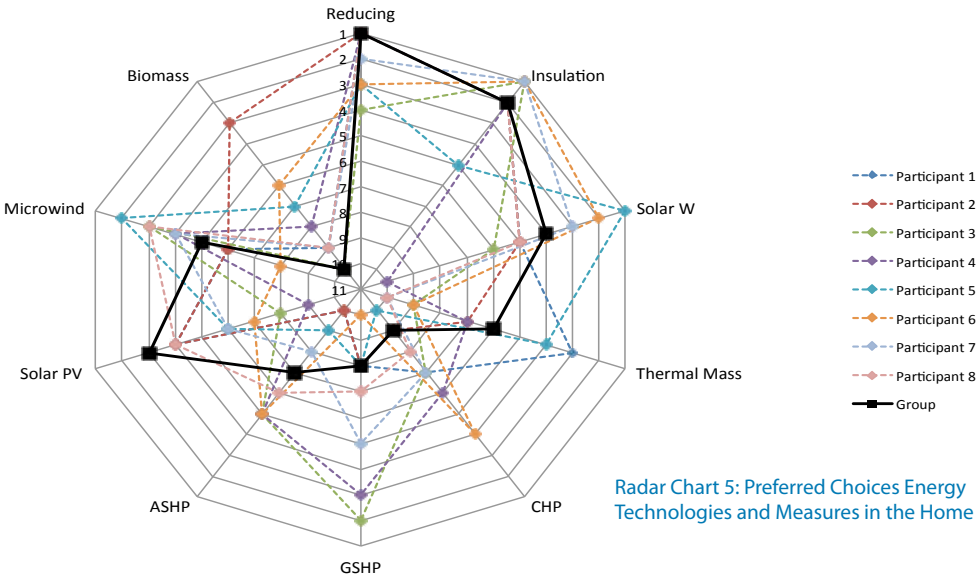
Thermal mass ranked sixth, with the stakeholders feeling it was best suited to new properties, with one feeling uncomfortable at the need for painting their house: "I had a problem with painted exterior linked to damp". The stakeholders felt that thermal mass was similar in its nature to reducing energy demand/efficiency measures, but were uncomfortable with its aesthetics.

Air Source Heat Pumps (ASHP) placed seventh, again (as with the previous two workshops) with concern raised about the aesthetics of the pumps, particularly for smaller and non-detached houses, with one participant remarking: "I live in a terrace house and if we all had one it would look terrible, I was thinking of the aesthetics". Concern was also raised about the refrigerants that are used in ASHPs and the wider environmental impact of this technology.

GSHPs placed eighth, despite being perceived by the group to be a reliable technology for heat provision (relative to other microgen options) throughout the year. The disruption caused by its installation and the need to "dig up the back garden" outweighed its technological benefits. There was little discussion of Micro CHP, but it placed ninth, due to stakeholders being uneasy at having "a power station in their home". Biomass placed last, because of concerns regarding "the work involved in topping it up" and the storage of the wood or pellets. Further concerns were raised over impact on the cost of food and issues regarding local air pollution. The results are displayed in Chart 5 below.

Financing

Stakeholders felt a need for more "targeted education" regarding reducing energy demand. However they also suggested that the impact of this would be limited as most people will not react "unless it hits them in their pockets". In order to gain buy-in, the stakeholders intimated that it was necessary for the public to "see the benefits" of action. When stakeholders were asked about different policy options, one felt that a ban on selling a home unless it was A-rated in terms of efficiency was "a bit harsh", to which another quipped "it has to be harsh". The stakeholders suggested that financial incentives and support were required on top of the renewable heat initiative and feed-in tariffs. However, they felt that having a second debt on a home was not practical and that penalising the home owner "was the wrong way of going about it". They felt the money should come in the form of grants, similar to the boiler scrappage scheme – as: "people who already have



Radar Chart 5: Preferred Choices Energy Technologies and Measures in the Home

houses are at a disadvantage". It was not possible, they said, to expect people to go into debt to pay for the changes. The stakeholders expressed dismay that they would be paying for such schemes twice, firstly through tax increases to support grants and secondly through buying it themselves. "The problem is money - if it was free everyone would have a solar panel on their house".

The stakeholders were asked about appliance efficiency. This, they suggested, would impact first-time buyers, who they deemed to have less money and therefore to not be able to afford the more efficient appliances: "if you are wealthy and conscientious you can just do it, but if you have to save for a year it is different".

Electricity Generation

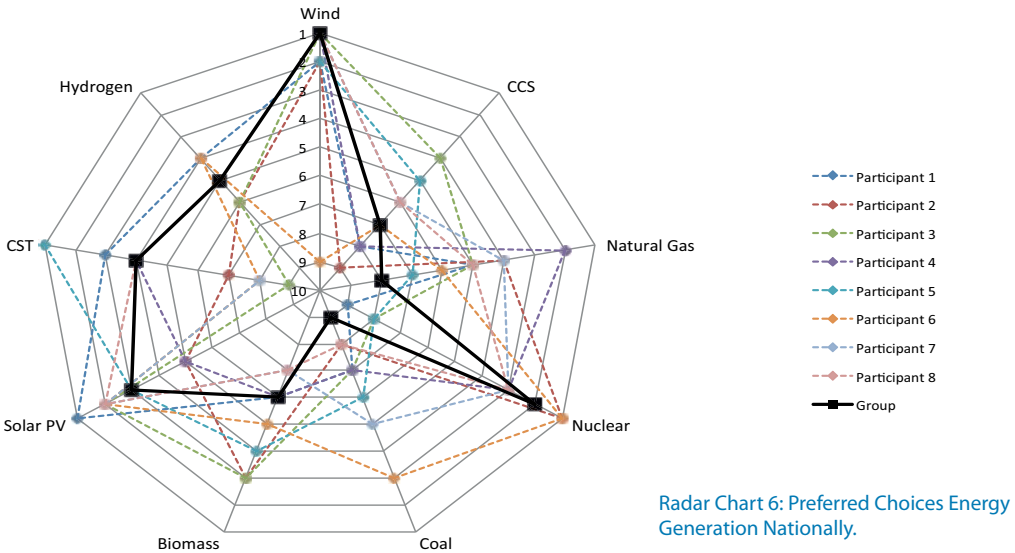
In this workshop, as with the other two, there was a strong division between stakeholders over the preferred position of nuclear generation in the list of options, with two stakeholders placing it first and two stakeholders placing it last in their own list of electricity-generation technology choices.

Eight of the nine stakeholders placed wind power as their first or second choice for electricity generation, five of the stakeholders placed solar PV as their first or second choice and five placed coal as their least preferred or second-to-last option. CCS was also one of the less popular choices, with one in three stakeholders placing it as their least or second-to-least choice.

In the group discussions, wind power placed first, "providing it was away from the house", e.g. "out at sea, out of the way". One of the participants felt that "there are real problems about migrating birds flying into them, so there will be environmentalists worried about that". The stakeholders recognised the problem of the intermittent nature of many forms of renewable electricity generation and the potential need for energy storage to make the technologies more viable. Distributed micro wind was judged likely to be more costly than macro wind. Nuclear power was placed second in the group discussion, although the stakeholders had concerns with "the safety and waste storage aspects of nuclear generation". The stakeholders all stated that they would not be happy with storing nuclear waste in Manchester. Nuclear generation was seen as a "'low carbon bridging technology" by one stakeholder, who saw it as providing an opportunity to develop renewable technologies. Another said that they "wouldn't mind living next to a wind farm, but nuclear is an issue for family health".

The group considered that there would be a need for an EU electricity grid to reduce emissions by the required amounts. As a consequence, they suggested that solar PV and concentrated solar thermal technologies placed third and fourth, respectively. The technologies were not perceived to have drawbacks, instead being seen as viable within the UK. Hydrogen placed fifth and was seen as a good technology for helping to balance the grid, although a long way off in terms of implementation. Bio-fuel/mass placed sixth and was seen to have both positive and negative aspects. From a positive perspective, "many types of food waste could be utilised". The waste and emissions that the biomass power plants may produce were seen negatively. This was followed by CCS, placed seventh, over which the stakeholders expressed safety concerns. Despite the technology "sounding good", these concerns centred on what might happen to the CO_2 in future and the risks associated with it "escaping".

The stakeholders in this group subsequently placed natural gas and coal as the least-preferred technologies. These placed last due to the emissions associated with them and the amount of available fuel. One participant saw natural gas generation as "the lesser of two evils".



Radar Chart 6: Preferred Choices Energy Generation Nationally.

The Scenario Exercise

Stakeholders were concerned that whilst reducing energy demand was key, they were unsure how many people could achieve it, principally due to a lack of awareness of the need. Nonetheless, reduction in demand would be largely delivered by insulation measures, assumed, at the beginning of the exercise, to be in the order of a 25% reduction by 2050.

The stakeholders did not see a role for either coal or natural gas production in 2050. Nor did they see a role for CCS in 2050, despite a perceived abundance of coal, due to concern regarding CO_2 storage. Nuclear power was judged to take on a larger role to compensate for this loss of electricity production, further supplemented by on- and off-shore wind. Biofuel and solar based generation from Europe comprised the remainder of the 2050 electricity mix.

Despite the split in the rankings within the previous exercise, the stakeholders viewed wind to be more reliable than solar for on-site and community generation. Renewable potential was perceived to be seasonal, with higher levels of electricity production in summer from solar generation and higher levels of wind generation in winter.

The stakeholders took a retrospective view of electricity consumption, looking to past levels as compared to today. Stakeholders saw an increase in the amount of electrical appliances in peoples' homes, but they saw this as being offset by the increased appliance efficiency in the future.

The proportion of dwellings using natural gas for space heating was seen to reduce to 60% in 2020, from 99% in 2005. Stakeholders saw significant time delays in the implementation of differing technologies. Certain devices were adjudged to be easy to install, notably ASHPs, which the stakeholders expected to account for 1% of the heat-energy demand in 2020. Electricity consumption was seen to drop by 15% by 2020, with 4% being produced onsite.

In terms of the provision of electricity, coal generation was seen to fall by nearly half, with additional demand reductions to come from the amount of natural gas-based generation. Stakeholders came to the conclusion that: "In the short term we'll have to reduce consumption by a lot more, and in the long term sort out the supply. The reduction has to be the short term plan". Another stakeholder suggested that we are: "Going to have to do the cleaner methods of energy a lot sooner, than I thought".

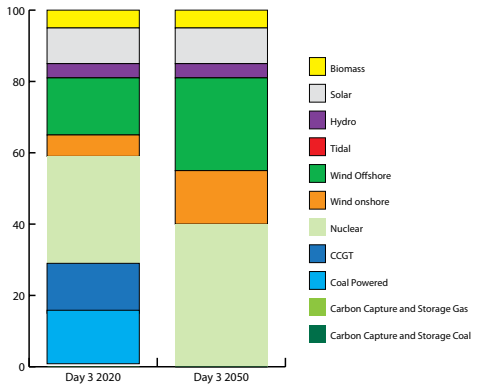
The stakeholders struggled to achieve the emissions reductions necessary in 2020 and one stakeholder suggested that the group's attention would have to switch to macro low-carbon electricity generation as: "We've done all we can do in the home. Can't do any more".

Stakeholders opted to further decrease the amount of energy being consumed in the home for heating, though, by 40%, through a variety of measures. Stakeholders then began to express the further concern that: "It looks really difficult to make these changes" and "It's the realisation of how much we rely on natural gas". This was supplemented by one stakeholder remarking that "It makes you think we're really going to have to cut back and everyone's got to do it. The message has got to get across that it's got to happen". Another remarked that it "Won't be done just by asking people". This led to a discussion between two of the stakeholders and a dialogue on the relative merits of educative and enforcement measures: "It has to be enforced and monitored in a person by person way"… "A lot of other people are struggling at the moment. Paying the bills is more important than these other things"…. "First time buyers don't have any spare cash for upgrades like solar panels etc". One stakeholder took a wider perspective and suggested: "It's not just about your home, it's about your children and about them having the same life we've had".

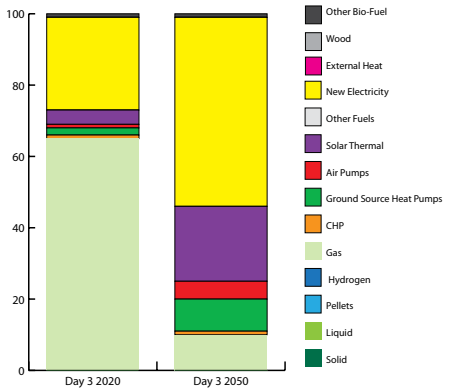
Workshop Preferred Choices and the Scenario for 2050

In both the previous exercise and the scenario exercise there was a focus on demand reduction through insulation and other approaches, as well as through behavioural changes. In this scenario, stakeholders envisioned a much larger reduction in energy consumption than in any of the previous workshops. The amount of energy provided by solar water featured highly in the scenario and in the choice exercise. However the same was not true of onsite PV, which featured at a comparatively low level in the scenario exercise and high on the choice exercise. Micro-CHP again featured little in the scenario, reflecting its second-to-last position in the choice exercise. Use of bioenergy for heat purposes in the home also featured little in both the scenario exercise and the choice exercise.

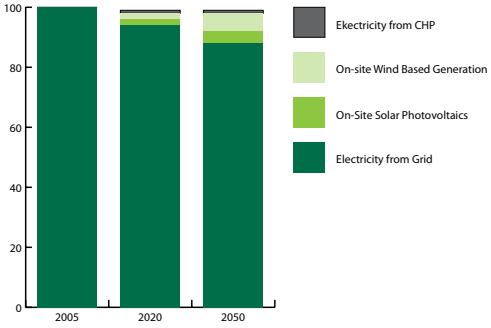
Nuclear power placed second in the choice exercise, with wind power being placed first. This was reflected in the scenario, where wind generation, both on- and off-shore was deemed to account for 41% of electricity generation, with nuclear power accounting for 40% of generation. Solar PV and centralized solar thermal placed third and forth in the choice exercise and accounted for a total of 10% of the power generation in the scenario. CCS, coal and natural gas generation, which featured seventh, eighth and ninth in the preferred choice exercise respectively, accounting for 0% of total power generation in 2050.



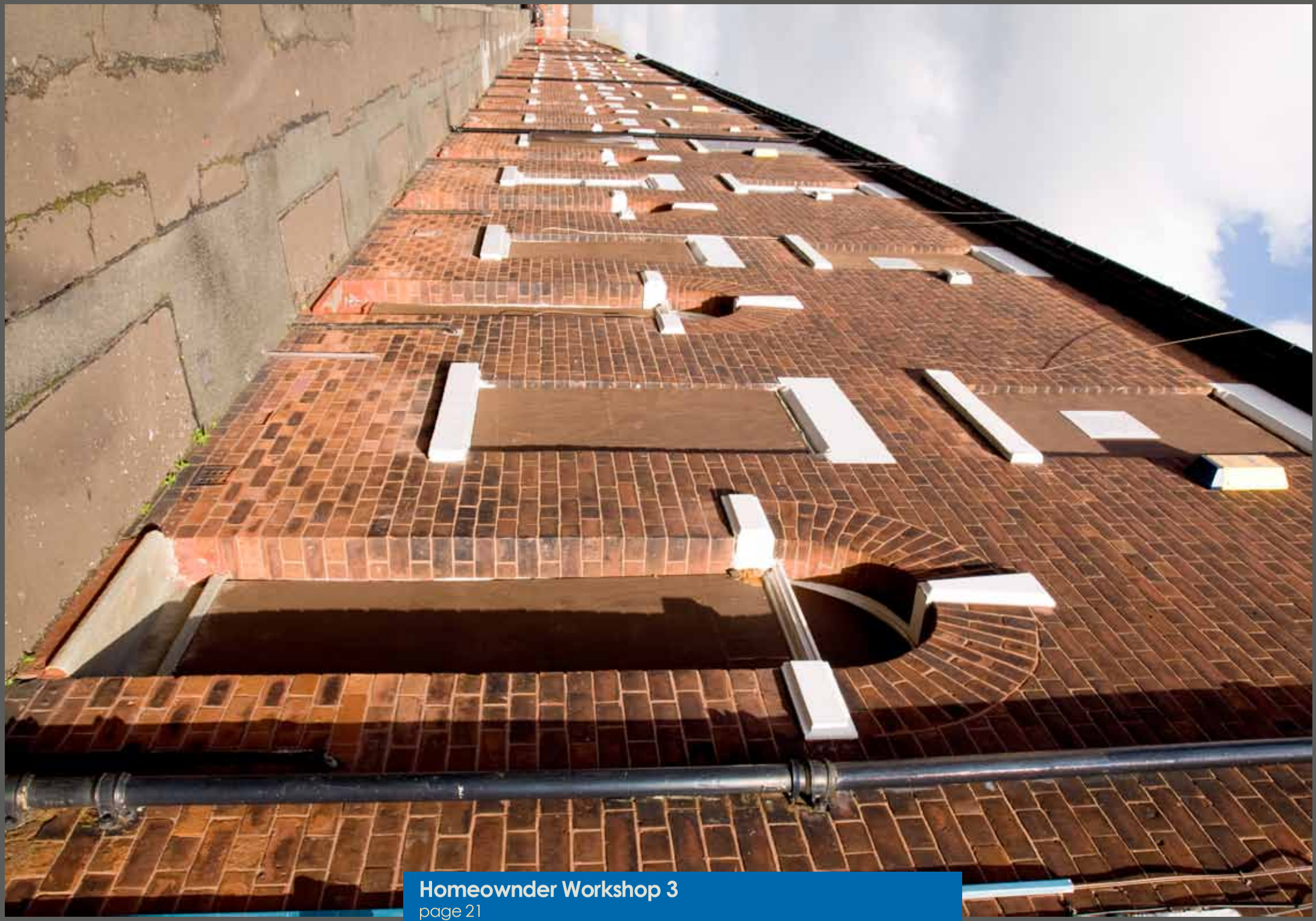
Bar Chart 7: Electricity Generation by technology in percentages.



Bar Chart 8: Energy by technology in the home in percent.



Bar Chart 9: Source of electricity consumed at home in percent.



Homeownder Workshop 3
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Landlord Workshop

Demographics

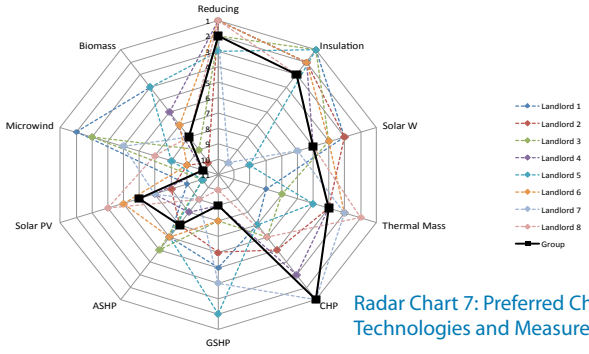
This group included eight stakeholders, five women and three men. The level of education reached by the stakeholders varied, with five Stakeholders educated to GCSE/O-Level, one to under-graduate level, one to Masters level, and one to PhD level. Two Stakeholders were between the ages of 26-35, two were between ages 36-45, one was in the 46-55 age range, one in the age group 56-65, with the remaining stakeholder in the 66-80 age range.

Overview

For the landlord group, stakeholders were required to list their preferred options for both their own homes and their rented properties. In all but one case, the landlords placed energy efficiency measures as their preferred approach to achieve emissions reduction. There was little difference between the individual choice of approach for the landlords' own homes and their rented properties. In the case of this group there was also less variation in relation to opinions on nuclear generation than in the other groups.

Energy Technologies on Own Property

The landlords, like all the previous groups, deemed reducing energy use as their most preferred option to reducing emissions. This was followed by energy efficiency technologies, and approaches that included insulation and thermal mass. Many of the landlords had already installed insulation in their properties.



Radar Chart 7: Preferred Choices Energy Technologies and Measures in the Home

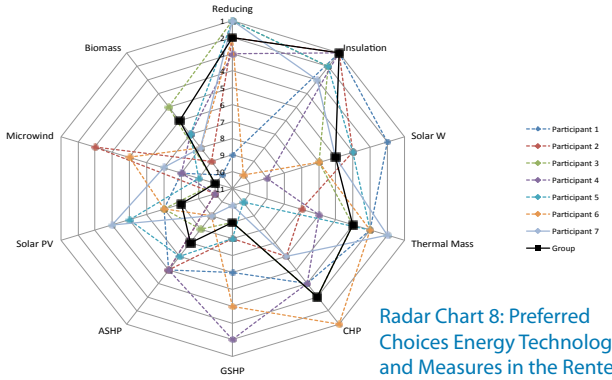
The landlords applied different financial decision rules to their own homes and to their rented properties. In their own homes, they were slightly more prepared to accept technologies with a longer term payback. This was mostly evident in the case of Solar PV panels and air-source heat pumps. The landlords tended to be less interested in micro-wind technologies, but were more accepting of community-based investment schemes that offered a return on investment and quicker payback time. Although reluctant to install micro-wind, they were more receptive towards this for their own home than for their rented property because tenants' noise tolerance was unknown. Regarding heating, some particular preferences were expressed in relation to the merits of air-blown heat and heat from water-filled radiators, with some disliking the former for their own home. Furthermore, concern was expressed regarding how different devices would work together, e.g., a solar thermal device working with a biomass boiler and requiring a hot water storage tank. These concerns primarily surrounded how many controls would be necessary to operate each device and how complicated they would be.

Energy Technologies on Rented Property

As stated, the landlords took a slightly different approach to their rented properties relative to their own homes, due to the money that needed to be spent on them, disruption to the landlord and the tenant and the long-term ownership of the property. The landlords placed energy efficiency measures first and second, as they did for their own properties, they reversed the order of specific measures within this category: whilst they felt that they could put in place insulation and devices such as smart meters, they did not feel that they could control what their tenants did in the properties. One of the landlords said: "young couples do not know where the off switch is".

A notable difference between preferences expressed in the previous workshops and this one was that the landlords opted for micro-CHP third, considering this an efficient bridging technology in the short run for their rented properties; this was similar to their own homes. Indeed there were signs of an economic calculus featuring more highly in this group than in the others. This focus on the short term was, in their view, the more sensible focus to take on investment properties, as it was likely to yield a higher return. One of the landlords stated that: "the expensive ones only tend to work in the long term basis, but many of us are looking in the short term".

Thermal mass, in its simpler forms, placed fourth, again largely to do to cost. This was followed by solar water, as it was seen as the cheapest form of energy production of the remaining



Radar Chart 8: Preferred Choices Energy Technologies and Measures in the Rented Property

technologies. The landlords did express concern regarding the need to supplement the technology with a water tank; the majority of the landlords had combi-boilers fitted in their rented properties which do not require a water tank. Using such technology required finding space for it.

The landlords subsequently opted for bio-mass using wood pellets sixth; they were concerned over the safety issues, particularly with those tenants who they deemed not to treat their properties with much respect. ASHP placed seventh as they have the versatility of providing both heating and cooling; they were seen as less disruptive than GSHP for producing heat and so placed higher. It was recognised that the technologies would vary depending on the type of property that they were renting (e.g., house or flat). Due to the perceived lack of disruption, solar PV placed eighth, with concerns raised about cost and its variability and suitability in Manchester. GSHP placed ninth because whilst it was seen to deliver a near constant level of heat, its implementation was seen to be disruptive. There was also concern expressed over maintenance. Micro-wind placed last due to cost, noise and payback time. The landlords felt that a lot of people would view micro-wind as "intrusive", one landlord felt "the tenants need to know as well, or they will come and see the wind turbine and think it is new age, unreliable and go somewhere else".

Finance

The landlords were largely skeptical of measures for reducing energy-related GHG emissions from their rented properties. They felt that it was more down to how their tenants resided in their properties, against what they could do to make emissions reduction lower. "It is a generation thing, they get told at school to switch off. But between leaving school and getting married and having kids of your own, they don't care and are more short term".

The landlords were not keen on "ripping things out" but felt more at ease with "replacing things, as time goes on when it comes to changing things you want the tenants to be safe and to keep the value of the property". The landlords were unaware of the feed in tariffs and the renewable heat incentives. The landlords felt that the incentives needed to be better advertised - one cited the example of the "landlord deposit scheme" which they felt was advertised "all over the radio". The cost of the various technologies was a concern to the landlords, with one remarking that "If it was £1,000 to insulate the loft, I wouldn't do it, but if its £50 then fine, go to B&Q and do it myself". The landlords felt that the cost of heating a property was not really conducive to attracting tenants, but it was conducive when it came to keeping tenants. The landlords wanted to have a number to call to get advice on what they needed to do for renovations. One of them felt that any scheme may be unfair to small landlords and that "if the government wants to do this, then the government should pay for it – not small landlords".

The landlords felt that the timing for expenditure on energy efficiency and microgen installation was inappropriate, given the economic downturn. It was also mooted that any mechanism put into place would need to be enforced in a similar manner to the gas certificate. There was a concern that any enforcement of energy efficiency or microgen installation would lead to many landlords trying to sell their properties. On the other hand, one landlord said that they wouldn't do it "without a strict policy". Again, concern was largely focused on the upfront costs of the technologies, with one of the landlords requesting "a self-funding loan". Another took an alternative view, speculating that: "The government does not have enough money for all of this, they're cutting left, right and centre. Maybe an interest-free loan or partial funding (on top of the incentive) is needed to make this happen".

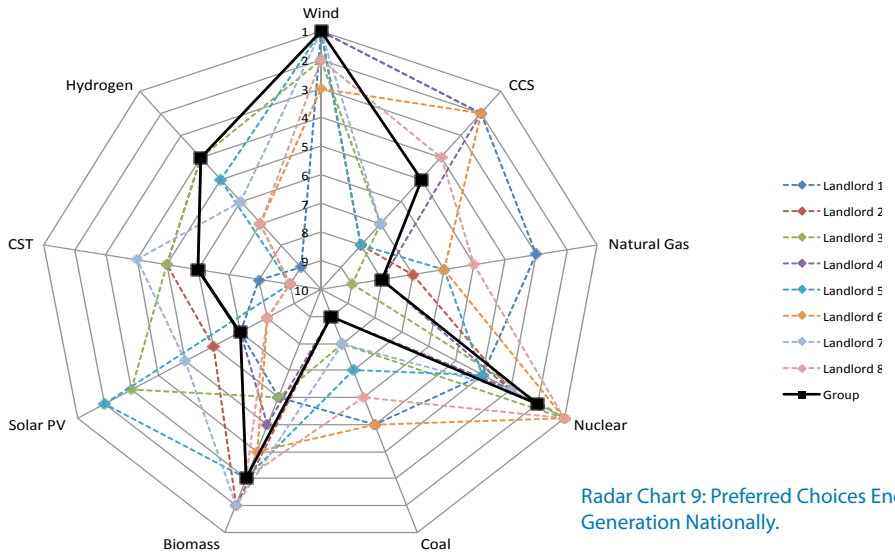
The landlords were not keen on the cost of any emissions reduction measures being passed on to the tenants in the form of an increase in council tax. The landlords were further concerned by the cost of measures on top of what they perceived to be an environment that will lead to increased mortgage costs. The time frames, 2020 and 2050, provided some consolation to the landlords with one saying that "we have nine years to do it in".

The landlords were keener on an external company installing the renewable technologies than self-installation, with such a company retaining the incentive from the feed in tariffs. "It's better if they do the initial outlay…that sounds better", "if someone came to me and said we'll install PV at no cost to you and recoup the outlay overtime, and you had some sort of benefit on your bill, that could work".

Electricity Generation

The landlord workshop spent less time discussing national energy options due to time constraints on the day and due to the interesting division between their perceptions of their own homes and their rented properties. Nonetheless, a list of preferences was developed and this followed a similar pattern to the other workshops. The group decided that wind power was their preferred electricity generation choice, though they were concerned by the visual intrusion of wind turbines: "offshore is better for people saying: ' I don't want to look at that'". When this stakeholder was asked about their own view, they responded that they wouldn't mind living near wind turbines - "It's not like it gives off anything that is harmful to kids, like a phone mast".

Again there was a split and consideration of trade-offs regarding nuclear power, though far less of a division than in the other groups, with nuclear being ranked at lowest 4th by the stakeholders in their individual choices. Overall, the landlords placed nuclear power second, despite concerns about "the waste". This decision was partly driven by the perceived longevity of nuclear power installations in comparison to other technologies. Biomass placed third by the landlords, again ranking higher in this group than in the others. There was concern that biomass production would compete with food production. However, taking into account the expectation of new generations of biomass technology and the potential to utilise food waste, the landlords settled on biomass as the third ranked option. Next was hydrogen, ranked fourth, as a basis for stabilising the grid to allow for greater control. This was followed by CCS, fifth, which was seen as an option for the UK in that it enabled continued consumption of fossil fuels, potentially also using coal reserves. Nonetheless concern was raised about the risk of later release of CO_2. The landlords opted for a European grid, importing solar-based generation from southern Europe, as they felt that solar power would be more practical there. This meant that the sixth- and seventh-placed options were concentrated solar thermal and solar PV, respectively. The last placed options, in a similar fashion to the other



Radar Chart 9: Preferred Choices Energy Generation Nationally.

Scenario

Limited by time, the scenario focus was consequently on 2020. The landlords saw a limited reduction in energy demand, with one remarking that: "In ten years, I don't think it would be very much." Another was more optimistic, suggesting: "I think it would be 2-3% per year at the start then slow down. I think 20% over the 10 years".

The landlords were split over use of electricity for heating, with one landlord saying: "I don't see electric heating going up", which was balanced by another who said: "If we can use from renewables then I think 10% electric heating".

In terms of onsite heat generation, one stakeholder believed that ASHPs would account for about 3% of generation, which was largely agreed with by the other participants. Then attention switched to GSHPs, about which one stakeholder, referring to the earlier exercise, remarked: "I think we said it would be a little bit more popular than heat pumps". The stakeholders recognised that their options for how they could meet near-term emissions reduction targets were limited. Micro-CHP was one technology they perceived as helping to deliver reductions, which began a dialogue between two participants: "I think if it's replacing the boiler, it will be popular"… "But it's very expensive." …"But there isn't much else to do".

In terms of biomass, one landlord said: "I think if I'm changing a boiler in a few years it sounds like a good idea, so maybe about 10% use". The discussion within the group continued, with the landlords arriving at the conclusion that wood pellets would be favoured over a wood burner.

The landlords continued in dialogue between themselves: "I think the renewable thing will work, if everyone can do a little bit in their home"…"Yes but how many people will be doing it in ten years?"… "I think we could be up to ten percent in ten years"…"That's one in ten homes having micro-gen installed in ten years"… "Maybe 5% then".

The landlords than began to discuss electricity generation: "Onshore [wind] should go up, but people will moan so it won't go up that far." Again, as with previous groups, the landlords suggested that there: "Has to be made a law or we won't do it", with another suggesting that "People don't have time to do this thing." The same stakeholder suggested that: "It all just comes down to money and what you can afford to do".

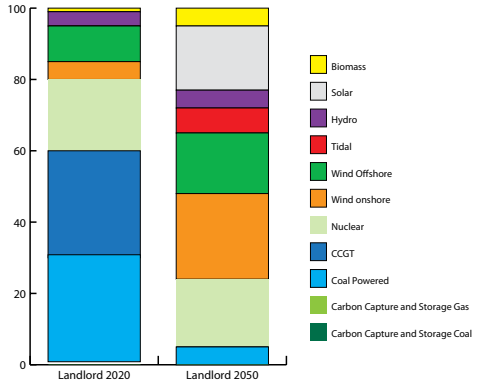
The issue of new laws came up again, with one stakeholder asking: "what about making new laws?", to which a response quickly came: "People are fed up with laws". Another stakeholder suggested that: "We're trying to reduce everything including crime. Climate change comes further down the list. Its far off so other things take priority". At this point, one landlord interjected, "If it were my choice and they said you need a new boiler I'd be interested in the biomass pellets".

The landlords were asked what they felt needed to be done to realise the changes necessary to deliver the emissions reductions. One landlord suggested that this needed to be "education" because "if you don't know about it what can you do?" This was supplemented by requests for technical assistance: "If you've got the right person to come in and install it tell you how to do it, then it's pretty good". Another landlord remarked that "You never hear about it. Why not have it on TV about solar panels with: this is who to call." One landlord suggested that measures should be linked to homes rather to individuals: "Put it on the council tax. People are sick of being penalised. Then the person who pays for it is the person in the house not their neighbour". However, another was more forceful: "If they said you've got to do this or you'll be fined". Taking a more macro supply-orientated approach, one of landlord enquired if there was: "Any chance of accelerating the programme, for example nuclear power?"

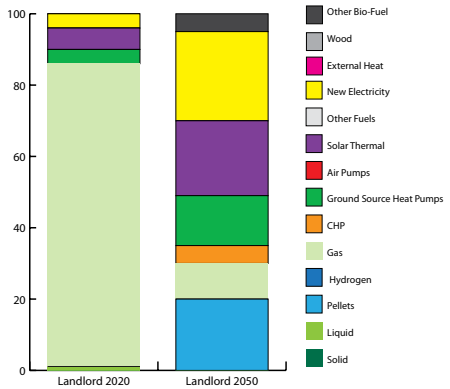
Workshop Preferred Choices and the Scenario for 2050

In both the previous choice exercise and in the 2050 scenario exercise there was a focus on demand reduction through insulation and other demand reduction options, as well as through behavioural changes. This was the case for the landlords' own homes and for their rented property, though the first choice for their own properties was micro-CHP. As said, this was unusual among the workshops. In the scenario, however, neither macro nor micro CHP featured highly, though it did account for a higher percentage of energy provision than in the other scenarios. The amount of energy provided by solar water did feature highly in both the scenario and in the choice exercise for landlords' own homes. Use of bioenergy for heat purposes in the home featured low in choice exercise, but highly in the scenario.

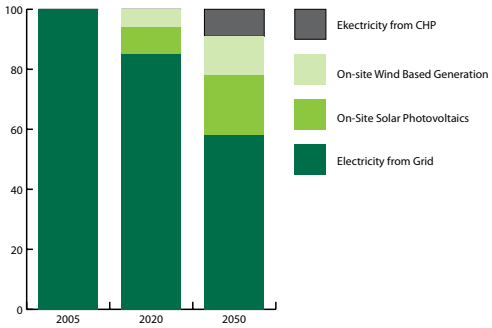
Nuclear power placed second in the choice exercise, with wind power placing first. This was also reflected in the scenario, where wind generation, both on- and off-shore, was deemed to account for 41% of electricity generation and nuclear power to account for 19% of electricity generation. Biomass placed third in the choice exercise, yet accounted for just 5% of generation in the scenario exercise. Solar PV and CST placed fifth and sixth in the choice exercise, yet accounted for a total of 18% of generation in the scenario. Coal and natural gas generation, featured eighth and ninth in the preferred choice exercise respectively, while in the scenario exercise, coal-powered heat generation accounted for 5% of the total with gas accounting for the remainder.



Bar Chart 10: Electricity Generation by technology in percentages.



Bar Chart 11: Energy by technology in the home in percent.



Bar Chart 12: Source of electricity consumed at home in percent.

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Research Exercise 2: Overview of Scenarios conducted with 'traditional' Stakeholders

The scenarios were produced using the Greenhouse Gas Regional Inventory Protocol (GRIP) approach to scenario formation. This process, to the best of our knowledge is unique as it uses an energy model with a graphical user interface to help facilitate discussion. The GRIP approach relies upon Stakeholders to provide qualitative visions of how they see an energy system changing to deliver the deep, but necessary cuts in carbon dioxide to help mitigate climatic change and then to quantify the changes in energy.

In the case of the three different Greater Manchester energy scenarios produced, an emissions reduction of at least 80% was delivered on each day. The scenarios are labeled Day 1, Day 2 and, Day 3, so that individuals do not associate with the scenario's name rather than its content. There is a comparison of the three scenarios below.

Each scenario looks at how Greater Manchester can help to achieve a national reduction of CO_2 emissions reduction of 90% and what can be also be achieved by 2025. The scenarios were formed by considering the same drivers used to form the storyline components of the Special Report on Emission Scenarios (SRES) of the Intergovernmental Panel on Climate Change (IPCC).

The scenarios presented below represent a consensus vision of how the future may unfold in three separate scenarios and therefore they should not be seen to be representative of any individual's view. Two out of the three scenarios achieved at least the desired 90% reduction in CO_2 emissions; the remaining scenario achieved an 87% reduction. In each case, overall end user energy consumption reduced. Interestingly, the two scenarios that achieved a 90% reduction in CO_2 emissions reduced end user energy consumption by a fairly similar 40-46%.

When considering the results it should be noted that the sessions were run independently of each other. Furthermore, in the two scenarios that achieved a 90% reduction economic growth was running at an average annual increase of at least 2.00-2.25%. Moreover, both the population of Greater Manchester and the amount of households increased in all of the scenarios. The reasons described by the stakeholders for this decoupling of economic growth from CO_2 emissions and energy consumption varied between the three scenarios.

It is also interesting to note that in the scenario sessions the production of electricity from the National Grid became largely carbon free. Where electricity was produced using fossil sources, this was usually combined with Carbon Capture and Storage (CCS). None of the scenarios had coal based electricity production without CCS. In two of the three scenarios, electricity consumption sourced from the National Grid reduced, displaced largely by a greater uptake of on-site renewable technologies and Combined Heat and Power (CHP) units for electrical energy. In all of the scenarios electricity consumption increased overall and there was similarity in the level of emissions reduction achieved in the domestic, services and road transport sectors (in excess of 85-90%). A common feature of the different scenarios was that industry reduced its emissions by a smaller amount compared to the other sectors. The scenarios are helpful, as they show a large degree of congruence in terms of the approaches taken between different stakeholder groups.

Emissions Reduction by Sector

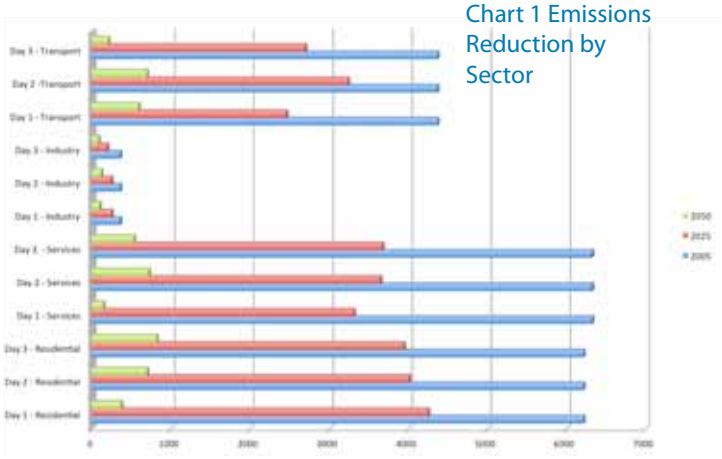


Chart 1 Emissions Reduction by Sector

Thousand Tonnes of CO_2

Chart 1 displays the change in emissions presented on a sector-by-sector basis for both 2025 and 2050, in each of the three scenarios. The chart shows that the emissions reductions achieved were largely similar by sector in each case. Whilst the largest reduction overall was achieved in the Day 1 scenario (93%, range 87%-93%) this did vary by sector. These overall reductions are very significant; however how these reductions are delivered in each sector is also very important. The Day 1 Scenario in 2050 had the highest emissions reduction in the service (98%, range 89%-98%) and residential (94%, range 87%-94%) sectors, but it had the second largest reduction in the transportation (87%, range 84%-95%) and industrial sectors (72%, range 66%-76%).

Similar results were achieved in the back-casting exercise for 2025, with the Day 1 Scenario achieving the highest reduction at 41% with a range of 35%-41%. Again there was a degree of variance between the sectors, although there were differences in how each sector contributed to the emissions reduction in 2025 in comparison to 2050.

The Day 1 Scenario did have the largest reduction in 2025 (48% - range 42%-48%), but it had the lowest reduction in the residential sector, despite having the largest reduction in 2050 (32% - range 32%-37%). The Day 1 Scenario had the largest reduction in the transport sector (44% - range 26%-44%). It was the transportation sector that showed the largest degree of variance. This was due to the group being less optimistic about what they believed could be achieved over the next 15years.

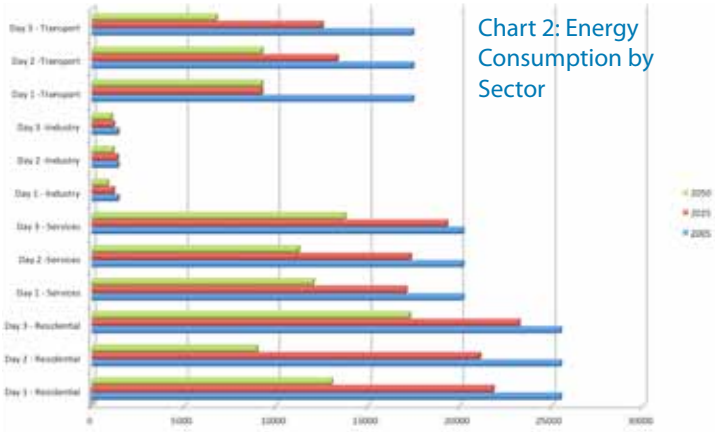


Chart 2: Energy Consumption by Sector

GWh

Chart 2 shows how end user energy consumption varied between the three scenarios. The Day 2 scenario, despite achieving the lowest emissions reduction of the three scenarios had the largest reduction in energy demand at 53%. The Day 3 Scenario achieved the lowest reduction of the three scenarios at 40% and the Day 1 Scenario had a reduction in energy demand of 46%. The Day 1 scenario had the highest reduction in energy demand for 2025 at 24% compared to 18% and 13% respectively for the Day 2 and Day 3 scenarios. As can be seen in Chart 2, these results varied by sector. It is interesting to note that the highest reduction in energy consumption was in road transportation, across each of the scenarios, in 2025. This is due to a consistent belief that the road transport sector has the opportunity to make changes to the efficiency of its future stock faster than the other sectors. The results for 2050 were similar, though there was greater confidence in the residential sector's ability to reduce energy demand in the Day 1 and Day 2 scenarios.

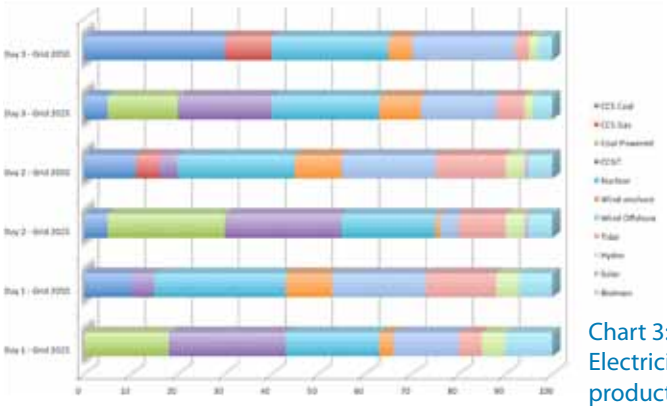


Chart 3: Percent Electricity production by technology

Chart 3 shows how each of the scenarios differed in terms of the technologies used to produce electricity in 2050 and 2025. In all three scenarios there was a role for electricity production using Carbon Capture and Storage (CCS) with the Day 2 and 3 scenarios imagining this technology would be introduced in 2025. The Day 3 scenario in 2050 was the only one that saw no role for fossil based generation without CCS. Every Scenario, in both 2025 and 2050 saw a role for nuclear power that would account for between 20% and 28% of electricity generation. There was also a large degree of consistency between the scenarios for the amount of wind based generation; accounting for 30% of generation in the Day 1 and 2 scenarios and 27% in the Day 3 scenario. Overall there was a significant reduction in the emissions factor for electricity generation in each of the three scenarios. There was a reduction from 0.57 units of CO_2 per unit of electricity to between 0.001 and 0.008 units of CO_2 per unit of electricity in 2050.

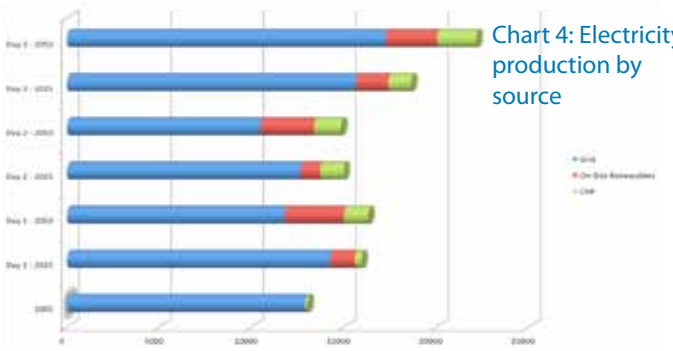


Chart 4: Electricity production by source

GWh

In chart 4 shown above, it can be seen that in every scenario the amount of electricity consumed increased, as did the level of decentralized electricity production. This increase in electricity consumption was largely driven by a switch in the fuel or source of energy in the transportation sector from petroleum to electricity and hydrogen produced through electrolysis.

The scenarios are useful as they help to understand the scale of change required to meet the near-term emissions reduction targets and what may be required to bring about those changes. The results show that even in an artificial context the Stakeholders in the exercise could not see how to deliver the emissions targets for 2020 by 2025. This may not be surprising as to put it into context, the changes that would need to be delivered over the next ten years in Manchester for it to meet its reduction targets are comparable to decarbonising electricity generation and halving total emissions from road transport.

Scenario Day 1

Economy and Demographics

Over the past five decades, Greater Manchester's economy has grown on average at a faster pace, relative to the rest of the UK. This represented a level of economic growth of 2.25% pa. Furthermore, the population has increased by more than 30%, This was partly due to an influx of migrant workers, climate refugees and a general desire of the wider populace to live closer to urban areas. With this increase in population has come an increase in households. Many of the recently constructed homes are small compact environments, built specifically with professionals in mind. In general the attitude to living in the north, particularly the North West and Manchester has become significantly more positive to living in the south of the country.

Residential Sector

The amount of non-electrical energy consumed in the domestic sector has reduced by 60%. This has been driven by a range of factors including behavioural change and an increase in the thermal efficiency of the housing stock, both old and new. In addition to this, there has been an expansion in the levels of CHP (Combined Heat and Power) usage – making more efficient use of fuel.

There has been no overall change in the amount of electricity consumed within the residential sector, despite an increase in homes and appliances used within them. There has been a significant increase in onsite power production, with onsite and local production now accounting for nearly 50% of electricity consumption within this sector.

Transport Sector

It has become relatively cheaper to use public transport rather than automobile transport, and it is a more pleasant and reliable experience. This is largely due to a much improved set of commuter links. However, it has not swayed everybody, although the decline in vehicle miles of 30%, despite the increased population, is an encouraging sign of more sustainable lifestyles.

Road vehicles are no longer dominated by oil, and are much more efficient on average than they were at the turn of the century. The majority of road vehicles in Greater Manchester are running on electricity, with hydrogen-based propulsion being the second most popular vehicle on the road.

Emissions from aviation have stabilised at 2005 levels, which required other sectors to reduce their emissions by higher quantities.

Electricity Generation

There are no longer any fossil based power stations within the north-west either with or without carbon capture and storage. The majority of electricity production in the region is from off-shore wind. This is largely due to the significant off-shore capacity

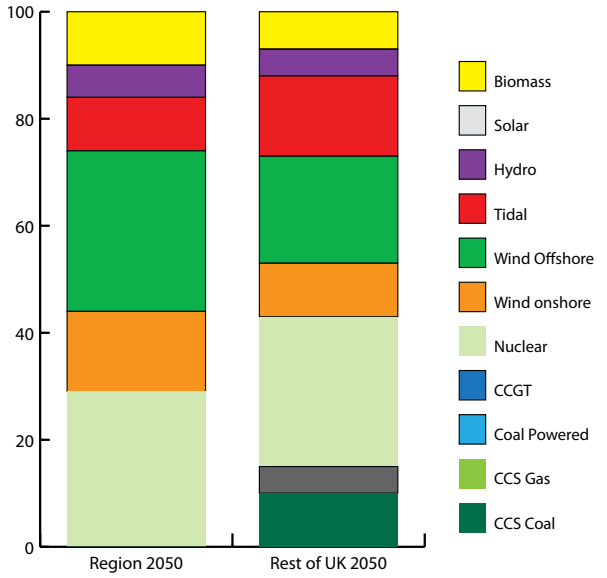
of wind on the coast. The second most prevalent generation technology in the region is nuclear power, which continues to occupy a sizeable share of production despite public opposition. The tidal barrage in the Mersey Estuary has now been built, bolstering the regions renewable supply. In the wider UK the amount of electricity produced from fossil fuels has reduced considerably to just 15% with two thirds of this coming from Coal with Carbon Capture and Storage. The remaining natural gas plants that are not fitted with capture technologies are used at times when electricity is in peak demand.

Service Sector

The amount of non-electrical energy consumed has reduced in line with the domestic sector. When this reduction is considered alongside strong economic growth and an increase in population, this change in energy consumption represents significant efficiency improvements. The production of electricity on-site has not resulted in the same levels of decentralization as seen in the residential sector.

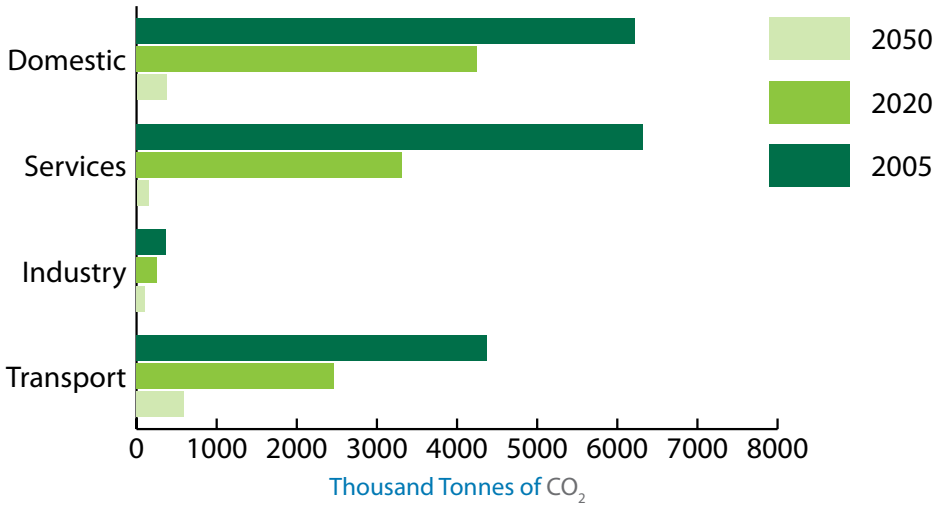
Industrial Sector

The lowest levels of emissions reduction have taken place within industry. This is largely because the industrial sector has remained dominated by fossil fuel combustion as it is seen as the best placed sector for making use of the fossil fuels. As a consequence, whilst industry has contracted and become more knowledge-intensive, total non- electrical energy demand has reduced by half – all of it natural gas.

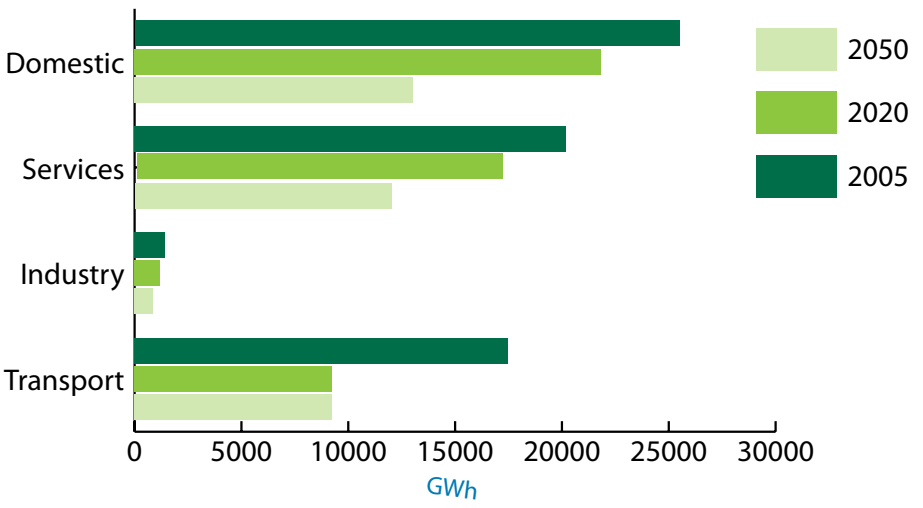


Scenario Chart A: Percentage of Electricity Generated by Technology, North West and UK

Scenario Chart B: Percentage of generated by technology type.



Scenario Chart C: Emissions Reduction by Sector



Scenario Chart D: Energy Change by Sector

Scenario Day 2

Economy and Demographics

Since the turn of the century, Greater Manchester's economy has grown. This has represented an average level of economic growth of 0.5% pa. This seemingly low level of growth was faster than the national average. The population has increased moderately, but it is aging. With this increase in population has come a small increase in the amount of households. In general there has been a change away from a consumerist mindset to one where people place more value on their quality of life.

Residential Sector

The amount of non-electrical energy consumed in the domestic sector has fallen by 75%. This has been driven largely through retro-fitting and an improvement in building standards. Fossil fuels do still account for half of the fuel consumed in this sector. There has been a 20% decline in the amount of electricity consumed within the residential sector, despite an increase in homes and the number

of appliances used within them. A quarter of the electricity consumed is produced through on-site renewable production.

Transport Sector

Due to a range of demand focused policies, the total amount of vehicle miles traveled over the past five decades has remained largely unchanged. This was partly aided by a lower than expected population increase. Approximately one fifth of vehicles on the road are powered using petroleum, the remainder using electricity. Overall, the vehicles are much more efficient on average than they were at the turn of the century. Hydrogen is emerging as a dominant mode, providing for a quarter vehicles which are ultimately powered by electricity. Emissions from aviation have stabilised at 2005 levels.

Electricity Generation

There are no longer any fossil based power stations within the North West either with or without carbon capture and storage. The majority of electricity production in the region is from nuclear power, with off-shore wind production coming a close second. The next most prevalent generation technology in the region is tidal power, which occupies a sizeable share of production despite public opposition. In the wider UK the amount of electricity produced from fossil fuels has fallen to approximately one fifth of supply with the significant majority of this coming with CCS. The remaining natural gas plants that are not fitted with capture technologies are used at times when electricity is in peak demand. More than half of overall electricity supply is from renewable technologies.

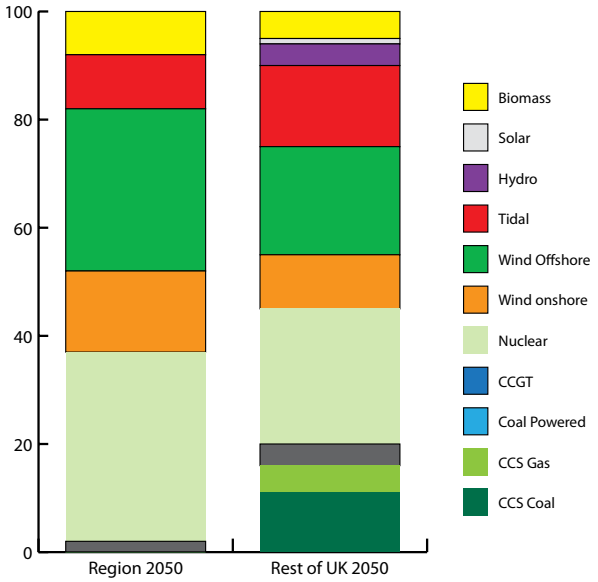
Service Sector

The amount of non-electrical energy consumed has fallen by 60%. This reduction should be considered in line with the economic growth experienced. This change in energy consumption represents significant efficiency improvements. The amount of electricity consumed has declined by 20%. The production of electricity from on-site renewable technology now occupies 30% of the total electricity consumed in this sector.

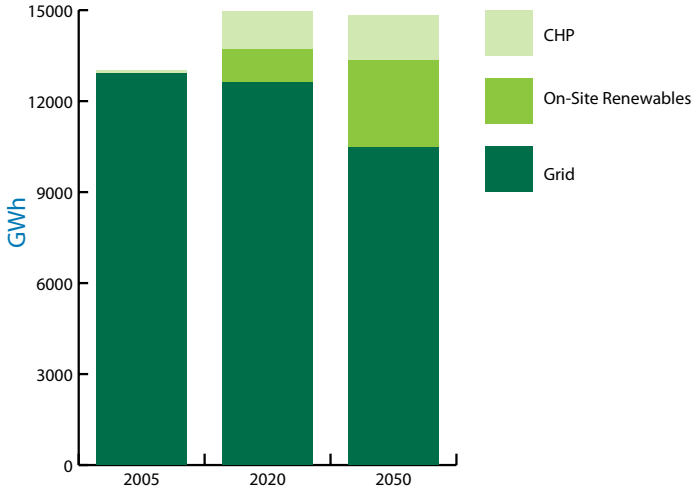
Industrial Sector

The industrial sector has reduced its emissions, but not by the same levels as the other sectors.

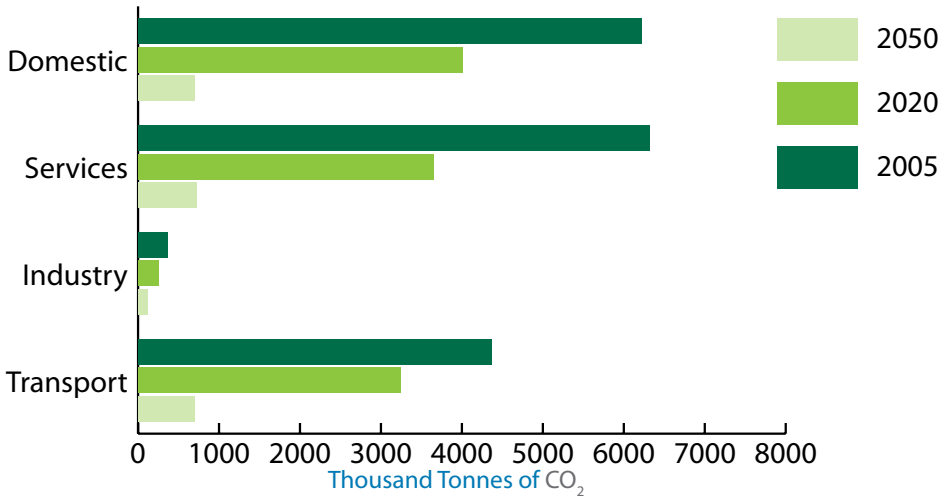
This is due to a combination of factors, firstly that industry has grown in size due in part to an increase in knowledge intensive industry. Fossil fuels remain the dominant fuel which means that emissions have remained higher than in the other sectors.



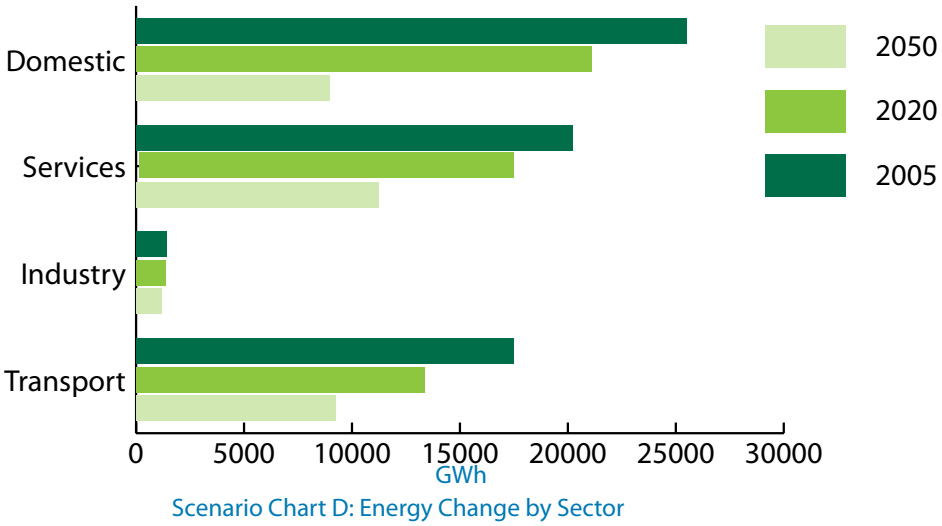
Scenario Chart A: Percentage of Electricity Generated by Technology, North West and UK



Scenario Chart B: Percentage of generated by technology type.



Scenario Chart C: Emissions Reduction by Sector



Scenario Chart D: Energy Change by Sector

Scenario Day 3

Economy and Demographics

Over the past 40 years, Greater Manchester's economy has grown on average at the same pace as the rest of the UK. This level of growth averaged 2.2% pa over this period. The population has increased at a faster rate than the rest of the country. With this increase in population has come a proportionate increase in the amount of households. In general, the quality of life of someone living in Manchester is perceived as relatively higher than in many other parts of the UK.

Residential Sector

The amount of non-electrical energy consumed in the residential sector has reduced by 60%. This has been driven largely through retro-fitting, behaviour change, the cost of fuel and an improvement in building standards. Fossils fuels, now account for one fifth of fuel consumed within this sector. There has been a 90% increase in the amount of electricity consumed within the residential sector. This is primarily due to an increase in homes and the appliances used within them. Even with this near doubling in electricity consumption, a fifth of the electricity consumed is produced through onsite renewable production.

Transport Sector

The amount of vehicle miles traveled has increased by 10% since the turn of the century, as people are more conservative with their use of motor-vehicles. Over this period there has been a range of largely technologically focused policies that has enabled this change to come about.

None of the vehicles on the road today are propelled by petroleum. In 2050, 50% are propelled by electricity, 40% by biofuel with the remainder powered by hydrogen. Overall the vehicles are much more efficient on average than they were turn of the century. Emissions from aviation has stabilised at 2005 levels.

Electricity Generation

There continues to be fossil fuel based power stations within the North West with every station being fitted with carbon capture and storage. The majority of electricity production in the region is from nuclear power, with off-shore wind production also playing its part. The next most prevalent generation technology in the region is onshore wind production. In the wider UK, the amount of electricity produced from fossil fuels has remained high at 40% of supply, although all of it has been produced at sites utilising carbon capture and storage. Nuclear power accounts for a quarter of supply with the remainder coming from a mix of renewable technologies.

Service Sector

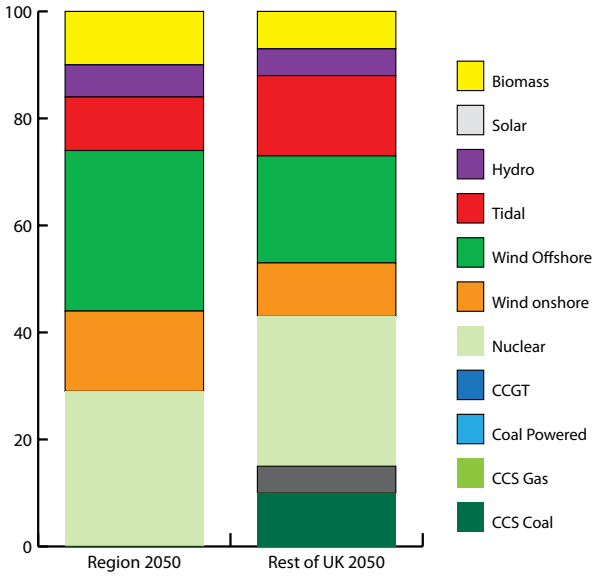
The amount of non-electrical energy consumed has fallen by 65%. This reduction should be considered in line with the economic growth experienced. This change in energy consumption represents significant efficiency improvements. The amount of electricity consumed has increased by 20%. The production

of electricity from on-site renewable technology now occupies 10% of the total electricity consumed in this sector.

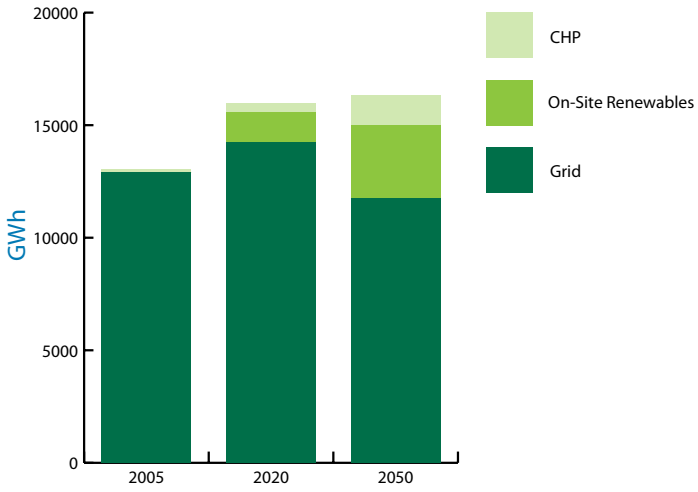
Industrial Sector

The industrial sector has reduced its emissions, but at a lower level than the other sectors. This is largely caused by the ongoing use of fossil fuels within this sector, due to industry finding it harder to reduce

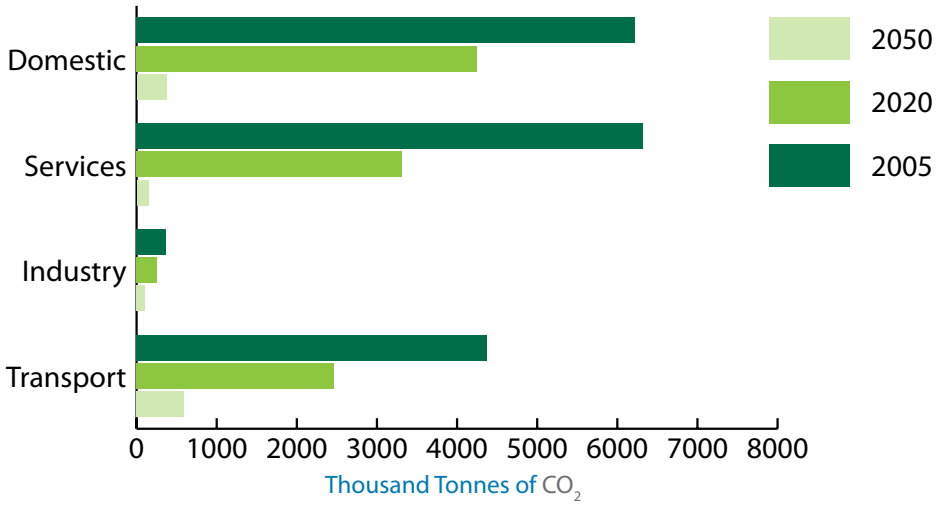
its emissions by switching to other fuel sources. In addition industry has declined in relative comparison to the other sectors in the economy.



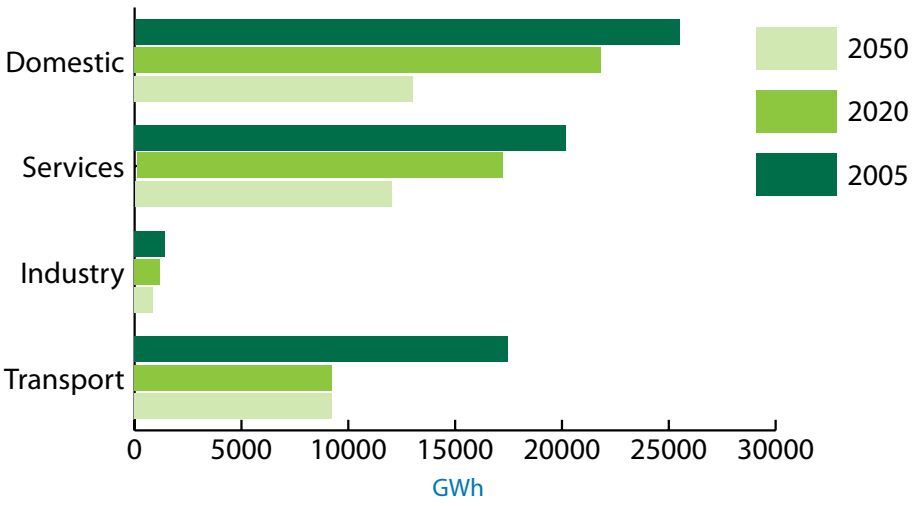
Scenario Chart A: Percentage of Electricity Generated by Technology, North West and UK



Scenario Chart B: Percentage of generated by technology type.



Scenario Chart C: Emissions Reduction by Sector



Scenario Chart D: Energy Change by Sector

Research Exercise 3: Questionnaire of Environmentally Concerned Individuals

Introduction

DEFRA estimates that fewer than 1% of the general population had installed microgen as of 2007 and fewer than 7% were judged able to install it (an indicative value based on those actively thinking about installation and able to do so in the sense of having sufficient income, being in an appropriate location etc) (DEFRA, 2008). In fact the situation may be worse than this: on the basis of estimates by Element Energy (2008), only 0.5% of UK households have installed microgen.

This strand of the research investigated microgen-related behaviour and attitudes among a sub-group considered (and found) to be more likely than average to install microgen technologies. The rationales for the questions partly follow from previous questionnaire surveys and are explained more fully in a later paper. Briefly, though, there are still relatively few studies of why some people install microgen technology and others do not. While this survey does not resolve the question, it does emphasise both the strength of but also the limits to environmental citizenship, as well as the significance of cost as an obstacle to installation.

Access to potential respondents was facilitated by the MIMP (Manchester is My Planet) climate pledging initiative, managed by Manchester Knowledge Capital (MKC) and launched in 2005. Some 10,000 people in Greater Manchester initially pledged to reduce their carbon dioxide emissions by 20% by 2010 and 21,309 residents were signed up by the beginning of 2010 (http://manchesterismyplanet.com/). The MIMP project has now come to an end. A web-link to a short, online questionnaire was headlined in an email, sent by MKC in May 2010 to its list of MIMP pledgers. MKC estimates that there are 6,000 live email addresses on this list. The response rate was low, at 3.33%, with 201 usable responses. Speculatively, a 5-10% response rate might be expected for an impersonal email survey of subscribers and it is likely that the number of actively interested MIMP subscribers was in fact very much lower than 6,000.

The respondents were found to be highly educated, with 43% having an undergraduate degree or equivalent and a further 32% a postgraduate degree or equivalent. Home ownership was above the UK national level of just under 70%. People of 60 years old and over (at only 6% of respondents) were under-represented relative to the actual population age structure of the UK: in 2008, 16% of the UK were 65 and over (ONS, 2009). This may perhaps reflect the online nature of the questionnaire. The gender balance was approximately normal relative to the national population.

Attitudes to Climate Change

The respondents expressed, as would be expected, strong concern about climate change. Moreover their responses are more concerned and accepting of climate change science than the responses of a nationally-representative sample (Spence et al., 2010). 96% of the pledgers agreed or strongly agreed with the statement that there are risks to people in Britain from climate change (66% nationally; 77% nationally in 2005); 78% agreed that they had strong opinions about climate change (51% nationally); and 86% agreed that most scientists agree that humans are causing climate change (56% nationally). 82% disagreed that the seriousness of climate change is exaggerated (40% nationally).

Environmental commitment, identity and behaviour

86% agreed or strongly agreed that they think of themselves as someone who is very concerned with environmental issues; 85% agree that being environmentally friendly is an important part of who they are (60% nationally); and 76% say that they identify with the aims of environmental groups such as Greenpeace and Friends of the Earth (53% nationally). The responses show the group to have a higher level of pro-environmental commitment than the population as a whole, as based on 2007 survey results by DEFRA (DEFRA, 2008). Taking extra care to avoid food wastage was undertaken by 64% in DEFRA's survey but 89% of pledgers; buying a more fuel efficient car was undertaken by 27% in DEFRA's survey but 41% of pledgers; avoiding car use for journeys of less than 2 miles was undertaken by 29% in DEFRA's survey but 56% of pledgers, with an additional 12% saying that the question was inapplicable because they did not own a car; avoiding short-haul jet travel for leisure (a reduction of one trip per year) was undertaken by 28% of those who fly in DEFRA's survey but 47% of pledgers, with an additional 10% saying that the question was inapplicable because they do not fly; adopting a vegetarian, vegan or fish-eating diet was undertaken by 6% of DEFRA's survey but 35% of pledgers (though 32% said they were not convinced that this is necessary – by far the largest response of the 'unnecessary' category).

Capacity for action

The respondents also had a strong sense of self-efficacy (ability to effect change) with respect to climate change and more so than nationally (national figures from Spence et al., 2010)): they feel that they have the capacity to take action and that this action will make a difference ('I can personally help to reduce climate change by changing my behavior: 91% agree or strongly agree; 63% nationally). 93% feel that it is their responsibility to help to do something about climate change (70% nationally). However, just over half (54%) also agree that there are a variety of external factors that make it difficult for them to take action (57% nationally – the most similar of any of the national/pledgers comparisons noted). The picture is more mixed when people are asked whether they agree that they can influence decisions in their local area: 25% disagree or strongly disagree (47% nationally); 51% agree or strongly disagree (32% nationally); and 21% are neutral on this (18% nationally) (Spence et al., 2010). That is, personal behaviour and consumption are considered more amenable to influence than is the local environment.

Willingness to pay (WTP) for low carbon electricity

Despite the above pro-environmental attitudes, values and identity, there was considerable variance in willingness to pay more per month for low carbon electricity. While the mean value that the pledgers were willing to pay was an additional £5 per month, 18% of respondents (36% nationally) were not willing to pay any more at all. Nonetheless, most did say that they were willing to pay more: for example, 23% were willing to pay £10 per month more and 25% (17% nationally) were willing to pay £4-6 more (Figure 3); national figures from (Spence et al., 2010).

Microgen attitudes and behaviour

Of the total sample of 201 individuals, 32 microgen appliances were installed by 22 people. Solar technologies were the most popular: 27% had seriously considered solar PV and 36% solar thermal; of these, 18% went on to install PV and 42% solar thermal. More generally, though, with the exception of solar thermal, fewer than 20% of those who had seriously considered a micro-gen option went on to install it. Respondents were asked for their reasons for not installing micro-gen options. By far the most frequent reason (cited by 36% of respondents) was the upfront cost being too high. The other main reasons were the payback time being too long (17%) and insufficient information (15%).

In terms of specific technologies, of those citing concern about visual appearance and noise as reasons for not installing, micro-wind was the main technology involved for about one half of respondents. Micro-wind was also the technology involved for about one third of those not convinced of a technology's environmental value, one third of those concerned about its effect on house resale and one third of those concerned about general inconvenience. However, both solar technologies were also singled out by about half of those expressing concern about general inconvenience.

Statistical analysis suggest that in this group of pro-environmental respondents, perceived self-efficacy and environmental values play a smaller associative role in actual installation than does having given serious consideration to other micro-gen options. Of course environmental values may show a stronger association with installation in a sample more representative of national demography or values. In terms of willingness to pay an additional sum per month for lower carbon electricity, willingness to pay more is positively correlated with having installed two of the most popular technologies: a biomass boiler and solar panels for heating. In terms of causality, whether this relates further to ability to pay is unknown, though it is worth noting that the analysis did not indicate a relationship between installation and professional or educational qualification. Indeed the analysis, in so far as it highlighted environmental commitment as contributing (in a small but significant way) to installation, taken in conjunction with the above correlation, is more supportive of environmental values than demographic variables as a driver of installation - for this group of climate pledgers, at least.

Conclusions

The microgen installation rate among those climate pledger who responded is very much higher than the national average: about 11% had installed one or more microgen options. Yet 52% said that they had seriously considered installation in the sense of looking at the costs involved. Thus while installation by the pledgers is perhaps some 11-22 times higher than that of the general population, clearly a substantial difference, their environmental commitment is also being frustrated. While a variety of factors were identified as obstacles or countervailing issues, upfront cost was by far the most common reason cited for not installing (36%). The second most common reason was also cost-related: the pay-back period being too long (17%); third was insufficient information (15%), which is perhaps a little surprising and which at least should be more readily amenable to remedy.

Summary

This report has outlined the results of a series of studies undertaken in Greater Manchester that have focused on public perceptions of micro-generation and emissions mitigation, primarily in the residential sector, but in the context of the wider energy system. The series of study comprised four full day workshops with middle and high income homeowners and landlords; three one day energy-emissions scenario workshops with traditional stakeholders; and a detailed questionnaire conducted with environmentally concerned climate pledgers.

The results provide an insight into public and stakeholder thinking with respect to the role of micro-generation and demand reduction in the context of energy system transition. In many respects, they reaffirm and highlight the results of previous opinion studies, the links to which will be set out in subsequent papers - for example, there are familiar themes of cost being a key factor; place identity and protection in relation to new infrastructure siting; and a general preference for renewables over nuclear and CCS. However there are also less familiar themes: the apparent (and of course questionable) acceptance of a need for more stringent regulation on installation of microgen and energy efficiency; the notable difference in thinking between landlord and general public groups, with the former appearing to extend their private commercial/financial perspective to the regional level when considering energy scenarios; and the difficulty that all, including traditional policy stakeholder groups, had in envisaging plausible scenarios for Greater Manchester's nominal 2050 Low Carbon Economic Area target. Then there are further themes that we don't explore here, relating to the detail of exactly what cognitive processes participants go through when faced with challenging (though still, to them, hypothetical) scenario choices.

Regarding perceptions of regulation and appropriate government response, it was evident that homeowner and landlord views changed as the workshop progressed, notably during the scenario exercise. In terms of discussions of how to finance energy system change from a domestic user perspective, participants shifted from an initially strong focus on governmental grants and financial incentives to a reluctant acceptance of the need for a more mandatory approach. It should be said, though, that for some stakeholders, the climate targets were deemed so stringent as to be unrealistic, unachievable and to be dropped. The latter is an obvious yet under-researched response to climate stringency.

Methodologically, we show that it is possible for alocality to actively engage the public in potentially complex discussions over the introduction of low-carbon technologies and energy demand reduction - providing appropriate technical support is in place. In fact GRIP scenario sessions have now been conducted with approximately 1,000 stakeholders spanning fifteen countries and two continents. Of the Individuals engaged, only a little over 1% had been previously engaged In energy scenario emissions calculations. In Greater Manchester too, the GRIP scenario tool worked well and will be available for the City Council to use in future.

Through the scenario process, participants also realised how little they knew of energy systems, technologies, grants and incentives and said that they wanted related information to be provided far more readily and easily. It would be worth following these individuals up at a later stage to check whether the learning acquired through the day persisted and fed through into any actual behaviour change. While the process that participants experienced could be characterised as one of social learning, the long term persistence of learning, and its integration into every day life, should not be assumed. Moreover it is clear from the questionnaire responses of the pro-environmental climate pledgers that until the upfront cost of lower carbon energy technologies reduces at the micro-level, only a minority will take up installation opportunities.

Practical action

In terms of high level climate policy targets, what energy-emissions scenarios show us is not that we should give up, a view that the large majority of participants shared, but that we must accelerate emissions reduction activity. In the context of a CO_2 emissions reduction of 93% for Manchester by 2050, one year of current emissions is the equivalent of more than all of the City's 2050-2060 CO_2 emissions. Indeed without action, the City's emissions between 2005-2010 are approximately the same as the total emissions budget set by Greater Manchester's targets for release between 2050-2100. To those working in climate policy, it is clear that delays to action will make avoidance of 'dangerous climate change' very much more difficult. Here we offer some suggestions for action, building on the workshops, for local implementation:

1) A council sponsored and accredited CPD course to be run in conjunction with the University of Manchester's School of Environment and Development on Carbon Intelligence.

2) A review of the emissions targets in Greater Manchester to ascertain the impacts of failing to meet short term targets.

3) A set of micro generation and energy efficiency targets for existing properties in Greater Manchester, plus consideration offinancial options for helping to deliver these.

4) A schools initiative, based upon GRIP, for explanation and exploration of mitigation options in an educational contexts.

References and Acknowledgements
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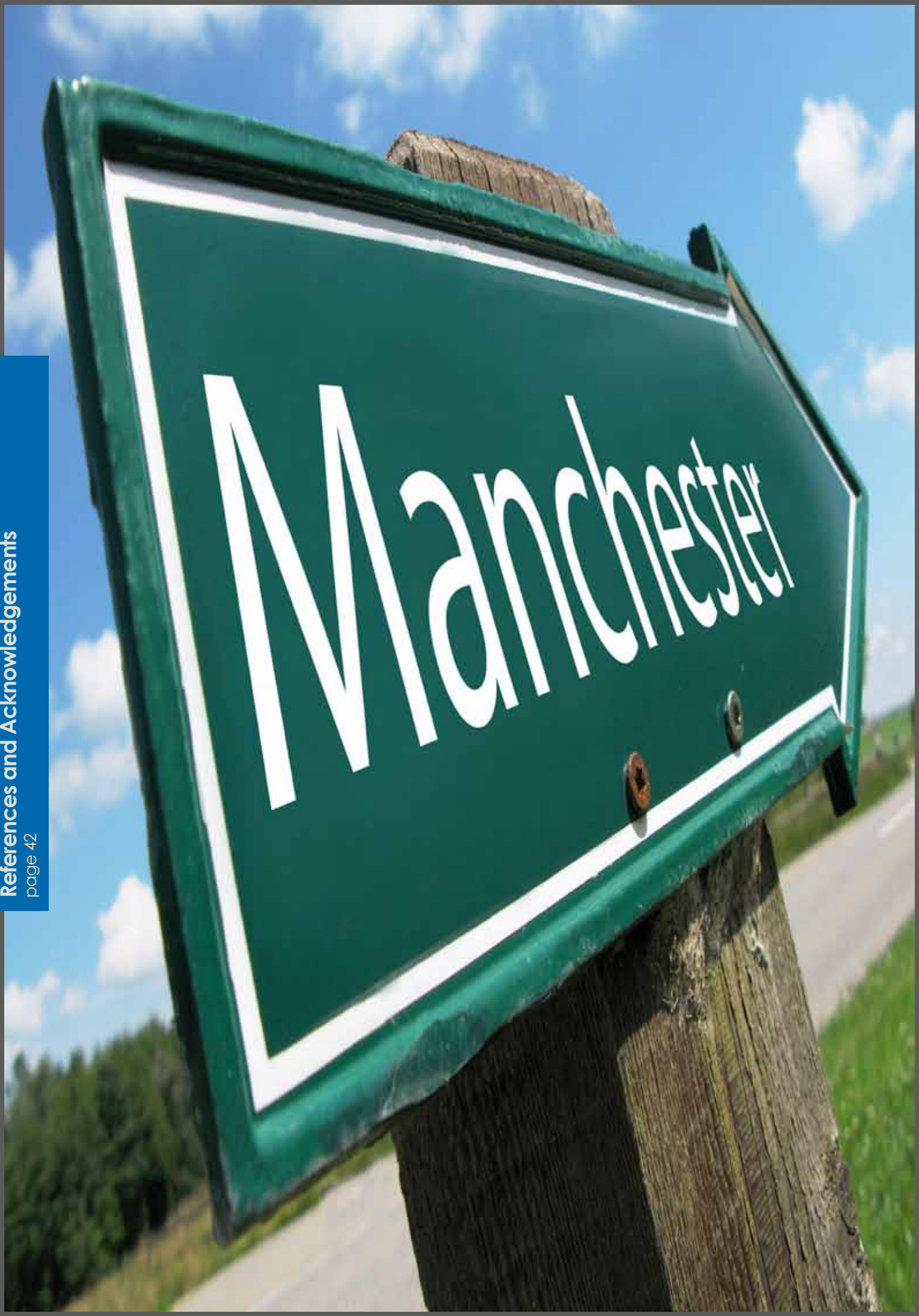

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