Building stronger and fairer communities: sharing the co-benefits of local action on climate change

Ruth Mayne, April 2016

Environmental *Change* Institute

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Foreword by Danny Dorling

Oxfordshire could be so different and was so different not very long ago. In the novel Larkrise to Candleford, the story of a very different Oxfordshire is told: one in which poverty was widespread but where the local population were self-sufficient. Progress improves lives, but if planned badly it can also accelerate pollution and produce an economically unequal and socially dislocated society. Today Juniper Hill – near where the novel was based – is too expensive an area for locals to afford to live; it is certainly not self-sufficient, being part of a car-based culture where the value of land is directly related to proximity to the carbon-emitting M40; and most of Oxfordshire's adults can no longer afford to live near to where they work. Homes have been built far away from workplaces.

Giant car parks surround the city of Oxford, making its buses amongst the most polluting in the country, once the carbon required to drive a car to the park-and-ride is factored in. The buses themselves may be low emitting, but the carbon taken to drive a car to the park-and-ride can be great. Investment goes more into improving roads than expanding cycling, and bus subsidies have recently been removed due to government spending cuts. Too many people still live in leaky cold homes with all the physical and mental health problems this entails.

We all produce the carbon pollution that contributes to climate change through the energy we use to heat and light our homes, to cook and wash, to power our transport, to produce our food and to recycle our waste. But affluent residents produce far more than those on lower incomes because they fly (on holiday), drive more and consume more energy in their homes and in other aspects of their lifestyles. A map of emissions is almost identical to a map of wealth.

All that is the bad news; there is also much good news and this report summarises a great deal of that. Oxfordshire contains a disproportionate number of people who care about issues such as the environment for a county of its size. Numerous schemes are promoted, the universities are hotbeds of both environmental activism and research; the county is also home to leading environmental campaigners and journalists.

Oxfordshire also has the potential to change. There is huge demand among the workforce of the city to live in and around the city rather than having to commute by car every day just to go to work. Oxfordshire is a beautiful county, most of which is not accessible to the public. If the land were opened up and the right to roam introduced – as it has been elsewhere in England – people from the county would not have to travel away so often for recreation or to go on holiday.

Oxfordshire's land is mostly flat, so far more people could cycle and far more public transport could be provided that even those living on the most austerity-restricted budget could afford. Rail is much safer than buses, but buses are safer than cars, and almost no one is ever killed who is hit by a bike. Oxford could be the Freiberg of England. Oxfordshire could be a truly green county. Freiberg is the greenest large city in Germany. The state it sits in, Baden-Württemberg, was a Conservative led state, like the English home counties, but its people voted to be more green after 2011.

Both the wind and the willows could provide far more of its energy. Its kitchens could be far less wasteful, its people could recycle far more and consume far less of what they are enticed to buy … but quickly throw away. People's homes could be warmer and cosier with lower fuel bills. So much more is possible; so much more is just waiting to happen. This report highlights how local efforts to reduce carbon emissions can be harnessed to improve lives and reduce social divides. A record of what could be achieved – and by implication what has not yet been achieved – lets the light in.

Danny Dorling, Halford Mackinder Professor of Geography, University of Oxford

1 Overview

1.1 Report purpose

The imperative of tackling climate change presents Oxfordshire with both a profound challenge and opportunity to improve people's lives and the environment. This report aims to promote discussion and provide practical ideas about how Oxfordshire can achieve both a fair and a fast transition to a low-carbon economy in a way that benefits local residents, reduces social divides and builds public support for action. In particular the report's purpose is to:

- ✓ Support local organisations' efforts to widen and deepen carbon reduction by highlighting recent evidence about the social, health, environmental and economic co-benefits of carbon reduction policies and programmes.
- ✓ Provide practical proposals, a checklist and motivating case studies about how to enhance the design of local carbon reduction interventions so that they generate and share co-benefits and hence contribute to stronger and fairer communities.

A large amount of experience and know-how has already been garnered in Oxfordshire and more widely in the UK about how to reduce local carbon emissions. This report does not seek to duplicate this. Rather, it seeks to build on and strengthen the many successful carbon reduction initiatives already being undertaken in the county. It follows on from the Low Carbon Economy report (Patrick *et al*., 2014), which outlined the potential economic co-benefits of local climate action for Oxfordshire.

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The report should be useful to all local organisations that are seeking to enhance the prosperity and well-being of their local communities and contribute to the county's economic, social and environmental objectives, whether practically or strategically. These may include existing members of the Low Carbon Oxford (LCO partnership –a network of over 40 organisations collaborating to reduce the city's carbon emissions – as well other public, private, civil society and community organisations in Oxfordshire. The report should also be also be of interest to senior management, political leaders, community leaders, front-line workers in different sectors and to national and EU stakeholders.

Co-benefits and costs

The term co-benefit refers to any additional social, economic, health and environmental benefits arising from carbon reduction programmes other than carbon savings.

The full report is available on line at: www.agileox.org/building-stronger-and-fairer-communities-sharing-the-co-benefits-of-local-action-on-climate-change. This extended Summary is also available in hard copy. The report is a work in progress and readers are asked to send comments or additional evidence to the author at ruth.mayne@ouce.ox.ac.uk.

1.2 Summary of key findings

Oxfordshire is a beautiful and prosperous county with a vibrant civil society, a strong economy, relatively low levels of unemployment and income deprivation, and high levels of life satisfaction. However, it also faces growing challenges from climate change and inequality. These twin challenges are interconnected:

- High levels of inequality have been found to be associated with high levels of carbon emissions in rich countries (Grunewald and Klasen, 2015) and high-income individuals emit more than those on lower incomes (Gough *et al*, 2012).

- The way we choose to tackle climate change can also affect income inequality. We can either choose to reduce local carbon emissions in a way that reduces social divides or in a way that exacerbates them.

There is a mounting body of evidence that carbon reduction initiatives can simultaneously generate a range of important economic, social and environmental co-benefits and that these benefits can outweigh the costs if early and strong action is taken. These co-benefits provide Oxfordshire with an opportunity to simultaneously widen and accelerate action on climate change, improve well-being and reduce social divides. Specifically, the existence and growing evidence about co-benefits:

- **can be used to strengthen the case for ambitious local action on climate change**. Climate change mitigation has conventionally been seen as a collective action problem whereby because everyone benefits from carbon reduction initiatives there is an incentive to free ride on the actions of others. The evidence that co-benefits outweigh the costs of climate action strengthens the case for Oxfordshire and the UK to reduce carbon emissions, irrespective of whether or not other regions or countries do so (Downie and Drahos, 2016).
- **means that local carbon reduction programmes can simultaneously help tackle climate change and contribute to other important local strategic objectives to improve well-being and the local environment**. The findings of this report suggest that local carbon reduction programmes, particularly when incentivised by national government, can help contribute to: the local economy and jobs, improved air quality, reduced congestion, reduced fuel poverty, healthier diets, active communities, reduced social isolation, amelioration of local flooding and an improved natural environment. The findings also show how different ownership models and ways of working, including partnership working, social enterprises and community action, can generate additional co-benefits.
- **reinforces the importance of designing local carbon reduction programmes in an inclusive and fair manner by balancing strategies to reduce the emissions of higher-emitters with strategies to share the co-benefits with lower-emitters, particularly low income groups**. The findings from this report suggest that:
    - a narrow focus on carbon reduction alone might suggest focusing efforts on reducing the carbon emissions of high-emitting individuals and organisations – often wealthier individuals and larger organisations. Such strategies are crucial and readers are referred to research on this topic (see 1.5 below). But focusing exclusively on high emitters risks inadvertently exacerbating existing social divides by concentrating co-benefits among the already advantaged and undermining broad-based support for strong action on climate change.
    - strategies to share co-benefits with lower-emitting individuals, communities and organisations – particularly low income ones - could potentially help reduce the county's social divides and strengthen the effectiveness and impact of carbon reduction programmes by widening the numbers and types of organisations taking action, strengthening the sense of common purpose and building public support for action on climate change. (Gross, 2007; Buell and Mayne, 2011; Edenhofer *et al*., 2014; IMF, 2015).
- **provides a way of achieving more with less**. Co-benefits can be used to help widen engagement, identify linkages between different work streams and organisation, encourage joint working and cut costs (International Energy Agency, 2014), which is increasingly important in the current, constrained financial context.

Communicating about co-benefits

Communicating the co-benefits of carbon reduction policies and programmes can help motivate people to act on climate change. One academic study of university students in 24 countries across the world showed that they were as motivated by the belief that climate action would create a more moral and caring community as they were that it would help reduce climate change, and more so than the belief that it would reduce pollution or disease or promote healthier lifestyles. Results were similar for both convinced and unconvinced participants and independent of perceptions of climate change importance, political ideology, age or gender. The study says that communicating about the likely impacts of climate change and co-benefits should be complementary, not competing strategies, although further research is needed about how to combine them. (Bain, P. *et al*., 2015).

- **can be used to strengthen the case for a strong and equitable central government policy framework and financial incentive structure to support local carbon reduction programmes**. A stronger evidence base on the co-benefits of local and community-owned renewable energy projects might, for example, have helped protect communities against the recent steep reduction in the Feed-in Tariff.
- **highlights the need for simple, transparent and participative ways to value and compare the trade-offs between carbon reductions, co-benefits, costs and distributional outcomes of different interventions to ensure optimal outcomes**. In some cases it may be possible to achieve benefit sharing with simple and low-cost programme design. In other cases benefit sharing may entail increased costs or smaller carbon savings (linked to increased incomes and hence possible increases in energy consumption). There are some tools that estimate the monetary value of various co-benefits (Heat, 2014; HM Treasury, 2011; IGCB, 2008, 2011). But as it is arguably neither practicable nor desirable to put a monetary value on all co-benefits, comparing different options therefore inevitably entails some subjective judgements (Clarke *et al*., 2014). Tools such as multi-criteria analysis can help provide transparent and participative ways of making comparisons and judgements (Communities and Local Government, 2009; Maxwell *et al*., 2011).

1.3 Oxfordshire's twin challenges: climate change and inequality

Oxfordshire has already suffered repeated floods, the increased incidence of which has been linked to climate change (Schaller *et al*., 2016). With the world emitting carbon into the atmosphere at a rate ten times faster than at any point since the dinosaurs era (Zeebe *et al*., 2016), future extreme weather events are expected. Outdoor pollution is estimated to contribute to up to 40,000 deaths each year in the UK due to the burning of fossil fuels to power vehicles and generate heat and electricity, and is estimated to cost more than £20 billion per year (RCP, 2016).

Air quality is a big issue in Oxfordshire. As one participant in a recent low-carbon learning workshop in Oxford noted: 'There are too many cars in the city area. Air pollution is a big problem' (Mayne, 2015).

A further challenge facing the county is the wide social divide between rich and poor. At one extreme, Oxfordshire hosts the seventh highest number of multi-millionaires in the UK counties outside London. At the other extreme, around 30,262 residents (or 4.5 percent of a population of 672,500) live in areas of deprivation with 2 communities among the 10 percent most deprived nationally and a further 13 communities among the 10–20 percent most deprived, with some residents unable to afford a home or adequately heat their homes or feed themselves (OCC, 2015a, 2015b). One workshop participant from a deprived area of Oxford remarked: 'the gap between rich and poor is getting wider all the time … the poor are getting left behind and their standards of living going down'.

High levels of inequality have recently been found to be associated with high levels of carbon emissions in high income countries (Grunewald and Klasen, 2015). In addition, higher-income people emit more greenhouse gas (GHG) emissions than those with lower incomes (Gough *et al*., 2012; Oxfam, 2015; Picketty and Chancel, 2015). A 2012 UK study, for example, shows that people in the top income decile emit 4.46 times more emissions than the lowest income decile from transport, 3.78 times more emissions from consumables, 3.61 times more emissions for private services, 1.82 times more emissions from domestic energy use and 1.81 times more emissions for food[1] (Gough *et al*., 2012).

High levels of inequality are also increasingly recognised as hampering poverty reduction, undermining growth, skewing policy and exacerbating social problems (IMF, 2015). As one participant from a deprived area of Oxford noted in a recent workshop: 'growth only benefits certain parts of the population … there is no trickle down and communities like this are left to flounder'. (Section 2 for further discussion about inequality).

What is already being done

As this report and case studies show, a large amount is already being done to reduce carbon emissions at the local level by public, private and third sector organisations. Oxfordshire's local authorities and partnership organisations have agreed to reduce countywide CO2 emissions by 50 percent by 2030 compared to 2008 in line with national policy commitments (Oxfordshire Partnership, undated). The county has:

- A proactive network of public, private and voluntary organisations working to reduce the county's emissions including one of the densest networks of low-carbon community groups in the UK. This network has built a participative social and institutional infrastructure that involves communities and residents in developing innovative low-carbon solutions, which could usefully be extended to other aspects of the county's governance.
- A thriving green economy generating £1.15 billion/year in sales and employs 8,800 people, 7 percent of Oxfordshire's economy (Patrick *et al*., 2014) and one of the top five counties in the UK for low-carbon entrepreneurial activity, ranked by total number of low-carbon SMEs (Carbon Trust, 2013).

1 These figures are for greenhouse gas emissions rather than just carbon dioxide, calculated on a consumption.

Local authorities and partners have also committed themselves to reducing deprivation and reducing inequalities, and Oxford City Council has set up an inequality panel (Oxford City Council, 2015; Oxfordshire Partnership, undated).

Nevertheless, the county's scale, pace and reach of local climate action needs to be accelerated and widened to achieve the county's ambitious carbon reduction targets (Aether, 2016) and help avoid dangerous climate change. The report argues that the generation and sharing of co-benefits of local carbon reduction programmes can help achieve this while simultaneously reducing social problems and social divides.

1.4 The opportunity: generating and sharing benefits

Generating co-benefits

Co-benefits vary according to the type of carbon reduction policy, sector or programme. This report focuses on low-carbon initiatives ranked as priorities by local residents from deprived and ethnic communities in Oxford who participated in recent low carbon learning workshops (Mayne, 2015).[2] Participants were asked to rank a number of possible low-carbon initiatives taking into account both their potential to reduce emissions and to create practical benefit for residents. The participants ranked the initiatives in the following order of priority: a low-carbon public transport network – particularly buses; green spaces; energy-efficient, warm homes; low-carbon and healthy local food; and local renewable energy generation programmes (the full ranking is outlined in Annex 1 and also included waste-recycling facilities and education, green businesses and jobs, cycling and facilities for electric cars). The potential co-benefits relating to these different low carbon programmes, informed by existing research and evidence, are outlined in the table below. Other co-benefits may exist but the table only includes those for which evidence has been found as part of the research for this report. Readers are referred to Clarke *et al*., 2014 (pp. 469–471) for an assessment of the strength of evidence and agreement about benefits and costs.

The report also highlights some of the potential additional co-benefits that can be derived from different ownership models and ways of working (See Table 2 below). Taken together, these co-benefits can help contribute to other important local strategic objectives relating to air quality, healthy and active communities, local economic growth and jobs. Indeed, many local carbon reduction initiatives are already generating these benefits although they may not be measured.

2 The workshops involved 36 Oxford residents from Barton, Littlemore, the Polish Association and the Hindu Temple Association.

Table 1: Potential co-benefits and costs of local carbon reduction programmes					
Type of local low-carbon programme	**Health co-benefits**	**Social co-benefits**	**Environmental co-benefits (non-carbon)**	**Economic co-benefits**	**Costs**
Low-carbon public transport network particularly buses and active transport[1]	Improved health (from improved air quality) Improved health (from active transport) Reduced noise pollution Reduced accident rate from increase in active transport[2]	Improved connectivity to places of work, recreation and health services	Reduced pollution (acidification, toxic metals etc.)	Reduced absenteeism and improved productivity at work (linked to improved health) Reduced cost (from cycling or walking vs car travel) Reduced congestion Reduced health care costs	Increased road accidents from cycling (if safety measures not taken)Lost jobs from car industry Lost tax revenue from fuel duty Upstream impacts of manufacture of efficient vehicles & infrastructure. Possible rebound factor[3]
Green spaces and trees	Improved physical and mental well-being Improved air quality	Reduced crime	Reduced run off/ flooding Reduced nitrate leaching Increased biodiversity Pollution and biological control pest reduction services	Improved value of homes and properties Contribution to local growth (through horticulture businesses, green jobs and tourism) Reduced air conditioning costs through cooling effects Reduced health care costs	
Energy-efficient homes	Improved thermal comfort. Improved physical and mental health (linked to reduced cold/damp) Improved nutrition[4] linked to increased income from lower fuel bills)	Improved well-being (linked to improved academic performance & sociability) Reduced social isolation (linked to home visits or community projects)	Energy security	Reduced fuel bills (fuel poverty) Local businesses & jobs Higher property values Reduced absenteeism and improved productivity at work (linked to improved health) Reduced health care costs	Risk of poor air quality (if measures not implemented well) Possible rebound
Food – reduced meat/high plant diets[5]	Improved health	Increased social interaction	Land take benefits Potential improved biodiversity	Reduced health care costs Local businesses & jobs from growing & processing local plant-based food	Reduced nutrition if complementary measures not undertaken Reduced jobs in livestock industry

Type of local low-carbon programme	Health co-benefits	Social co-benefits	Environmental co-benefits (non-carbon)	Economic co-benefits	Costs
Renewable energy generation	Improved air quality (from avoided fossil fuels)		Energy security Strengthened local economy Catalyst for other local programmes	Income from Feed-in-Tariff (FiT) or Renewable Heat Incentive (RHI) (net of costs)[6] Reduced fuel bills. Energy security Local businesses & jobs	Amenity/landscape impacts Storage costs Possible rebound

Source: Adapted from Smith et al., 2016; IEA, 2014; Clarke et al., 2014 (pp. 469–71) and Rolls and Sunderland, 2014. In addition, detailed sources and evidence on co-benefits and costs are provided in section 4.

Notes:

1: Cycling received a low ranking from residents in the workshops but it is included in the report because of health and cost co-benefits (see Section 4).

2: However, the overall numbers of accidents may increase due to increased numbers of people walking or cycling unless safety measures are installed.

3: There may be lower carbon savings (rebound) if financial savings from improved energy efficiency are used to increase energy consumption.

4: Nutrition may be improved if lower fuel bills enable people to buy more/healthier food.

5: The low-carbon workshop consulted residents about local food but the report focuses on the co-benefits of reduced meat/high plant diets due to its higher carbon-saving potential and potential health co-benefits.

6: The reduction in the FiT has reduced the payments and hence surplus available to renewable energy generators.

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Table 2: Potential additional co-benefits from different ownership models or ways of working	
Ownership model/way of working	**Co-benefits**
Home energy efficiency	
Local authority or partnership area-wide approaches to home energy efficiency	*Economic*: Increased incomes for residents linked to the provision of additional services relating to fuel switching, benefits and jobs advice Reduced public expenditure due to efficiencies, increased financial and economic benefits from working at scale
Renewable energy	
Local authority-owned renewable energy	*Economic & social*: Income stream for local public services.
Community-owned social enterprise or community shared ownership renewable schemes	*Economic*: New sources of investment (due to social & environmental, as well as financial returns) Longer term investment (due to asset locks) Strengthened local economy (linked to increased retention of financial earnings and greater potential for local supply of technologies and services) *Social & environmental*: Greater proportion of surplus reinvested for social or environmental benefit (due to dividend/interest caps) Strengthened awareness and public acceptance of renewables Catalyst for other local environmental & social projects Increased public participation
Community-led carbon reduction initiatives	
Community carbon reduction initiatives (home energy, renewable energy, food, transport, waste reduction, tree planting etc.)1	*Social*: Strengthened public motivation, engagement & participation in low-carbon activities Empowerment of residents (linked to collective action and action and learning groups) Strengthened social interaction Increased public support for low-carbon technologies
Note 1: A 'community' [energy] project' is defined as 'one with an emphasis on community ownership, leadership and/or control in which the community benefits from the outcomes of the project' (DECC, 2014).	

Co-benefits of community energy projects

A recent survey of 80 community energy organisations in the UK (Quantum, 2015) found:

- £28 million raised in community share issues
- £50 million leveraged in private investment
- £23 million invested in community benefit
- 45 percent of spend going to local contractors
- 88 percent of community energy groups actively involved in wider community initiatives
- 83 percent of schemes mentor other community energy organisations
- 155,000 volunteer hours valued at £5 million.

Sharing co-benefits

A narrow focus on carbon reduction alone would suggest that efforts to reduce the carbon emissions of the highest-emitting individuals and organisations will deliver the greatest carbon impacts. Such strategies are crucial. However, the growing evidence about co-benefits also highlights the need for inclusive strategies to share these benefits with lower-emitting individuals, communities and organisations – particularly low-income and marginalised groups. It is commonly accepted that low-income households should be given the opportunity and necessary financial and practical support to benefit from home energy-efficiency programmes due to the health co-benefits of warmer homes and also national requirements for distributional assessments. Yet, distributional issues are not necessarily routinely built into the design of local home energy, low-carbon local transport, food, renewable energy and food strategies or programmes. There is still considerable potential in the county to share co-benefits more widely. Certainly, local residents from deprived areas and ethnic groups in recent low-carbon learning workshops were both concerned about climate change and recognised the potential practical benefits from action (Gupta *et al*., 2015; Mayne, 2015).

Sharing co-benefits: Kirklees Warm Zone scheme

Kirklees Council's Warm Zone scheme, a home energy-efficiency programme in a deprived area of the UK, is one of the few examples in the UK where the co-benefits from home energy-efficiency programmes have been measured. Evaluations of the Warm Zone home insulation programme suggest that overall the programme, which insulated 51,155 homes, was estimated to have generated a net social benefit of nearly £250 million from an initial investment of £20.9 million including:

- **a reduction in CO2 emissions of 23,350 tonnes per year**
- **lifetime CO2 savings (40 years) of £30.6 million (934 ktonnes)**
- **lifetime fuel savings (40 years) of £156m (4,237 GWh)**
- **savings to the NHS of £4.9m**
- **jobs and indirect income impacts valued at £39.1m**
- **house value increases valued at £38.4m**
- **confirmed benefit claims valued at £0.7m.**

(Source: Butterworth *et al*., 2011.)

Costs

Mitigating climate change also entails costs – both the direct costs of implementing the mitigation actions, and sometimes also indirect costs arising from adverse side-effects – but evidence shows that they are outweighed by the benefits. The Stern report (Stern, 2006) showed that the economic benefits of early, strong action (in terms of avoided climate damage) would outweigh the costs of action but that delaying action would become much more expensive.

Recent research commissioned by the UK Committee on Climate Change indicates that at national level the environmental and health co-benefits of reducing carbon emissions in priority action areas identified by the government significantly outweighs the costs, for those impacts that could be quantified. Air quality benefits alone are valued at £1.1 billion in 2030, with a net

present value (NPV) of £5.6 billion from 2010 to 2030 (Smith *et al.*, 2016). The fifth IPCC report also concludes that the co-benefits of carbon reduction outweigh the adverse side-effects for demand-reduction measures in the transport, buildings and industrial sectors (Clarke *et al.*, 2014). The report also says that delaying mitigation efforts is likely to substantially increase subsequent mitigation costs (Edenhofer *et al.*, 2014).

The issue of who bears the costs for carbon reduction programmes is also important, as recent public debates about green levies on fuel bills demonstrated. Although local organisations have little short-term influence over the government financial incentive structure, they can mobilise supplementary sources of finance or help ensure that low-income groups can access co-benefits.

In practice whether and which co-benefits and costs materialise, and how they are distributed, is case specific and dependent on context and policy and programme design.

Future challenges and opportunities

Achieving a fast and fair transition in Oxfordshire will depend on both local action and a strong and equitable national policy framework and financial incentive structure. At local level the county faces a considerable challenge to ensure that its ambitious economic growth plans help achieve, rather than undermine, local objectives to reduce carbon reduction targets (Aether, 2016) and greater equity. It is also facing severe cuts in central government funding of local councils. At national level some of the government's key low-carbon policies have been weakened, making joined-up working based on co-benefit approaches all the more important. However, looking forward the combination of intensifying climate change and the UK government's commitment to become zero carbon suggest that policies and resources will need to be increasingly geared to carbon reduction. In the meantime, ways need to be found to achieve more with less, and an inclusive co-benefits approach can help with this.

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1.5 Sharing co-benefits: suggestions for low-carbon programme design

The section below provides some practical suggestions, informed by the research, about how local organisations might design local carbon reduction interventions to share co-benefits more widely. More detailed suggestions relating to transport, green spaces, food, renewable energy and community action are outlined in Section 4 of the report. Strategies to reduce emissions from high-emitting organisations and individuals are also crucial but are not covered here due to limitations of space. Readers are referred to the following papers for discussion on policies to reduce emissions of higher emitters: Fawcett, 2005; Gough *et al.*, 2012; Oxfam, 2015; Picketty and Chancel, 2015; Preston *et al.*, 2013.

Transport: local low-carbon transport programmes make an important contribution to carbon reduction and generate important health, social and economic co-benefits including access to a wider range of better-paid jobs, healthier food and health services, as well as improved health from active transport. Prioritising improvements in the coverage and quality of local energy-efficient bus services is the strategy most likely to benefit low-income residents as they are less likely to own a car, cycle or use rail than higher-income groups. Participants in recent low-carbon learning workshops in Oxford identified the need for improvements in radial and orbital routes around the city, an issue also identified in Oxfordshire's long-term vision for transport. Making bus services financially viable, particularly in rural areas, will require a long-term strategy to improve the quality of the service and drive demand. Health co-benefits can be shared by encouraging and enabling cycling and walking by low-income and other under-represented groups. Measures to increase cycling rates overall do not necessarily result in increased use by under-represented groups, suggesting the need to pilot and test complementary interventions aimed at addressing 'barriers to participation' such as affordability, accessibility, infrastructural and trip needs as well as cultural and social factors.

Green spaces: Green spaces and trees play an important role in sequestering carbon as well as generating important wellbeing, health, environmental and economic co-benefits, including improved air quality, improved physical and mental wellbeing and reduced noise pollution and flooding among other things. They are also highly loved and valued by local people. The evidence suggests the importance of Local Authorities developing green infrastructure strategies if they don't already have one, and ensuring that benefits are accessible to all communities'

Examples of co-benefits from the natural environment

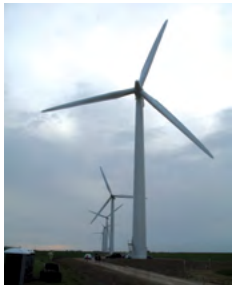
'There is strong evidence, from a large number of high-quality studies that nature promotes recovery from stress and attention fatigue, and that it has positive effects on mood, concentration, self-discipline, and physiological stress' (Rolls and Sunderland, 2014 pp 48).

'Test plots in Manchester demonstrated that over a year, the addition of a street tree could reduce storm water runoff by between 50 and 62 percent, compared with asphalt alone. Grass reduced storm water runoff by 99 percent compared with asphalt' (Armson *et al*. 2013 cited in Rolls and Sunderland, 2014).

A survey of all the trees in London estimated the value of the air pollution removal service as £127 million per year (Rogers *et al*., 2015).

Home energy: improved home energy efficiency simultaneously reduces carbon emissions and generates important health and economic co-benefits. It is widely accepted that low-income households should be included in home energy-efficiency programmes due to these co-benefits. However, local action has been constrained by a weak government policy and financial incentive framework. A key challenge is to attract the necessary public finance to enable a progressive roll-out of local authority-led home energy-efficiency programmes across the county. Some evidence suggests that where possible this should be based on area-wide partnership approaches co-designed between local authorities, statutory agencies and community groups, with differential funding packages and practical support for different income groups. New housing needs to be both low carbon and affordable.

Food: replacing meat with consumption of plant-based foods reduces carbon emissions and generates important health co-benefits. However, low incomes, lack of physical access to healthy food and existing food cultures can combine to prevent low-income residents from sharing these co-benefits. This suggests the need for pilot interventions to test ways of: increasing physical access to affordable, healthy, low-carbon food through initiatives to enable own-growing, local markets etc.; supporting local initiatives to change food cultures and build cooking skills; and improving incomes. Local organisations should also include food in their carbon reduction strategies. Supermarkets could also be encouraged to do more to ensure green and healthy food choices for customers.



Renewable energy: community-owned and social enterprise renewable energy projects reduce carbon and can generate a range of important additional economic, social and environmental co-benefits over and above conventional business models, including generating an income stream that helps finance other carbon-cutting programmes. Yet there is no automatic reason why these benefits will accrue to disadvantaged communities, households or individuals without a conscious strategy to share the benefits. One possible way of achieving this might involve using funds generated from cross-county share offers to invest in renewable energy projects in disadvantaged communities. Another possibility could be to invest the income generated from the FiT into programmes directly benefiting low-income households, for example by contributing to fuel poverty grants as the Low Carbon Hub did recently with the Warming Barton home energy project. Where locally owned social enterprises are able to supply energy directly to local residents, escalating tariffs could be explored as a means of reducing fuel poverty among low-income groups while curtailing emissions of high-emitting households.

Community-led action: evidence shows that community-led initiatives can help reduce local emissions including by motivating and empowering people to take action on climate change, developing innovative approaches to reduce carbon, strengthening social norms, and enabling behaviour change. They can also generate a range of important additional social, environmental and economic co-benefits compared to other organisations. However, community groups are a complement to – not a substitute for – action by public and private sector organisations. Their inconsistent funding and voluntary nature also means that they can struggle to achieve equitable approaches when acting on their own. Ensuring a fast and fair transition requires active partnership working between local authorities, statutory agencies and local communities, with the roles of each organisation reflecting their respective duties, responsibilities and capabilities. Partnerships need to understand and respect the aspirations and independence of community groups.

Economic growth strategy: the way the county grows will also affect carbon emissions and inequality. Achieving both a fair and a fast transition to a low carbon future may require a rebalancing and shaping of the expected scale and pattern of the county's economic growth. The analysis in this report suggests the need to:

- ensure that carbon reduction, growth and social inclusion strategies are designed in an integrated and mutually supportive way
- focus part of the economic growth strategy on the low-carbon, infrastructural and programmatic areas outlined above (accompanied by complementary behaviour-change and capacity building programmes)
- encourage and incentivise local businesses to adopt business models that value social and carbon/environmental – not just financial – returns to shareholders

- encourage the county's employers to adopt an appropriate local living wage (that recognises the high housing costs in Oxford and Oxfordshire) to help local residents afford low-meat/high plant-based diets and reduce fuel poverty.

Local sources of financing: some possible additional local sources of funding for low-carbon investments and benefit sharing measures might include:

- reinvesting pension funds or raising local bonds
- using congestion charging to cross-subsidise bus routes
- using power purchase agreements or developing shared ownership approaches with large conventional companies to finance renewable energy
- reinvesting surplus income from existing and future government financial incentives – such as the FiT or the RHI – into programmes that directly benefit low-income communities and individuals
- developing a county-wide campaign (led by the voluntary sector and parish councils) to raise awareness about the importance of local taxation and to press government to allow increases to upper council tax bands to better reflect property value and wealth
- developing a fundraising plan offering wealthy individuals the opportunity to donate more tax to local authorities following the recent lead of New York's multi-millionaires. [voluntary sector organisations]

National policy: achieving a fast and fair transition in Oxfordshire requires a strong, equitable and supportive policy framework. The creation of a local authority led cross-county public–private–voluntary sector policy group could usefully help press for the needed policies, including for example:

- adequate capital and revenue funding for priority local carbon reduction programmes financed through progressive financing methods
- wider reforms to company law, for example, that put social and environmental benefit on a par with financial return to shareholders, and enable local reinvestment for community benefit.

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1.6 Checklist for programme design

Oxfordshire has an opportunity to achieve both a fair and fast transition to a low-carbon future by ensuring every new strategy and policy includes consideration of the generation and distribution of co-benefits from local action on climate change. In relation to local carbon reduction programmes this will entail balancing interventions to target high emitters with interventions to ensure that low-income residents can enjoy the co-benefits. The checklist below offers some potential ways of harnessing and sharing co-benefits.

Harnessing co-benefits:

- ✓ **Decision-making** – have transparent and participative decision-making methods been used to value and compare the costs, carbon savings, co-benefits and distributional implications of different carbon reduction options and inform strategy? [Local Authorities]
- ✓ **Planning** – have co-benefits been factored into the initiatives aims, objectives and activities from the start?
- ✓ **Joined-up working** – can co-benefits be used to identify synergies, linkages and efficiencies between different work streams and with other organisations to promote joined-up working? [All local organisations]
- ✓ **Communications** – to what extent can co-benefits be used to communicate and engage wider stakeholders and audiences in local low-carbon reduction programmes? [All local organisations]
- ✓ **New ownership and business models** – does the business model value social and environmental, as well as financial, returns to shareholders? [LEP, local authorities]
- ✓ **Reporting** – does the initiative measure and report on the generation and distribution of co-benefits (and costs) as well as carbon savings and financial return? [LCO, Low Carbon Hub, all local organisations]

Sharing co-benefits:

- ✓ **Governance, consultation and engagement** – [All local organisations] Could the initiative do more to consult and engage a cross section of the community in the design, decision-making and implementation of low-carbon initiatives, for example by:
  - conducting a mapping of local residents, groups and organisations?
  - using informal and participative workshops and meetings to consult residents on their priorities and needs in their own communities and workplaces?
  - using new ownership models that widen ownership and benefits?
  - exploring ways of including a cross section of residents, including low-income and marginalised groups, in governance structures such as advisory groups or boards, and nurturing grass-roots leaders to engage in local decision-making forums?
- ✓ **Strategy** – [All local organisations] Does the strategy/plan balance interventions to reduce the emissions of high-emitting individuals and organisations with interventions to share co-benefits with those having lower-emissions, including low-income and marginalised groups?

✓ **Programme design** – [All local organisation]

- Is the initiative relevant and accessible to a cross section of residents?
- Does the initiative address the priorities and barriers to participation of low-income and vulnerable residents and provide them with the practical and financial support they need to share co-benefits if they so want?

✓ **Implementation/delivery roles** – [All local organisations]

- Is it possible to set up an area-based partnership of local stakeholders, with representation from the local authority, to design and implement local strategies to reduce carbon emissions and share co-benefits?
- Do local implementation and delivery roles reflect the duties, responsibilities and capabilities of local organisations (and recognise that voluntary community groups are complements to, rather than substitutes for, action by local authorities and other statutory bodies)?

✓ **Communications** – to what extent do different stakeholders have access to information about low-carbon programmes, resources and co-benefits and how they might participate and benefit? [All local organisations]

✓ **Monitoring** – does the initiative monitor the demographics of participants/beneficiaries in low-carbon programmes? [All local organisations]

1.6.4 Report background, methodology and structure

The report forms one of the outputs from the author's secondment to LCO funded by a University of Oxford Impacts Acceleration Award. The idea for the report emerged from discussions between the researcher, the Low Carbon Hub and Oxford City Council, with the intention that the report would build on the Oxfordshire Low Carbon Economy report, which highlighted the economic benefits of local carbon reduction investment.

Photograph
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Report methodology and limitations

The report has been written with oversight and contributions from representatives from local public, private, civil society, community, residents and the university (see acknowledgements). One-to-one initial consultation meetings were carried out for the report and comments were received from around 20 people.

The research for the report draws on a number of sources including: recent evidence from the academic and grey literature; the Environmental Change Institute's research and expertise relating to home energy, fuel poverty, food, transport, low-carbon communities; and illustrative case studies.

Given the wide scope of the topic it was not possible to carry out a comprehensive literature review of the evidence on co-benefits and related distributional issues. Instead the research used a snowballing approach informed by relevant issue experts and where possible refers to meta reviews. The report therefore provides an indication of recent evidence on co-benefits and related distributional issues and readers are encouraged to refer to source material for further information, as well as about assumptions underpinning models and figures. There is less evidence on distributional aspects of co-benefits so suggestions for future programme design are illustrative rather than firm recommendations.

The report also draws on learning from a series of low-carbon learning workshops with four groups of Oxford based residents from Barton, Littlemore, the Polish Association and the Hindu Temple Association. Although this is a small and non-representative sample of residents it provides useful, real-life insights that complement the academic research.

The report should be considered a work in progress. It is hoped local stakeholders will help add to the evidence base over time.

Structure and content of the report

The report starts by describing the benefits and challenges of living in Oxfordshire, including the need to tackle climate change and inequality as well as summarising what is already being done to reduce carbon emission and tackle deprivation in the county (Section 2). Section 3 develops a simple framework for understanding how to generate and share co-benefits (and costs) from local carbon reduction policies, and how co-benefits can be used to help widen and deepen action on climate change. Section 4 presents evidence and case studies about the carbon reduction potential, co-benefits and costs for various local low carbon initiatives. It focuses on initiatives that were ranked as priorities by local residents from deprived and ethnic communities in recent low carbon workshops, taking into account both their potential to reduce carbon emissions and to generate practical benefits for residents (Mayne, 2015). (See tables 1 and 2 in Section 1 and Annex 1 for further details). It also identifies the additional co-benefits that can be generated by different ownership models or ways of working and suggests ways in which programmes might be designed to share co-benefits more widely and outlines what Oxfordshire is doing and what more it could do to harness and share co-benefits.

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2 Oxfordshire's twin challenge – climate change and inequality

2.1 Prosperity and well-being

Oxfordshire is a largely rural county with almost a quarter of the land designated as areas of outstanding natural beauty, and with a wealth of historical towns and buildings. The green spaces and waterways are much loved and valued by residents as shown by recent opinion polls (CPRE, 2015) and make an important contribution to people's well-being and economic prosperity.

It is a prosperous county with a strong economy and lower than average income deprivation. Average unemployment – at 0.4 percent – is also low compared to other parts of the country (OxLEP, 2014; Public Health England, 2013). It has a strong economy, which contributes £20.5 billion a year to national output (ONS, 2015) or 1.3 percent of the UK's total Gross Value Added. It also has an innovative business culture and a higher than average skilled workforce (OxLEP, 2014). Oxford has the third highest proportion of knowledge-intensive services jobs of any UK city (Oxford Strategic Partnership, 2015).

There is a vibrant and dynamic civil society in Oxfordshire with active third sector organisations including over 60 low-carbon communities, one of the densest concentrations in the country. Oxford city has a rich cultural diversity, with 22 percent of its residents identifying themselves as belonging to non-white ethnic groups; this is celebrated every year in the Cowley Carnival.

Overall, quality of life is good, with many Oxfordshire residents reporting high levels of life satisfaction. The county also faces a number of challenges.

2.2 Climate change

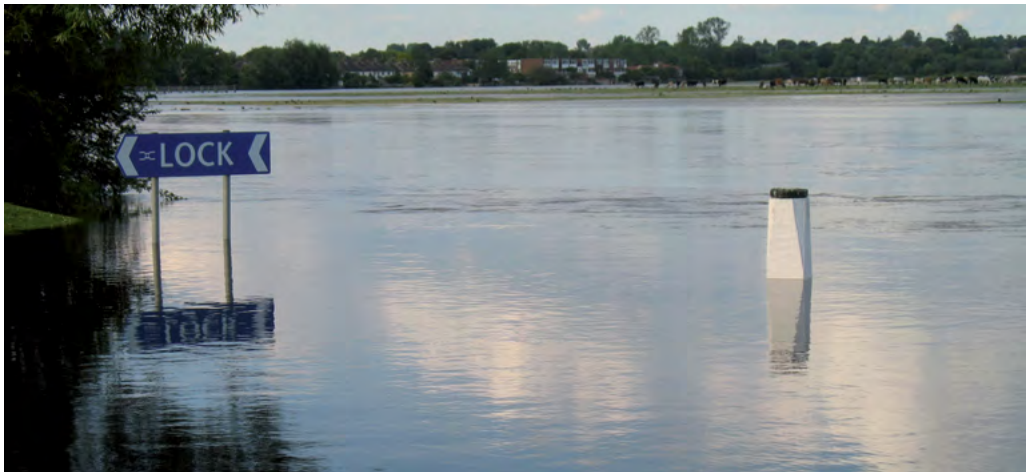
Local residents and businesses have already experienced the adverse human and economic impacts of extreme weather events linked to climate change and land use patterns. There have been four major floods this decade and the Met Office predicts that Britain will face more extreme weather events over the next century. A recent academic study finds that human influence on climate change increased the risk of extreme precipitation in Southern England during the winter floods in 2014 (Schaller *et al*, 2016).

There are 4,500 properties at a 1 percent or greater risk of annual flooding in Oxford, which is expected to rise to over 6,000 properties by 2080 because of climate change (Environment Agency 2015). Loss of transport infrastructure due to flooding occurred in 2003, 2007, 2012, 2013 and 2014 with a negative impact on existing businesses and on the confidence of new business wanting to invest in the area. The 2007 flood event created £874,000 worth of damage on the Botley Road, Abingdon Road and Kennington Road alone, excluding the effect of people not being able to get in or out of Oxford (OxLEP, 2014).

Looking forward, it is expected that Oxfordshire will see more floods in winter, and heatwaves and droughts in the summer due to rising temperatures. Globally temperatures have risen by 0.6°C. In central parts of England they have risen by almost 1°C. The climate system is complicated with many different effects at work but Met Office climate scientists predict that over the next half century Oxfordshire can expect:

- hotter, drier summers
- warmer, wetter winters
- more frequent extremes of temperature, rainfall and wind
- reduced air quality and higher levels of ozone (Oxford City Council).

Mark Carney, the Governor of the Bank of England, has warned that climate change is also a risk to financial stability that will lead to financial crises and falling living standards but that risks can be minimised if action is taken in time (Carney, 2015). We are also unlikely to be immune from overseas impacts as climate change becomes a growing cause of migration. In many cases it will be those countries that have least contributed to climate change that will suffer the most.



2.3 Deprivation and inequality

A second major challenge facing Oxfordshire is the wide social divide between rich and poor and related problems of deprivation, homelessness, fuel poverty, poor health and hunger. At the one extreme Oxfordshire has the seventh highest number of multi-millionaires in UK counties, excluding Greater London (Wealth Insight, 2012). Oxfordshire individuals appearing in the Sunday Times Rich List and with strong county connections are now worth £12.3 billion, £2.7 billion more than in 2011 (Koenig, 2012).

At the other extreme, around 30,262 residents (or 4.5 percent of a population of 672,500) live in areas of deprivation with 2 communities among the 10 percent most deprived nationally and a further 13 communities among the 10–20 percent most deprived, with some residents unable to afford a home or adequately heat their homes or feed themselves (Oxfordshire County Council, 2015). In Oxfordshire around 13,800 children live in poverty (Public Health England, 2015) and in Oxford, one in four children live in poverty with nearly half of children living in poverty in the most deprived areas (OSP, 2015).

As one workshop participant from a deprived area of Oxford observed, 'The gap between rich and poor is getting wider all the time … the poor are getting left behind and their standards of living going down'. Another participant noted that the city is 'divided and unfair' and 'wealth is concentrated in the hands of a few'.

Deprivation is sometimes seen as mainly an individual responsibility linked to low educational attainment, broken families, poor diets and/or alcohol abuse. But structural factors such as low wages and poor quality jobs, unaffordable housing and an unequal education system play a role and can make it difficult for people to break out of the poverty trap.

A review of reports and research produced by Oxfordshire local authorities, statutory agencies, the Local Economic Partnership and other bodies show that Oxfordshire faces the following social problems and divides:

- **Air quality**: much outdoor pollution arises from the burning of fossil fuels to power vehicles, and generate heat and electricity. It is estimated that in 2010 in Oxfordshire 276 deaths among people over 25 were attributable to exposure to outdoor pollution (Public Health England, 2014).
- **A highly polarised job market**: the county has low wages and poor quality jobs contributing to poverty and deprivation at one end of the market and relatively high-wage, high-skilled jobs at the other (OSP, 2015).
- **Barriers to housing**: although Oxfordshire has relatively low levels of deprivation compared to the rest of the country, it is slightly more deprived than average with respect to barriers to housing and services (Oxfordshire County Council, 2015). Oxford has the least affordable housing in the UK, which contributes to homelessness, temporary accommodation and overcrowding and increased traffic as people have to travel further to work (OSP, 2015; OxLEP, 2014; Patrick *et al*., 2014).
- **Fuel poverty**: fuel poverty arises when people are not able to afford to heat their homes properly (linked to a combination of leaky houses, low incomes and high energy prices).

It is known to contribute to poor physical and mental health. Recently revised government figures[1] suggest there were around 21,799 fuel-poor households in Oxfordshire in 2013 (8.2% percent of around 266,571 households) contributing to associated health problems (DECC, 2015a). There were 35 excess winter deaths[2] linked to cold in 2012, of which around 10 percent may be attributable to fuel poverty and 21 percent due to cold homes at national level (Public Health England, 2015; Public Health England/UCL, 2014).

- **Hunger**: the Oxford Food Bank estimates that it provides meals for up to 7,000 people living in fuel poverty (Oxford Food Bank, 2014). A recent survey in Oxford found that 53 percent of the interviewees had experienced food poverty – 57 percent in Barton, 100 percent in Blackbird Leys and 40 percent in Rose Hill (Hansford and Friedman, 2015). As one of the respondents explained: 'If I ain't got enough for the electric I go without a meal'.
- **Health inequalities**: life expectancy is 6.2 years lower for men in the most deprived areas compared to the least deprived areas of Oxfordshire (Public Health England, 2014).
- **Educational inequalities**: education in Oxfordshire is also divided. There are 17,270 pupils attending independent schools in Oxfordshire out of a total of 108,350 (DOE, 2015). Pupils known to be eligible for free school meals in Oxfordshire schools were 31 percent less likely to achieve five or more A*–C grades at GCSE than those who were ineligible (OSP, 2016).
- **Isolation**: loneliness is seen as an important problem in Oxfordshire (OSP, 2016) with an estimated 29,900 older people living alone in 2011 and, based on national trends, an estimated 7,000–15,000 older people likely to experience frequent loneliness (Oxfordshire County Council, 2016).

1 Until recently, a household was considered to be fuel poor if it needed to spend more than 10 percent of household income on energy (to warm the house to 21°C in the living room and 18°C elsewhere in the house). Following the Hills Review (Hills, 2012) the government has now formally adopted a new definition for fuel poverty in England known as 'high cost, low income' whereby a household is said to be in fuel poverty if (a) they have required fuel costs that are above average (the national median level) and (b) were they to spend that amount they would be left with a residual income below the official poverty line.

2 Excess winter deaths is defined as the difference between the number of deaths that occurred in winter (December to March) and the average number of deaths during the preceding four months (August to November) and the subsequent four months (April to July).

- **Traffic and congestion**: traffic and congestion contribute to poor air quality and hence ill health, as well as injury from road accidents and economic costs to business (Oxfordshire County Council, 2015). Yet low-income residents contribute the least to pollution: 47 percent of households in the lowest income group have no car compared to only 12 percent of the highest income group (DFT, 2015).
    - Each year in the UK around 40,000 deaths are attributable to exposure to outdoor pollution with an estimated cost of more than £20 billion per year, with vehicles as one of the principal contributors (RCP, 2016). As one participant in a recent low-carbon learning workshop in Oxford said: 'There are too many cars in the city area. Air pollution is a big problem'.
    - A rate of 49.9 people per 100,000 were killed and seriously injured on Oxfordshire roads in 2014, a significantly higher rate than in the South East and England overall (Oxfordshire County Council, 2015).

Air quality and childhood respiratory problems

Exposure to high levels of air pollution results in increased respiratory symptoms (coughs and wheezes) in children and adversely affects the normal growth of lung function during childhood, although it is contested whether or not it causes asthma in previously healthy children. (RCP,2016)

High levels of inequality are increasingly recognised as hampering poverty reduction, undermining growth and exacerbating social problems (see box below). As one participant from a deprived area of Oxford noted in a recent workshop: 'growth only benefits certain parts of the population' … 'there is no trickle-down and communities like this are left to flounder'.

Why inequality matters

Fairness is an important value in and of itself – irrespective of background, people care about inequality (IMF 2015) – and is part of national well-being measures (Beaumont, 2011). Some degree of inequality is inevitable but a high and sustained level of inequality is increasingly considered to be bad for policy, people, the economy and the environment for the following reasons.

Impact on climate change:

- **Richer people emit more GHG emissions than poorer people (Gough *et al*., 2012).**
- **A recent study of 158 countries has found that in high and upper-middle income countries, high inequality is associated with higher carbon emissions (Grunewald and Klasen., 2015).[3] Some of the possible reasons for this link are understood to be (Gough, forthcoming 2017): increased consumption due to status competition and emulation (Christen and Morgan, 2005; Frank, 2011; Picket *et al*., 2014; Walasek and Brown, 2015); an increased demand for growth (Laurent, 2015); hindering of collective action to restrain emissions by strengthening the power of the rich to make decisions, set agendas and inculcate selfish values (Boyce, 2007); increased incentives and means for the rich to substitute private amenities for public, reducing their commitments to public actions (Neumayer, 2011); and/or strengthening of polluting business interests (Boyce, 2007).**

Impact on people:

- **High inequality 'hampers' poverty reduction because 'the benefits of growth do not trickle down' (IMF, 2015) and means that we require far greater levels of growth to reduce poverty (Woodward, 2015).**
- **It can damage trust and social cohesion and is associated with conflict (IMF, 2015).**
- **It is has been associated with a range of social problems related to physical health, mental health, drug abuse, education, imprisonment, obesity, social mobility, trust and community life, violence, teenage pregnancies and child well-being (Wilkinson and Pickett, 2010).**
- **It can significantly undermine individuals' educational and occupational choices (IMF, 2015).**

Impact on economic growth:

High income inequality has been found to negatively affect growth (IMF 2015; OECD, 2014) and is associated with lower output growth over the medium term. Some of the reasons given are that it may:

- **lower the incomes of the bottom 40 percent of income earners**
- **hinder human capital accumulate and undermining education opportunities for disadvantaged individuals, lowering social mobility and hampering skills development**
- **reduce the provision of growth-boosting public goods such as education**

3 Previous studies have showed mixed results about whether rising inequality leads to higher carbon emissions. For example, some studies have found that the marginal propensity to consume and to emit falls as income rises implying that higher incomes might reduce emissions. However, the Grunewald and Klasen 2015 study clarifies some of the contradictory findings by using a substantially larger data set than the previous literature and distinguishing between countries at different income levels. It finds that the relationship depends on the level of income: in low- income countries higher income inequality is associated with lower carbon emissions, whereas in high and upper-middle income countries the opposite is the case (discussion from Gough, forthcoming 2017).

- **lead to a backlash against growth-enhancing economic liberalisation**
- **lead to a loss of confidence in institutions, eroding social cohesion and confidence in the future**
- **concentrate political and decision-making in the hands of a few, lead to a sub-optimal use of human resources, cause investment-reducing political and economic instability and raise the risk of financial crisis.**

There is also inequality in carbon emissions. High levels of inequality have been found to be associated with higher carbon emissions in richer countries (Grunewald *et al*., 2015). Richer people emit more GHG emissions than poorer people: a 2012 UK study shows that people in the top income decile emit 4.46 times more emissions than the lowest income decile from transport, 3.78 times more emissions from consumables, and 3.61 times more emissions for private services. 1.82 times more emissions from domestic energy use and 1.81 times more emissions for food[4] (Gough *et al*., 2012).

2.4 Reducing carbon emissions

Energy use permeates many aspects of our lives – how we heat and light our homes, the transport we use, the food we eat, the goods and services we buy, the waste we produce. Carbon reduction therefore entails both the re-engineering of our technologies, infrastructures and buildings and changing our personal behaviours and the way we live. As one study shows, approximately half of the energy used in the home depends on the physical characteristics of a house and its equipment, with residents' behaviour accounting for the rest (Schipper *et al*., 1989).

There is considerable consensus about what we need to do to reduce carbon emissions: divest from fossil fuels, invest in new sources of clean renewable energy (and also storage capacity), improve energy efficiency and reduce our demand for energy. We also have much of the know-how and many of the technologies to achieve this.

There is also recognition that reducing our carbon emissions will require mutually reinforcing action by multiple actors across multiple levels and sectors and a supportive national policy framework and financial incentive structure (see summary table in Annex 1).

4 These figures are adjusted – or equivalised – to take into account differences in household size.

Why local action on climate change makes a difference

Local action to reduce carbon emissions may seem small and not particularly meaningful in the national or global context. However it makes a difference:

- **It can increase the number of range and actors taking action.**
- **Modelling and copying of successful solutions is an important way that change happens (Braithwaite and Drahos, 2000). Successful local (or 'niche') innovations can be replicated, scaled up and mainstreamed, contributing to much wider system change (Geels and Schot, 2007). For example, community renewable energy cooperatives with innovative new financing models have rapidly spread across the country (see section below).**
- **Small actions when aggregated across a large number of people add up:**
  - **One calculation undertaken for Low Carbon Oxford suggested that if everyone in Oxford gave up meat for 1 year it could reduce the city's carbon emissions by 77,400 tonnes (LCO, 2015).**
  - **Lighting use in buildings represents 20 percent of the UK's total electricity consumption: if all compact fluorescent lamps were replaced with light-emitting diodes (LED) we would halve the electricity consumption for lighting (Boardman, 2015).**
- **Local action can also provide individuals and organisations with the know-how and legitimacy to demand a stronger and more supportive policy framework from government. This is important as the effectiveness and fairness of local carbon reduction initiatives also depend on such policies and financial incentive frameworks.**

There is already a large amount going on locally to reduce carbon emissions in Oxfordshire:

- It has a proactive and innovative network of public, private and civil society organisations working to reduce carbon emissions (see box below) and one of the densest concentrations of low-carbon groups in the UK.

Oxfordshire already has a thriving green economy that generates £1.15 billion/year in sales and employs 8,800 people, 7 percent of Oxfordshire's economy (Patrick *et al*., 2014).

- It is reported by the Carbon Trust as one of the top five counties in the UK for low-carbon entrepreneurial activity, ranked by total number of low-carbon SMEs (Carbon Trust, 2013).

Photograph
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Local low-carbon organisations and networks in Oxfordshire

- **Oxfordshire's local authorities and partnership organisations** have all agreed to reduce countywide CO2 emissions by 50 percent CO2 by 2030, compared to 2008, in line with national policy commitments (Oxfordshire Partnership, undated).
- **Oxford City Council, Oxfordshire County Council and the Low Carbon Hub OxFutures programme** – together with the Local Enterprise Partnership – seek to raise £400 million for clean energy projects by 2020.
- **A range of local businesses and social enterprises** are working to reduce their carbon footprints, such as Mini Plant Oxford and Oxford Bus Company.
- Community Action Group (CAG) – supports 63 low-carbon community groups across Oxfordshire who are at the forefront of community-led climate change action on issues such as home energy, waste, transport, food, tree planting and biodiversity. The groups run over 1,000 community events per year, attended by over 60,000 local residents across the county. CAG, which is funded by the county council, supports the groups through capacity building, small grants and facilitating peer-to-peer learning and skills sharing.
- Low Carbon Oxford (LCO) is a city council-led network of over 40 public, private and civil society organisations collaborating to reduce the city's carbon emissions through shared visions, networks, joint projects and shared learning working groups. Current members account for more than 40 percent of the industrial and commercial footprint of the city and over 20 percent of the city's households (13,400 out of 63,000). Every year the network runs LCO Week, which is a city-wide summer festival, using culture, creativity and community to inspire local people to take action against climate change.
- Low Carbon Hub is a social enterprise tackling the big issue of climate change in Oxfordshire by sharing and supporting local low-carbon innovations. It supports communities, schools and businesses to scale-up renewable energy generation and to put local power in the hands of local people supporting communities. It has put panels on 19 schools and 4 businesses with 9 schools and 2 businesses in development, as well as helping set up a number of micro-hydro schemes. It has 25 community shareholders who help shape and benefit from the Hub's community benefit strategy.
- Good Food Oxford (GFO) – is a multi-stakeholder network working towards a fair, healthy, ethical and sustainable food system for Oxford and Oxfordshire. The charter has been signed by Oxfordshire and Oxford City Councils and over 100 other organisations. GFO offers support, catalyses action and partnerships, conducts research and organises events.

In addition to these local activities, national opinion polls show that most people – around 70 percent – are worried about the impacts of climate change.5 In recent low-carbon learning workshops in Oxford, most participants also expressed concern about, and felt responsible for, climate change (Mayne, 2015). However, the polls also show that a significant group – 30–50 percent – feel there is little or nothing they can do about it. A key challenge for local organisations therefore is to help translate concern into action by providing people with the means to action alongside the call to action (Hammond, personal communication, 2007).

5 An Ipsos Mori poll surveyed 1,822 people across England, Scotland and Wales from January to March 2010. It showed that most people (71 percent) remained fairly or very concerned about climate change, but between 30–50 percent felt there was little or nothing they could do about it. More recent polls also show high levels of concern about climate change.

2.5 Tackling deprivation

Oxfordshire County and City Councils are also committed – and carry out a range of services – to tackle deprivation and support vulnerable people. There is also a shared commitment between LEP partners at county level to promote 'inclusive, smart and sustainable' growth and the local authorities and partners are committed to tackling inequalities (Oxford City Council, 2015; Oxfordshire Partnership, undated). A key aim of the Oxford Strategic Partnership is to balance social, economic and environmental goals. Key areas of emphasis are on improving educational attainment and skills, promoting healthy lifestyles and targeting services. As we see below, achieving these aims are becoming more challenging due to the increased demand for services, government funding cuts, the recent Housing Bill (Oxford City Council, 2015) and pressures linked to the envisaged scale and pattern of economic growth.

2.6 Opportunities and challenges

Oxfordshire faces a number of opportunities and challenges in its efforts to reduce carbon emissions and tackle deprivation.

People and organisations

One of the county's biggest assets is the motivation, expertise and creativity of local organisations and residents. Energy demand is highly distributed and so are many of the emerging solutions. A key strength has been the way the county has nurtured and scaled up grass-roots low-carbon innovations. However, it is likely there will be a large amount of untapped innovation and grass-roots leadership going on under the radar of planners and decision-making hierarchies.

Local authorities and local partnerships are keen to engage a wider range of local residents Yet while the reach of Oxfordshire's low-carbon networks and programmes have expanded in the last decade there are still too many individuals and residents who are excluded from these networks and the resources and co-benefits they can bring. Moreover, many residents do not attend formal workshops or meetings despite having extremely useful local knowledge to contribute. Successful engagement entails reaching out to people in their communities and engaging them in less formal and intimidating ways. There are many well-tested creative and informal methodologies to do this (Albert and Passmore, 2008). The low-carbon workshops referenced in this report provide one possible way of achieving this (Mayne, 2015). As well as being a useful way of providing information and consulting with people, such processes can also help increase motivation, action and public support for carbon reduction.

Local authorities and the LEP want to balance economic, social and environmental goals and there is also a growing momentum for local organisations to work together and capture synergies between different work streams. Yet current structures and decision-making processes can work against this (Albert and Passmore, 2008), and funding pressures mean that local authorities and statutory organisations do not run active carbon reduction programmes in many communities and have shed some important delivery roles.

The pattern and scale of economic growth

The way the county grows will also affect carbon emissions and inequality. The county's strategic economic plan (which was undergoing consultation at the time of writing) offers both opportunities and challenges for reducing carbon emissions and sharing co-benefits. There is a welcome shared vision in the plan that economic growth should be 'inclusive, smart and sustainable'. The 2014 plan was expected to deliver, among other things, an increase in Gross Value Added in the county by £6.6 billion, 85,600 new jobs, an increase in the proportion of the working age population qualified to level 2 and above to 90 percent, and an additional 1,150 apprenticeships for young people in the priority and growth sectors by 2031[6] (Green *et al*., 2013; OxLEP, 2014; Williams, 2016).

The expected expansion of high-knowledge jobs is likely to be less carbon intensive than other sectors. However, it is acknowledged that the ambitious scale and expected pattern of economic growth 'will put pressure on … natural resources and greater demand for energy' (OxLEP, 2014). A recent analysis commissioned by the county council shows that it will be difficult to achieve a 50 percent carbon reduction target by 2030 under the expected high growth and current government policy framework unless carbon mitigation plans are also greatly stepped up (Aether, 2016).

In addition, given the current high employment levels in Oxfordshire, it is likely that the growth in high-knowledge jobs will attract new workers into the county rather than benefit local people (Oxfordshire County Council, 2015). This in turn is likely to generate more traffic and additional housing requirements over and above existing needs: the 2014 plan anticipated a growth of 93,560 to 106,560 new households by 2031, i.e. 1.8 times the current dwelling stock of Oxford (OxLEP, 2014). Even with innovative affordable and sustainable housing solutions, additional housing is likely to increase carbon emissions (Aether, 2016). As some residents in local workshops noted growth will mean 'more carbon emissions' and 'you can't have growth indefinitely – it is not sustainable'. It will also put more pressure on Oxfordshire's green spaces, which are important carbon sinks and beloved by local people. As another Oxford resident said: 'It's development on the green belt I object to. These green spaces will disappear … once you start that then will they creep over' (Mayne, 2015).

6 The economic plan is also expected to support growth throughout the rest of UK.

It is not clear to what extent the growth plan can help reduce exclusion and inequality. Poor quality and low-wage jobs appear to be a key cause of poverty in Oxfordshire rather than unemployment, which stands at 0.4 percent.[7] There are, however, some pockets of high unemployment: five LSOAs had unemployment rates between 18 percent and 22 percent in 2012 (Oxford City Council, 2016). Yet low-paid workers are unlikely to benefit directly from the expansion of knowledge-intensive jobs in the high-tech or 'big science' growth sectors such as life sciences, physics, engineering and electronics, and telecoms and computer hardware. Around 8.7 percent of the population – or 36,300 people – lack qualifications (OxLEP, 2014). As one local resident reflected 'growth will not create jobs that we can do … trickle-down does not work, wealth stays where it is – not here'. It will 'only benefit certain parts of the population' and will mean 'more ostentatious wealth'. There is a welcome commitment to invest in education and skills, which 'will target those furthest from the labour market … and seek to channel unemployed residents towards those sectors with the most appropriate opportunities for them' (OxLEP, 2014). However, the 1,150 planned apprenticeships are a fraction of the expected 85,600 new jobs. One rationale for local economic growth is that it will help fund local service provision via increased council tax, business rates and the community infrastructure levy. But ambitious growth will also simultaneously create new demands on the public purse.

None of this is to suggest that growth is not needed, but rather that the scale and pattern of growth may need to be rebalanced to better support the county's carbon reduction and social goals and meet the needs of local residents. The Oxfordshire Low Carbon Economy report, for example, sought to make the case for investment in household energy efficiency, which has the potential to drive down building energy use and carbon emissions while simultaneously creating jobs for semi-skilled workers, reducing fuel poverty, improving health and creating wider economic multiplier effects (Patrick *et al*., 2014).

7 The LEP's stated rationale for growth is that 'we operate in a globally competitive arena where historic and continued success cannot be taken for granted. It is therefore vital that our strategic economic plan focuses on our unique economic assets and seeks to drive investment in our sectors and locations of greatest economic return and potential'. It aims to do this by 'increasing business growth and productivity supported by accelerated housing delivery, better integrated transport, a better qualified workforce underpinned by a quality of place that few locations can offer'. .

Government policy

A strong, supportive and equitable policy framework and financial incentive is needed to support local action and to ensure a fast and fair transition to a low-carbon future. Although low-carbon investments increasingly make commercial sense, public and grant funding continue to be vital as there are limited markets for low-carbon programmes targeting low-income groups or for programmes to build skills and enable behaviour and cultural change. Moreover, government financial incentives can help to greatly accelerate the pace, scale and reach of local carbon reduction programmes.

Despite the Department of Energy and Climate Change's (DECC) welcome community energy strategy (DECC, 2015) there are few consistent or reliable sources for revenue funding for the important implementation and delivery roles of local actors. The LEP is channelling important EU funding to local organisations but it is small in relation to the scale of the problem. Recent government climate mitigation policy has also been weakened in a number of critical areas, reducing both the potential for carbon reduction and the generation of co-benefits. Policy changes under the current and previous governments include: a reduction in the subsidies for home energy-efficiency improvements; the abolition of the zero carbon homes standard; a reduction in the FiT for solar photovoltaic (PV), onshore wind and energy efficiency (and previous scrapping of tax-payer funded grants for energy efficiency), and plans to sell off the Green Investment Bank.

In addition, central government has recently cut revenue grants for local authorities while other funding streams are not able to keep pace with the cuts and demand for services continue to grow.[8] This is causing a scaling back of some local key social services and is limiting local authority capacity to deliver a carbon reduction programmes. Oxford City Council's ability to provide affordable housing has been seriously compromised by recent changes in government policy, which means more workers living outside of the city and adding to emissions from traffic.

Nevertheless there are new opportunities such as the RHI, and the hope and expectation is that government will have to strengthen the policy framework and financial incentives in the future if it is to meet its carbon reduction targets.

8 The Autumn 2015 statement announced a further 24 percent reduction in government central funding of local councils, coming on top of previous substantial reduction. The County Council has had £626 million cut from its budget since 2010/11, its revenue support grant has been cut by almost 50 percent in the first half of the decade and total government grants have been cut by 37 percent. Between 2010 and March 2016, Oxford City Council will have had its government grant reduced by 47 percent. .

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3: The opportunity – a framework for generating and sharing co-benefits

This section develops a simple framework about how to generate and share the co-benefits (and costs) of local carbon reduction policies to help widen and deepen local action on climate change and tackle other important local strategic objectives. The assessment builds on the Oxfordshire Low Carbon Economy report which examined some of the economic benefits to the county and argued that an ambitious low-carbon investment over the next 15 years might add £1.35 billion annually to the Oxfordshire economy by 2030, creating over 11,000 new jobs, and may generate energy cost reductions of about £900 million (Patrick *et al*., 2014).

3.1 Generating co-benefits

There is a growing body of evidence showing that as well as helping combat climate change carbon reduction policies and programmes can simultaneously generate a number of social, health, economic and environmental co-benefits.

This report highlights some of the recent academic evidence about co-benefits from **low-carbon transport (particularly buses), green spaces, energy efficiency in homes, local food and renewable energy**. (See Tables 1 and 2 in Section 1 for a summary of co-benefits, and Section 4 for detailed analysis). These are the sectors that participants in recent low-carbon learning workshops in Oxford ranked as possible priorities for LCO, taking into account both their potential for carbon reductions and the practical benefits for residents (see Annex 1 for details of the full ranking). Section 1 also identifies some of the additional co-benefits that can be generated by different organisations, ownership models or ways of working, including community led initiatives.

The report's findings suggests that local carbon reduction programmes, particularly when incentivised by national government, can in turn help contribute to other local strategic objectives including a strengthened local economy and jobs, improved air quality, reduced congestion, reduced fuel poverty, healthier diets, active communities, reduced social isolation, amelioration of local flooding and an improved natural environment.

3.2 Sharing the benefits: reducing deprivation and inequality

The existence of co-benefits also reinforces the importance of designing carbon reduction programmes in an inclusive and equitable way.[9] The report argues that where the co-benefits from local carbon reduction programmes are shared with lower-income individuals and communities they can also simultaneously help reduce poverty and inequality.

Sharing co-benefits may also help increase the effectiveness of carbon reduction programmes by increasing the number and range of actors taking action, strengthening the legitimacy of carbon reduction programmes and helping build public support for the county's carbon reduction targets (Gross, 2007; Buell and Mayne, 2011; Edenhofer *et al*., 2014; IMF, 2015). Conversely, without equitable design, co-benefits may inadvertently accrue to the larger organisations and wealthier individuals, reinforcing exclusion and exacerbating existing inequalities.

Where significant co-benefits exist it is important that lower-income households and lower-emitting communities and organisations are offered both the opportunity – and the financial and practical support – to benefit from carbon reduction programmes, rather than focusing programmes solely on the highest carbon emitters. However, as low income residents generally emit less carbon than higher income ones, and may in some cases need to increase their consumption of energy-using services for example to increase the warmth of their homes, their participation in low carbon programmes should be voluntary. In some cases, inclusive approaches may entail increased costs or smaller carbon savings (linked to increased incomes and hence increased energy consumption), although not in others.

9 The Government Green Book requires that all new policies and programmes should be subject to comprehensive but proportionate assessment wherever practicable so as to best promote the public interest. This includes a distributional analysis to identify how costs and benefits accrue to different groups in society. It also states that ideally each monetary benefit should be weighted according to the relative prosperity of those receiving the benefit or bearing the costs if available. It states that broadly an extra £1 of consumption received by someone earning £10,000 a year will be worth twice as much as when it is paid to a person earning £20,000.

3.3 Costs

Of course reducing carbon emissions also entails costs – both the direct costs of implementing the mitigation actions, and sometimes also indirect costs arising from adverse side-effects. For example, it has been estimated that just to meet our climate commitments, Oxfordshire will collectively need to invest at least £100 million/year to 2030, and perhaps treble that if it is serious about providing leadership on carbon reduction (Patrick *et al*., 2014). Globally, the Stern Review estimated that countries should invest at least 1 percent of gross domestic product (GDP), later updated to 2 percent, to avoid the worst effects of climate change (Stern, 2006). These may sound like large numbers but are small when compared to the costs of not acting, previously estimated by Stern as at around 5 percent of GDP (Stern, 2006). Also, importantly, carbon mitigation can be achieved by diverting high-carbon investments to low-carbon investments rather than through additional funding (IEA, 2014).

There may also be unintended adverse effects of low carbon initiatives, for example when financial savings from energy-efficiency measures are spent on other energy-consuming goods and services. This is often known as the rebound effect, and may typically offset between 10 and 30 percent of potential carbon savings in home energy use (Sorrel, 2007). However, 'rebound effects' can also be considered positive co-benefits, for example if households use financial savings to improve the warmth of their homes or improve their food intake.[10] Reducing carbon emissions also involves changes to people's ways of life – whether in the home, food or transport they use. While these changes may bring overall benefits, people may find making the changes difficult. This is why, at local level, participatory approaches are important.

There is also mounting evidence that the costs are likely to be outweighed by the co-benefits. One study, for example, found that at national level the health and environmental benefits of the carbon reduction activities recommended by the UK Committee on Climate Change would significantly outweigh the negative impacts, for those that the study was able to quantify in monetary terms (Smith *et al*., 2016). The fifth IPCC report also concludes that the benefits outweigh costs for demand-reduction measures in transport, buildings and industry (Clarke *et al*., 2014). And the International Energy Agency says that fuel cost savings more than offset the additional investments to achieve a 2 degrees scenario (IEA, 2014).

Even where the co-benefits of local carbon reduction outweigh the costs, it is important that, as far as possible, the costs are distributed fairly (see box below). Fairness is important as a principle in its own right but also because regressive financing mechanisms can reduce the legitimacy of – and hence public support for – climate mitigation policies, as the recent public debates on energy tariffs in the UK have demonstrated. Local organisations have little short-term influence over the government financial incentive structure but they may be able to mobilise supplementary sources of finance by other means such as local share offers, or ameliorate negative impacts by ensuring that low-income groups can access benefits.

10 One way of reducing the rebound effects associated with increased consumption of other energy consuming goods and services can be to complement technical energy efficiency programmes with behavioural advice and/or participatory action and learning programmes.

Who pays?

This report considers a funding source to be 'fair' if the main costs are born by those with the largest emissions (the 'polluter pays' principle) and the 'ability to pay':[11]

- **For example, a publically funded grant scheme for energy-efficiency improvements can be considered a relatively 'fair' funding source as it is financed through progressive income tax, whereby people on low incomes pay a smaller proportion of their income than those on high incomes.**

It considers a funding source to less fair – or regressive – when it imposes a greater burden on individuals or organisations that have low emissions and/or low 'ability to pay':

For example, energy-efficiency grants and the FiT are financed through a small flat levy on fuel bills and can be considered regressive as this represents a greater burden on low-income than high-income householders. However, the regressive effect can be reduced if low-income households are able to benefit from energy-efficient or renewable measures as these can reduce fuel bills. The green levy represents a small proportion of fuel bills and has been cut by government.

Different carbon reduction options also involve different opportunity costs relating to the loss of other potential courses of action. The report does not explore opportunity costs in detail as social costs should be reflected in central government policy and in the financial incentive structure.

The generation and distribution of co-benefits is shaped in part by economic, technical, social, cultural and political factors beyond immediate local control. These may include: government policy (energy, economic, company law etc.); the pattern of economic growth; the availability and cost of low-carbon technologies, goods, services and local infrastructure; existing socio-economic inequalities; and cultural beliefs (Mayne *et al*., 2013) However, as this report shows, local action can and does have an important influence.

11 An important principle in international climate change negotiations is the polluter pays principle. This says that those with highest carbon emissions should do the most to mitigate them and carry the biggest financial burden. Another important principle is 'ability to pay'.

3.4 Widening and deepening action on climate change by engaging stakeholders

An understanding of co-benefits offers local organisations a useful opportunity to:

- Engage the public: communicating about the practical benefits of carbon reduction programmes as well as carbon savings can be used to help motivate and engage residents.

Eco Easterside in Middlesbrough

A low carbon project in a deprived area – successfully engages residents in carbon reduction projects by highlighting the personal, practical, financial and health benefits of action as its primary message, but also the wider environmental and social benefits to society (Mayne *et al*., 2013).

- **Widen organisational engagement**: co-benefits can be used to identify and engage a wider range of stakeholders to help promote or implement carbon reduction policies and programmes (beyond those with a specific mandate or direct interest in doing so) and enhance the rationale/business case for carbon reduction programmes both within organisations and externally.
- **Strengthen decision-making and strategy**: an understanding of co-benefits can help decision makers inform sectoral and programme selection.
- **Strengthen programme design**: co-benefits can be included in programme aims, objectives, reporting and feedback.
- **Promote joint working**: co-benefits can help local organisations:
  - achieve a better mutual understanding of what different organisations care about, and how they might benefit from carbon reduction programmes
  - strengthen the case for joint working
  - achieve greater efficiencies
  - tailor communication messages and policy and programme design to interests of different stakeholders
  - use a wider range of 'messengers', 'role models' and contexts where carbon reduction information, nudges, norm appeals, capacity building, behavioural interventions, practical advice etc. can be delivered.
- **Encourage new business models**: the identification and measure of co-benefits can help strengthen the business case for ownership/legal models that generate environmental and social, as well as financial, benefits.
- **Government policy**: strengthen the case for a strong and supportive government policy and financial incentive structure (adapted from IEA, 2014).

Co-benefits and government policy

The importance of identifying and measuring co-benefits is illustrated by the government's recent decision to reduce the FiT. The review was carried out because of concern about the rising cost of FiT and the pressure this put on consumer bills. The decision to reduce the FiT has in turn undermined many community renewable energy projects (Quantum, 2015).

The government impact assessment of the FiT (DECC, 2015) stated that the costs of the renewables tended to be higher than for other technologies but that the benefits of the FiT – reduced electricity bills, potential behaviour change and jobs – were unlikely to fully compensate for the cost of the scheme. The assessment did not appear to provide a value for these co-benefits and also omitted a number of other potential co-benefits from renewable energy highlighted in this report, such as: reduced local air pollution; increased energy security; increased proportion of surplus income invested in social and environmental benefits; mobilisation of new sources of finance; longer term investment; strengthened local economies (from increased retention of earnings and local supply) and increased public engagement and support for renewable energy.

Some caution is needed however, as simply using co-benefits as a communication tool to persuade other stakeholders about the importance of carbon reduction is unlikely to translate into action on its own. Rather, the concept of co-benefits opens the door to mutual exploration between stakeholders about what is important to them, possible linkages and synergies between different work streams and the opportunity for joint working and reciprocal support. This process is likely to generate other useful learning (Cooremans, 2015).

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4: Co-benefits of local carbon reduction initiatives

The section presents evidence and case studies about the carbon reduction potential, co-benefits and costs for a number of local low carbon initiatives. It focuses on initiatives that were ranked as priorities by local residents from deprived and ethnic communities in recent low carbon workshops, taking into account both their potential to reduce carbon emissions and generate practical benefits for residents (Mayne, 2015). (See tables 1 and 2 in Section and Annex 1 for further details). It also identifies the additional co-benefits that can be generated by different ownership models or ways of working. It suggests ways in which programmes might be designed to share co-benefits more widely and outlines what Oxfordshire is doing and what more it could do to harness and share co-benefits.

Local action and community energy

- **By local action on climate change we mean carbon reduction programmes carried out at neighbourhood, town, city or county level that involve some degree of local ownership, leadership or control and benefit.**
- **By a 'community [energy] project' we mean 'one with an emphasis on community ownership, leadership and/or control in which the community benefits from the outcomes of the project' (DECC, 2014).**
- **Local carbon reduction or energy programmes may involve or be implemented by a range of local organisations including LAs, community groups, residents, local installers, energy companies, social enterprises, housing associations, other statutory agencies or a mix of organisations.**

4.1 Transport

4.1.1 Introduction

Local carbon transport programmes offer the potential to simultaneously reduce carbon emissions and generate important economic, health and social co-benefits for local residents. Where programmes are designed to share the co-benefits with low-income groups, they can also potentially help reduce social exclusion, poverty and inequality.

Reductions in carbon emissions from transport can be achieved through a wide range of interventions aimed at helping people **AVOID** making a trip or delivery altogether (or reducing distances travelled), **SHIFT** to lower carbon transport modes or **IMPROVE** the carbon efficiency per unit of service (passenger-km, tonne-km) (Clarke *et al*., 2014; Patrick *et al*., 2014). The main low-carbon transport modes with typical journey lengths include: walking (up to 2 miles), cycling (up to 5 miles), low-carbon buses (up to 10 miles), low-carbon coaches (up to 400 miles) and low-emission hybrid electric and full electric cars (up to 400 miles) and electric trains. Transport behaviour change relates to any changes in people's trip-making behaviour (means of transportation, destination, route, replacement of a physical trip by internet use etc.), in how cars are driven (e.g. 'eco-driving'), in vehicle purchasing (means of transport, fuel type, size of car etc.), in purchase of transport cards or subscriptions to a mobility service scheme (car club, bike sharing scheme, etc.) and where people work and live.

This section focuses on improving the coverage, quality and efficiency of the bus system (whether hybrid or battery electric buses) as it is an important form of transport for low-income residents, is more sustainable for long journeys and has higher health benefits than cars for long journeys (BMA, 2012). It was also ranked highly by local residents from deprived areas in recent low-carbon learning workshops.

This section also explores the potential for increasing the use of cycling by low-income residents as there is robust evidence about the health co-benefits of active travel. Although nationally cycling is mainly carried out by white, male professionals (see below) and received a low ranking in the low-carbon workshops, its low cost makes it a potentially accessible form of transport and it is also an effective way of integrating and increasing physical activity into everyday life. The section does not focus on walking due to limitations on space.

4.1.2 Carbon reduction potential

Transport is Oxfordshire's highest-emitting sector and currently accounts for about 37 percent of total emissions in Oxfordshire; this compares to 35 percent in the South East, 29 percent in England and 29 percent in the UK. The main source of emissions is the use of petrol and diesel from road transport, which accounted for 17 percent of total CO2 emissions in Oxfordshire, compared to only 12 percent in England. This reflects, in part, the presence of a busy motorway (M40) and trunk road (A34) (Patrick *et al*., 2014). According to the 2011 census, two thirds (66 percent) of Oxfordshire's 246,000 journeys to work are made by car or motorcycle, almost one quarter (24 percent) by foot or bicycle and 10 percent by bus (Oxfordshire County Council, 2014). A survey of residents' non-business travel patterns in Oxfordshire showed that carbon emissions from air travel accounted for 49 percent of total, car travel 44 percent and all other modes

(rail, bus, taxi, motorcycles, ferry) made up only 7 percent of the CO2 total (Brand and Preston, 2010). Public transportation produces 95 percent less CO, 45 percent less CO2 and 48 percent less NO2 than private vehicles (cited in Kwan and Hashim, 2016).

4.1.3 Co-benefits and costs

Co-benefits

Low carbon, accessible and affordable transport services can generate a range of potential social, economic and health co-benefits including:

✓ **Overall benefits** – At national level Smith *et al*. (2015) estimate a benefit of £8.4 billion per year in 2030 from reduced congestion, pollution, noise, and accidents as a result of avoided journeys through 'smarter' transport choices (active travel, a shift to public transport and demand reduction).

✓ **Economic and social co-benefits from:**

- **Improved accessibility to jobs, learning, health services, social networks and shops** for non-car-owners, which in turn may contribute to economic competiveness, social inclusion and poverty reduction. Conversely, transport disadvantage and the consequent inaccessibility of goods and services can lead to social exclusion. (Social Inclusion Unit, 2003; BMA, 2012; DFT, 2015; Lucas and Stokes, 2011; Welch, 2013).
- **Financial savings from improved efficiency of vehicles and behaviour change**. For example, training employees to become more efficient drivers can save organisations up to 15 percent of their fuel cost.
- **New local jobs**. A study by the WHO identified that a wide range of local jobs can be created linked to public transport, cycling and walking (WHO, 2014). One study estimated that the numbers of direct and indirect (i.e. supply chain) jobs associated with rail, light rail, bus, coach and cycling industries in the UK was about 450,000 (around 5 percent of which related to cycling) representing about 38 percent of all transport jobs (Ekosgen, 2010).
- **Reduced congestion** can save as much as 3 per cent of a city's GDP. Nationally, congestion is estimated to cost the English economy around £11 billion (Cabinet Office estimate cited in BMA, 2012). The RAC suggests a national cost of £20 billion, translating into between £400–£500 million a year for Oxfordshire and £491 per household from wasted fuel, wasted commuting time and additional delivery cost (cited in OxLEP, 2014). Smith *et al*. estimate possible congestion benefits at national level at a NPV for 2008–2030 of £14.6 billion from a shift to active transport, and £12.7 billion from a shift to public transport (Smith *et al*., 2015).

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✓ **Health co-benefits from:**

- **Improved air quality**:
  - Exposure to vehicle exhaust emissions can contribute to cardiovascular, pulmonary and respiratory diseases and other negative health impacts (Clarke *et al*., 2014). It has been estimated that 40,000 deaths each year in the UK are attributable to exposure to outdoor pollution caused by the burning of fossil fuels to power vehicles and generate heat and electricity, estimated to cost up to more than £20 billion per year (RCP, 2016). The BMA estimates that in the UK air pollution is associated with 50,000 premature deaths per year (BMA, 2012).
  - In Oxfordshire there are currently 11 areas of the county where nitrogen dioxide exceeds the desired limit (Oxfordshire County Council, 2015a). An estimated 276 deaths among people over 25 in Oxfordshire were attributable to exposure to outdoor pollution (Public Health England, 2014).
- **Increased physical activity from active travel (cycling, walking and accessing public transport)**:
  - The reduction of active travel linked with the increase in driving is associated with generally higher levels of physical inactivity and sedentary lifestyles. This can contribute to higher levels of morbidity and mortality through an increased risk of clinical disorders such as cardiovascular disease, overweight and obesity, metabolic disorders and some cancers (BMA, 2012). Evidence from systematic reviews shows that increased physical activities reduce the risk of cardiovascular disease, depression, dementia, diabetes, breast cancer and colon cancer (Woodcock *et al*., 2009).
  - The health benefits of physical activity in general are well-documented (Mueller *et al*., 2015). More recent studies have confirmed the health benefits for cycling and walking. It is estimated that walking for 150 minutes/week can reduce the risk of mortality by about 10 percent (Active Living Research, 2016).
  - Smith *et al*. (2015) estimate that 34,000 disability-adjusted life years could be saved in 2030 – valued at over £2.5 billion a year – from a shift to increased walking and cycling. (Smith *et al*., 2015; Woodcock *et al*., 2009).
- **Fewer accidents**:
  - Three-year rolling data for 2011–2013 show a rate of 49.9 people per 100,000 being killed and seriously injured on Oxfordshire roads, a significantly higher rate than in the South East and England overall (Oxfordshire County Council, 2015a). Road deaths and injuries are understood to disproportionately affect vulnerable road users such as pedestrians and cyclists (BMA, 2012).
  - Reducing motor vehicle use decreases the injury risk for existing pedestrians and cyclists although the overall number of injuries can increase if more people walk or cycle. Injuries can be reduced by measures to increase safety. Increased levels of walking or cycling are also associated with increased safety due to greater driver awareness of cyclists and pedestrians. Substantial increases in the distances cycled in cities including Copenhagen, London and New York are associated with a decrease in the numbers of cyclists killed or serious injured (Active Living Research, 2016; Woodcock *et al*., 2009).

- **Reduced noise pollution**: Transport-related noise pollution can adversely affect the cardiovascular system, mental health status and school performance in children (BMA, 2012). In Oxfordshire 22,647 people – or 3.4 percent of the population – are exposed to high noise levels during the day (Oxfordshire County Council, 2015a). As one local resident noted: 'There are few green spaces where you can go without the noise of traffic'.
    - Smith *et al*. (2015) estimated that the noise reduction benefits from smarter travel choices (reducing car vehicle kilometres by 5 percent via a combination of reduced travel demand, active travel and public transport) and the use of electric vehicles outlined in the Committee on Climate Change's medium abatement scenario for the fourth carbon budget would be £148 million in 2030, with a NPV of £947 million from 2008 to 2030. The noise and air quality benefits of a switch to public transport are offset by emissions from public transport vehicles (trains, buses and coaches). The benefits can therefore be enhanced by investing in cleaner and quieter vehicles for public transport.

✓ **Reduced health care costs**: Illness as an outcome of physical inactivity has been conservatively calculated to directly cost the NHS up to £1.0 billion per annum (2006–2007 prices). Indirect costs have been estimated as £8.2 billion per annum (2002 prices) (Davies, 2014).

Energy-efficient buses and driving in Oxford

Oxford Bus Company has reduced carbon emissions by more than 20 percent per vehicle since 2007 through a combination of:

- **Green buses: The main bus operators in Oxford run one of the lowest emission bus fleets of its size in the UK. The Oxford Bus Company has 37 electric-hybrid buses or 36 percent of their fleet and Stagecoach Oxford has 26.**
- **Green driving: Oxford Bus Company introduced a driver training scheme, which resulted in: fuel savings of around 13.07 percent or £392,100; a significant reduction in engine idling across all their locations; reduction in accidents; better green credentials. New contracts; passenger retention through smoother and safer driving; and driver praise from customers increased significantly**
- **Efficiency: Trials of a flywheel on the Brookes Bus achieved 30 percent reduction in fuel usage and emissions compared to a standard bus.**

(Sources: Oxford Bus Company; Patrick *et al*., 2014)

Costs

Both the infrastructural and capital costs of energy-efficient buses and rail can be high so it can be difficult to achieve adequate commercial returns without initial government support. Other costs of a shift to low-carbon transport modes may include the upstream carbon impacts of the manufacture of efficient vehicles and infrastructure, or the rebound effect if providers or users use the financial savings from energy efficiency or cheaper energy transport to increase energy consumption elsewhere. If a modal shift to public transport and active travel eventually leads to a lower demand for cars then jobs in car manufacturing and services – an important source of employment in Oxford – could be lost. This loss of jobs would need to be compared with the creation of new local green jobs. It could also lead to less tax revenues from fuel duties.

This needs to be balanced against the reduction in damage to health and the environment that would reduce health costs and help offset reduced income from taxation (WHO, 2014).

In relation to cycling, costs may include increased road accidents or exposure to air pollution. However, a growing number of studies have shown that the health benefits of active travel significantly outweigh the costs of increased risk of road accidents and exposure to air pollution (Active Living Research, 2016; Mindell, 2015; Mueller *et al*., 2015, Tainio *et al*., 2016).

4.1.4 Sharing the benefits

When low-carbon transport programmes are designed to share the co-benefits with lower-income residents they can also help reduce deprivation and inequality.

Distributional issues

As noted above access to transport services affects people's access to work, learning, health care and other goods and services (see box below).

Why access to transport matters

Access to work: Two out of five jobseekers say lack of transport is a barrier to getting a job. One in four jobseekers say that the cost of transport is a problem getting to interviews. One in four young people have not applied for a particular job in the last 12 months because of transport problems.

Access to learning: 16–18-year-old students spend on average £370 a year on education related transport, and nearly half of them experience difficulty with this cost. Six per cent of all 16–24-year-olds turn down training or further education opportunities because of problems with transport.

Access to healthcare: 31 per cent of people without a car have difficulties travelling to their local hospital, compared to 17 per cent of people with a car. Over 1.4 million people say they have missed, turned down, or chosen not to seek medical help over the last 12 months because of transport problems.

Access to food shops: 16 per cent of people without cars find access to supermarkets difficult, compared to 6 per cent of the population as a whole.

Access to social, cultural, and sporting activities: 18 per cent of people without a car find seeing friends and family difficult because of transport problems, compared with 8 per cent for car owners. People without cars are also twice as likely to find it difficult getting to leisure centres (9 per cent) and libraries (7 per cent).

These problems have an impact on the individuals concerned, for example by cutting them off from jobs, education and training. This in turn prevents them from breaking out of the cycle of social exclusion. The problems have costs for communities, which may be left isolated or unable to attract investment. They also undermine Government objectives that are essential to combat poverty and social exclusion like welfare to work, raising educational participation and attainment, narrowing health inequalities, and reducing crime and antisocial behaviour.

(Source: Social Exclusion Unit, 2003)

Yet access to and use of transport services is unevenly distributed. Travel behaviours are affected by income, economic activity, age area of residence, knowledge of travel options (Social Inclusion Unit, 2003; Stokes and Lucas, 2011). In relation to income, people in the highest household income group travel more than twice as far as people in the lowest group, and are more likely to travel by car, rail and air (DFT, 2015). By contrast, low income groups travel less, nearly half as far as the highest income group, have no car and are more likely to walk and use buses (see box below).

Uneven transport use

Overall travel: on average the highest income quintile makes 28 percent more trips, and travels more than twice the distance travelled by the lowest income quintile (DFT, 2015a).

Buses: nationally people from the lowest income households travel on average 2.4 times further by bus than people from the highest income households People who are unemployed and students make more trips by bus than average. (DFT, 2015a).

Cars:

- **People in households of the highest income group travel on average 2.6 times further by car than people in lowest income households per person per year (DFT, 2015a).**
- **47 percent of households in the lowest income group have no car, compared to only 12 percent of the highest income group (DFT, 2015a).**
- **In Oxford, one third (33 percent) of households don't own a car. Outside Oxford only 10 percent of households don't own a car (Oxfordshire County Council, 2015). The 2011 Census shows that 22 percent of people over 65 in Oxfordshire had no access to cars or vans (Oxfordshire County Council, 2016). One study suggests that 49 percent of older people in rural areas of Oxfordshire do not have access to a car (Banister *et al*., 2013).**

Rail and light rail investments: people in the highest income quintile make four times more rail trips than people in the lowest (DFT, 2015a).

Cycling: national statistics show that people from managerial and professional occupations are more likely to cycle than those from intermediate/routine and manual occupations (DFT, 2015b). In Oxfordshire people in professional jobs are also most likely to cycle to work than other professions, but for men, those in semi-routine jobs are not far behind. However, in Oxford people living in deprived neighbourhoods such as Rose Hill, Barton and Blackbird Leys are less likely to cycle to work (DataShine, 2011). Cycling rates between different ethnic groups in Oxfordshire are similar (Office for National Statistics, 2011).

Flights: in 2013, 15 percent of the population in England took 70 percent of flights while 55 percent of the population took no international flights at all. More than three quarters of people in the top income quintile took one or more flights abroad, whereas only one quarter of the lowest income quintile took one or more flights in 2014 (DFT, 2015a).

There are also inequalities in patterns of transport use relating to gender, urban/rural areas, ethnicity and age.

The uneven transport pattern also means that higher-income households emit more than poorer households:

- A survey of Oxfordshire residents' non-business travel patterns showed that respondents in the highest income group produced on average 3.5 times the annual emissions level of respondents in the lowest income group for all types of travel (Brand and Preston, 2010)
- A 2012 UK study, for example, shows that people in the top income decile emit 4.46 times more greenhouse gas emissions than the lowest income decile from transport (Gough *et al.*, 2012).

Yet while low income households contribute the least to emissions and pollution, people living in deprived areas are more likely to live near busy roads and are at greater risk of air and noise pollution and accidents (Social Inclusion Unit, 2003; BMA, 2012; Marmot Review, 2010). Children from the lowest social class were five times more likely to die in road accidents than those from the highest social class, and more than a quarter of child pedestrian casualties happen in the most deprived 10 per cent of wards in 2003 (Social Exclusion Unit, 2003).

A narrow focus on carbon reduction would suggest targeting higher-income, higher-emitting residents to reduce their carbon emissions from car use e.g. at local level by investing in rail, electric cars or cycling infrastructures and targeted behavioural programmes. Such strategies are crucial, not least because low income residents stand most to benefit from cleaner air and reduced traffic accidents. However, the existence of co-benefits – particularly perhaps accessibility – highlights the importance of also developing strategies that share co-benefits with low-income households.

Table 3 Potential benefits and costs of investments in different low-carbon transport mode				
Type of transport mode	**Costs**	**Carbon savings**	**Co-benefits (trade-offs)**	**Who benefits[1]**
Energy-efficient buses	Investment costs – high. User costs – medium	Medium – less likely to take car users off the road in the short term	Economic & social benefits from: access to jobs & leisure reduced congestion	Mainly low-income, rural, elderly
Cycling (and walking)	Investment costs – high. Users costs – low	Medium – mainly short trips displaced	Economic & social benefits from: access to jobs & leisure reduced congestion Health benefits from active travel	Mainly white, male professionals
Electric rail	Investment – high User cost – medium/ high	High – as takes car users off the road	Economic & social benefits from: access to jobs & leisure congestion benefits	Mainly higher-income groups
Electric cars	Investment – medium User cost – medium/ high	High – as reduces emissions of car users	None	Mainly higher-income groups
Cross cutting benefits	Health benefits from improved air quality and reduced noise pollution			
Note 1. Assessment based on estimates of costs of current use patterns without complementary efforts to extend to other groups				

Programme design

The above analysis suggests that to benefit low-income groups low carbon transport programmes would need to:

✓ **Prioritise improvements in the quality and coverage of (energy-efficient) bus services**. This would help increase access by people living in deprived and rural communities to a wider variety of potentially better-paid jobs, healthier food, as well as health care. It would also encourage active transport as each trip begins and ends with walking or cycling (Active Living Research, 2016). Making bus services affordable, low-carbon and financially viable, particularly in rural areas, will require a long-term strategy to improve the quality of the service and drive demand. As well as widening the network of buses, and providing priority bus lanes, research suggests (Social Inclusion Unit, 2003; Banister *et al*. (2013)) suggests this might involve such things as:

- partnerships between local authorities and bus companies to improve coordination and make routes and timetables become more complementary between bus companies
- improved provision of transport information, for example through trusted individuals such as community networkers and parish transport representatives
- better timetabling and alignment with schools and workplaces.

Another option to drive demand for public transport is integrated 'intermodal' journey planning (Kamargianni *et al*., 2015) to link up buses, bike sharing, trains, car sharing, local taxis (see box below). However, these schemes often rely on digital technologies which low income or disadvantaged transport users may lack access to or not have the skills to use (Banister *et al*., 2013; OFCOM, 2015). Digitally based schemes may therefore need to be accompanied by complementary interventions to increase access, as well as other ways of sharing information and booking rides, such as through community networkers or parish council representatives (Banister *et al*., 2013).

Advanced integrated transport systems

'Intermodal' journey planning, ticketing and supply systems can variously entail integrated booking, single (discounted) payment methods, real-time information, integrated ownership and tailored mobility packages (Kamargianni *et al*., 2015). Integrated transport modes may include bus, train, car and bike sharing, local taxi.

In Germany, Moovel integrates countrywide mobility via a single smartphone platform. It includes public transport, car sharing, car rental, national rail, bike sharing and taxi, all provided by separate operations. The core of the service is the Moovel mobile application that facilitates intermodal journey planning, booking and payment for all services (Kamargianni *et al*., 2015).

✓ **Increasing cycling and walking by low-income groups**. Although not ranked as a priority by participants in low-carbon workshops, the low cost and health co-benefits of cycling suggest that it would be beneficial to widen its use by low-income residents. While most elderly participants in the workshops did not cycle, some of the younger participants in the workshops said they would cycle more if it was safer.

- Research suggests increased levels of cycling are best achieved through comprehensive packages including: investment in safe and convenient cycling paths; reduced cycling distances through increased density of housing and urban spaces; and educational/behavioural programmes such as personalised travel planning, training and trials (Active Living Research, 2016; Anable *et al*., 2012; Clarke *et al*., 2014; Pucher *et al*., 2010).

Shifting travel behaviours

Some transport behaviour-change programs that targeted information or advice to groups already motivated to walk or bike were found to be effective in shifting as much as 5 percent of all household trips from cars to walking or cycling (Ogilvie *et al*., 2004).

Behavioural programs that were tailored to individuals or small groups who were already motivated to change their behaviour resulted in increased walking overall by 30–60 minutes per week, and walking for transportation by 15–30 minutes per week in the short term (Ogilvie *et al*., 2007).

However, measures to increase cycling rates overall will not necessarily or automatically increase uptake by under-represented groups. This may require additional efforts to understand the infrastructural needs, trip characteristics and cultural norms of under-represented groups and deliberately targeting interventions and policies towards them (Aldred *et al*., 2016). Additional measures might include:

- improve affordability and accessibility – For those on very low incomes the cost of a bike can be a barrier. Extending subsidised cycle to work schemes to non-working residents, and extending cycle hire or sharing schemes into deprived areas could allow users to rent bikes relatively cheaply without having to buy one (Pucher *et al*., 2010).
- address infrastructural and trip needs – under-represented groups such as women may be more risk averse; elderly people may prefer cycling on paths that are separated from traffic; and women may have to carry shopping or children (Aldred *et al*., 2016). Low-income groups may have lack of storage space for bikes or fear that it might get stolen if left outside (Transport for London, 2011).
- address cultural and social factors – lack of social identification and lack of confidence has been found to be a key barrier to cycling for low-income and black and minority ethnic (BME) residents in London. People may see it as something done by others e.g. couriers, lycra clad serious cyclists, trendy hipsters, sporty men, tourists etc. A strong 'white middle class' image of cyclists/cycling is particularly alienating for hard pressed BME audiences who fear how they will be seen (Transport for London, 2011).

Currently there does not seem to be enough known about how to increase cycling among non-represented groups, although there are some encouraging examples (see Middlesbrough box), suggesting the need for innovative pilot projects.

Improving cycling rates with under-represented groups: Middlesbrough case study

Integrated and inclusive cycling schemes can increase cycling uptake by non-represented groups. Middlesbrough contains some of the country's most deprived areas together with poor health indicators: levels of cancers, coronary heart disease, heart attacks, strokes and chronic liver disease are significantly above the Standard Mortality Ratios for England. The town has seen a rise in cycling journeys of 5 percent per annum each year since 2003, combined with a decline in accidents linked to the Healthy Towns Programme, Local Sustainable Transport Fund and other initiatives involving partnerships including Middlesbrough Council, NHS and Middlesbrough Environment City (a local not-for-profit organisation). Key features of its cycling strategy include:

- **communication messages** – outlining the carbon and co-benefits of cycling linked to One Planet Living principles of sustainable transport, local employment, health and happiness and publicising bikes, which can address a wide range of needs
- **consultation with and involvement of local people** – to take into account the views, needs and aspirations of local people
- **inclusion** – working with under-represented groups to increase levels of participation including: cycle recycle schemes with young and unemployed people, refugees and asylum seekers; a new Cycle Champions programme with BME communities; and a vintage cycles project with older people
- **behaviour change** – including cycling promotion, awareness raising and maps; a Bike Academy, which provides cycle training and maintenance courses from a base in a local park and mobile in workplaces and community venues; incentivised bike schemes, travel plans and cycle training with schools; workplace cycling schemes, including assisted cycle purchase scheme to employees; flexibility by employers in working practices such as dress code and additional time allowance for attending meetings by cycle
- **facilities** – dedicated safe cycle paths integrated with public transport connections; a Cycle Centre at Middlesbrough bus station (with free, indoor, secure cycle parking along with shower/locker facilities, basic maintenance advice, route planning and guided rides); a community cycle parking scheme involving provision of up to two free bicycle stands in locations agreed by the council for voluntary sector groups, small businesses, shops, offices, cafés, pubs, places of worship, surgeries, allotment and sports grounds
- **safety** – local audits of cycling routes and attention to the needs of vulnerable people; engaging Cycle Rangers to check on maintenance and safety issues on routes
- **monitoring and evaluation** – via automatic cycle count sites for monitoring and path-side surveys.

(Source: Middlesbrough Council)

Government policy and financial incentive framework

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The possibility of achieving an effective and fair, local low-carbon transport programme depends in part on government policy. The key planks of government low-carbon transport policy currently include: fuel duty, which penalises higher-income car users but may also feed through to public transport fares used by low-income groups; tax breaks for low-carbon vehicles, which mainly benefit higher-income groups; vehicle emission targets, which benefits everyone through cleaner air; free bus passes for 60+ year olds, which has a mixed distributional impact depending on the income of user; and allowing local authorities to use congestion charging at peak times, which penalises higher-income car users. Carbon pricing through a downstream carbon tax and downstream cap and trading (e.g. through tradeable personal carbon allowances) have also been suggested, which would have varying equity impacts. Escalating taxes on air flights have also been suggested as possible measures to curb flying patterns of higher income groups, which would have a largely progressive impact (Devlin and Bernick, 2015). Local organisations have little immediate control over national policies and financial incentives but could improve distributional outcomes at local level by using congestion charging to cross-subsidise bus services.

4.1.5 What is Oxfordshire doing?

Oxfordshire has highest public transport use of any county (not including Greater London) and there are high levels of sustainable transport use in Oxford (see box below). However, it suffers from traffic and congestion and related problems including poor air quality, accidents, noise and economic costs. It's traffic problems reflects the chronic shortage of (affordable) housing in county towns that forces people to live miles from their workplaces, combined with inadequate public transport (Patrick *et al*., 2014). Most people who live outside Oxford currently use a car to get to work (64.5 percent compared to bus: 4.5 percent and bike: 4.3 percent) and traffic is predicted to grow by 25 percent by 2026, linked to the county's ambitious growth drive. While Oxford has a strong public bus system (see box) there are gaps in services: over half of the city's jobs are in the more outlying areas to the east of the city, which are often poorly accessible by public transport (Oxfordshire County Council, 2015b). Participants from deprived areas in the recent low-carbon learning workshops in Oxford complained about the lack of radial bus routes to other parts of Oxford, the station and/or hospital limiting access to higher paid jobs and hospitals (Mayne, 2015).

Oxford Local Transport Plan

Traffic volumes on routes into Oxford city have decreased by nearly a quarter since 1993 due to the Oxford Transport Scheme. In Oxford people commute more by sustainable transport (i.e. bus and rail: 18.6 percent, walking: 16.8 percent, cycling: 17.1 percent) than by car (35.6 percent). Oxford also has a higher cycling prevalence than most of the rest of the country, only topped by Cambridge (Patrick *et al*., 2014). The scheme included policies to restrain car use (through parking control and traffic management) and promotion of more sustainable alternatives (walking and cycling, bus services and P&R car parks at the city's periphery) (Patrick *et al*., 2014).

The county council and partners have developed a comprehensive local transport plan, Connecting Oxfordshire, which aims to respond to increased transport demand, support growth, reduce carbon emissions and increase the net positive impact of transport on people's quality of life (Oxfordshire County Council, 2015 b,c; OxLep, 2014). There is much that is positive in the plan, including plans to improve bus routes and cycling and pedestrian pathways, but it is recognised that it will be extremely challenging to reduce transport emissions across the county, as the planned economic growth for the county is expected to increase traffic (Aether, 2016; Oxfordshire County Council, 2015b; Patrick *et al*., 2014). An additional risk is that investment and effort will end up focussing on improving transport modes and linkages along the knowledge spine and from the knowledge spine to national hubs and airports, including expanding the local airport, which will mainly benefit the professional middle- or higher-income residents while neglecting the needs of low income residents. The county council recently cut subsidies for 118 bus routes in Oxfordshire – mainly for services in rural Oxfordshire – due to recent reductions in central government funding. These cuts are likely to have a detrimental effect on low-income, elderly and disabled groups, exacerbating exclusion and inequality through reduced connectivity. The responses from 2,656 respondents to a county council consultation about the cuts suggest that this might mainly impact especially rural elderly people and young people in the county's rural areas by exacerbating isolation, deprivation, and exclusion (Oxfordshire County Council, 2015d).

Looking forward, the longer-term vision contains important ideas that might help improve benefits sharing, such as improving cross-city orbital bus services and re-opening the Cowley branch line, further measures to reduce the environmental impact of buses, and workplace levies or congestion charges.

4.1.6 What more could Oxfordshire do?

To help ensure effectiveness and fairness, local low-carbon transport programmes need to balance interventions that aim to get high-emitting residents to reduce car use and flying with interventions to ensure that low-income residents can also capture the social and economic co-benefits of improved connectivity and active transport. Distributional analysis suggests benefit sharing would entail:

- ✓ prioritising improvements to the coverage and affordability of energy-efficient public buses in rural areas, and closing gaps in radial bus routes around Oxford (as suggested in Oxfordshire's long-term vision for transport) supported by a long-term strategy to drive demand for bus services

Green bonds

The city of Johannesburg has pioneered a municipal green bond (approximately US $143 million) to respond to climate change, and is funding projects across a range of sectors including 150 new dual fuel buses and converting 30 buses to biogas. The use of green bonds offers the opportunity for creditworthy cities to access large-scale debt finance to finance low-carbon buses (and green projects more broadly). The cost of finance depends on the structure of the bond and the creditworthiness of the project or the issuer but is generally a competitively priced source of long-term finance (C40 cities, 2016).

- ✓ ensuring distributional impact assessments of all transport plans (DTI, 2013) including monitoring the impact of reduced bus subsidies and their replacement by community transport schemes on low-income and vulnerable residents and the effectiveness and distributional implications of community transport schemes
- ✓ widening the cycling and walking by low-income and other under-represented groups by improving accessibility and affordability and addressing cultural and social factors. In addition to a comprehensive package of interventions to expand safe cycling and pedestrian pathways, and increase density/height of new developments the following measures could usefully be piloted:
    - consulting on and addressing the concerns and needs of non-represented users relating to social identification, safety concerns, confidence, weather, journeys with shopping/ children
    - tailored cycle training to unrepresented groups in a 'safe environment' to build confidence
    - subsidised cycle to work schemes for workers, whereby employees can buy bikes tax-free from their employers and pay back the cost from their salaries, saving a minimum of 25 percent on the cost of the bike with additional discounts for lower paid workers
    - subsidised cycle hire schemes and shared bike schemes in deprived areas that do not require credit cards to use e.g. run by local community associations
    - publicising and ensuring availability of bicycles to suit a wide range of needs e.g. trikes, electric assisted bikes, wheelchair combos, tandems or ordinary bikes.

Community bus schemes

There is a range of community transport schemes in Oxfordshire, which OCC supports through small grants, a self-help toolkit, an Oxfordshire travel advice line and a transport directory for residents. The toolkit suggests a number of ways in which communities can help address local transport needs including by: asking commercial operators to divert services; setting up community car schemes, lift share schemes, car clubs, taxi share services, taxi bus service, minibus service, community bus service, as well as exploring creative solutions to reduce the need for travel. OCC supports the development of not-for-profit community transport groups and services with small grants.

Such schemes help fill transport gaps but they face challenges and experience is varied. They still need some degree of core funding to pay organisers' time and as they rely on volunteers they can be unreliable or unsustainable and some people may feel excluded or reluctant or unwilling to rely on others for rides. There may also be concerns over regulation and quality control. It is therefore important that community transport schemes are monitored and evaluated (Schwanen *et al.*, 2015; Banister *et al.*, 2013).

4.2 Green spaces and trees

4.2.1 Introduction

The natural environment plays an important role in sequestering carbon as well as generating important health, social, environmental and economic co-benefits. As two comprehensive evidence reviews of the co-benefits of green spaces already exist this section lists the co-benefits and refers readers to these comprehensive studies for detailed evidence (See Rolls and Sunderland (2014) and Bowen and Parry (2015) for details).

4.2.2 Carbon reduction potential

The natural environment makes an important and cost effective contribution to climate change mitigation by sequestering carbon. Environmental stewardship schemes, forest and woodland creation programmes, and grassland restoration among other things can all increase carbon sequestration. Trees and vegetation can also reduce the need for heating and cooling of buildings and hence cut energy use and carbon emissions.

The Natural Environment : examples of carbon reduction potential

'UK forests and woodlands contain around 150 million tonnes of carbon in the biomass and 640 million tonnes of carbon in the soil. They act as a carbon sink, as they remove (sequester) about 10 million tonnes of carbon from the atmosphere every year' (Forestry Commission).

'An enhanced woodland creation programme involving planting 23,200 hectares could deliver abatement of approximately 15 megatonnes of CO2 per year by the 2050s; representing 10% of total emissions at that time (if we assume emissions have fallen as required by the Climate Change Act). Mixed woodlands for multiple objectives can deliver abatement at less than £25 per tonne of CO2, which is significantly less than the £100 per tonne cost effectiveness threshold set by the Committee on Climate Change' (Read *et al*. 2009, cited in Rolls and Sunderland, 2014).

'It is estimated that in 2009 the value of carbon sequestered by UK woodlands was £680 million. This is additional to the value of the carbon already stored in existing woodlands. Two thirds of the carbon sequestered was in Scotland. On a per hectare basis, woodlands are estimated to sequester 5.2 tonnes of CO2 per year, with an average value of £276 per hectare per year' (Valatin and Starling 2010, cited in Rolls and Sunderland, 2014).

4.2.3 Cobenefits

The natural environment provides the following key material goods and services essential to social welfare and the economy:

✓ **Social benefits**

- Improved air quality, depending on vegetation type and context
- Improvements to mental health and well-being
- Improvements to physical health through provision of green space for physical recreation, reduced noise and improvements in air quality, noise, and temperature regulation from trees, vegetation,
- Increased social cohesion and reduced crime specific to particular case studies and locations and influenced by other contributing factors

Green spaces , air pollution and health

Modelling found that 547 ha. of mixed greenspace within a 10 x 10 km square of East London (i.e. 5% of 100 square kilometres) could significantly reduce pollution with an estimated effect of two deaths and two hospital admissions avoided per year (Tiwary, Sinnett *et al*. 2009 cited in Rolls and Sunderland, 2014). More recently, a survey of all the trees in London estimated the value of their air pollution removal service as £127 million per year (Rogers *et al*., 2015).

There is strong evidence, from a large number of high-quality studies that nature promotes recovery from stress and attention fatigue, and that it has positive effects on mood, concentration, self-discipline, and physiological stress (See Rolls and Sunderland, 2014 pp 48 for a review).

Fang and Ling found that a tree belt 3.6 metres wide, 4 metres high, and with visibility of 2 metres could reduce the sound level by 4 decibels for a noise source/receiver 1.2 metres high and 28 metres away (Fang and Ling 2005, cited in Rolls and Sunderland, 2014).

✓ **Economic benefit**s:

- Strengthened local economy by attracting people to live, work, shop and spend leisure time in the area
- Cost savings to the public purse from reduced health care costs and supply of eco services such as natural water filtration and natural flood defences

✓ **Environmental benefits**:

- Reduced flooding from rainwater by reducing run off or slowing the movement of water e.g. through less intensive farming, grass buffers, temporary ponds, appropriate ditching and decanalisation, tree planting, urban forests, green roofs, and woodlands
- Increased biodiversity through provision of habitat for wildlife
- Pollination and biological pest control services through provision of floral resources for bees and other beneficial insects
- Reduced nitrate leaching for agricultural land

Green spaces, trees and flooding

Test plots in Manchester demonstrated that over a year, the addition of a street tree could reduce storm water runoff by between 50 and 62 percent, compared with asphalt alone. Grass reduced storm water runoff by 99 percent compared with asphalt (Armson, Stringer *et al*. 2013).

Green roofs intercept rain water and reduce peak run off. This is most effective for smaller storms but the effect is reduced for larger storms in which roofs become saturated. The effectiveness will vary according to type of roof and local climatic conditions (Mentens, Raes *et al*. 2006).

Modelling conducted on Manchester found that adding green roofs to all buildings in town centres, retail and high-density residential areas could reduce run off by 17.0 – 19.9% (Gill, Handley *et al*. 2007).

Over 27 months, a green roof test bed in Sheffield was found to retain 50% of total runoff. For significant storm events with a likelihood of occurring less than once per year, the green roof retained 43% percent of all on average, although this was highly variable (Stovin, Vesuviano *et al*. 2012).

4.2.4 Distributional Issues

There is good evidence that environmental benefits are unequally distributed through society, with disadvantaged groups having poorer access to the natural environment. In such cases improving green spaces in a deprived area might therefore lead to a better health improvement than in a wealthy area which was already well endowed with green space. (Rolls and Sunderland, 2014).

4.2.5 What more could Oxfordshire do

The evidence suggests the importance of Local Authorities developing green infrastructure strategies, if they don't already have one, and ensuring that benefits are accessible to all communities.

4.3 Energy-efficient homes

4.3.1 Introduction

Improving the energy efficiency of people's homes can simultaneously generate substantial and relatively cheap carbon savings and a range of important health and economic co-benefits for people. Where energy-efficiency programmes are designed to share the benefits with low-income groups they may also provide an important way of reducing existing income and health inequalities. The latter can entail increased costs but evidence shows that the co-benefits outweigh the costs.

4.3.2 Carbon reduction potential

The energy we use in our homes is responsible for 29 percent of emissions in Oxfordshire, about the same proportion as for England (27 percent) (DECC, 2013; Patrick *et al*., 2014). Britain is known to have one of the leakiest and least energy-efficient housing stocks in Western Europe. There were 272,900 homes in Oxfordshire in 2013, many of which are considered to be very energy inefficient and in need of refurbishment because they are old, have solid walls, are detached or have non-gas central heating. In addition, local councils in Oxfordshire (Oxford City and four district councils) have identified sites for 50,000 new homes to 2031, which offers an opportunity for high energy-efficiency housing (Patrick *et al*., 2014).

Household carbon emissions can be reduced by improving energy efficiency, generating or using renewable energy, and/or reducing energy consumption, all of which also require changes in people's energy-using behaviour. Almost two thirds of the 5 percent annual reduction in household gas consumption recorded between 2006 and 2009 was attributed to improved home energy efficiency (Centre for Economic and Business Research, 2011).

4.3.3 Co-benefits and costs

As well as saving carbon, investment in home energy efficiency can generate considerable co-benefits.

General benefits

Living in cold, damp homes can lead to respiratory and cardiovascular disease and contribute to excess winter deaths, and the stress of living in cold homes with high energy bills is also linked to mental health problems including depression and anxiety. It also contributes to high fuel bills. (IEA, 2014; Marmot Review, 2010; Public Health England, 2014; Thomson *et al*., 2013). Improving the energy efficiency of homes can therefore contribute to the following co-benefits:

- ✓ **physical health** – reduced winter deaths and improved physical health, reduced symptoms of respiratory and cardio-vascular disease, arthritis and rheumatism and allergies, close contact infectious diseases, improved nutritional status
- ✓ **mental health** – improved mental health including reduced stress and depression
- ✓ **well-being** – improved academic performance, increased sociability, reduced isolation, reduced absenteeism and improved productivity at work, improved nutrition linked to financial savings on fuel bills
- ✓ **public spending** – savings in public health spending due to fewer visits to doctors and hospitals
- ✓ **economic benefits**:
  - direct – savings on fuel bills, increased value of homes
  - indirect – creation of local jobs and indirect economic benefits via multiplier effects.

(Sources: Butterworth *et al*., 2011; Eldrich *et al*., 2010; IEA, 2014; Marmot Review, 2010; Thomson *et al*., 2013).

Additional benefits

Additional co-benefits can be generated from home energy-efficiency programmes linked to different types of implementing agencies or ways of working:

✓ **Joint working** – partnership and multi-agency approaches can result in increased efficiencies and additional co-benefits such as increases in confirmed benefit claims (see box below).

✓ **Community/resident involvement**

- Participatory action and learning processes used by community groups can motivate and empower people, strengthen norms, and in some cases change behaviours (DECC, 2012a; Cox *et al*., 2010; GAP, 2008; Gupta *et al*., 2015).
- One community initiative made free energy-efficiency measures conditional on residents' participation in action and learning groups, which contributed to high levels of resident motivation and know-how (Gupta *et al*., 2015).

Co-benefits of Kirklees Warm Zone scheme

Kirklees Council's Warm Zone scheme, a home energy-efficiency programme in a deprived area of the UK, is one of the few examples in the UK where the co-benefits from home energy-efficiency programmes have been measured. Evaluations of the Warm Zone home insulation programme suggest that overall the programme – which insulated 51,155 homes – was estimated to have generated a net social benefit of nearly £250 million from an initial investment of £20.9 million including:

- **a reduction in CO2 emissions of 23,350 tonnes per year**
- **lifetime CO2 Savings (40 years) of £30.6 million (934 ktonnes)**
- **lifetime fuel savings (40 years) of £156m (4,237 GWh)**
- **savings to the NHS of £4.9m**
- **jobs and indirect income impacts valued at £39.1m**
- **house value increases valued at £38.4m**
- **confirmed benefit claims valued at £0.7m.**

As Kirklees is a deprived area many of the benefits can be assumed to have accrued to low-income households. (Source: Butterworth *et al*., 2011).

Potential costs

Potential implementation costs include the financial costs of home energy improvements (which may vary from one-off measures – such as insulation, double-glazing, energy-efficient boilers – to whole house approaches, which can cost up to £30–40,000).

There may also be unintended adverse effects for health. If homes are sealed without adequate ventilation or if ventilation breaks down it can raise humidity levels and lead to mould and dust mites, prompting allergic symptoms and asthma as well as leading to dangerous build-up of radon or carbon monoxide and other pollutants (IEA, 2014). The balance of risks and benefits varies between buildings however; the Cochrane Review (Thomson *et al*., 2013) shows there

is little evidence of adverse health impacts from energy-efficiency improvements and another study indicates that adverse effects are outweighed by the benefits (Wilkinson *et al*., 2009).

Carbon savings can be reduced if householders use the financial savings from improved energy efficiency to increase consumption of energy e.g. by turning up the heating, or buying other energy-consuming goods and services, or increased economic activity.[12]

Financing mechanisms for home energy improvements are financed by a flat rate levy on fuel bills. As this represents a larger proportion of income from low-income than from high-income households it has a regressive impact (although not vis a vis future generations). This reinforces the importance of including low-income households in home energy schemes as a means of protecting against high fuel bills.

4.3.4 Sharing the benefits

When local home energy-efficiency programmes are designed to share co-benefits with low-income residents they can also provide an important way of improving health and reducing deprivation and income inequality.

Distributional issues

Low-income households are more likely to suffer from fuel poverty along with private tenants, elderly people, BME groups (Boardman, 2010; Butcher, 2013; IEA, 2014; Public Health England, 2014).

Higher-income households use more gas and electricity and hence have higher carbon emissions than those on lower incomes, although the correlation is not as strong on a per capita basis because higher-income homes contain more people on average (ONS, 2013). There are also wide variations in carbon emissions and energy use between households in the same income decile due to variations in income, age, geographic location, household size and family stage of life, as well as the energy efficiency of housing and energy-using equipment, available fuel choices and energy-using practices (Fawcett, 2005).

Figures for household gas and electricity consumption in Oxford city in 2012 (per domestic energy meter) show that average household energy consumption in some areas is over double that of others, with most of the high energy consumption areas in the wealthier areas of North Oxford and Headington (Franshaw, 2014). Nationally, the richest 10 per cent of households emit twice that of the poorest households from heating or lighting their homes (Fahmy *et al*., 2011; Preston *et al*., 2013).

12 As noted above, rebound is normally considered to be between 10 and 30 percent of potential carbon savings (Sorrell, 2007). As we see below 'rebound effects' can also be considered to be positive co-benefits when they lead to increased comfort and health. Rebound effects associated with increased consumption of other non-essential energy-consuming goods and services can be reduced when EE programmes are accompanied by awareness raising or participatory action and learning programmes.

Programme design

A narrow focus on carbon reduction would suggest targeting higher-income, higher-emitting households to reduce their carbon emissions. However, it is widely recognised – and established policy in the UK – that disadvantaged communities and households should benefit from energy-efficiency programmes because of the health risks associated with fuel poverty and cold homes. Local home energy-efficiency programmes therefore need to target both high-income and low-income households but with differential funding and support packages. Including low-income households can entail higher costs and some reduction in carbon savings due to their lower average emissions and the potential rebound effects, but this should be balanced against the health and other co-benefits.

The following design features may potentially help ensure that low-income households benefit from home energy-efficiency programmes.

✓ **Implementing organisations** – Local organisations play an important role in helping improve home energy efficiency but have different strengths and limits. As Table 4 below shows, partnership or multiagency approaches tend to be better equipped to address fuel poverty than community groups. As one council officer involved in an interagency, area-wide home energy-efficiency programme in Kirklees explained: 'If we [the Council] had not done this project, there was no way the householders would have installed renewable energy or likely energy-efficiency measures. Many are unable to access the information and grants that are available to them, and because we took it straight to them it made it much easier for them'. Community groups may find it harder addressing fuel poverty due to difficulties: accessing government energy-efficiency grants or subsidies[13]; identifying, tendering and recommending installers; providing the needed technical support (due to reliance on volunteers); and coordinating installation at scale. Neither do they necessarily have the mandate or skill set to provide related fuel poverty advice e.g. about benefits uptake. However, as the table shows, community groups play other valuable roles (Gupta *et al*., 2015; Mayne, 2013; Mayne and Hamilton, 2014)

Table 4 Implementing roles of local organisations: strengths and limits

Low Carbon Community (LCC) type	Strengths	Limits
Local Authority led, partnership or multi-agency approaches	Engagement Adoption of low-carbon technologies Addressing fuel poverty	Behaviours Innovation
Community group led	Engagement Innovation Empowering residents Changing behaviours	Adoption of new low-carbon technologies Addressing fuel poverty

Source: Gupta et al., 2015

13 The new Energy Company Obligations introduced under the previous coalition government have proved difficult to obtain in Oxfordshire generally (Mayne and Hamilton, 2014) and it is particularly difficult for community groups, due to the complex tendering system run by energy suppliers and the small areas in which they work. In addition, the Green Deal loans proved unattractive for 'able to pay' residents.

✓ **Targeting**: As noted above there is some evidence to suggest that area-wide approaches are more likely to increase the uptake of energy-efficiency measures by low-income groups than approaches specifically targeting low-income or vulnerable households, as they create a stronger social norm and reduce stigma (Butterworth *et al*., 2011; Boardman, 2012: Gupta *et al*., 2015). Different approaches have different pros and cons in relation to the balance of carbon savings, co-benefits, benefit sharing and costs which table 5 below lays out:

Table 5 Costs and benefits of different approaches

Type of EE programme	Indicative costs	Expected carbon savings	Expected co-benefits	Who benefits
Area-wide programmes	Capital – high due to large scale Revenue – high due to management, coordination & process roles including home visits & handholding	High – as both high-income and low-income households are reached	High economic benefits from savings on fuel bills, increased jobs & multiplier effects from working at scale Cost savings from increased ability to access Energy Company Obligation (ECO) funding, efficiencies from economies of scale & joint working Lower health benefits as not targeted only on cold homes	Potentially all residents in the area (if funding available) High uptake by low-income groups due to strong social norm, provision of handholding & reduced stigma
Programmes targeting people with health problems	Capital – medium smaller scale Revenue – medium as identification carried out through existing infrastructure but handholding may be required	Lower carbon savings due to rebound effect	High health benefits High economic benefits from savings on fuel bills	People in cold homes & with health problems, often private sector tenants, low-income & vulnerable But stigma & inadequate handholding may reduce potential uptake
Programmes targeting fuel poor	Capital – medium due to targeting Revenue – high as difficult to identify & find fuel poor	High – due to careful targeting	High economic benefits from savings on fuel bills	Fuel poor – i.e. those in low-income & energy inefficient households but stigma may reduce uptake
Programmes targeting low-income households	Capital – depends on scale Revenue – high as handholding is required	Medium – as low-income households have slightly lower carbon emissions than richer	High health benefits	Low income – easier to identify & find than fuel poor households but stigma may reduce uptake
Programmes targeting high-income households	Capital – low as no subsidies required Revenue – medium as handholding required	High – as high-income households emit more than low-income		Higher-income households
Programmes targeting private rented homes for excess cold	Capital – low as carried out by landlord Revenue – low as carried out by existing Environmental Health teams	Varies by property	High health benefits High savings on fuel bills	Private sector tenants in cold homes

Sources: Boardman, 2010; Butterworth et al., 2011; Eldrich et al., 2010; Thomson et al., 2013

✓ **Funding and practical support**: Evidence from the EVALOC research project (Gupta *et al*., 2015) suggests that the following measures are important to enable low-income households to benefit from home energy-efficiency programmes:

- **The coordinated delivery and installation of free energy-efficient measures** in people's homes.
- **In-home visits and advice and handholding** can help increase take up, and proper use of home energy improvements by residents. Private tenants require their landlord's permission to make physical changes to their homes so may need additional support to help approach landlords.
- **Participation in learning and action groups** to help residents value, understand and use home energy improvements properly and adjust their personal energy behaviours. Sustainable Blacon, a project in a deprived area of Blacon, successfully increased resident participation, know-how and motivation by conditioning the receipt of free energy-efficiency measures on their participation in group workshops. In contrast another community, which provided free measures without group activities, concluded that: 'At the end of the day – we have had fantastic savings on energy bills. But all the cultural and behavioural change stuff hasn't happened yet. We should have got them to commit to come to a set amount of meetings per year'.
- **Joined-up advice and cross-referral systems by and between local authorities and other statutory agencies about affordable warmth and related services is important to help reduce fuel poverty**. Whereas these approaches were present in LCCs in disadvantaged areas, they were not available in middle- and high-income areas which made it difficult for LCCs to help the pockets of fuel poor people living in their areas.
- **Energy feedback** via energy display monitors or smart meters to help build energy awareness and understanding.

National policy framework and financial incentive structure

A strong and supportive policy and financial incentive framework is also important to ensure that low-income and other households can benefit from home energy-efficiency programmes (Gupta *et al*., 2015). UK energy policy traditionally has provided subsidised or free EE measures for those on low incomes or where households face structural barriers such as hard to heat houses, exemplified in the obligation on large energy suppliers to improve household energy efficiency. Higher-income households are offered loans instead.

However, there are a number of problems with the current policy framework. Recent changes to the energy supplier obligations have reduced the amount of grant funding available for energy-efficiency measures and have proven difficult to access in Oxfordshire (Mayne and Hamilton, 2014). As mentioned above, financing mechanisms are regressive – the previous tax-funded grant programme was abolished. Additionally, government policy does not typically address the range of practical, social and cultural influences constraining occupants from improving their home energy efficiency, nor does it provide revenue funding to finance vital support roles of local organisations (see box).

Energy efficiency and government policy

Historically, government policy has helped achieve substantial home energy reductions in recent years through a mix of taxpayer funded grant programmes providing free energy-efficiency improvements for low-income households, and obligations on energy suppliers (DECC, 2012b). Energy use in homes has been decreasing in recent years: on a temperature-corrected basis, consumption has fallen by an average of 2 percent per annum since 2005 (DECC, 2013).

However, home energy-efficiency improvements stalled drastically following the introduction of new government policies in 2012, the Green Deal and new ECO. Nationally it is estimated that the annual number of policy-driven, major energy-efficiency measures installed in households has declined by 80 percent between 2012 and 2015 (ACE, 2016). In Oxfordshire there was also a significant overall reduction in home energy improvements linked to the change in government policy, from 9,832 households under previous government policy in 2012 to 990 recommended measures in 2013 at the start of the new policy (Mayne and Hamilton, 2014).

Local organisations have limited influence over government funding mechanisms but they can help offset the regressive effects of national financing mechanisms by ensuring low-income households benefit from EE improvements thereby protecting them from future increases in energy prices. In addition local authorities may be able to supplement national funding mechanisms with more progressive local forms of financing e.g. revolving low-cost loans by local council bonds.

4.3.5 What is Oxfordshire doing?

A number of approaches to home energy-efficiency programmes have been or are being tried in Oxfordshire. A number of these are outlined below.

The district councils fund the countywide **Affordable Warmth Network** (AWN) to deliver EE improvements and related affordable warmth advice to owner occupiers and private tenants. The AWN provides an important service but a combination of the wide geographical area, chronic underfunding and the difficulty of accessing energy supplier grants in Oxfordshire means that the uptake of measures can be slow and piecemeal (AWN annual reports; Mayne and Hamilton, 2014).

An area-wide partnership approach, Warming Barton, was recently piloted by a partnership of Oxford City Council, the Low Carbon Hub and a local community group in a deprived estate of Oxford, informed by experience in Middlesbrough and Kirklees. Large parts of the estate consist of steel frame prefabricated houses and many of the privately owned houses have poor wall insulation leading to high fuel bills, poorly heated properties and adverse health effects. The programme carried out energy performance assessments and remedial work on 18 properties. The difficulties of obtaining adequate funding under the ECO and Green Deal meant the Low Carbon Hub ended up having to part-fund the external wall insulations in the 18 households to a value of £60,000 from its own funds. This turned out to be a positive redistributive outcome from local social enterprise, but took place despite, rather than because of, the government policy (Low Carbon Hub, 2013).

Eco Easterside Partnership

Eco Easterside is a local partnership between the local authority, a town-wide environmental charity (MEC), local residents, housing associations and other statutory agencies, which works in a disadvantaged suburban estate on the edge of Middlesbrough with the aim of reducing local carbon emissions and promoting sustainable and healthy living. It runs a range of community projects including home energy projects.

The key success of its approach to home energy projects included: a partnership approach with roles allocated according to capabilities; an area-wide approach, which reduces stigma and enables efficiencies and economies of scale to be generated; home visits and support of residents; availability of free measures, particularly for low-income households; coordinated delivery/installation to people's homes by recommended installers; joined-up multi-agency provision of related, affordable warmth advice, support and cross-referral service by local agencies; complementary local carbon reduction projects; and positive messages focusing on the environmental, health and economic benefits of sustainable living (Gupta *et al*., 2015; Mayne *et al*., 2015).

Oxford City Council is also working with Environmental Health to improve conditions in the private rented sector including running awareness events for, and offering grants and thermal imaging to, landlords as well as using enforcement powers (CC, 2015). (Oxford City Council, 2015).

In many areas, the absence of energy-efficiency programmes means that **low-carbon community groups** have tried to fill the gap. Community groups can play useful and positive roles in changing energy behaviours, helping improve home energy efficiency and tackling fuel poverty (Cox *et al*., 2010; DECC, 2012a; Gupta *et al*., 2015) (see Section 4.6). But, as noted above, they can also find it difficult to achieve the larger physical home improvements needed to address fuel poverty.

An innovative **health-based approach to tackling fuel poverty** coordinated by the National Energy Foundation (NEF) – Better Housing, Better Health – is currently being piloted in Oxfordshire that targets people with cold-related health problems. The programme aims to reduce the health impacts of cold, damp housing and improve health and well-being for those living with cardiovascular disease or respiratory illness by helping improve the energy efficiency of their homes (see box below). The scheme will provide free assessments, grants and related advice (benefit checks, fuel debt mediation and tariff switching). Referrals for the scheme will be made by health or social care professions, the local authority carries out an assessment and identifies measures, and NEF organises installation. The pilot is being funded by British Gas, but if it is successful then funding will be sought from the Clinical Commissioning Group.

Boiler on Prescription

The Oxfordshire Better Housing, Better Health programme builds on the experience of Gentoo Housing, which worked collaboratively with local NHS Clinical Commissioning Groups to deliver a project called 'Boiler on Prescription'. In the project local residents were provided with simple measures by health agencies with the aim of lowering their visits to health services. Early evidence shows that this has radically reduced NHS interventions among a pilot target group. Liverpool City Council set up the broad 'Healthy Homes Project' as part of its proactive approach to identifying priority in-need households across the city. 927 serious cold hazards were removed and 1,405 referrals were made for energy efficiency. Projected overall NHS savings for the project were £852,000 per annum for excess cold hazard alone (£8.5 million over 10 years) Source: National Energy Foundation.

4.3.6 What more could Oxfordshire do?

The weakness of government energy-efficiency policies and lack of revenue funding for the delivery roles of local actors means that home energy-efficiency improvements in Oxfordshire are currently piecemeal and slow. Drawing on EVALOC, the recommendations from a recent fuel poverty workshop in Oxfordshire (REF) and wider research, the following approach is suggested [LEP, local authorities, AWN, health agencies, community groups]:

- ✓ **Aim**: support the roll-out of a major home energy efficiency and fuel poverty programme in the county with clearly delineated target and timelines.
- ✓ **Finance**: attract increased finance as part of the refreshed economic growth strategy. Complementary local sources of financing could be raised from local authority bonds, local health agencies and reinvesting surplus income from government incentives such as the FiT or RHI into programmes that directly address fuel poverty.
- ✓ **Roles**: where possible ensure area-wide partnership approaches between local authorities, statutory agencies and community groups with a clear delineation of responsibilities and roles according to their duties and capabilities, with communities playing complementary roles.[14]
  - Local authorities do not need to provide the main delivery role but they often have capabilities other organisations lack, and as local elected bodies, it is important they help lead and coordinate strategy design.
  - Community groups can provide complementary support to local authorities and other statutory agencies' programmes by: holding local authorities and health agencies to account for addressing fuel poverty; helping link people to existing services and support;[15] raising awareness among residents about their rights to health and tenants' and landlords' obligations; providing low-cost measures such as energy saving tips, draught proofing, curtains, thermometers.

14 In areas where this is not possible, joined-up multi-agency, cross-referral systems are needed with basic affordable warmth training for health workers, tenants' officers, police community officers, local chemists, fire brigades and community groups.

15 This might include (a) signposting and delivering affordable warmth information through community centres, health centres, and shops (b) hiring locally based outreach workers to identify and visit vulnerable people or (c) identifying street champions – and encouraging neighbours – to look out for people who might benefit from affordable warmth services (Note: this may require funding and training of community groups by local authorities).

✓ **Financial and practical support**: provide differential funding packages and practical support for different income groups where resources permit including:

- free measures for low-income households (conditional on residents' participation in behavioural workshops)
- coordinated delivery and installation of measures to people's homes using recommended installers
- home visits and support to provide energy assessments, technical and behaviour advice, and help for private tenants with landlords
- energy feedback via energy display monitors or smart meters and follow-up spot inspections by thermal imaging.

Low carbon, affordable and permanent new homes

Homes for Oxford is a coalition of local community-led housing organisations (Oxfordshire Community Land Trust, Oxford CoHousing; Kindling Housing Co-op; Happy House) who at the time of writing had successfully raised over £500,000 in donations and pledged investments to bid to buy and develop land for local, affordable and low carbon housing for the Wolvercote Paper Mill site in North Oxford.

4.4 Food

4.4.1 Introduction

There are various ways of reducing carbon emissions from the food system, whether through demand or supply measures or whether relating to food production, the supply chain or final consumption. Fresh and local food was ranked as a relatively high priority by local residents in recent low carbon workshops. However, the focus here is on reducing the consumption of meat, as this has been identified as one of the most important ways to reduce Oxfordshire's GHG emissions from food, along with food waste (Curtis, 2013; Garnett, 2009)[16]. Replacing meat with plant-based food can also create important health co-benefits if care is taken to ensure a sufficient intake of necessary iron and micronutrients. Designing local food programmes so that they encourage and enable low-income groups to benefit from lower meat/higher plant-based diets may entail some increased costs due to the need to address problems of physical access and low incomes, but may also help reduce health inequalities (Nelson *et al*., 2007; Public Health England, 2014).

4.4.2 Carbon reduction potential

The food system accounts for around 19 percent[17] of total GHG emissions in the UK and around 20 percent of Oxford's GHG emissions (Curtis, 2013). The latter is equivalent to 380,000 tonnes of

16 Other strategies focused on livestock might include improved efficiency of livestock farming; increased carbon capture through management of land use; improved manure management; and decreased dependence on fossil fuel inputs; reducing food waste; and reducing emission from food transport, processing and retailing (Garnett, 2009).

17 The figure doesn't take into account land change use overseas caused by UK consumption of food such as deforestation, forest degradation and peat land degradation.

CO2 per year – double the annual emissions from all of Oxford's cars. It has been estimated that we need to achieve a 50 percent reduction in GHG by 2030 in the UK food and agricultural sector to help the UK government achieve its overall carbon reduction targets (Garnett, 2009).

Livestock production accounts for about half of the food system's GHG emissions due to the methane emissions[18] emitted from ruminants' (cows and sheep) digestive processes[19] and the production of crops for animal feed. These sources are estimated to be responsible for approximately 8 percent of the UK's consumption-related GHG emissions (Garnett, 2008, 2009). The emissions per unit of livestock vary by animal type and production method however overall those of beef and sheep seem to be higher than for pigs and poultry:

- The GHG footprint of ruminant meat (beef, lamb) is estimated to be, on average, 19–48 times higher than that of high-protein plant foods[20] depending on the production methods used.
- Non-ruminant meats, such as those from pigs and poultry (and marine fisheries), have a lower carbon equivalent footprint than ruminants, although they are estimated to average 3–10 times greater than high-protein plant foods (Ripple *et al*., 2014).[21]

A recent study found that the GHG emissions for a meat-based diet in the UK are approximately twice as high as for a vegan diet and about 50 per cent higher than for a vegetarian diet, and concluded that it is likely that reductions in meat consumption would lead to reductions in dietary GHG emissions (Scarborough *et al*., 2010, 2014).

4.4.3 Co-benefits and costs

Co-benefits

As well as reducing carbon emissions, lower meat/higher plant-based diets could have the following health and environmental co-benefits:

✓ **Improved health**: There is evidence of a link between processed red meat and a higher incidence of bowel cancer and heart disease, and some evidence of a link with cancers, diabetes and obesity (see Friel *et al*, 2009 for review of evidence):

18 Methane from ruminants (beef and sheep) is the single biggest human-related source of methane. It is more short-lived but around 30 times more potent than CO2 in warming the planet (Ripple *et al*., 2014).

19 Globally the livestock sector is responsible for approximately 14.5 percent of all anthropogenic greenhouse gas emissions (Ripple *et al*., 2014).

20 These figures takes into account full life cycle analysis including both direct and indirect environmental effects from 'farm to fork' for enteric fermentation, manure, feed, fertilizer, processing, transportation and land-use change. Another study in the UK found that emissions from beef amount to 16 kg CO2-eq/kg beef compared to 0.8 kg CO2-eq/kg of wheat and 0.4kg of in-season lettuce (Garnett 2009).

21 One study shows that on a per kg product basis beef emits 22.6 kg CO2-eq/kg compared to pork (3.5), poultry (1.6), eggs (1.7) and milk (1.3) (Lesschen *et al*., 2011). Industrialized beef relies on large inputs of cereals and oilseeds with accompanying methane emissions. However, there are uncertainties in the data and large variations in GHG emissions per unit product due to differences in animal production systems, feed types and nutrient use efficiencies (Garnett, 2009). However, in some cases cattle and sheep graze marginal pasture land that could not be used for arable production, which can help maintain and even sequester carbon in the soil. Pigs and poultry have a better feed conversion efficiency than cattle and sheep and do not emit methane, however they depend on cereal and soy feed, which could be more efficiently consumed by human beings directly.

- Diets that are low in animal products and high in unrefined carbohydrates, fruit and vegetables and polyunsaturated fats are associated with significant health benefits (Tilman and Clark, 2014).
- It has been estimated that a lower meat diet (i.e. two or three meat meals each week) combined with an increase in the consumption of fruit and vegetables and an increase in the amount of starchy carbohydrates could prevent approximately 45,000 early deaths each year in the UK from heart disease, cancer and strokes (Scarborough *et al*., 2010).[22]

✓ **Public expenditure** – it has similarly been estimated that lower meat/higher plant-based diets as above could save the NHS £1.2 billion each year (Scarborough *et al*., 2010).

✓ **A more efficient use of resources** – rearing animals for food uses far more land, energy and water than growing crops to provide people with the same number of calories (Bailey *et al*., 2014; Erb *et al*., 2009; Smith *et al*., 2013) although the precise figures depends on the animal type and production method. However, reducing demand for livestock products needs to be set against possible increases in land required to grow crops for human consumption (Garnett, 2009).

✓ **Improved animal welfare** – a reduction in demand for meat could potentially contribute to an improvement in animal welfare if less intensive farming methods were adopted as result and/or if consumers used the financial savings from reduced meat consumption to purchase organic meat.

Costs

A possible adverse effect of a shift to low-meat/higher plant-based diet might be higher food bills if individuals are unable to access nutritional substitutes at low costs. Another possible adverse could be nutritional deficiencies. A considerable body of research shows that lower meat/higher plant-based diets are theoretically able to provide the full range of nutrients needed to maintain a healthy diet (Garnett, 2008, 2009, 2013). In the UK, protein intake is consistently above recommended levels – on average 78 g per day against a recommended 50 g – or around 50 per cent more than we need (Friends of the Earth, 2010). The EPIC-Oxford study (Davey *et al*., 2003) is one of the largest studies to compare the diets of meat eaters with vegetarians and vegans, and its results suggest that a diet with little or no meat is unlikely to cause any *substantial* deficit in dietary nutrients. However, vegans had less protein and vitamin B12 than recommended, and all groups except vegans had an iron intake below recommended values. These deficits need to be made up through the inclusion of dark green vegetables, beans and/or supplements.

Another set of concerns relates to possible indirect adverse effects if reduced consumption of livestock led to a switch from the production of grass-fed ruminants on marginal pastures to more carbon intensive farming (Garnett, 2008). However, this effect could be counteracted if less land was needed overall due to a widespread adoption of low-meat diets as some of the pasture could revert to forest. Other potential adverse effects would result if reduced meat consumption led to structural changes in the farming sector, affecting farmers and jobs in the livestock and feed crop industry. Finally, food choices have cultural and emotional roots and there are concerns that the public will not tolerate attempts by government or other bodies to interfere in lifestyle decisions, inviting accusations of 'nanny statism' and preaching. Moreover, promoting dietary change necessarily challenges the cultural significance of meat for some people (Bailey *et al*., 2014).

22 The modelling assumes that meat is substituted with more fruit and vegetables and an increase in the amount of starchy carbohydrates. It does not estimate the change in diet from nutritional inadequacy (e.g. anaemia from low iron intakes) that may result from a change in the consumption of meat and dairy products. Also see Smith *et al*., 2013.

4.4.4 Sharing the benefits

If local low-meat/high plant-based food programmes are designed to share co-benefits with low-income groups they could also reduce health inequalities, although this will require complementary interventions.

Distributional issues

The types and quantities of food eaten by different income groups are generally similar. However, low-income households consume relatively higher amounts of meat and processed meats (Nelson *et al*., 2007) and lower amounts of fruit and vegetables, fish and less high fibre breakfast cereals (Nelson *et al*., 2007; Public Health England, 2014). There is a strong relationship between deprivation and obesity prevalence in Oxfordshire: 10 percent of reception-year children are obese in the most deprived income bracket compared with 6 percent in the highest income bracket (OSP, 2016).

In line with the general population, the average daily intake of protein of low-income households exceeds recommended levels, so reduced meat intake need not lead to nutritional deficiencies but needs to be part of a carefully planned diet (Europe Economics and New Policy Institute, 2010; Friends of the Earth 2010).

Low income is a key driver of poor diets for low-income groups. Price is a key driver of food choices and healthier food choices can be more expensive (The Food Foundation, undated). Recent research with 57 low-income residents from two of Oxford's most deprived neighbourhoods shows that food choices of low-income households are driven more by sustenance and survival needs than health or environmental issues, education levels or habits (Hansford and Friedman, 2015).

Lack of physical access can also restrict food choices. In some low-income areas there are limited food shops or restricted choice and higher prices in local shops, and people are unable to afford the transport costs to get to larger, cheaper out of town shops (Hansford and Friedman, 2015; Nelson *et al*., 2007). There is also evidence of a positive association between the availability of quick-service restaurants and the level of deprivation (The Food Foundation, undated). A Barton resident in the Oxford study observed that the local store sold '*old, tired vegetables and a bit of fresh meat, it's mainly tins and packets*' and access to better-stocked food retailers was '*a bit long of a walk for most of us*' for older residents in Barton and Rose Hill.

At the same the Oxford study found there was considerable interest among respondents to improve their knowledge of food and cooking skills and learning new recipes as a way to broaden their repertoires, although some wanted to increase meat consumption (Hansford and Friedman, 2015). More widely the Low Income Diet and Nutrition Survey showed that 35 per cent of men and 44 per cent of women wanted to change their diet; and 60 per cent of parents/carers wanted to change their children's diet (Nelson *et al*., 2007).

Unequal access to healthy food

Recent research in Oxford commissioned by Good Food Oxford (Hansford and Friedman, 2015) confirmed that healthy food options are not readily accessible in Barton and Rose Hill, two of the most deprived areas of Oxford. Both neighbourhoods have a local convenience store with a limited variety of foodstuffs, including limited fresh fruit and vegetables, at higher prices than in the major larger supermarkets. The study found that a medium-size banana cost approximately 60 percent more in the convenience stores than in larger supermarkets in adjacent neighbourhoods; this differential is likely to carry over to many other food products. The study also calculated the distance, by road, from various points in each neighbourhood to the nearest larger supermarket with more affordable fruit and vegetables. The average distance for Barton households was 1.3km, and the distance from the furthest point in the neighbourhood was 2.4km. In Rose Hill, those distances were 0.8km and 1.3km. These distances may create access difficulties, at least for households without a car (38 percent of Barton households and 40 percent of Rose Hill households) (Barton and Rose Hill Area Profiles). Unlike many low-income neighbourhoods, Barton has only one fast-food outlet – a fish and chip shop – as well as a community café in the Barton Neighbourhood Centre. Rose Hill, in contrast, has five takeaways in the neighbourhood, only one of which was assessed as offering some 'healthy' options.

Implications for programme design

The above analysis indicates that local programmes to help income groups benefit from healthier eating need to simultaneously address affordability and physical access, as well as helping change food cultures and building cooking skills. They also need to address low incomes that underpin some poor food choices. Possible strategies could include the following.

✓ **Addressing affordability and physical access**:

- As noted above, healthier (although not staple) foods can be more expensive than unhealthy and more processed foods (Jones *et al*., 2014). However, meat is typically the most expensive food item in people's shopping baskets and shifting to lower meat/more plant-based eating can save money (Dibb and Fitzpatrick, 2014). Shifting to higher plant-based diets requires knowledge, skills and time.
- Enabling people to grow food in allotments and gardens can simultaneously help reduce food poverty and increase consumption of fruit and vegetables, particularly when it tastes better than supermarket food. Evidence suggests that community food growing can generate additional co-benefits that contribute to a range of local strategic objectives, including improved well-being, education, skills and enterprise, regeneration and community development, and residential amenity (Morgan, 2014).
- Local markets can increase availability of fresh vegetables and fruit but there is concern that prices may be too high. Participants in recent low-carbon workshops in the city indicated a strong interest in local markets as a way of accessing fresh food but also expressed concern that prices would be to too high. Countering this, a price comparison conducted by Good Food Oxford between Wolvercote Farmers Market and three major supermarkets in Summertown showed that local prices for a range of vegetables, eggs, milk and meat selected food items at local food markets were comparable with the large supermarkets, or at least more so than local convenience stores.

- ✓ **Changing food cultures and building food and cooking skills** – A key recommendation from the recent Feeding the Gaps report, is the need to build food and cooking skills and to encourage healthy eating by making food a social event. A study of Oxford Food Bank showed that it increased users' consumption of fresh fruit and vegetables and reduced consumption of meat products and highly processed foods (MSc dissertation, University of Oxford).
- ✓ **Addressing low incomes** – As low incomes are a key cause of poverty in Oxfordshire and are a key driver of poor diet, any initiatives that increase incomes will also potentially help improve food choices.

National policy

Traffic light labelling of unhealthy or high-carbon foods, restrictions on advertising and a meat tax have all been suggested as ways of reducing red meat consumption. However, in order to avoid potential negative impacts on the diets of low-income households, such policies would need to be accompanied by complementary interventions to ensure access to affordable and nutritious alternative sources of plant-based food and support a behavioural shift towards a healthier diet. Public Health England advises local authorities to use the legal system and planning system to regulate the growth of fast-food restaurants (Public Health England, 2013).

4.4.5 What is Oxfordshire doing?

The city council is implementing health and well-being plans through local partnerships in four deprived communities in Oxford including activities with Good Food Oxford. Good Food Oxford is working to develop a **food strategy** with Oxford City Council and to promote partnership working between communities, businesses and local authorities to improve the local food system.

Local organisations and community groups also coordinate and run a range of creative and effective local food initiatives which seek to reduce food waste and hunger.

✓ **Reducing food waste and addressing hunger**: Initiatives like the Oxford Food Bank, the Community Energy Food Bank and Oxford Food Surplus Café (see box below) simultaneously address hunger – by redistributing waste food from supermarkets – and reduce food waste.

✓ **Changing cultures and building cooking skills**:

- The Oxford Surplus Café and Oxford Food Bank also introduce people to low-meat diets as meat and dairy products are not re-distributed for hygiene reasons.
- The Cultivate vegetable van brings local ethical and delicious fruit and vegetables to people in their communities.
- Local CAGs also run a wide range of projects to encourage local residents to eat locally grown seasonal fruit and vegetables through apple days, local food growing activities, apple harvesting and pressing events, farmers' markets, composting training, disco soup, community kitchens, community orchards, local food distributors/veg vans, cooking workshops, gardening in public spaces, plant and seed swaps and meat-free days (CAG Oxfordshire).

The Oxford Food Surplus Café

The Oxford Food Surplus Café is a volunteer-run project aiming to use existing surplus food to reduce waste (and its embedded carbon and water costs) while providing affordable, accessible healthy meals for all. It collects surplus food from the Oxford Food Bank, South Oxfordshire Food and Education Academy and local restaurants and bakeries. The volunteer staff open pop-up cafés with meals available at a Pay As You Feel Able rate, ensuring that no one is excluded. While waste avoidance messages are available, they are not overt; the communication is more experiential, inviting customers to engage socially with the idea of waste reduction. Each event prevents approximately 250kg of food becoming waste, which has an associated carbon-saving of 10.5 tonnes, and a water saving of 2,579.5m^3.

Alongside the carbon benefits, there are also important economic, health and social benefits for people as the café enables them to access affordable healthy food and also interact socially with others. The food is almost entirely vegetarian and vegan. The average payment for the meal is £1.50 which, when subtracted from the average cost of the food at each event of £7,730.60, gives an average customer saving of £13.96. Those who self-identify as being in need of a free meal are able to do so without judgement or justification.

As one customer from the October 2015 event said: 'This is just amazing! Thank you! I work for the arts. I can't afford to eat out, I take home under 10k a year. This is a new lease of life at the weekend and a wonderful place to meet people. I'm in awe! Thank you. It's also good to be doing something good, to be using up surplus food.'

The visible amount of food surplus available is a strong reminder of the scale of food waste, and information is provided on reducing household waste, promoting long-term behaviour change. Volunteers also gain useful skills, both accredited, through food hygiene qualifications, and informal, event management and large-scale cooking.

(Source: CAG Oxfordshire based on figures taken from its Community Impact Modelling Tool (CIMT), a University of Oxford and Defra approved tool for quantifying the impact of environmental action in the community.)

4.4.6 What more could Oxfordshire do?

- ✓ Develop a county-wide food strategy that outlines the contribution that sustainable and healthy food production and consumption can make to the county's carbon reduction, health, education, and regeneration and biodiversity targets. This could include planning requirements for on-site food production, procurement policies, food business regulation, protection of and identification of new community food-growing spaces in priority areas, and support for community initiatives. [local authorities, civil society, supermarkets]
- ✓ Help improve physical access to fresh local fruit and vegetables in deprived areas [local authorities, allotment committees, traders] by:
  - piloting local and food markets in deprived areas where appropriate and practicable and exploring ways to make them affordable
  - helping low-income residents to grow food in window boxes, gardens and communal areas
  - local authorities designating land for food growing as 'Local Green Space' in neighbourhood plans
  - widening access to allotments and encourage allotment committees to provide support to new members.
- ✓ Support initiatives by Good Food Oxford to change food cultures and build food skills, which draw on the skill of diverse local residents. [Funding organisations]
- ✓ Use the legal system and planning system to regulate the growth of fast-food restaurants. [Local Authorities]
- ✓ Convene a forum with local supermarkets to discuss ways in which they can support dietary changes that support the county's carbon reduction and health targets. For example, supermarkets could set targets for reducing GHG intensity of an 'average' trolley of goods, offering more meat-free, ready-made meals, promoting plant-based foods, labelling airfreighted goods with a view to phasing out airfreighted imports from middle or high-income countries such as the US (Garnett, 2009). [LCO, local authorities to lead]
- ✓ Develop and support campaigns to get Oxford-based organisations and businesses to pay a living wage.[23] [All organisations]

23 There is a strong business case for paying the living wage including increased skills development, staff performance, job satisfaction, staff retention and reputational benefits. Implementation costs therefore need to be weighed against these benefits (Coulson and Bonner, undated). Oxford City Council has adopted a living wage policy for its own employees and contractors who work for the Council which is currently set at £8.01 per hour.

4.5 Local renewable energy generation

4.5.1 Introduction

Renewable energy has the potential to reduce carbon and generates considerable co-benefits. Ensuring low-income communities can benefit from renewable energy can create important additional benefits without significantly affecting costs or carbon reductions.

This section focuses on small-scale renewable energy as it is well suited to local production and also produces a range of important co-benefits as outlined below. The focus is mainly on solar PV, as it is well suited to local use due to low maintenance requirements and because there is a proven track record of delivery locally. Recent government incentives have been reduced for solar PV reducing the scope for future expansion until costs fall further. However, some of the lessons learnt may be relevant to other local community renewable energy projects, for example relating to renewable heat, due to government financial incentives

Government renewable policy

The EU Renewable Energy Directive commits the UK to producing 15 percent of energy, 30 percent of electricity and 12 percent of heating from renewable sources by 2020. In 2010, the DECC introduced a system of FiTs to encourage low-carbon electricity generation, including wind; solar PV; hydro; anaerobic digestion; biomass (wood fuelled) and biomass combined heat and power (CHP); and non-renewable micro-CHP. In 2014 the government introduced the RHI to encourage the generation of renewable heat. It provides financial support to the owner for seven years covering biomass (wood fuelled) boilers, biomass pellet stoves, ground to water heat pumps, air to water heat pumps and solar thermal panels.

The FiT works by paying a premium price for the generation of renewable electricity. The tariff rates are a set at a level that guarantees investors an approximate rate of return over 25 years. The cost of the tariff is paid for by consumers through a small levy on energy bills. In order to reduce the costs of the FiT, the government decided to reduce the FiT paid to solar, wind and hydro setting a target rate of return of 4.8 percent for solar, 5.9 percent for wind and 9.2 percent for hydro. The amount paid for domestic solar energy generation, for example, was reduced by 87 percent to 4.39p/kWh. The reduction is expected to reduce renewable capacity, increase carbon emissions and reduce employment in the sector (DECC, 2015a).

The FiT works in combination with the Renewable Obligations (RO) scheme, which places a legal obligation on electricity suppliers to purchase an increased proportion of their electricity from renewable energy producers. The government has closed the RO to new solar PV capacity at 5MW and below from April 1st 2016.

Photograph
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4.5.2 Carbon reduction potential

Energy generation accounts for an estimated 36 percent of UK carbon emissions (DECC 2014b). The recent growth of renewable energy is contributing to a decline in carbon emissions from the energy sector. Provisional figures released in June 2015 showed that 6.3 percent of energy consumption for 2013/14 came from renewable sources, against a target level of 5.4 percent and over 19 percent of UK electricity generation came from renewable sources. Furthermore, 35 percent of renewable electricity generation came from bioenergy, 50 percent from wind, 9 percent from hydro and 6 percent from solar (DECC, 2015b). There are now over 780,000 solar PV installations connected in the UK with a total of 4.2 gigawatts (GW) of renewable electricity generating capacity across all supported technologies, compared to just over 7,000 installations five years ago (Capener, 2014).

4.5.3 Co-benefits and costs

As well as helping avoid carbon emissions, renewable energy generates a range of other co-benefits.

Table 6 Summary of co-benefits from different renewable generation models

Ownership/business model	Benefits
All ownership models (including conventional business models)	Improved air quality (from non-biofuel renewables) Reduced electricity bills Income stream from sale of energy and FiT Energy security Local businesses & jobs
Community-owned social enterprises & shared ownership models	New sources of finance Longer-term investment Strengthened local economy (linked to increased retention of financial earnings and greater potential for local supply of technologies and services) Increased public participation Increased public acceptance of low-carbon technologies Greater proportion of surplus reinvested in social/environment benefit
Local authority owned (direct or indirect via ESCO)	Savings on fuel bills & income stream (linked to FiT), which can be used for public service delivery
Schools	Savings on fuel bills & generation of income (from FiT) Educational benefits with children
Community buildings	Savings on fuel bills & generation of income (from FiT), which can be used to e.g. improve warmth of buildings and potentially increase engagement of previously isolated elderly people, reducing isolation

General co-benefits

Typical co-benefits include:

- ✓ **Asset and income stream**: from reduced electricity bills, sale of energy to building owners and the FiT, shareholder returns: according to the Energy Saving Trust a typical 4kWp solar PV in 2016 could save up to 1.9 tonnes of CO2 and around £60 on fuel bills and earn between £200–£255 per year from the FiT from generation and export of renewable energy.[24]
- ✓ **Improved energy security**: renewable energy is collected from secure, although intermittent, local resources that are naturally replenished such as sunlight, wind, river flow, rain, tides and waves, geothermal heat and biomass.
- ✓ **Local green jobs and businesses**: there is reasonable evidence from the literature that renewables are more labour-intensive than fossil-fired generation, both in terms of short-term construction phase jobs, and in terms of average plant lifetime jobs (Blythe *et al*., 2014) although this has to be set against loss of jobs in other energy sectors. In the UK, many of the component parts are likely to imported but local jobs can be created linked to installation and maintenance. There were an estimated 112,028 jobs in the UK renewable energy sector in 2013/14 growing over 7 times faster than national average employment growth (REA, 2015). However, it is estimated that the recent reduction in the FiT may lose 18,700 of the industry's total 32,000 jobs (16,103 full-time jobs) in solar (DECC, 2015a).
- ✓ **Improved air quality**: from avoided pollution from fossil fuels. One study valued the air quality benefits from implementing the measures in the Committee on Climate Change's 4th carbon budget medium abatement scenario at £1.1 bn per year in 2030 with a net present value of £5.6 bn from 2010-2030 (Smith *et al*, 2015).

Co-benefits from community-owned and shared ownership schemes

A number of additional co-benefits can be generated from community renewable generation schemes (see box below). According to DECC, a 'community' energy project is one with an emphasis on community ownership, leadership and/or control in which the community benefits from the outcomes of the project.' They can be: run by community groups; shared ownership schemes whereby commercial companies pay the community per megawatt installed, through a share offer or other means; or a joint venture where a 'special purpose vehicle' is formed between the community and commercial developer to own and manage the installation together (DECC, 2014a).

24 Figures for England, Scotland and Wales. Assumes unshaded 4kWp system.

Community renewable energy

There are at least 5,000 community energy groups active in the UK since 2008, with at least 600 community groups having a strong interest in renewables – the most prevalent technologies being solar PV and onshore wind. At least 66MW of community-owned renewable electricity generation capacity is currently in operation and there is over 200MW more in development. While this remains a small fraction of the UK's installed renewable electricity generation capacity, the growth potential for the sector is potentially significant when both wholly and partly community-owned renewable installations are considered (DECC, 2015). With a future 'high' scenario characterised by a strong, stable and supportive policy regime and proactive support and guidance and finance, it has been estimated that the community energy sector[25] could deliver 3GW of solar PV, onshore wind and hydro projects by 2020, representing 14 percent of the total capacity of these technologies and 1.4 percent of total electricity consumption by the end of this decade, assuming typical load factors. This could provide enough electricity to power over 1 million homes (Capener, 2014).

Co-benefits from community schemes may include:

Strengthened local economy from:

- **New and increased income streams for communities** – community-owned schemes can mobilise new sources of finance. With shared ownership schemes, large commercial companies can raise more finance and operate at a larger scale than community organisations and hence generate a larger income stream for communities, depending on the terms negotiated with the community. According to DECC, the renewables industry has committed to facilitating a substantial increase in the shared ownership of new, commercial onshore renewables developments. Plus, the onshore wind industry's new community benefits protocol commits to a fivefold increase in the amount that developers pay to communities. This means that, in England, community benefits packages should be worth at least £5,000 per MW of installed capacity for communities every year (DECC, 2014a).
- **Local retention of financial earnings** – one report suggested that community-owned schemes and shared ownership schemes (commercial/community split), could retain around 12 times greater economic value at a local level than delivery via a 100 percent commercial model (Capener, 2014).
- **Greater potential for local supply of the technologies and services** – which, in turn, can increase local job creation and boost the local economy through multiplier effects (Patrick *et al*., 2014).
- **Strengthened awareness and public acceptance of renewables** (Archard, 2011; DECC, 2014b; Gupta *et al*., 2015).

25 In terms of community energy delivery models, this analysis assumes that community energy groups raise finance from various sources to invest and as a result wholly-own or part-own renewable electricity projects. This may include both community organisations set up for the purpose of delivering renewable energy projects and existing non energy community groups adapting their focus to include renewable energy installations across their community. This definition does not include the wide range of community organisations such as schools, village halls etc. that have installed micro renewable energy systems only on their own buildings or site.

Co-benefits from social enterprises

Many community renewable energy initiatives are carried out by social enterprises (Capener, 2014), which can generate additional co-benefits compared to conventional businesses. A social enterprise is the broad term for 'a business with primarily social objectives whose surpluses are principally reinvested for that purpose in the business or in the community, rather than being driven by the need to maximise profit for shareholders and owners' (DTI, 2002). There are a range of possible legal forms in the UK for social enterprises including: charities, which have the most stringent public benefit rules; community benefit societies (see box below); community interest companies; and companies limited by guarantee or shares, which have the least public benefit regulation. Some of the additional co-benefits include:

- **Greater proportion of surplus reinvested for social/environmental benefit** – some social enterprises include interest caps, bans on dividends and/or asset locks (see box below). This means that a greater proportion of surplus is available for re-investment for community/public benefit than in conventional business, where the primary duty is to maximise benefits to shareholders.[26]
    - The 2011 Survey of Social Enterprises (Villeneuve-Smith, 2011) shows that 82 percent reinvest some of the surplus back into the community whether through reinvestment in business, grants to communities or cross-subsidisation of other services. This situation can be contrasted with conventional businesses whose main fiduciary duty is to ensure financial return to shareholders: pay-outs by companies to shareholders have increased from around 10 percent of total internal cash flow in 1970 to around 60 percent today (Haldane, 2015).
    - West Oxford Community Renewables, for example, has managed to generate a community benefit of £25,000 p.a. for reinvestment in carbon cutting projects.

26 Section 172 of the UK Companies Act (2006): 'A director of a company must act in a way he considers, in good faith, would be most likely to promote the success of the company for the benefit of its members as a whole …' directors' duties are 'to serve the interests of shareholders, first and foremost, but also had to 'have regard' to wider interests, including employees, customers, suppliers and the wider community'.

Characteristics of community benefit societies

- **Objectives are mainly social/environmental.**
- **Surpluses must be reinvested in the primary purpose of the IPS.**
- **Democratic membership structure – based on one member one vote.**
- **Shares can be raised but no dividend can be paid and community benefit must be the main primary motivation for members. An annual payment – that is like the interest payable on a loan – can be paid but as a pre-profit expense, rather than a form of profit distribution, and must be in line with current interest rates.**
- **Asset lock: if the IPS is wound up and its assets are sold, the profits are not shared out among the shareholders but must be given to a charity or organisation with similar objectives.**
- **The maximum investment by any individual is £20,000.**
- **Share capital is not transferable, only withdrawable at the discretion of the board: this means that shares cannot be traded or increase in value; shareholders can only take out the money they put in.**

Note: Previously termed Industrial and Provident Societies (IPS)

- **New sources of investment** – Community renewable energy shares offer environmental and social, as well as financial, returns, which may attract new types of investors motivated by altruistic concerns as much as personal financial gain.
    - Until the recent reduction in the FiT, community energy projects were increasingly funded or part-funded by local share offers, with over 40 share offers issued on community renewables projects, raising around £17 million from approximately 10,000 community member investors to date (Capener, 2014). DECC has estimated that, since 2012, community energy groups have raised up to £29m in share capital (DECC, 2015c). If the current growth rate is maintained, independent modelling estimates that this could rise to more than £320m by 2020, or as much as £1.5 billion under the most optimistic scenario (DECC 2014).
- **Longer term investment** – social enterprises can help ensure longer term investment as shares are not transferable in some enterprise models (see box above). Again this can be compared positively with conventional businesses in which the average holding period of shares has fallen in the UK from around 6 years in 1950 to 6 months today (Haldane, 2015).
- **Jobs**: social enterprises have higher employment relative to turnover and greater involvement of women and BME groups on the boards than conventional SMEs; 66 percent actively recruit locally to a large extent and 88 percent recruit locally to some extent (Villeneuve-Smith, 2011).
- **Strengthened public participation** – 74 percent of social enterprises actively involve their beneficiaries in decisions about their business to some extent – a proportion that rises to 9 out of 10 social enterprises in the most deprived communities in the UK (Villeneuve-Smith, 2011).

Raising capital through local share offers – Oxfordshire examples

West Oxford Community Renewables (WOCoRe) and Osney Lock Hydro in West Oxford have between them have raised £848,780 for community-owned renewable energy installations (solar, PV, micro-hydro and small wind turbines) since 2010.

Oxford North Community Renewables (ONCORE) have raised £290,000 for solar PV on Cherwell Secondary School and St Barnabas primary school in Oxford since 2011.

The Low Carbon Hub has raised over £1.6 million through a community share offer in autumn 2014 to develop 1MW of solar PV on other local schools and businesses.

Co-benefits from other ownership models

Similarly additional, or different types of, co-benefits may be generated by other ownership and business models:

- ✓ **Local authority** owned or controlled renewable energy projects can use the generation of income for public services (see box below).
- ✓ **Local schools** may use the income from the FiT and financial savings on fuel energy costs to invest in educational materials.
- ✓ **Villages halls or churches** may use financial savings to improve the warmth of buildings and potentially increase engagement of previously isolated elderly people and hence reduce isolation.

Lark Rise primary school

The Low Carbon Hub raised investment for and installed 78 solar panels on Lark Rise primary school. The panels will save 163 tonnes of CO2 emissions over the 20 years of the project life and provide a 25 percent discount on electricity bills; 16 percent of the school's electricity needs are met onsite. As teacher Ed Finch said, 'What was great about the Hub's offer is that they do the fundraising and installation costs, and all we do is get cheaper power and produce less carbon. We pay less and we are able to learn more about being responsible citizens. With the children in the computer room we can look at how much electricity we're generating, so talking about responsible energy use I can make it real and base it on our usage and production.'

Local authority ownership

In the early 1990s, Woking Council set up an energy service company (subsequently converted into a holding company with a number of subsidiaries) to supply sustainable energy to council, businesses and residents etc. by building CHP plants and solar PV through the town. The council owns all the shares (financed from a mix of council's reserves, a loan from the Public Works Loan Board and shares from a Danish pension fund). The large scale of the renewable energy generation enabled by local authority involvement – around 6 megawatt from 14 CHPs and 1.3 megawatt of solar in 2014 (a) generates an annual surplus of around £1 million annually the majority of which is reinvested in council services, obviating the need for the council to raise taxes and (b) employs around 60 people (Woking, 2014).

Potential costs

Costs to renewable energy producers include capital expenditure (pre-development, construction and installation) and operational expenditure (fixed, variable, financing, insurance, storage, maintenance, decommissioning costs). Pre-development and capital costs per megawatt tend to be greater for community schemes than for commercial schemes due to the relatively small size of each project and the inability to achieve economies of scale for bulk purchases, but these costs could be driven down if framework agreements were established with commercial companies (Archard, 2011). The capital costs of 66MW of community renewable electricity capacity installed has been primarily funded through debt and grants, but a rapidly increasing number of projects are being funded or part-funded by local share offers (Capener, 2014).

There may also be a rebound effect from renewable energy if people use savings on fuel bills to increase their consumption of other energy-using goods or services (see Section 3 for explanation of rebound) and hence increase their carbon emissions.

The total cost of the FiT was £1,700m in 2014. However, the government recently decided to cap it at a maximum of £100m by 2018/19 (see Box X above).[27] In their submission to DECC on the FiT consultation, Good Energy – a green energy supplier – estimated that wind and solar reduced the wholesale cost of electricity by £1.55 million in 2014, which more than halves the cost of FiT (DECC, 2015a).

There may also be costs relating to visual amenity/landscape impacts from renewable energy, although these are difficult to value as they are highly variable and subjective depending on individuals and the area. Conventional energy sources – coal, gas and nuclear – also have amenity and landscape impacts such as fracking rigs, opencast coal mines. They also have upstream impacts such as water pollution from coal mines, air pollution from gas flaring.

27 As noted above, DECC's impact assessment for the 2015 FiTs review (DECC, 2015a) states that the benefits of FiT – such as reduced electricity bills, potential behaviour change and jobs – are unlikely to fully compensate for the cost of the scheme.

Comparative costs of renewables and fossil fuels

It is still often assumed that renewables are an expensive option compared to fossil fuels. In 2012 the levelised costs[28] of onshore wind was cheaper than coal or gas and biomass was on a par with gas, although solar PV was still higher than other fossil fuels and other renewable technologies (DECC, 2012b, 2013b). However the costs for renewables generally are expected to continue falling and eventually reach grid parity.[29] The costs of solar PV, for example, have fallen by 24 percent for every doubling in production since 1976 and are predicted to continue doing so, with storage costs falling at a similar rate (Eyre, 2016). This means that by 2019 large-scale solar PV will be cheaper than coal with carbon capture and storage and nearly on a par with standard gas production[30] and wind (DECC, 2012b, 2013b). Installation and maintenance is relatively straightforward, which makes it an attractive option for community energy.

4.5.4 Sharing the benefits

Local renewable energy projects have significant potential to reduce carbon and simultaneously generate a range of important co-benefits, although this has been weakened by the recent reduction in the FiT. However, there is no automatic reason why the co-benefits of renewable energy projects will accrue to disadvantaged communities, households or individuals. This requires conscious strategy.

Distributional issues

Deprived communities are likely to face greater obstacles to establishing renewable energy projects than higher-income communities. It may be difficult to raise finance from share offers in low-income communities and harder to find the individuals able to dedicate the time to starting up a renewable energy social enterprise. Unless positive redistributive measures are taken at a local level, low-income households are likely to be negatively affected by renewable energy generation as the FiT represents a greater proportion of their income than richer households and they are less likely to install renewable energy options in their homes.

As noted above, social enterprises reinvest a greater proportion of their surplus for social/environmental benefit than conventional business. The State of Social Enterprise Survey 2011 also shows that social enterprises are more likely to operate in deprived communities (39 percent) than conventional small businesses (13 percent) and more likely to hire people disadvantaged in the labour market (56 percent say they do this to some extent) (Villeneuve-Smith, 2011). However, even with a social enterprise it is possible that much of the potential surplus could be swallowed up by salaries (of board members or staff) or that the jobs, returns to shareholders and/or the services provided by the social enterprise accrue to the already advantaged.

28 Levelised costs are the lifetime costs of electricity divided by the expected power output (kWh) adjusted for inflation and discounted for the time-value of money, and is used to compare different energy generation options. Levelised costs are very sensitive to underlying assumptions and costs and are likely to vary according to design, time and location. The DECC levelised costs cited here do not include environmental costs, risk, financing costs or external incentives. They do include storage costs of CO2 but not storage of electricity, which may become increasingly important for wind and solar as they grow in importance.

29 If the cost of renewable energy production reaches the same level as fossil fuel production it is said to have reached 'grid parity'.

30 Combined Cycle Gas Turbine.

The following design features can help ensure that disadvantaged communities and individuals benefit from renewable energy:

- ✓ **Finance** – county-wide share offers could help redistribute income to install community-owned renewable projects in low-income communities.
- ✓ **Governance** – involving low-income and marginalised residents in governance structures and upstream programme design can help ensure a fair balance of benefit between different stakeholder groups, as well as addressing barriers and increasing the sense of common purpose in the community.
- ✓ **Programme focus and design** – installing solar PV on social housing or on schools or community buildings in deprived communities can help to ensure that low income groups benefit. Ensuring a low threshold for share offers can enable lower-income households to invest and benefit from shares.
- ✓ **Practical support** – providing external support and handholding to disadvantaged groups or households is important. This includes: advice about legal structures, business models, planning permission, green leases, raising finance, design of share offers, insurance etc. In Oxfordshire the Low Carbon Hub can provide this support.

Examples of distributed benefit in Oxford

- **WoCORe has installed solar panels on five council homes in West Oxford providing free electricity and generating an income for the Hogacre Eco Park.**
- **Oxford City Council has installed solar PV on a number of council homes in order to generate green energy, provide free electricity to tenants and generate an income for the council from the FiT. In 2014 Oxford City Council installed solar PV on five council houses in Blackbird Leys to supply green energy, provide free electricity to tenants and generate an income for the council from the FiT. The systems are predicted to generate a total of 10,700 kWh per year, income to the council of £1,400 per year in FiT payments for 20 years plus an extra £250 per year in export payments. Tenants can expect to save around £150 a year or more in energy bills. Next steps will be to roll this scheme out more widely on the 1,000+ OCC council houses.**
- **Project ERIC (Energy Resources for Integrated Communities) has installed Solar PV panels on 30 council homes in Rose Hill as part of a wider project (see separate box).**

- ✓ **Policy environment** – the FiT is a regressive source of financing as it is raised from a small levy on fuel bills. The FiT represents a small and declining percentage of fuel bills, but represents a bigger proportion of the income of poorer than wealthier households. Ideally the FiT would be financed through tax, however local organisations have limited influence over government financing mechanisms, at least in the short run. However, they can minimise negative distributional effects by ensuring that low income communities and households benefit from projects.

Project ERIC

Project ERIC (Energy Resources for Integrated Communities) is an innovative project to create a virtual localised energy grid using solar PV and battery storage across 82 homes, a school and a community centre in Rose Hill, east Oxford. The project operates as a partnership between Moixa's smart technology, Bioregional's community engagement, Oxford Brookes' monitoring and evaluation the local Community Action Group, Oxford City Council, Green Square housing association and others. The project aims to demonstrate how smart battery storage technology can help a community save energy and install more renewables on the electricity network and hence reduce carbon emissions. It also hopes to generate a range of other co-benefits including greater understanding by residents of climate change and energy issues, reduced electricity bills and more control over the energy they use. For example, Bioregional has conducted a series of engagement workshops with participants and with pupils at the Rose Hill primary school. This includes workshops on fuel poverty, energy democracy, global energy issues and how to build a DIY solar charger. In addition, ERIC has raised additional funds for a classroom demonstrator unit through crowdfunding from within the Rose Hill community. 74 of the 82 households are social housing tenants. Many of these households are in fuel poverty, therefore the reduction in their bills is having a significant impact on their cost of living which can have additional benefits, such as reducing stress. In some cases, residents' have said they are saving £1-5/week, a significant proportion of their bills. The project will also generate other wider co benefits by reducing peak demand and generation, reducing the impact of households and renewable energy generation at the sub-station level. This has potentially nationally significant impacts, as reduced peaks mitigate the need for expensive grid infrastructure upgrades, frequently cited as one of the primary barriers to installing high density PV in communities. (Source: Bioregional)

4.5.5 What is Oxfordshire doing?

The county is still mainly dependent on energy from polluting fossil fuels supplied by large, privately owned commercial energy suppliers. However, renewable energy generation is growing fast, driven by a range of organisations at local level including the Local Carbon Hub, community social enterprises and groups, local authorities, village halls, schools, farmers and commercial companies. The Low Carbon Hub estimates Oxfordshire has installed renewable capacity to produce 139 GWh per annum of electricity (about 4 percent of demand) with an additional 301 GWh (8 percent) of demand in the pipeline. The OxFutures programme (jointly managed by the city council, county council and Low Carbon Hub) is aiming to bring £400 million of investment in renewable energy infrastructure into the county by 2020 which could generate 20 percent of the county's electricity demand (Patrick *et al*., 2014).

Despite its recent growth, the renewable energy sector faces considerable challenges due to recent changes in policy, including a reduction in the FiT and the removal of community energy from access to Enterprise Investment Scheme tax relief and Social Investment Tax Relief. Nationally, the deployment of domestic rooftop solar, for example, is anticipated to be 50 percent of the current monthly average (around 10,000 installations per month]) over the next FiTs review period (DECC, 2015b).

However there will be future opportunities. A recent study (Alkiviades and McCulloch, 2012) identified particular opportunities, not just for solar PV but also agricultural waste (anaerobic digestion) and woodland/biomass, suggesting that renewable energy has the potential to generate up to 1190 GWh/year or 30 percent of Oxfordshire's demand as well as up to 2560 GWh of thermal energy (50 percent of gas demand).

4.5.6 What more could Oxfordshire do?

- ✓ Use county-wide shares that raise funds for renewable projects in low income communities (Low Carbon Hub, community social enterprises).
- ✓ Reinvest surplus income derived from government incentives such as the FiT or RHI into programmes that directly address fuel poverty e.g. a fuel poverty grant fund run by the AWN or local councils.
- ✓ Install renewable energy on low income social housing or on schools.
- ✓ Ensure share offers have a low minimum threshold so low-income people can benefit from interest.
- ✓ Where community-owned renewable projects are able to supply energy directly to households, explore the use of escalating tariffs to penalise high energy users and subsidise bills for low-income households.

4.6 Community-led action

4.6.1 Introduction

Community groups have a proven capability to reduce local carbon emissions and can also generate additional co-benefits across all sectors – transport, green spaces, home energy projects, food and waste reduction. They also have the potential to distribute co-benefits and thereby help reduce social exclusion, poverty and inequality, although this requires conscious strategy and can be difficult for them to achieve on their own.

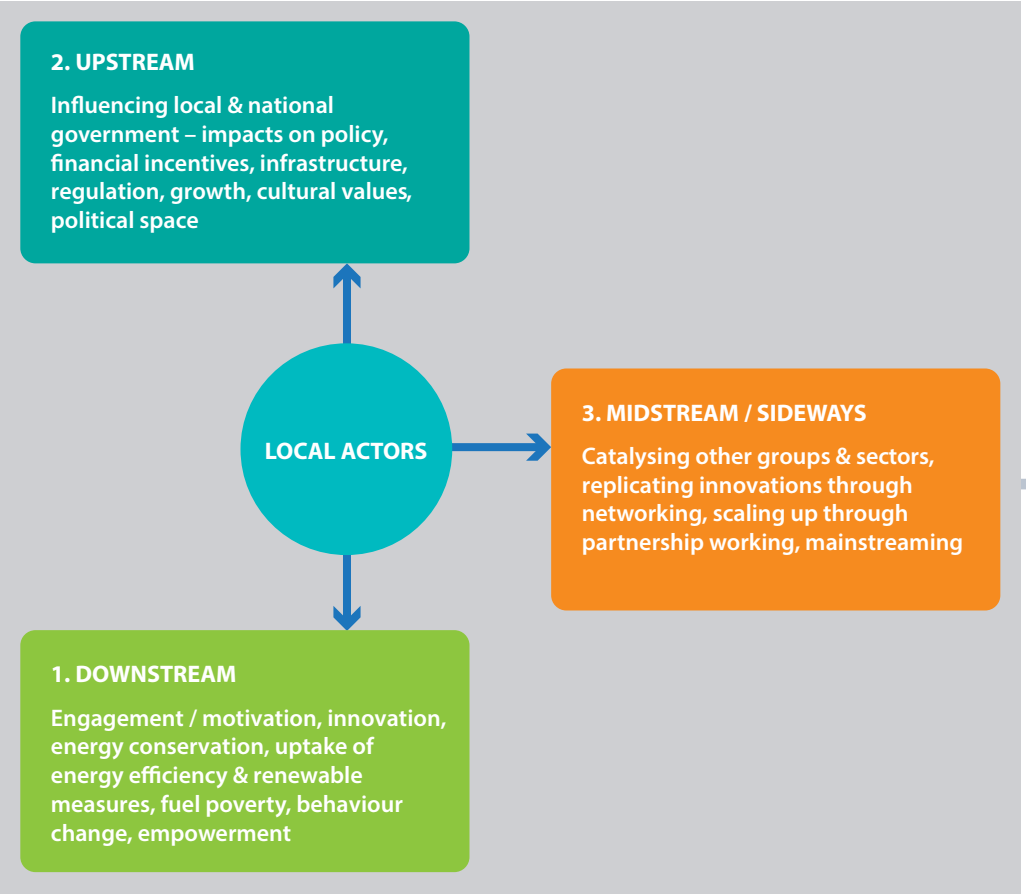
4.6.2 Carbon reduction potential

There has been increasing recognition of the role that community action can play in reducing carbon emissions, reflected in the development of the first ever government community energy strategy (DECC, 2014).

- Finalists in the Big Green Challenge national competition reduced emissions by between 10 percent to 46 percent (Cox *et al*., 2010).

- Six communities participating in the EVALOC project achieved percentage reductions in domestic energy use equivalent to or greater than the national average, despite having lower than average base lines (Gupta, *et al*., 2015).
- Community groups have been shown to help residents achieve average reductions of 10 percent in their personal carbon footprints (including home energy, food, transport, waste and lifestyle) through behaviour-change projects such as Carbon Conversations, Transition Streets and the Low Carbon Living Programme (DECC, 2012; GAP, 2008; Hamilton *et al*., 2015).

Figure: Down, up and midstream roles of local community organisations/actors (Source: Gupta *et al*., 2015)



Evidence also suggests that community-led initiatives can help foster the following mediating factors, which in turn may contribute to action on climate change:

- **Innovative ways of cutting carbon** – community groups use creative new ways to get people to take up and use new low-carbon technologies and change their personal energy behaviours and lifestyles. When local and national conditions are right, successful 'innovations' can then subsequently be scaled up, replicated and/or mainstreamed (Gupta *et al*., 2015; Seyfang and Haxeltine, 2012).
- **Strengthened social norms about reducing carbon** – community action can strengthen social norms, for example that reducing your carbon footprint is the 'normal thing to do' (DECC, 2012; Gupta *et al*., 2015) contributing to long-term cultural change.

- **Increased uptake of low-carbon measures** such as insulation or solar PV (DECC, 2012).
- **Behavioural change** – community action can help change energy behaviours through resident participation in community projects, local action and learning groups, and provision of practical support and advice (Bunt and Harris, 2011; Cox *et al*., 2010; Gupta *et al*., 2015; Heiskanen *et al*., 2010; Staats *et al*., 2004).

Grass roots innovations in Oxfordshire

Taken together, community groups have developed or adapted a range of innovative activities in Oxfordshire to foster and enable behaviour change and the uptake and use of low-carbon technologies:

- **home energy and fuel poverty – action and learning groups such as the Low Carbon Living Programme, Carbon Conversations, Transition Streets, thermal imaging, open home events, home energy advice/support, eco renovation activities, light bulb libraries**
- **renewable energy – new legal, financial and governance structures to support local renewable energy generation: community ownership and generation of renewable energy; green leases for community renewable energy generation; the recycling of surplus income from renewable energy into further carbon cutting activities**
- **food – food growing activities, apple harvesting and pressing events, farmers markets, composting training, disco soup, community kitchens, community orchards, local food distributors/veg vans, cooking workshops, gardening in public spaces, plant and seed swaps**
- **transport – bike repair sessions, car rental/car sharing/car clubs, green driving courses**
- **waste – eco refills, bring and take/show shops, local tool/equipment sharing, up cycling, PAT testing, repair/fix it parties, clothes swapping 'swishing' parties, promotion of real nappies/reusable carrier bags**
- **trees/wildlife – tree planting, wildlife areas, plant and seed swaps.**

(Source: Oxfordshire Community Action Group)

4.6.3 Co-benefits and costs

Community-led carbon reduction initiatives can also generate a number of additional co-benefits compared to other organisations. Evidence suggests they can help:

- **Strengthen public action**: community groups are considered to have a distinctive competence in motivating and engaging residents to take action.
    - Some of the potential strengths of community-led initiatives is that they are closer to residents than government or business, treat people as citizens rather than consumers, enable collective rather than individual action, use a range of creative and participatory engagement methods, and can have legal models that prioritise social and environmental, as well as financial returns (DECC, 2015; Gupta *et al*., 2015).

- One academic study of university students in 24 countries across the world showed that they were as motivated by the belief that climate action would create a more moral and caring community as they were that it would help reduce climate change, and more so than the belief that it would reduce pollution or disease or promote healthier lifestyles. Results were similar for both convinced and unconvinced participants and independent of perceptions of climate change importance, political ideology, age or gender. Communicating about the likely impacts of climate change and co-benefits should be complementary, not competing strategies, although further research is needed about how to combine them. (Bain, P. *et al*., 2015).
- A survey of participants in Low Carbon West Oxford's low-carbon living programme showed that the second most important reason residents participated in the programme was to be part of a community initiative (LCWO, 2010).

- **Empower residents and build skills**: community projects and collective action can empower people, make individual action seem more meaningful and build confidence and skills (DECC, 2014).
- **Strengthen social capital**: community groups can help strengthen social interactions and public participation in energy projects (Bunt and Harris, 2011; Cox, *et al*., 2010; Gupta *et al*., 2015).
  - The Oxfordshire CAG's annual report 2014/15 showed that 58 local groups held 1,438 community events with 65,253 attendees (9.98 percent of the population of Oxfordshire). (CAGs Oxfordshire)
  - There is some anecdotal evidence that community groups can increase community pride and reduce crime (Gupta *et al*., 2015).
- **Strengthen awareness and public acceptance of renewable energy projects** (Archard 2011; DECC, 2014; Gupta *et al*., 2015)
- **Strengthen the local economy**:
  - The sections on home energy and renewables above illustrate some of the ways community groups can help strengthen the local economy.
  - The CAG annual report 2014/15 showed that 58 community groups saved the county £1,073,966 from avoided waste collections, including the value of volunteer time, consumer costs savings and generation of external income (CAGs Oxfordshire).

Community energy can also entail costs. As well as the financial capital and revenue costs it also involves volunteer time of residents and while this is widely regarded as a positive contribution it can also contribute to burnout.

4.6.4 Sharing the benefits

From a narrow carbon reduction perspective it would make sense for community organisations to focus on getting the highest-emitting households and organisations in the community to reduce their carbon emissions. However, the existence of co-benefits highlights the importance of also engaging low-income and other under-represented residents.

There are many community groups working on fuel poverty in the county and/or some that are involved in projects to help low-income communities benefit from renewable energy.

There is limited research about the distributional outcomes of low-carbon community groups but some evidence suggests that they may struggle to achieve positive distributional outcomes if working on their own due to their particular mandates and skills, uneven and uncertain financing, reliance on volunteers and/or the scale at which they operate (Gupta *et al*., 2015; Mayne and Hamilton, 2014 (See box below).

As noted in Section 4.3 different local actors have differing strengths and limits, therefore ensuring a fast and fair transition ideally requires local partnerships working between local authorities, statutory agencies, community groups, residents, and other organisations (Gupta *et al*., 2015). Due to limited resources, local authority-led partnership approaches are often mainly focused in disadvantaged communities. This means that community groups can find themselves as the main organisation proactively encouraging residents to reduce their carbon emissions in middle- and higher-income areas. The risk is that the pockets of low-income residents residing in these areas are not given the practical support to enable them to benefit from carbon reduction programmes that may, in turn, exacerbate income inequality. In such cases, at a minimum there needs to be joined-up, inter-agency cross-referral systems for home energy-efficiency improvements programmes (Gupta *et al*., 2015)

Low Carbon West Oxford case study

Low Carbon West Oxford is a community led initiative which was set up after the summer floods of 2014 to reduce carbon emissions in West Oxford (West Oxford Community Renewables, Osney Lock Hydro). It illustrates both many of the positive strengths of low-carbon community groups and some of their limits. It has sought to have an inclusive approach and has succeeded in reducing local carbon emissions and contributed to 'significant' changes in energy behaviours through a range of innovative and creative methods (engagement, governance structures, double carbon cut, green lease, low-carbon living programmes). It has also generated a range of social, health, economic and environmental benefits and sought to ensure they are fairly distributed through the use of inclusive messages, relevant and accessible design of projects, and addressing barriers to participation. It's success catalysed the establishment of the Oxfordshire Low Carbon Hub as well as the establishment of a number of other low carbon communities. (Sources: Cox, J *et al*, 2010; GfK NOP 2011; DECC, 2012; Gupta *et al*, 2015)

However, the reductions in household carbon emissions have to date mainly been achieved from behaviour change rather than improvements in building fabric or uptake of new low-carbon technologies, which are also needed to accelerate carbon reduction, ensure low income residents enjoy co-benefits of warmer homes and lower fuel bills, and protect against fuel poverty. As noted in section 4.3 on energy-efficient homes, this is due to a combination of factors including: a weak national policy environment; hard to treat houses; the lack of local infrastructure for home energy programmes and affordable advice in the area; the difficulties volunteer-led community groups face in tendering for installers and accessing government grants or subsidies (in a middle-income community); and lack of volunteer time for outreach work and providing support to enable vulnerable people to benefit. This in turn also limits the extent to which it can help offset the regressive effects of the ECO by helping energy-efficiency improvements in low-income households.

Community groups are a complement to, not a substitute for, action by public and private sector organisations.

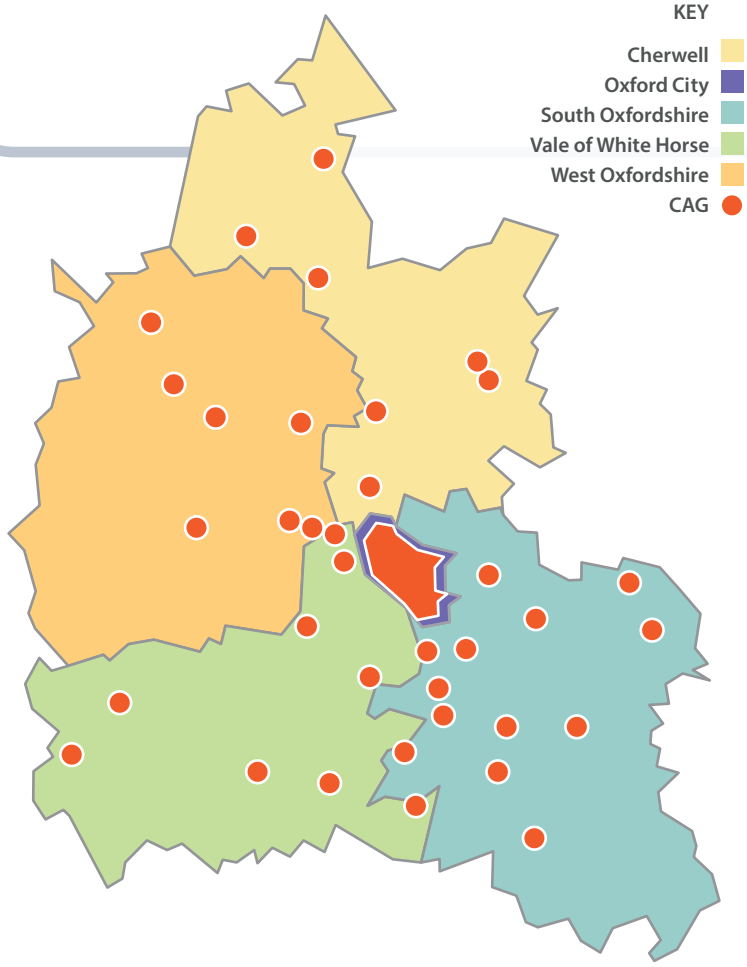
The policy environment

The UK is one of the first countries to have a community energy strategy. The strategy provides an important acknowledgement of the role, contribution and some of the co-benefits of community energy projects. However, the strategy does little to address some of the key factors constraining the pace, scale and reach of community energy projects, such as revenue funding. In addition, the recent reduction in the FiT has undermined the potential for communities to reduce carbon emissions through renewable energy projects (see sections on transport (4.1), green space and trees (4.2), food (4.4) and renewable energy (4.5) projects).

4.6.5 What is Oxfordshire doing?

According to Community Action Groups Oxfordshire (CAG) there are 67 low-carbon community groups in Oxfordshire alone – one of the densest concentrations in the UK (Hamilton *et al*., 2015) – running a range of local carbon reduction programmes. There are also a large number of communities who are developing community-led plans, a growing number of which have low-carbon renewable energy, tree planting, food, transport or waste projects. However, their uneven and limited funding and reliance on volunteers (Seyfang *et al*., 2012) can limit their reach, pace and scale of action.

Figure: Community Action Groups map of Oxfordshire.



Carbon reduction in community-led plans

Tetsworth's Community-led plan includes the following carbon reduction elements:

- **Consider development of a not-for-profit enterprise to install solar/acoustic barriers alongside the M40 to generate renewable energy and reduce noise pollution**
- **Reflect local opinion on alternative energy source planning applications (majority support for commercial solar energy arrangements but opposition to commercial wind turbines and fracking)**
- **Plan and implement a community orchard**
- **Identify potential new allotment sites**

(Source: Tetsworth Community-Led Plan 2015–2025)

4.6.6 What more could Oxfordshire do?

✓ Ensure that community groups complement rather than substitute for the delivery roles of local authorities and statutory bodies.

✓ Set up local carbon reduction partnerships that reflect their duties, responsibilities and distinctive competences for low-carbon transport, home energy, food and renewable energy.

✓ Involve low-income and vulnerable groups in governance structures and upstream programme design.

✓ Ensure that local programmes are relevant and accessible to low-income groups and address barriers to participation.

✓ Help ensure low-income, vulnerable and excluded households receive the financial and practical support needed to benefit from low-carbon reduction programmes as outlined in this report.

✓ Use co-benefits to communicate both wider social/environmental and practical benefits of action.

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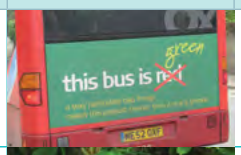
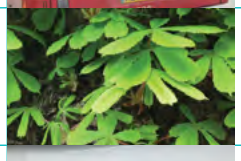
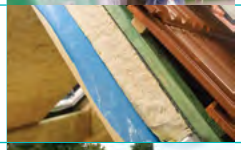
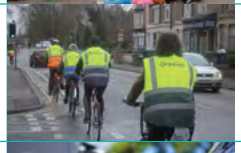
ANNEX 1: Workshop participants' ranking of possible local low carbon initiatives

In recent low-carbon learning workshops with 36 residents from disadvantaged communities in Barton and Littlemore and from the Polish Association and Hindu Temple Association were asked to prioritise a number of possible work options for Low Carbon Oxford, taking into account their potential for carbon reduction and creation of co-benefits for individuals, the environment and society. The initial list of work options was selected by the researcher. Participants ranked the work options in the following order of priority:

Work priority		Votes
A green **public transport** system that provides a convenient and affordable way of getting around reduces traffic and improves air quality		33
More **trees and natural green spaces** that absorb pollution, reduce flooding and contribute to well-being		33
Energy-efficient homes that are warmer, healthier, more comfortable and have lower energy bills		24
Local shops and markets that provide fresh, healthy, **locally grown food** and local products		15
Clean, locally owned **renewable energy** (from the sun, wind, or waste and rivers) that replaces polluting coal and oil, and can generate income		13
Waste recycling facilities and education for residents and institutions that help **reduce, reuse and recycle waste**		13
Green businesses that create local green jobs and apprenticeships for low-carbon businesses		11
Practical advice and support that helps residents and communities reduce their carbon emissions, save energy and money and bring their community together		11
Safe cycling and pedestrian routes and facilities that provide a cheaper, faster and healthier way of getting around		9
Facilities **for electric cars** that improve air quality		7

ANNEX 2: Summary of change theories and implications for policy and programme design

Table 1 Summary of change theories and implications for policy and programme design		
Theory	**Key elements influencing energy use**	**Implications for policy and programme design**
Individual level		
Rational choice theory	Ideas (individual preferences) Materials (availability, design & cost)	Provision of relevant information, technologies and financial incentives
Socio-psychological & behavioural theories	Ideas (personal values, intentions, perceptions of social norms) Competencies (personal agency, know-how, skills, routines)	'Attractive' messengers Well designed 'nudges' Framing of messages (e.g. values, salience) Norm appeals Provision of practical advice and support Regular prompts at convenient times
Interpersonal, group & organisational level		
Social learning; communities of practice	Ideas (perceptions of social norms) Competencies (personal agency, know-how, skills routines; group or organisational capabilities) Standards & rules (group norms & standards)	Group action and learning groups, skills shares, peer to peer mentoring, communities of practice Regular provision of energy feedback Community (whether of geography, identity or interest) programmes and projects
Organisational models	Ideas (organisational cultures) Competencies (organisational capabilities) Standards & rules (organisational norms, rules, incentives)	Use of messages, norms, rules, incentives to influence employees' routine actions. Use of local delivery agents to provide needed complementary programmes, services & infrastructure Local joint/partnership/interagency working Government policy framework and financial incentive structure that supports local delivery agents
Structural level		
Cultural theories	Ideas (societal cultural beliefs)	Use of (government) social marketing campaigns, education, media Participatory, awareness raising groups and action groups
Socio-economic theories	Socio-economic influences (income, class, tenure, gender, ethnicity)	Inclusive & representative governance structures Relevant and accessible project design that addresses 'barriers' to participation

Theory	Key elements influencing energy use	Implications for policy and programme design
Structural level, continued		
Social network theories	Competencies (network structure)	Mapping, widening, deepening and/or building social networks
Power theories	Power relations (personal, interpersonal, societal)	Change interventions which address visible, hidden and invisible resistance Strengthening change agents' sources of power Processes of group reflection, learning and capacity building
Policy change theories	Ideas (ideologies, cultural beliefs) Standards & rules (policy framework & incentive structure) Competencies (government capabilities) Power relations (all levels)	A mix of interventions involving (a) persuasion (research, lobby, dialogue, modelling solutions) and (b) pressure (e.g. alliance/ movement building, media, public campaigns) to influence government policy and widen democratic space
Systems levels		
Actor network, social practice, socio-technical theory theories, Multi-Level Perspective of Transition Theory	Interactions between elements and/or levels	Innovative visioning, steering, learning & experimentation to develop & nurture niche social-technical innovations A mix of mutually reinforcing change interventions by different actors at different levels & sectors A strong and supportive government policy framework and financial incentive structure

Building stronger and fairer communities: sharing the co-benefits of local action on climate change

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