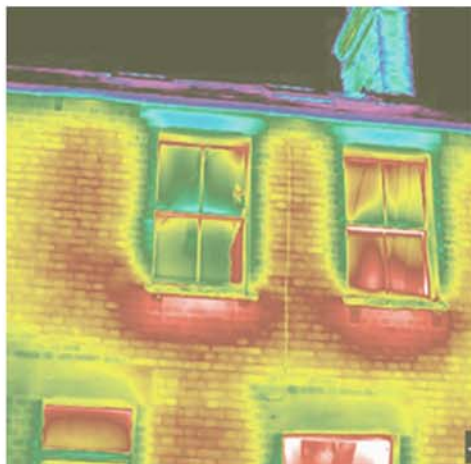
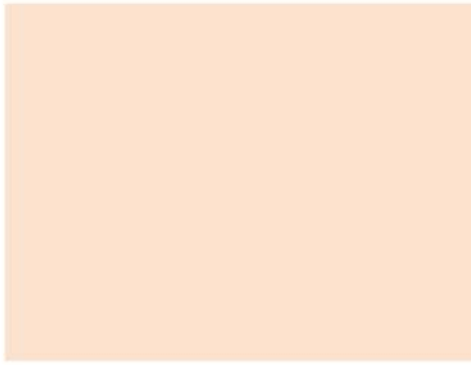


# Evaluating the impacts, effectiveness and success of low carbon communities on localised energy behaviours (EVALOC)



## Final report

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For more information on EVALOC project, please visit: [www.evaloc.org.uk](http://www.evaloc.org.uk) or contact Professor Rajat Gupta, [rgupta@brookes.ac.uk](mailto:rgupta@brookes.ac.uk)

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## Research Team

### Principal Investigator:

**Professor Rajat Gupta** is Director of Oxford Institute for Sustainable Development and Low Carbon Building Group at Oxford Brookes University. He developed the RIBA award-winning DECoRuM model for carbon mapping communities. In 2013 Rajat was voted as one of 13 international building science stars. Rajat's research interests lie in scaling up energy retrofits and monitoring and evaluating impacts of community-led retrofits. Rajat was lead academic on several Government funded Retrofit for the Future and Invest in Innovative Refurbishment projects on advanced low carbon refurbishment solutions, as well as a LEAF project on carbon mapping communities. Presently Rajat is evaluating an Innovate UK funded project on distributed energy generation and storage for reducing peak grid loads. Rajat has published widely, including strategic journal papers on future direction of energy demand research and evaluation of an innovative retrofit programme.

### Co-Investigators:

**Dr Nick Eyre** leads the Lower Carbon Futures Programme at the Environmental Change Institute (ECI) at the University of Oxford, and is a Jackson Senior Research Fellow at Oriel College, Oxford. He is a co-Director of the UK Energy Research Centre leading it work on decision making. Previously he has worked at the Energy Saving Trust as Director of Strategy and on secondment to the Cabinet Office, where he was a co-author of the 2002 UK Government's Review of Energy Policy. Nick has worked on energy, environment and climate issues for 30 years and was a lead author in the Fifth Assessment Report of the IPCC.

**Dr Sarah Darby** is deputy programme leader with the Lower Carbon Futures team at the ECI. She is particularly interested in how people adopt technologies and make them part of their way of life. Her interest in the social dimensions of energy systems came from evaluating the effectiveness of energy advice programmes. Recently she has been researching social and environmental dimensions of smart grids. This has included modelling the potential carbon impacts of smart grid development for the European Commission and a 'Smart Metering Early Learning' synthesis report for the Department of Energy and Climate Change (published March 2015).

**Dr Karen Lucas** is Associate Professor of Transport Geography and Director of Research and Innovation at the Institute of Transport Studies, University of Leeds. She has had 20 years of experience in social research in transport. She is a world-leading expert in the area of transport-related social exclusion. Her most recent project was for the Asian Development Bank to develop a training program for Designing Inclusive Transport Projects. She specialises in action-based research and participative planning exercises bringing together local communities with policymakers.

### Researchers:

**Laura Barnfield** is a Research Fellow at the Low Carbon Building (LCB) Group of the Oxford Institute for Sustainable Development (OISD) at Oxford Brookes University (OBU). Prior to joining OBU, Laura worked in a local sustainable architectural practice that drew work from a variety of sectors including the public and housing sectors. Most notably she worked on a young people's centre with solar PV panels and high performance building fabric specification in Oxfordshire. Laura holds an MSc in Sustainable Buildings: Performance and Design as well as a DipArch from OBU. Prior to studying at OBU, she studied an MA (Hons) in Architectural Design at the University of Edinburgh.

**Jo Hamilton** joined the ECI, University of Oxford in 2006. Jo's research focuses on community-led energy projects and local energy governance through the UNLOC project (Understanding Local Governance of Energy); and monitoring and evaluation of community energy groups through EVALOC and the MESC (Monitoring and Evaluation for Sustainable Communities) projects. Within these projects she has explored the role of social learning and social networks in disseminating energy messages; the role of the arts in engaging individuals and communities with climate change and energy; and has collaboratively developed monitoring and evaluation resources. Jo holds an MSc in Energy and Environment Studies from the Centre for Alternative Technology / UEL.

**Ruth Mayne** has over 25 years' experience working as a community practitioner, a researcher, and a policy advisor on a range of social, economic and environmental issues, as well as the design and assessment of change strategies. She is also co-founder and currently strategy director of Low Carbon West Oxford. Since joining the ECI, Ruth has worked on a number of research projects



including EVALOC which assesses the environmental, social and economic effects of low carbon communities. She has recently won an Impact Acceleration Award from University of Oxford, to bring learning and best practice from her research to Low Carbon Oxford.

**Matt Gregg** is a Research Fellow in Architecture and Climate Change, based at the OISD: LCB Group at Oxford Brookes University. Matt has worked on a number of climate change adaptation projects including the 3-year EPSRC-funded Suburban Neighbourhood Adaptation for a Changing Climate and has undertaken the carbon mapping of six case study communities as part of EVALOC. In 2009, Matt graduated with an MSc Sustainable Building: Performance and Design from OBU. Prior to joining OBU in 2010, Matt worked over three years in an architecture practice in Tennessee after getting his BArch at the University of Tennessee.

**Chiara Fratter** is a Researcher based at the Low Carbon Building Group of the OISD at OBU. Her involvement in the EVALOC project has covered several areas of analysis from householder interviews to domestic energy use. She holds an MSc in Sustainability Environment Design (Honours) from I.U.A.V in Venice; her dissertation was entitled *Energy optimization and functional refurbishment of an existing school building*. Previously she achieved a DipArch and MSc in Sustainable Architectural Design from the Polytechnic Institute of Milan. At the same institute she received a Bachelor's degree in Environmental Architecture with a dissertation topic on Life Cycle Assessment.

**Dr Bob Irving** joined OISD as Research Associate in 2013 after completing his PhD with Rajat Gupta as his Director of Studies. Bob holds an MSc in Energy Efficient & Sustainable Buildings from Oxford Brookes and has a BA from Lancaster University. His previous career was in IT in fields ranging from uranium mining to mail order book-selling. His PhD thesis examined the possible effects of the mass installation of domestic heat pump systems on the UK energy supply. His main work in EVALOC has been the analysis of monitoring data on window opening and performance of air source heat pumps.

## Acknowledgements

The EVALOC team would like to acknowledge the input of all the participants in the research. Residents and members of the six case study low carbon communities located across the UK (Swansea and Amman Valleys, Chester, Middlesbrough, Hook Norton, Huddersfield and Oxford) contributed to the project through focus groups, community events, trial of energy feedback devices and monitoring and evaluation of household energy use. They provided the EVALOC team with valuable insights into the challenges of reducing household energy use and changing energy behaviours. We would particularly like to acknowledge the time and commitment of John Barnham, Nathan Brett, Ged Edwards, Mark Fishpool, Jem Hayward, Emily Hinshelwood, Saskya Huggins, Tim Lunel, Frank Lucas, Dan McCallum, Sarah Mitchell, Angie Moray, Dennis Reeves, Sarah Spilliotis, and Ruth Sherrat, as well as the residents of the 88 case study households involved in the research. We would like to thank Dr Bernie Hogan of the Oxford Internet Institute (University of Oxford) for guidance and assistance with the social network analysis, Anthony Psaila for his facilitation of two rounds of focus groups, Adorkor Bruce-Konuah of the Low Carbon Building Group (Oxford Brookes University) for assistance with analysis of energy and environmental monitoring, Marina Topouzi, Priyanka Arora, Ruchi Parakh, Nina Sharp and Tara Hipwood for their help in undertaking the household interviews and data collection, and Dot Kirkham for transcribing all interviews and focus groups. We would also like to thank our Project Advisory Board members and International Visiting Researchers for their valuable contributions to the research.

## Case study low carbon communities

**Awel Aman Tawe** (AAT) is a community energy charity and a social enterprise project focusing on a population of over 13,000 people in 12 villages located in the Upper Amman and Swansea Valley, South Wales. The project grew out of a local community meeting in 1998, and has focused on a community-owned wind farm as a way to rejuvenate the local economy and address fuel poverty, which is a major concern in the local area.

**Sustainable Blacon Ltd** is a community-based company limited by guarantee, formed in July 2009 dedicated to promoting and developing Blacon, a suburb of Chester, North-West England, as a model sustainable urban community. It was a subsidiary of Blacon Community Trust, a registered Charity and company limited by guarantee.

**The Eco-Easterside** project was led by Middlesbrough Council, Middlesbrough Environment City and local housing associations, in partnership with local residents in the Easterside area, a suburb of Middlesbrough, North-East England. Its objectives are to raise awareness among residents to reduce carbon emissions from domestic housing and public facilities, cut energy use and household energy bills, encourage the use of active and sustainable transport, and contribute to sustainable, healthy living by encouraging residents to grow their own food.

**Hook Norton Low Carbon** (HN-LC) is a Co-operative and Community Benefit Society set up by members of **Low Carbon Hook Norton**, a community action group which started in 2008 with the aim of reducing the energy consumption and carbon emissions of the 2,500 strong community in the South-East of England. Hook Norton Low Carbon provides a range of community-based schemes as well as providing low interest loans to local residents for household energy improvements.

**Kirklees** Council-led *Hillhouse Greening the Gap* project aimed to encourage positive behaviour change among residents to reduce carbon emissions, as well as act as a catalyst for wider community benefits such as affordable warmth, skills development, job creation, improved health, and stronger communities. Hillhouse is an urban neighbourhood in Huddersfield, Yorkshire & Humber, England, with strong community networks and community centres, as well as a diverse mix of residents with over 65% from ethnic minority groups.

**West Oxford: Low Carbon West Oxford** (LCWO) is a charity set up by local residents, in a neighbourhood of Oxford, South-East England, with the aim of helping local residents take practical action on climate change. **West Oxford Community Renewables** (WOCRe), a registered society, generates renewable energy and donates the surplus to LCWO to run further carbon-cutting projects in the community. This generates a double carbon cut which reduces the cost of carbon reduction, as well as a range of other community benefits. The residents aim to achieve an 80% reduction in emissions in West Oxford by 2050.



## International visiting researchers

**Professor Jonathan Fink** is Vice President for Research and Strategic Partnerships and Professor of Geology at Portland State University (PSU) in Portland, Oregon. PSU works closely with the City of Portland (the only large city in the U.S. to have reduced its carbon emissions below 1990 levels) to advance a green agenda around transportation, land use, ecosystem services and sustainable construction. Dr Fink, a volcanologist by training, is a member of the Board of Advisors of the Smithsonian Institution's National Museum of Natural History, and the National Board of Advisors for KB Home, the fifth largest homebuilder in the U.S.

**Trevor Graham** is Head of Sustainable Communities and Lifestyle in the City of Malmö (Sweden) working with sustainable urban regeneration through a wide range of projects and strategic initiatives. He has previously worked with community development, urban sustainability and sustainable building in the UK and Germany and came to Sweden in 1998 to head the Eco-City Augustenborg initiative. Current work includes establishing the new large scale regeneration programmes in Malmö incorporating social innovation and sustainable economic development as key parameters to speed up the process towards the sustainable city. Trevor has also led a bilateral programme for knowledge and technology transfer on sustainable construction between UK and Sweden.

**Dr Michael Ornetzeder** is a Senior Researcher at the Institute of Technology Assessment at the Austrian Academy of Sciences, and a Lecturer at the University of Natural Resources and Life Sciences in Vienna. His research interest lies in science and technology studies, with a particular focus on participatory forms of technology assessment, user innovation, social learning and innovation networks. His current research is in the field of transition of the energy system towards sustainability and on climate change issues. Michael is also an advisor for a large-scale pilot project on energy efficiency and smart metering in Austria.

**Professor Ashok Lall** is Principal of Ashok B Lall Architects (India) specializing in low-energy sustainable architecture. He is also chair for Design and Technology at the Kamla Raheja Vidyanidhi Institute for Architecture (KRVI) in Mumbai, India and Visiting Professor at the Guru Gobind Singh Indraprastha University (GGSIPU) in New Delhi. Prof Lall is currently engaged in several initiatives for the improvement of public spaces in cities and affordable housing. He was convener of the Delhi Urban Arts Commission Work group on Energy, and coordinator of an EU-funded program for the development of a web-based teaching package for low-energy architecture. He was a member of the Holcim Awards jury for Asia Pacific in 2005 and 2011, and head of the Holcim Awards jury for Asia Pacific in 2008.

## Advisory board members

Professor Roy Alexander, University of Chester

Graham Ayling, Energy Saving Trust

Chris Church, Low Carbon Communities Network

Professor Paul Ruyssevelt, UCL Energy Institute

Dr David Strong, David Strong Consulting and Visiting Professor, Oxford Brookes University

William Walker, Community Energy Unit, Department of Energy and Climate Change

Chris Welby, Good Energy

Members of the six case study low carbon communities: Awel Aman Tawe, Sustainable Blaenau, Eco Easterside, Low Carbon Hook Norton, Kirklees Council, Low Carbon West Oxford



## Glossary of terms

**Area:** In this report, 'area' may mean a geographical neighbourhood, town or city depending on the low carbon community (LCC).

**ASHP:** Air Source Heat Pump

**Behaviour change interventions:** LCC activities that seek to change residents' energy behaviours (as defined below), through increased motivation, knowledge and agency (ability to make change). The intervention may include provision of energy feedback measures such as energy display monitors, face-to-face advice and support, community-based social learning opportunities and events, and energy management or low carbon living programmes.

**DECC:** Department of Energy and Climate Change.

**Dwelling:** a self-contained 'substantial' unit of accommodation. In this report it refers to the physical building which is inhabited.

**EDM:** Energy display monitor (also known as an in-home display, or IHD).

**Energy behaviour:** the EVALOC research focuses on energy behaviours relating to electricity and gas use within households, rather than energy use related to food, waste, transport, or other services. This may include the purchase, use, maintenance or lease of energy-using appliances, technologies, goods or services. These energy behaviours may be influenced by a range of individual, social, cultural, technical and economic influences.

**Energy champions:** local residents enlisted by a LCC to encourage other residents to adopt sustainable energy behaviours and/or take up renewable and energy efficiency measures. The role of the energy champions may involve helping communicate energy saving measures, leading-by-example, and providing face-to-face information and advice.

**Extrinsic values:** values related to external approval or rewards such as money and status.

**Know-how:** practical knowledge about perform tasks or solving problems, such as how to manage energy use in the home.

**Household:** one or more people who live in the same dwelling and also share meals or living accommodation. A single dwelling can contain multiple households.

**Interventions:** energy-saving activities or processes that are offered by LCCs. In relation to the households, these were either physical or behaviour change interventions.

**Intermediary organisations:** organisations which can catalyse, support and facilitate action by LCCs, with a view to helping initiate, replicate, grow and mainstream low carbon innovations. Their roles can include capacity development, communication and networking, coalition building, provision of funding, and aggregating projects. They mostly operate at a national or regional level. Intermediary organisations are typically social enterprises, charities or non-governmental organisations.

**Intrinsic values:** values which are inherently rewarding to pursue e.g. concern for the environment, social justice.

**LCC (Low Carbon Community):** the organisations in a locality involved in promoting community-level energy and carbon reduction. This term can cover a single Low Carbon Community Group (LCCG), or a partnership or multi-agency approach involving LCCGs, local authority, other statutory agencies and intermediary organisations.

### LCC roles and activities:

- **Downstream:** refers to LCC roles and activities with local residents.
- **Midstream:** LCC roles and activities with other local organisations or with other LCCs.
- **Upstream:** LCC activities with national policy-makers.

**LCCC (Low Carbon Communities Challenge):** a government-funded two-year programme of action research carried out with 22 communities between 2010-12. All six of the communities who contributed to EVALOC were involved in the LCCC.

**LCCG (Low Carbon Community Group):** a group or organisation working on issues of carbon reduction at a local level, where members of the local community govern and run the group, and are beneficiaries of the group's activities.

**Learning and action groups:** groups taking part in a structured programme of meetings in which participants learn about energy and carbon reduction, set goals to reduce carbon, reflect on their actions, and learn from other participants.

**Local:** refers variously to village, urban neighbourhood, town or city.

**Low- or zero-carbon technologies (LZTs):**

Technologies that are low- or zero-carbon in operation. For this project, that includes air source heat pumps, as well as renewable systems such as solar PV, solar thermal and wind turbines.

**Monitoring and evaluation (M&E):** monitoring is the collection and analysis of information about an intervention, project, programme or process, undertaken while the project/programme is ongoing. Evaluation is the periodic assessment of interventions in terms of process, outcomes, and significance. Evaluation may be conducted internally by the organisation itself or by external evaluators.

**Multi-agency:** some combination of statutory services, agencies and teams of professionals and other practitioners, working together to provide services.

**Partnership:** a voluntary but structured collaboration between two or more organisations to address a common problem or issue of concern. In this report, the main forms of partnership referred to are between local authorities, community groups and other agencies to reduce carbon emissions and energy use. A partnership may involve multi-agency working.

**Physical interventions:** changes made to a building in order to reduce carbon emissions and/or reduce energy demand. They can be:

**Fabric measures** – energy efficiency measures to upgrade the physical fabric of a dwelling (e.g. draught-proofing, double glazing, loft insulation, cavity/solid wall insulation).

- **Technical measures** – measures relating to services and systems within a dwelling (e.g. condensing boiler, appliances with high efficiency ratings and items such as timers and standby-off switches). In this report they also include LZTs.

**Renewables:** systems that generate energy (heat or electricity) from resources which are naturally replenished on a human timescale such as sunlight, wind, rain, tides, waves and geothermal heat.

**Sense-making:** making sense of new information or experiences. It is a process or activity in which we understand, create order, and give meaning to new concepts and experiences, and integrate these concepts and experiences with what we already know (Weick, 1995).

**Social learning:** at an individual level social learning can occur in social or informal contexts, through interactions with others, or by observing their behaviour and actions. At an organisational level, social learning can involve participative and collaborative approaches to addressing complex problems (for example, workshops which encourage the sharing of experiences and approaches to address issues such as tackling fuel poverty).

**Subnational energy data:** annual energy datasets published by DECC at various scales including local authority and super output areas.

**Super output areas:** designed to improve the reporting of small-area statistics, they offer a choice of scale for the collection and publication of data. Local Super Output Area datasets show changes in energy and carbon outcomes in the areas immediately around and adjacent to the EVALOC LCCs.

## Key findings

### *Why do the impacts of low carbon communities need to be evaluated?*

- Low Carbon Communities (LCCs) across the UK have significant potential to secure greater public participation in energy and carbon reduction projects than conventional 'top-down' approaches to promoting energy efficiency and distributed generation. According to the national Community Energy Strategy (CES) launched in January 2014 and the CES update published in March 2015, there are now more than 5,000 low carbon community groups (LCCGs) active in the UK working to transform how their community uses energy.

- LCC projects are usually diverse, including both supply- and demand-side initiatives. They often incorporate a far greater range of sustainability objectives than simply carbon reduction and financial benefits, combining behaviour change initiatives, efficiency measures and micro-generation with empowering and enabling change and participation in local social, economic and technical contexts. Using varied approaches, they often take account of localised issues and contextual factors in a way that wider-scale programmes cannot.

- LCCs are often best placed to influence and communicate with individual occupants and households due to their familiarity with the contextual factors that shape individuals' behaviours.

- Despite the impetus for LCC action and the growing number of LCC groups, detailed evidence on the impacts of LCC projects is very limited and fragmented. LCCs also find it difficult to measure the outputs and outcomes of their activities in a way that enables comparison with other groups. This provides a good rationale for bringing together academic researchers with case study LCCs, to conduct action based research and provide support for capacity building in LCCs to improve their effectiveness.

- EVALOC research focussed mainly on energy and carbon reductions, and related social and economic benefits, from LCC household energy and carbon reduction activities. LCCs are also active on related issues such as transport, food, waste and tree planting, but evaluation of these aspects was outside the scope of the project.

### *What are the impacts of community-based low carbon initiatives?*

- LCCs are contributing to energy and carbon reductions at community and household level:

- Directly through their own activities.
- Indirectly through spin off or ripple effects such as the growing numbers of solar PVs installed by households in an LCC area, or the insulation of local tower blocks resulting from a chance meeting between an LCC member and council officer.

- Percentage reductions in average household annual gas and electricity use in the Lower Layer Super Output Areas (LSOAs) containing the six case study LCCs, are favourably comparable to national percentage reductions in average household gas and electricity use over the same period of time (January 2008 to January 2012), with two of the LSOAs showing strikingly higher reductions (Sustainable Blacon for gas consumption; Kirklees-Hillhouse for grid electricity). This is particularly significant as four of the LCCs had low starting baselines, which can indicate reduced potential for savings.

- LCCs also generated a range of related social and economic benefits at household and community level:

- At individual household level, benefits included increased agency, energy know-how/skills, financial savings, warmer and more comfortable homes (and hence improved health).
- At community level, benefits included: interest, volunteering and resident participation in energy activities, including people who would not otherwise been able to afford interventions and/or would not have previously considered themselves 'green'; the creation of community-owned assets and related income streams; skills and jobs; social relations and networks that enabled and sustained LCC action; community pride; and energy and carbon reduction activities by other organisations catalysed by the LCCs.

- There were also some unintended outcomes such as a degree of 'jealousy' among residents who did not receive solar panels, or the production of an Eco Guide for mosques by a young woman who had been inspired by one of the LCC projects.



### **What are the roles, capabilities and limits of LCCs in reducing local energy use?**

- LCCs seek to play a wide range of roles to reduce local energy use, most of which are arguably under-resourced. Ten interlinked and mutually reinforcing roles were identified that all the LCCs undertook to a greater or lesser extent to reduce local energy use at *downstream* level (with local residents), *midstream* level (with other local organisations and LCCs), and *upstream* level (with government and policy makers).

- Most LCC effort was spent at *downstream* and *midstream* level to enable residents to reduce their energy use and carbon emissions.

- Lack of time and resources meant that LCCs were unable to spend much effort on *upstream* roles to influence policy makers, despite having valuable intelligence about what policies work and don't work on the ground.

- The capabilities and limits of the LCCs to undertake the identified roles and reduce energy use depended on the types of organisations involved in the LCC and their mandates, powers and resources.

- The organisations directly involved in reducing local energy use in the six EVALOC LCCs included local authorities, city-wide and local charities, social enterprises, community groups, residents, housing associations, other statutory agencies and private sector companies contracted by the LCCs to install community and household physical interventions.

- There did not appear to be much active involvement from statutory health agencies despite the well documented links between household energy efficiency, cold homes and health.
- In some LCCs, the community groups were the main actors in carrying out carbon and energy reduction activities (e.g. LCWO and HN-LC). However, there was an uneven distribution of organisations involved in the LCCs which affected the capacity, reach and scale of their activities.

- The LCCs involving an active local authority (Kirklees-Hillhouse) or city-wide charity (Eco Easterside) were more confident about promoting the uptake of physical interventions and addressing fuel poverty than the others, whereas community-led initiatives tended to be more confident about developing innovative approaches to reducing energy use, empowering residents to take action and enabling them to change their behaviours. Two of the community-led LCCs (Sustainable Blacon and Hook Norton Low Carbon) were also relatively confident about promoting the uptake of physical

interventions (although no LZTs were funded in Sustainable Blacon).

- All LCCs were confident at community engagement and dissemination. Partnership and multi-agency approaches helped increase the scale and reach of energy efficiency and renewable programmes by combining the resources and strengths of different organisations. However these approaches were not present in all case study communities.

- The ability of LCCs to reduce energy use and carbon emissions is constrained by a range of structural influences on energy use that are beyond their control. Some of these include: changes in and uncertainties around the Feed-in-Tariffs (FiT); financial cuts; withdrawal of statutory duties on local authorities; effects of austerity and recession on local people (e.g. reduced confidence to take on loans); and lack of local infrastructure and capability (e.g. recycling facilities, trusted installers).

### **In what ways do LCCs engage and motivate residents to get involved in LCC initiatives?**

- The LCCs used a range of methods to motivate residents to get involved in community-based initiatives on energy and carbon reduction. These included free energy efficiency measures or renewables; provision of technical or behavioural advice and support; complementary sustainable living projects on transport, waste reduction and food. Other engagement methods included newsletters, door-knocking, home visits, community events, word of mouth, community hubs, photo stunts and flash mobs.

- Residents were motivated to reduce energy use for both intrinsic reasons (e.g. climate change and social justice) and extrinsic reasons, such as saving money. One of the disadvantaged communities successfully used a mix of extrinsic and intrinsic messages to engage and motivate residents.

- All the LCCs have succeeded in engaging and motivating significant sections of their community to get involved in their activities, however the reach of the different LCCs varied according to their organisational make up and capabilities.

- All LCCs also faced difficulties in widening engagement, related to: (a) the nature of the LCC as a community (b) the resources it could draw upon (c) the design of the project interventions (d) characteristics of the individuals involved, and (e) the time available for their involvement.

***What is the role and influence of community-based social learning for stimulating energy saving behaviours? What is the role of shared learning amongst LCCs for energy-related change?***

- Community-based social learning through community events can play an important role in stimulating energy reduction, by increasing participants' know-how, motivation, ability and intentions to take action on energy. The community events:

- Enabled participants to learn about energy saving and energy generating technologies, behaviours and practices through informal interaction with others in social settings.
- Increased participants' belief that their actions were meaningful, and hence their motivation and intention to act.
- Created a space, and permission, for conversations about energy, and provided an opportunity for individuals to develop a more publicly-minded conversation about energy.

- The most effective social learning methods were participatory and interactive activities which provided opportunities for people to discuss and share experiences of energy and carbon reduction, as well as demonstrations.

- A limitation to social learning through community events appeared to be the limited resource and capacity of some of the LCCs to provide complementary and structured programmes of outreach and support to residents, so as to address other technical and economic influences on energy use.

- Shared learning events and activities between LCCs helped them increase their understanding of complex challenges and strengthen their change strategies. Intermediary organisations were able to play an important role in developing a low carbon community of practice, by supporting and enabling shared learning activities.

***How useful is carbon mapping in baselining, predicting, visualising and communicating domestic energy use and carbon savings to communities?***

- Carbon mapping LCCs, using the established DECoRuM carbon counting and carbon reduction model, has emerged as a useful approach for rapidly

and visually measuring, modelling, (spatially) mapping and managing energy use and carbon emission reductions on a dwelling-by-dwelling level, and aggregated to a community scale.

- Carbon mapping helped LCCs to:

- Visualise using spatial maps, the distribution of physical characteristics (by age, built form, south facing roofs etc), energy use and carbon emissions of the local housing stock. This in turn revealed areas of high energy use that can be targeted for action.
- Cross-relate energy performance of dwellings with actual heat loss shown through thermal images, to improve energy literacy and awareness.
- Estimate domestic energy use and carbon emissions pre-Low Carbon Community Challenge (LCCC) funded LCC activities (baseline) and post-LCCC funded activities, thereby quantifying the energy and carbon savings achieved from the implemented domestic carbon reduction measures.
- Evaluate the potential for further energy, carbon and fuel cost reduction in dwellings, using a whole range of best-practice energy efficiency measures and low-zero carbon technologies, either singly or in combination (packages). Bespoke scenarios for reduction of energy, cost or carbon emissions were created, which helped communities prioritise measures for future action.

- By identifying what dwelling can take up which carbon reduction measure at what cost, carbon mapping can help local authorities, community groups, housing associations and householders prepare for policy mechanisms such as the national Green Deal/Energy Companies Obligation (ECO) programmes, and 'scaling up' energy improvement measures and retrofits. Although not explored in the project, carbon mapping also offers the capability to update and track energy improvement measures installed and energy savings achieved in practice.

- Outputs from DECoRuM carbon maps of estimated energy use and carbon reduction potential of individual dwellings were used to provide energy feedback to householders (on a community level) through workshops, wherein the local community also had access to expert information and advice on how to take action on energy and carbon reduction through individual discussions and group presentations.

- The workshops were found to engage and empower householders in taking action by providing technical knowledge on carbon reduction; and also influence behaviour change through education and collective action.
- The potential improvement measures that were most popular included wall and roof insulation, draught-proofing, double glazing, improved heating systems, renewables, LED lighting, and thermostat-setting changes.
- The workshops also helped to gather more data from householders (using questionnaires), to further refine the model.

***What are the effects of community-based home energy improvements (related to building fabric, energy systems, controls and LZTs) and behaviour change initiatives on household energy use, indoor environmental conditions and energy behaviours? How sustainable are these behaviours?***

- The analysis of longitudinal gas and electricity data (January 2008-January 2013) showed that the majority of households with physical interventions (related to building fabric, energy systems, controls and LZTs) and/or behaviour change interventions achieved reductions in both electricity and gas use. This corroborates findings from the occupant interviews which revealed that 90% (43/48) of those that directly benefited from LCC activities felt that the LCC had helped them reduce their energy use.

- However changes in energy use varied greatly across different households. The reasons for this are equally as varied (e.g. changes in occupants, thermal comfort expectations, health) thereby reinforcing the case study based monitoring and evaluation approach that the project adopted. The impact of LZTs on grid electricity use is particularly evident; where increases of nearly 500% can be seen in electricity use of households with ASHPs, as well as reductions of up to 65% in mains electricity after solar PVs have been installed.
- The monitored energy use in case study households (from December 2012 to November 2014) showed that, in relation to national averages for their dwelling type, the majority of the case study households are using less energy, although further energy reductions are still possible.

- The majority of the case study households experienced increased comfort levels since they installed physical interventions (both fabric measures and technical measures such as improved heating systems and controls). Unsurprisingly more stable and warmer indoor temperatures and lower relative humidity levels were measured during the heating season in dwellings with more than three fabric measures, than in those with fewer fabric improvements.

- However dwellings with relatively high levels of fabric insulation were found to be at a greater risk of overheating, particularly in the bedrooms, during summer. Background ventilation (without losing heat) in such dwellings is vital for maintaining comfort and good levels of indoor air quality.
- Some unintended consequences of 'poorly installed' fabric insulation (loft and wall) were seen through the occurrence of condensation and appearance of mould in some cases.

- Physical energy improvements and behaviour change initiatives have had significant impacts on energy-related (habitual and 'one-off'<sup>1</sup>) behaviours within the homes in which these took place. These include *direct* and *indirect* impacts, and appear to be generally positive:

- *Direct*: following advice and information from the LCC (e.g. from workshops), householders reduced water use in kettles and changed their washing machine settings.
- *Direct*: following advice and information during active-learning workshops and/or home visits, households felt more able to purchase and/or undertake further physical improvements.
- *Indirect*: heating behaviours were altered due to a perceived increase in warmth and comfort levels following insulation, as occupants felt less likely to turn on the heating, and in some cases turned their radiator thermostats down completely in rooms they rarely occupied.

- Most of the case study households were found to have sustained positive energy-related behaviours from 2012 to 2014. This may be in part due to most of the participants having high levels of motivation and concern about energy-related issues, and the fact that a significant number commented on practicing energy-saving behaviours prior to their

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<sup>1</sup> 'one-off' behaviours can also be referred to as 'purchasing' or 'consumer' behaviours and refer to less regular behaviours such as installing loft insulation.



involvement in the LCC activities and EVALOC research study.

- Overall LCC-led home energy improvements have been effective: by channelling technical and financial help to install physical interventions, providing the residents with the motivation, and agency to undertake physical measures, and/or reinforcing habitual energy-saving behaviours.

### ***What is the influence of low and zero carbon technologies (LZTs) such as heat pumps and solar photovoltaics (PV) on energy use, carbon reductions and household energy behaviours?***

- The influence of LZTs such as air-source heat pumps (ASHP) and solar PV systems on energy use, carbon reductions and household energy behaviours is mixed.

- Monitored electricity generation data from solar PV systems indicated that they performed as well as, or better than predicted. This indicates that solar PV systems have had a positive impact on reducing carbon, either directly (by reducing the amount of electricity supplied from the grid), or indirectly, by exporting zero-carbon electricity to the grid.
- ASHPs had a positive impact through enabling some residents in rural areas to switch away from expensive oil to a relatively efficient form of electrical heating. However, physical monitoring of ASHPs' performance, indicated that there were no significant carbon savings, based on the current carbon intensity of grid electricity.

- Households with solar PV systems showed signs of adapting their behaviours, where possible, to use their 'free' electricity, either by undertaking electricity-using activities during the daytime wherever possible, or even putting the washing machine or dishwasher on a timer so that it came on during daytime. This indicates potential interest of householders in demand response, an area that will gain salience with smart metering.

- PV systems did not always inspire energy-saving behaviours. Some households commented that since having the PVs they started using their dishwasher (prior to PVs, they did not) or even put their clothes in the tumble dryer rather than hang them out in the sun.

- Most households with ASHPs had experienced issues with the installation and commissioning of their systems, which in some cases led to recurring

problems with performance. Despite this, they seemed relatively satisfied in terms of the system providing uniform heat throughout the home.

- EVALOC monitoring experience showed that retrofitting monitoring devices (heat meters, electricity sub-meters) to measure actual performance of LZTs (especially solar thermal and heat pumps) was neither easy nor cheap. It would be better if such devices were either built into the system or fitted at the time of installation which would also enable householders to receive feedback on the performance of LZTs to potentially motivate further behaviour change and allow them to monitor the performance of their systems.

- Without any feedback available from the LZTs, householders have no way of knowing whether these are working or not, nor engaging with and optimising their use of the technology and resulting cost/energy savings.

### ***How useful are techniques such as thermography, community carbon maps, web-based energy-environmental feedback and personalised household energy reports in providing feedback to householders and raising awareness?***

- Energy feedback was recognised as an important aspect of this research study, not only in terms of how the LCCs provided it as a means of supporting learning and behaviour change, but also in terms of how the results of the research were fed back to a) the communities and wider public and b) to the case study households involved. A variety of techniques were trialled within the study. What EVALOC has shown is that by offering feedback that is complementary in time and application, there is potential for covering the whole spectrum of home energy use in a single programme, using a range of media.

- At community level, carbon mapping and thermal imaging workshops aimed to feedback community-wide findings in terms of changes in carbon emissions and energy use, as well as pointing to possible future activities. Carbon mapping was relatively successful, but was felt to be aimed more at community groups and organisations rather than individual householders and as such did not engage the local residents as much as thermal imaging.

- The majority of the feedback approaches used were able, to some extent, to engage, raise awareness and motivate householders into action. Different feedback techniques appealed to different

households, and this did not necessarily depend on the community in which they lived. However, even in households with high levels of engagement both with energy use and the research study, often the posted or emailed home energy reports were forgotten or 'put in a drawer for later'. Yet, when combined with a researcher's visit, they created the opportunity for discussion and 'sense-making' conversation, using the feedback as a prompt which appeared to increase engagement through contextualising the feedback for the occupants, and also created an awareness of energy on a very personal level for the household.

- The usefulness of different modes of feedback at several levels, to contextualise as well as engage, has been an important lesson from the EVALOC feedback programme.

- A further outcome has been to drive home the point that it is difficult to raise awareness or to prompt durable carbon reductions through technology alone: knowledge and practical know-how need to be transferred along with technology. Where feedback is concerned, some degree of personal contact was usually needed to make the most of what the feedback technology was able to provide in the way of information.

### ***How are energy display monitors used in a social context, and how can they be used to best effect to raise awareness and change practices?***

- The social contexts for energy display monitors (EDMs) were the community in which the EDMs were introduced and experimented with and, at the smallest scale, the household itself. The EVALOC findings come from a small sample of households therefore statistically valid conclusions cannot be drawn from them. Nonetheless, they fit with what has been learned elsewhere in the UK about the use of home energy displays. A recent review of evidence from the UK and elsewhere<sup>2</sup> concludes that:

- Most householders are willing to try out an EDM, and can gain some benefit from it in terms of better understanding of their energy use. EDM users make energy savings of a few percent on average, with considerable variations in outcome.

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<sup>2</sup> In particular, see AECOM (2011) Energy Demand Research Project: final analysis. Raw G and Ross D, AECOM, London; Darby, S.J., Liddell, C., Hills, D. and Drabble, D. (2015) Smart Metering Early Learning Project: synthesis report. For the Department of Energy and Climate Change, London

- It helps to have some prior knowledge about energy displays ahead of installation, so that householders have some idea of what to expect, and of how the display might help them.
- Good design is important: the basic design needs to be very simple, with more complexity available for people who want to 'dig deeper' into their energy data.
- Even with good design, many people will not find it easy to set up and use a new piece of technology<sup>3</sup>. It helps to have complementary advice and information from trusted sources, during or after installation.
- People mostly use displays in one of two basic ways: 1) to primarily to find out how much electricity each of their appliances uses, after which they often lose interest and 2) others progress to using their display as part of their housekeeping routine, for example by checking that appliances are switched off at bedtime, or monitoring usage over time to see whether their energy-saving efforts are effective. This 'monitoring' approach is the one that offers the best prospect of satisfaction with the display and reductions in energy usage.

- The EVALOC findings are consistent with these conclusions, and help to fill out knowledge of how EDMs can be used in parts of the country where there is already a 'community conversation' about energy. The case study home interviews, and the feedback from EDM libraries, shows how EDMs:

- Created 'lightbulb moments' by making energy use visible.
- Became talking-points and part of a process of social learning.
- Prompted changes in everyday energy use, especially with kitchen appliances.

- The EVALOC evidence also shows how rare it is for EDMs to 'work' in isolation (that is, when the householder is simply given the device and left to get on with it); and how important it is to *introduce new technology along with the knowledge needed to make sense of it and operate it*. Thus the most enthusiastic references to EDMs came from householders who belonged to 'sense-making' groups, looking at different aspects of low-carbon living. Failing that, it could be useful to have a little support and advice at or around EDM installation,

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<sup>3</sup> The EVALOC researchers had difficulty in setting up some of the EDMs used in the project.

from a technically-savvy family member or part of the LCC team.

***What is the role of social networks in promoting or suppressing the communication and take-up of new energy technologies, and how far do these interconnect with local community networks?***

- 'Energy messages' (conversations about any aspect of energy and carbon reduction) are transmitted through personal social networks, mainly to close friends and family. Through social network analysis of the case study households, it was found that they mostly took the form of discussions concerning general energy efficiency, energy prices and bills, and low carbon technology. Other findings from the EVALOC study included:

- Energy was not necessarily considered a neutral subject by the interviewees: they may consider it as *novel* (e.g. new solar panels or EDMs), a *practical issue* (e.g. how to get a boiler upgrade) or an *issue which implies judgement* (e.g. the feeling of not being 'green' enough). This influenced whether, and to whom, they communicated energy messages, and the contexts where energy was discussed.
- The transmission of energy messages did not happen automatically through personal and social networks but required individuals to actively 'navigate' through the attitudes and experiences of those they were talking to.
- Fear of judgement or stigma could impede the dissemination of energy messages; no-one wants to be thought of as a bad person because they are not thinking about energy or climate in the approved manner.

- LCCs also used personal social networks to promote the communication and uptake of energy messages and know-how, e.g. by holding community events to provide a focus and space for conversations, by identifying and training community champions, by word of mouth, and by demonstration projects.

- LCCs can aid the dissemination of energy messages by creating a range of opportunities in different contexts where energy conversations can be catalysed and seen as permissible, as evidenced in qualitative feedback from the case study households.

- There is some anecdotal evidence that energy conversations have influenced energy behaviours and/or the take up of new energy-related technologies in the communities.

***How effective are LCCs in helping householders change their energy behaviours and reduce energy use? What are the constraints?***

- The majority of the LCCs in the study appeared effective in enabling local residents to overcome some constraints to changing their energy-related behaviours at household level. They achieved this in a variety of ways including:

- *Economic and technical resources and support* to enable the uptake of energy efficiency and renewable measures. Offering free measures and arranging for them to be installed increased uptake, particularly for low-income residents.
- *Careful, expert in-home advice and discussion* to enable residents to use LZTs effectively, and to give installers and the LCC programme a better understanding of energy-related behaviours and the ways in which people adopt and adapt to new technologies.
- *'Sense-making'* to build energy literacy through feedback about energy use, including EDMs, thermal imaging, carbon mapping, self-reporting community evaluations and national databases.
- *Group-based social learning opportunities* in informal and safe settings such as community events or 'action and learning' groups, so residents could acquire understanding, knowledge and practical know-how about reducing their energy demand and adopting LZTs.
- *Complementary community activities* to encourage and enable residents to change wider practices that contribute to carbon emissions, for example in relation to transport, food, and waste.

- A number of factors were found to constrain the effectiveness of LCCs in supporting physical and behaviour change interventions in households. For example it was difficult to source funds for important support roles and behaviour change work. Also it was often challenging to find and employ local skilled tradespeople, particularly when dealing with relatively new technologies such as heat pumps.



- Both behaviour change and physical interventions required a lot of resources (time, financial, human) upfront, during and after interventions. This required on-going support for both the beneficiaries of the interventions and the LCCs and their volunteers, to maintain and develop physical measures, behaviour change, local knowledge and skills.

### **How can LCCs best monitor and communicate their own effectiveness at energy demand reduction and learn from their work?**

- LCCs are closer to their local communities; more able to call on trusted local volunteers and able to use more varied engagement techniques (from children's theatre to carbon mapping) than government or business actors.

- To maximise learning, LCCs need to be able to contribute to the design of Monitoring and Evaluation (M&E) and have opportunities to learn from and reflect on the research findings.

- Action research provided a useful way of conducting M&E and also increased the quality of the research. However LCC participation in research can be constrained by lack of time and resource; participation needs to be resourced appropriately to allow for full participation by voluntary organisations.

- Annual reflection on the LCC group processes, as well as outcomes and impacts, aided group cohesion. Participative and visual materials helped with qualitative group evaluation processes. Furthermore the dissemination of results in a clearly-understandable format was essential for communicating effectiveness.

- EVALOC research identified the following support and resources to assist LCCs with M&E:

- The provision of energy data at a more granular level from DECC (e.g. at street or postcode level), which would assist LCCs in assessing their impact on overall energy use in smaller geographical areas, than what is possible at present.
- Longitudinal data collection (i.e. over 5-10 years) is needed where possible to give a more accurate appraisal of LCC impacts and sustainability. LCCs lack the guaranteed long-term capacity to do this. It can also be difficult to access retrospective energy data for individual households in an area, especially from some energy suppliers.

- Integration of visual tools such as carbon mapping, with publicly-available energy, built environment and social datasets to reduce time and effort for collecting data to build carbon models.
- Support and resources to help LCCs implement, analyse and interpret longitudinal surveys of residents, whether involved in LCC projects or not.
- Accessible M&E resources, such as M&E guides, easy-to-use tools and sample questionnaires.

- For M&E of LCCs to be effective, it should take account of their *downstream* impacts (upon local community members/beneficiaries of activities such as householders); *midstream* impacts (e.g. on local partnerships, and other LCCs); and *upstream* impacts (e.g. on influencing government policy). In this way, M&E could pave the way for 'scaling up' the impacts of LCCs through aggregation of outcomes, without LCCs losing their grounding in place and community.

- Support from academics, skilled M&E mentors or peer mentoring would help LCCs design and implement their own M&E programmes, including assessing longitudinal changes. Ultimately this would help to build a more comprehensive picture of the impacts and outcomes from LCC projects across the UK, to help the LCC sector continue to grow and also support national policymaking.

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# Chapter 1

## Introduction

This report presents findings from the EVALOC research project (Evaluating the impacts, effectiveness and successes of low carbon communities on localized energy behaviours), which was funded by the ESRC-EPSRC Energy and Communities stream of the Research Council UK's (RCUK's) Energy Programme (Grant reference: RES-628-25-001).

The project ran for four years and three months (January 2011 to March 2015), and brought together an interdisciplinary team of building science and social science researchers from the Low Carbon Building Group of Oxford Brookes University and the Environmental Change Institute of University of Oxford, to assess and explain the changes in energy use due to community activities within six selected low carbon community projects, funded under the Department of Energy and Climate Change's (DECC) Low Carbon Communities Challenge (LCCC) (DECC, 2012). The LCCC initiative was a government-supported initiative that ran from 2010 to 2011, and was designed to test the effectiveness of community-scale approaches that combine low carbon technologies with engagement and behaviour change activities. The overall aim of the EVALOC project was to evaluate the role, impacts, effectiveness and limits of low carbon communities in motivating energy reduction and renewable investment amongst local residents. These low carbon community projects were evaluated in terms of their IMPACTS on changing household and local energy behaviours, EFFECTIVENESS on achieving real-savings in energy use and carbon dioxide (CO<sub>2</sub>) emissions and SUCCESS in bringing about sustained and systemic change. The research focussed mainly on assessing the LCCs' household energy and carbon reduction activities, which involved a variety of approaches and were resourced from a variety of sources. The research did not investigate in depth the outcomes or impacts from the LCCs' wider sustainability activities relating to waste, transport, food.

To address the overall aim, the project aimed to answer the following questions:

- What are the roles, capabilities and limits of LCCs in reducing local energy use?
- What is the role and influence of community-based social learning and shared learning for stimulating energy-related change?
- How useful is carbon mapping in baselining, predicting, visualising and communicating

domestic energy use and carbon savings to communities?

- What are the effects and impacts of community-based home energy improvements (related to building fabric, energy systems, controls and LZTs) and behaviour change initiatives on household energy use, indoor environmental conditions and energy behaviours?
- How useful are techniques such as thermography, community carbon maps, web-based energy-environmental feedback and personalised household energy reports in providing feedback to householders and raising awareness? How are energy display monitors used in a social context, and how can they be used to best effect to raise awareness and change practices?
- What is the role of social networks in promoting or suppressing the communication and take-up of new energy technologies, and how far do these interconnect with local community networks?
- How can LCCs best monitor and communicate their own effectiveness at energy demand reduction, and learn from their work?

To address the research questions, the project adopted a *programme of collaborative action research*, complemented by a *mixed-methods monitoring and evaluation (M&E) approach*, using qualitative and quantitative methods. The action research approach entailed an iterative cycle of action and reflection in which the six case study communities were involved as co-researchers in shaping the design, implementation, and interpretation of the research programme and its outputs, as well as being subjects of the research. This involved working interactively with the case study communities at both the organisational and individual household level. A variety of research methods were used, including co-design of 17 community events, three rounds of focus groups and an energy display library and trials, to stimulate energy reductions and learning. The M&E framework adopted in the EVALOC project included evaluation of the impact of community events, focus groups and EDM trials; dwelling-by-dwelling mapping of energy use and carbon emissions of approximately 1,700 households using the DECoRuM carbon mapping tool; with physical monitoring and household surveys to assess the performance and impacts of community-led home energy improvements and energy retrofits across 88 households; and exploration of how knowledge and know-how are transmitted through social networks.

This report gives an overview of the project's approach and methods, and summarises its findings. First, it sets the context for community action on



energy and climate change, and then explains how the project conceptualised the challenge of measuring the impact of community-based energy initiatives.

## 1.1 Context for energy and communities

In 2009, the UK Government's Department of Energy and Climate Change (DECC) Low Carbon Transition Plan noted that "We often achieve more acting together than as individuals", and that the government's task is to foster "an environment where the innovation and ideas of communities can flourish" (DECC, 2009, p. 92). And indeed, a quiet revolution has been happening in grassroots-led energy action - communities across the UK are coming together to take more control of the energy they use. Over the last 10 years, the annual rate of formation of community energy projects has doubled (Seyfang, Park and Smith, 2013). According to the first-ever national Community Energy Strategy (CES) launched in 2014 (DECC, 2014a) and CES update published in March 2015 (DECC, 2015c), there are now more than 5,000 low carbon community groups (LCCGs) active in the UK working to transform how their community uses energy (DECC, 2014a). A LCCG is an organisation working on issues of carbon reduction at a local level (e.g. village, neighbourhood, town or city), where community members govern and run the group, and are the beneficiaries of the project. A broader term is 'low carbon communities' (LCCs) - organisations in a geographical community that are jointly involved in promoting community-level energy and carbon reduction activities that are often innovative, with benefits enjoyed collectively and locally (Peters and Jackson, 2008).

Energy action in LCCs can be led by LCCGs (community-led); or through a partnership or multi-agency approach involving LCCGs, local authority, other statutory agencies and intermediary organisations but targeted at communities (community-focused). Typical LCC projects are diverse, including both supply- and demand-side initiatives. Rarely single-faceted, they often incorporate a far greater range of sustainability objectives than simply carbon reduction and financial benefits, combining behavioural initiatives, efficiency measures and micro-generation with empowering and enabling change and participation in local social, economic and technical contexts. Such projects also fall under the umbrella term 'community energy', widely used in academic and policy literature, representing community initiatives focused on reducing energy use, managing energy better, generating energy or purchasing energy (DECC, 2014a).

What is becoming increasingly clear is that such bottom-up and localised approaches can stimulate pro-environmental behaviour by provoking greater participation, fostering networks, relationships and capacities for future action, and reducing carbon emissions as a result (Barr, 2008; Hobson, Hamilton and Mayne, 2014). It is also found that community-led action can tackle some of the most difficult issues more effectively than government alone, since communities have the ability to mobilise and engage people creatively and effectively by tailoring community engagement to an audience that they understand well, using their presence and 'representative voice' to meet local needs. A government report shows potential value from community activity to smart meter roll-out, through awareness raising, motivating people to continue using their smart meters beyond the initial period, providing practical help and support, and handholding householders through the process of getting and living with a smart meter (DECC, 2013a). Community-based projects focussing on household energy use are thus increasingly seen as drivers of change due to their multi-faceted and innovative approaches to a complex set of issues, as well as their unique potential to 'localise' agendas and account for contextual factors (Karvonen, 2013). In fact, community-based programmes of energy improvements and retrofits complement conventional energy-efficiency approaches to create large-scale, deep changes to domestic energy consumption (Gupta, Barnfield and Hipwood, 2014).

## 1.2 Challenge of measuring impact of low carbon community initiatives

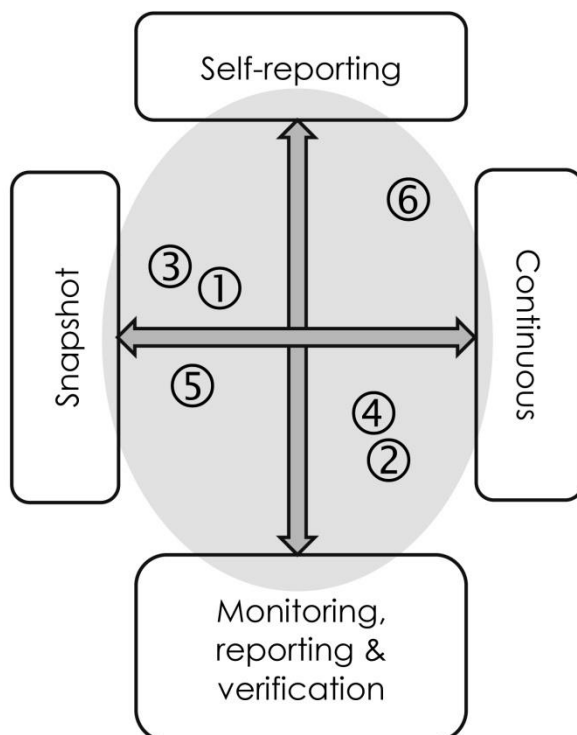
While many LCC projects take place with low levels of external support, some funding has been available over the past five years, such as DECC's £10million Low Carbon Communities Challenge, and £9.2m Local Energy Assessment Fund, and the Big Lottery Fund £50m Sustainable and Resilient Communities strategy. Despite this impetus for LCC action, the usefulness of LCCs as a policy tool (Seyfang, Park and Smith, 2013) and the growing number of LCCGs, detailed evidence on the impacts of LCC projects is very limited. In particular, there is a lack of evidence on measured energy (carbon) outcomes, impacts on energy behaviours, or added benefits (DECC, 2013b).

Existing research (Figure 1.1) on evaluating LCCs consists mostly of qualitative studies of a small number of projects and a snapshot survey of the scope, character, activities and challenges faced by the sector (Seyfang, Park and Smith, 2013).

Although the DECC-commissioned evaluation report on the LCCC programme (DECC, 2012) is one of many independent light-touch evaluations, many

aspects of the evaluation rely on self-reporting from both the community groups and individuals involved, and the process lacks in-depth evaluation of the long-term systemic effects and impacts of the programme (Gupta, Barnfield and Hipwood, 2014). In this context, being able to assess and evaluate outcomes and impacts over time and across scales is imperative for LCCs themselves, as well as researchers and policy-makers, to understand what works and what does not, especially when exploring the possibilities and processes of scaling up such 'niche' innovations. Furthermore, evaluation of LCC action can provide group learning, improve process and impact, ensure accountability of stakeholders, and provide evidence to motivate support, influence policy and support fundraising (Cox *et al.*, 2010).

However, questions remain about what role M&E can play in helping LCCs improve their effectiveness. While monitoring is understood here as the tracking, collection and analysis of information about an intervention, project, programme or process, undertaken while the project/programme is ongoing; evaluation is the assessment of the significance and longer-term effectiveness of interventions, during and after a project or programme. M&E may be conducted internally or by external independent evaluators. According to the DECC Community Energy Strategy documents of 2014, LCCs find it difficult to measure the outputs and outcomes of their activities in a way that enables comparison with other groups due to lack of knowledge about how to examine the data and concerns about tools and approaches, combined with a lack of volunteer time. This was the rationale for bringing together academic researchers with case study LCCs to conduct action based research and attempt to provide support for capacity building for LCCs to improve their effectiveness. Mixed-methods M&E approach was conducted using innovative tools and methods to provide empirical evidence on the outcomes and impacts of LCC action at community and household level.



①DECC LCCC evaluation

A multi-organisational, mixed-methods evaluation of 22 communities (DECC, 2012)

②EVALOC

An interdisciplinary, mixed-methods evaluation of 6 case study communities employing continuous household monitoring

③Big Energy Shift

A mixed-methods evaluation of public dialogue commissioned to identify community and household motivations to adopt low carbon measures (Rathouse and Devine-Wright, 2010)

④Energy Management Programme

A continuous evaluation of one community programme undertaken in partnership with University of Chester (Alexander and Hunt, 2011)

⑤Big Green Challenge

An evaluation of NESTA's £1million challenge prize focussing on measurable carbon reductions (Brook Lyndhurst, 2010)

⑥Low Carbon Living Programme

A toolkit based evaluation of carbon footprint using continuous self-reporting (Huggins, 2012)

**Figure 1.1** Conceptual framework for monitoring and evaluating low carbon communities initiatives (Gupta, Barnfield and Hipwood, 2013)

### 1.3 Structure of the report

The report is structured around nine chapters. Although 'community energy' is a widely used term in the energy-and-communities sector, due to the nature of EVALOC project, the terms 'low carbon communities' (LCCs) and 'low carbon community groups' (LCCGs) are used in this report. Wherever possible, the effectiveness of community-led household interventions is assessed in terms of both energy and carbon reductions. This is because carbon reduction may not necessarily be correlated with energy demand reduction.

Following the background and context provided in Chapter 1, a more detailed explanation is given in Chapter 2 on the EVALOC project framework, research methods and the case study communities. In Chapter 3, the roles and capabilities of organisations involved in the six LCCs are assessed so as to better understand the strengths and limits of LCCs in reducing carbon emissions, Chapter 4 assesses the extent to which the LCCs have motivated and engaged residents to get involved in their projects. In Chapter 5, the effectiveness of LCC projects in reducing energy use and carbon emissions is assessed, using longitudinal energy data across different scales, and combined with primary data gathered through a unique community carbon mapping approach. In Chapter 6, the monitoring and evaluation of the effectiveness and impacts of community-based home energy improvements and behaviour change initiatives are discussed, while Chapter 7 describes the energy and carbon feedback activities that were undertaken, their evaluation and key learnings. In Chapter 8, findings on measuring the impact of LCC action are presented, drawing from the action research approach and household level M&E. Finally in Chapter 9, the key findings are reviewed and their implications for policy and practice are discussed, with a description about the EVALOC energy and communities toolkit. The Appendices contain further details about the research methods, including details about community events organised and household M&E methods and techniques.

## Chapter 2

### EVALOC research project and case study communities

This chapter provides a brief summary of the approach, methods and activities adopted and undertaken by the EVALOC project in order to understand the roles, impacts and effectiveness of low carbon community activities. In addition, it outlines the main characteristics of the six selected case study low carbon communities (LCC) projects, including their geographical locations and socio-economic context as well as descriptions of the characteristics and interventions within the 88 case study households that are spread throughout these six communities.

#### 2.1 Overall approach and framework

The EVALOC study adopted a two-pronged methodological approach (Figure 2.1) involving a programme of collaborative ‘action research’ and a socio-technical mixed methods monitoring and evaluation (M&E) methodology in order to evaluate the six selected case study LCC’s in terms of their **impacts** (on changing individual and community energy behaviours), **effectiveness** (on achieving real-savings in energy use and carbon emissions) and **success** (in bringing about sustained and systemic change).

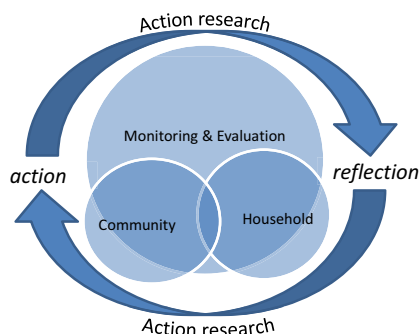


Figure 2.1 Overall EVALOC methodological approach

‘Action research’ (AR) is a now well-recognised approach for fulfilling the expressed needs of community-based organisations to share what they have already learnt with others, to build capacity within their groups for initiating further energy-saving activities and/or extend their existing communication networks, to maximise the impact, effectiveness and success of their activities and to bring together other communities of practice ‘to produce results they truly care about’ (Senge and Scharmer, 2006). Action research in the context of EVALOC, entailed an iterative cycle of action and reflection in which the

case study low carbon community organisations and groups were involved as co-researchers in shaping the design, implementation and interpretation of the research programme and its outputs, as well as being subjects of the research. The role and limits of action research in relation to the case study LCCs is discussed in Chapter 8, including a more detailed schematic of the overall AR framework and strategy. EVALOC conducted research and also fed back the findings to the LCC stakeholders, to assist in shaping future research and activities.

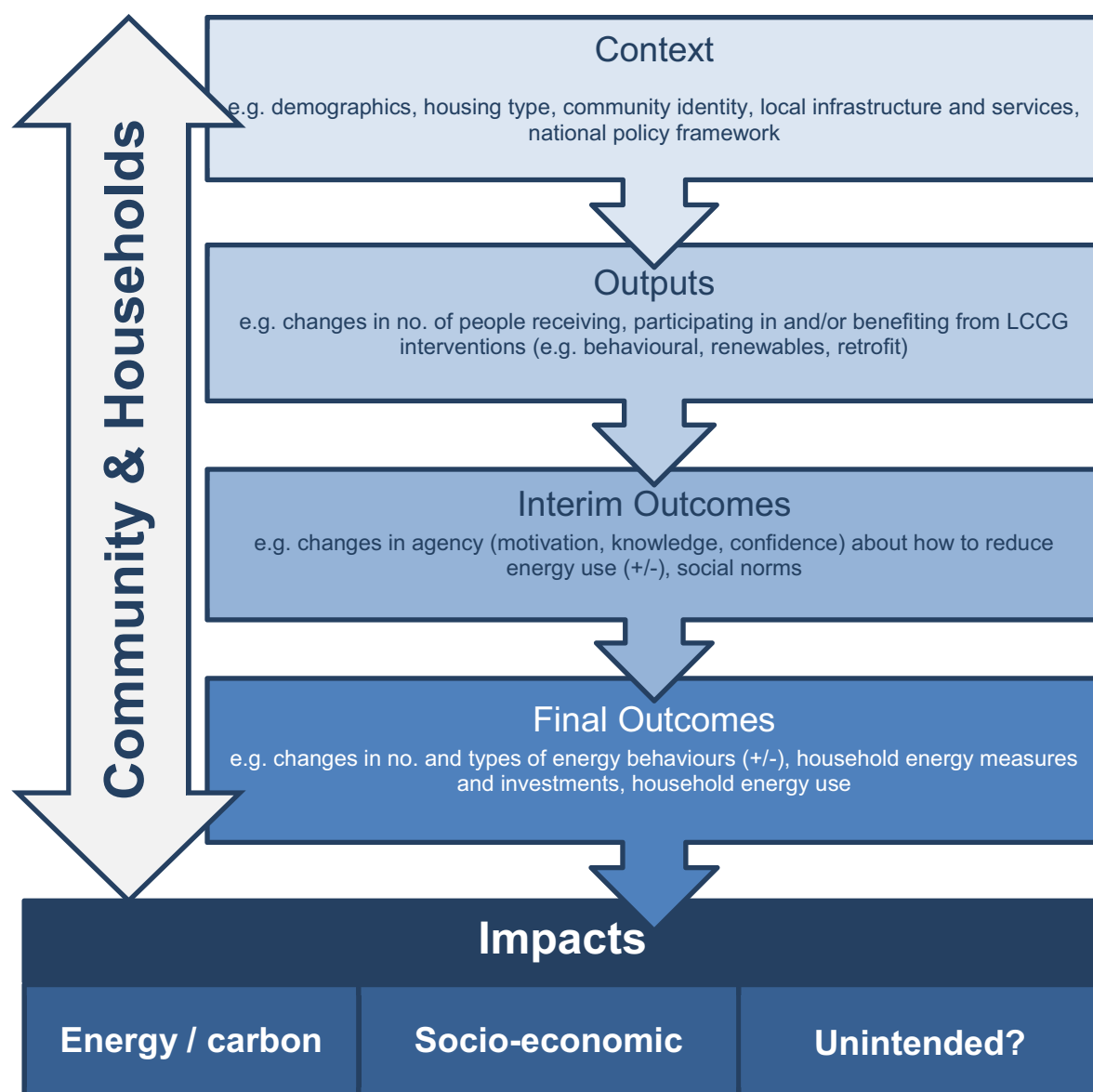
The socio-technical mixed-methods M&E approach enabled assessment of the effectiveness and impacts of the case study community activities at community and household level, as well as the exploring of some specific research questions relating to the role of social networks, community events and energy feedback in helping residents reduce energy use. Due to the evaluative nature of the study, the overall research framework (Figure 2.2) closely follows the impact pathway of interventions in terms of outputs, outcomes and impacts.

#### 2.2 Research methods and activities

The research was designed to provide in-depth insights into the effectiveness of LCC activities and thematic questions rather than to provide statistically valid findings. A range of research methods were used at household and community level to collect both qualitative and quantitative data; including:

- Collection of longitudinal community-wide energy data (gas and electricity only) for approximately 12,774 households across the six case study communities.
- 1,659 dwellings across the six communities carbon mapped.
- 142 DECoRuM carbon mapping self-completion questionnaires (across six communities, including non-LCC households).
- 17 focus groups with 76 participants in total (three rounds of focus groups across the six LCCs).
- 486 evaluation forms from 17 community and shared learning events.
- 146 interviews with case study households within the local LCCs (two rounds of interviews with 88 households).
- Longitudinal annual electricity data (from 2008 to 2012) collected for 77 households, and gas data for 47.
- Thermal imaging surveys of 88 households.
- Social network analysis of 86 households.
- Continuous physical monitoring of energy use and environmental conditions (with remote access) in 30 households.





**Figure 2.2** Overall research framework

In addition, EVALOC researchers supported 17 community events, with 2,155 participants, across the communities, including seven shared learning events that were attended by the case study LCCs as well as other LCCs from across the UK. Carbon mapping and thermal imaging workshops were also undertaken in five of the communities and energy display libraries were set up in four. A full list of research methods including sample numbers can be found in Appendix B.

### 2.3 Case study low carbon communities

The research was undertaken in six case study low carbon communities (LCCs) across the UK; one in North-East England, one in North-West England, one in Yorkshire & Humber, one in South Wales and two in South-East England (Figure 2.3).

They were chosen, in part, due to their involvement in the Department of Energy and Climate Change's (DECC's) Low Carbon Communities Challenge initiative (LCCC). This initiative, which ran from 2010 to 2012, provided around £400,000 - £500,000 to each of 22 low carbon community projects across England, Wales and Northern Ireland, to explore pioneering approaches to reducing carbon emissions through motivating energy reduction and renewable investment. All six case study communities had undertaken a variety of activities as part of the LCCC, and had adopted a variety of approaches.

In addition, the six EVALOC communities were chosen to represent a mix of socio-economic and geographical areas. Table 2.1 outlines the main characteristics of the area and the LCC activities from 2010 onwards.

It demonstrates that a number of the activities were only partly funded by DECC. These activities were happening concurrently to the DECC-funded activities and (although the focus is on evaluating the DECC-funded activities), the wider aims and activities of the LCCs are also assessed in this report where appropriate.

Throughout this report, the case study LCCs will be referred to either in full, or by their acronym as follows:

- Awel Aman Tawe (AAT)
- Sustainable Blacon (SB)
- Eco Easterside (EE)
- Hook Norton Low Carbon (HN-LC)
- Kirklees-Hillhouse (KI)
- Low Carbon West Oxford (LCWO)

## 2.4 Case study households

A case study approach was felt the most appropriate in terms of assessing the effectiveness and impacts of the LCC activities as it enables researchers to be close to real-life situations, access a great wealth of details and receive direct feedback from the households (and communities) under study.

Whilst this not only provides concrete experiences, it also creates an active learning process in itself. As Flyvberg (2006) notes, “Context dependent knowledge and experience are at the very heart of expert activity.”

Therefore, 88 case study households were recruited from across the six communities. Of these, 62 were studied in detail mainly due to the number and type of physical and behaviour change interventions present and their involvement in the LCC, whilst 26 were used as ‘control’. Further detail on the monitoring and evaluation approach can be found in Chapter 6.

Whilst the households were chosen due to their involvement in LCC activities (or non-involvement in the case of the ‘control’ households), they were also chosen to represent, where possible, the physical dwelling characteristics of their local area. This means that the case studies do not fully represent the UK’s national stock. For example, in West Oxford, Huddersfield (Kirklees-Hillhouse) and Hook Norton, many of the dwellings are pre-1919 solid wall dwellings; therefore the proportion of pre-1919 dwellings among the case study households is 30%, compared to the national figure of 20%.



**Figure 2.3** The six case study low carbon communities

**Table 2.1** Main characteristics of the LCCs including area characteristics and LCC activities from 2010 onwards

	Awel Aman Tawe	Sustainable Blaen	Eco Easterside	Hook Norton Low Carbon	Kirklees-Hillhouse	Low Carbon West Oxford
<b>LCC characteristics</b>	Community led	Community led	Partnership	Community led, mainly voluntary	Multi agency	Community led, mainly voluntary
<b>Location</b>	Port Neath & Talbot, South Wales	Cheshire West & Chester, North West England	Middlesbrough, North East England	Cherwell, South East England	Kirklees, Yorkshire & Humber	Oxford, South East England
<b>Geographical type</b>	Rural	Suburban	Suburban	Rural	Urban	Urban
<b>Socio-economic status</b>	Disadvantaged	Disadvantaged	Disadvantaged	Affluent <sup>2</sup>	Disadvantaged, multi ethnic	Middle income <sup>2</sup>
<b>No. of households / residents<sup>1</sup></b>	13,500 residents in 12 villages in upper Amman Valley	5,600 households (13,000 residents)	1,350 households (3,250 residents)	1,100 households (2,500 residents)	800 households (1,800 residents)	1,550 households (3,300 residents)
<b>Main aims &amp; Focus of LCC</b>	Carbon reduction, community development	Energy reduction and sustainability	Sustainability and healthy living and fuel poverty	Energy reduction	Fuel poverty	Carbon reduction and sustainable living
<b>LCC energy-related activities (from 2010 onwards)<sup>3</sup></b>						
<b>Renewables &amp; LZTs</b>	Community-scale (e.g. wind turbines, solar PV systems on local community centres, schools)	✓*	✓	✓	✓	✓*
	Individual household-scale (e.g. solar PV and solar thermal systems installed on dwellings)	✓*	✓	✓	✓*	✓
<b>Physical (fabric) measures</b>	Basic DIY measures (e.g. draught-proofing, radiator reflector panels)	✓		✓		
	Wall and loft insulation	✓*	✓*	✓	✓*	

		Awel Aman Tawe	Sustainable Blacon	Eco Easterside	Hook Norton Low Carbon	Kirklees-Hillhouse	Low Carbon West Oxford
Technical measures	Improved heating systems & controls		✓	✓	✓		
	Energy efficiency appliances & lighting		✓*		✓		
Behaviour change interventions <sup>4</sup>	Group based or social learning interventions (e.g. awareness and energy management programmes, meetings, action and learning group workshops)	✓*	✓	✓	✓*	✓*	✓*
	Stand-alone community events	✓*	✓*	✓	✓	✓	✓*
	Feedback interventions (e.g. energy display monitors)		✓	✓		✓	✓*
	Home visits		✓*	✓*		✓*	

**Notes:-**

<sup>1</sup> Household and resident numbers based on subnational data figures in relation to LCCC evaluation figures. Household data for AAT unavailable.

<sup>2</sup> With pockets of deprivation.

<sup>3</sup> The scale of each type of intervention varies between LCCs. Table 4.1 provides an indication of scale.

<sup>4</sup> The behavioural interventions listed here relate to home domestic energy use and do not include all types of behavioural interventions carried out by the LCCs. For example the list does not include the use of energy champions or one to one advice outside the home. Nor does it include LCCs complementary community interventions aimed at changing wider practices relating to food, waste, transport, lifestyle activities.

\* Activity not fully-funded through DECC LCCC initiative directly, but as part of wider LCC programme of activities.



Figure 2.4 outlines the main dwelling and household characteristics for all 88 households (88 dwellings). The majority of the case study households are owner-occupied (74 out of 88), with only two long-term privately rented dwellings and 12 owned by a social landlord. The social housing dwellings are in the Easterside and Blacon communities, both with a relatively high social housing stock.

The majority were households with adults only (58) which may be indicative of the type of household most likely to be involved in LCC activities. The average number of occupants per household was three and the average number in full- or part-time employment was only one. The average age of the main respondent was 58 years old, and 57% of the main respondents were female. The main dwelling and household characteristics across all the case study households as well as per community are outlined in Appendix B.

### 2.4.1 Physical and behaviour change interventions

Towards the beginning of the study, it was agreed to split the households into groups of those with physical interventions *from the LCC activities*, those with behaviour change interventions *only from the LCC activities* and a 'control' group with no interventions. As became obvious during the first physical survey of the dwellings, though, it was impossible to do this due to the fact that so many households had undertaken a variety of physical interventions in the same time frame as the LCC activities (post-2008), either self-funded or funded through sources other than the local LCC project, such as Warm Front and the Carbon Emissions Reduction Target (CERT). Figure 2.5 shows the interventions carried out across the 88 households. Some households had more than one intervention type.

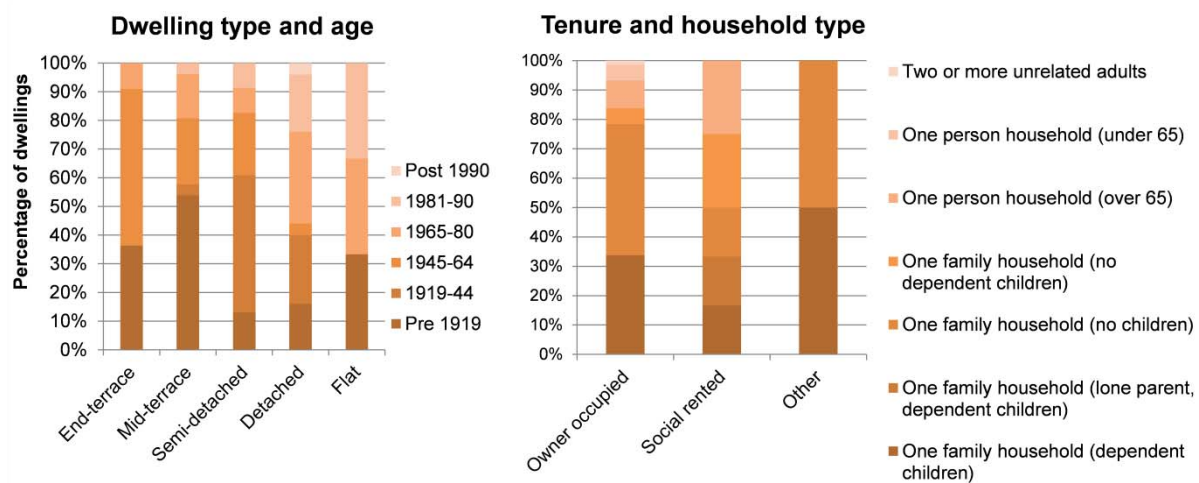


Figure 2.4 Dwelling and household characteristics of 88 case study households

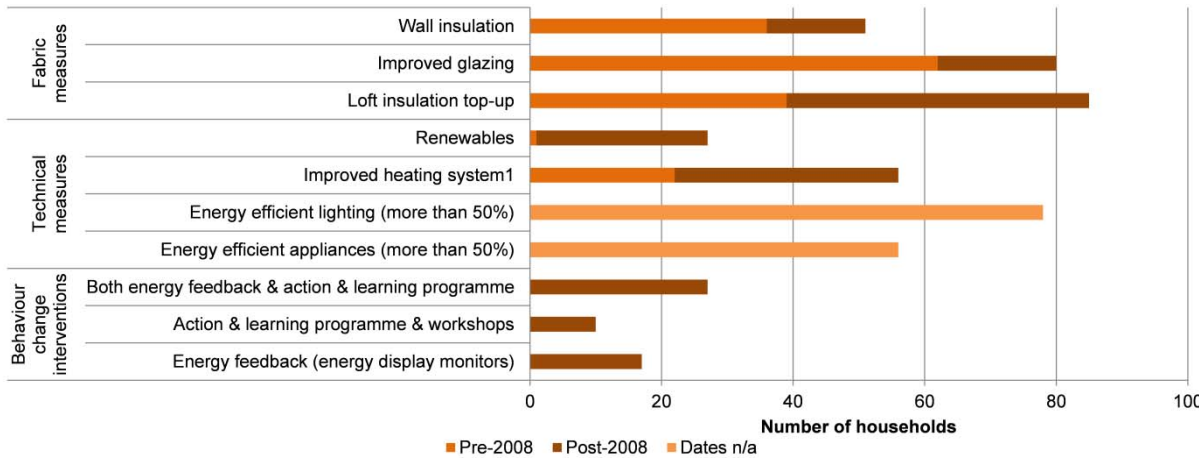


Figure 2.5 Physical and behaviour change interventions in case study households

## 2.5 Recruitment and participation of case study households

The original aim was to recruit 90 households across the six communities to provide case study evidence on low carbon interventions. Recruitment was undertaken in a variety of ways, and was found to be very challenging, particularly in some communities. Several different means (Table 2.2) of recruiting household were attempted, with varying levels of success in different communities. The 'success' was loosely based on the balance between the number of potential participants approached and the number of positive responses (i.e. the number of interviews confirmed). An added complexity was the requirement of approximately a third of the case studies to have had no involvement with the local low carbon community organisation.

In total, 88 participated in the first round of interviews and surveys (summer 2012); interviews with 95 households were arranged but seven cancelled or were absent on the date in question and were non-contactable after. Following a heating control questionnaire and thermal imaging survey in winter 2013, the 26 'control' households were not contacted again, leaving 62 case study households remaining. By the end of the study (winter 2014), participation of these 62 had dropped to 59 (95%) due to one household moving house, and two dropping out due to the intensive nature of the monitoring equipment (one before installation and one after).

Not all households completed or responded to all survey activities. Participation remained high, however, despite the financial incentives for participation being relatively low (approximately £50 per household), the long term nature of the study (approximately two years), and the presence of the monitoring equipment. This highlights the dedication as well as the enthusiasm within the households that were involved in the LCCs.

As Table 2.2 demonstrates, the most successful approaches throughout the communities were through recruited households recommending local friends and family (often contacting them during the interview, and organising an interview with them directly); and through the contacts and activities of the LCC organisation. All contained the same element; a **trusted** member of the community.

The 'control' households proved the most difficult to recruit, which was to be expected as they were required to have 'no active involvement in the low carbon community group'. As such, there was a reliance on existing recruited households to recommend friends, family and neighbours highlighting the difficulties in attempting to undertake

a long-term study with a representative set of households.

Whilst approaches such as community events and community groups do not appear to be very successful for recruitment, they cannot be ruled out for other research projects. The EVALOC experience was that much depended on preparation time prior to visiting the communities, and timing visits to coincide with popular events such as fetes and school activities.

There was one community in which recruitment was particularly unsuccessful, potentially for several reasons: the LCC organisation was in a period of change, with all three of the original contacts for the EVALOC project leaving, and the area had a high level of privately-rented houses with a short turn-over. There were also some cultural and language barriers. Some of these barriers were overcome with the use of researchers who spoke the language as well as the recruitment of a respected and trusted member of the community who helped introduce the researchers to further participants. However, case study households with these barriers were few in number from this community. Even in communities with long lists of potential recruits from the LCC organisation, there was a feeling that research 'saturation' had already been reached, so that some potential participants were wary of committing time and effort to another research project.

## 2.6 Summary

- The overall approach of the study is action research combined with in-depth monitoring and evaluation of LCC activities on a community and household level.
- The six case study LCCs are across England and Wales, with four situated in disadvantaged communities. Of the six, four are community-led, with the other two adopting a partnership and/or a multi-agency approach. Furthermore, two are located in rural areas, two are in suburban areas and two are in urban areas.
- Whilst the LCCs were chosen due to certain activities being funded by DECC's LCCC initiative, most undertook (and continue to undertake) activities funded through other means. The findings in this report take this into consideration.
- Within the six case study communities, 88 households were recruited as part of the study's household monitoring and evaluation process. Of these, 62 were studied in detail mainly due to the number and type of physical and behaviour change interventions present and their involvement in the LCC, whilst 26 were used as 'control'.

- The household and dwelling characteristics of the case study households reflect the individual communities, and do not necessarily represent the UK housing stock as a whole. Examples of this include the fact that the primary fuel of 26 out of the 88 households was oil or coal (two of the communities are in rural areas).

- A number of recruitment approaches for case study households were attempted across the six communities, the most successful being through recruited households recommending local friends and family and through the contacts and activities of the LCC organisation.

- Of the 62 in-depth case studies, 59 still had active participation at the end of the study (two years after recruitment), which highlights the dedication as well as the enthusiasm within the households that were involved in the LCCs.

**Table 2.2** Type and 'success' of different recruitment approaches across six communities

Potential Recruitment Approaches	AAT	SB	EE	HN-LC	KI	LCWO
1 LCC list of potential participants						
2 Community newsletter						
3 LCC organisation website						
4 Letter from LCC						
5 Recruited household						
6 Door-to-door with LCC member						
7 Local businesses (cafes/hairdressers)						
8 Community meeting (LCC)						
9 Community event (LCC)						
10 Community event (general e.g. summer fete)						
11 Local community groups (social, religious)						
12 Local community buildings (schools, libraries)						
13 Street approach (direct contact)						
14 Door-to-door knocking						
15 Other (acquaintance of researcher)						

**Key:**

	Used – good success		Used – no success
	Used – some success		Not used
	Used – little success		

## Chapter 3

### Low carbon community groups' roles, processes and joint working

In order to better understand the strengths and limits of LCCs in reducing carbon emissions, the roles and capabilities of organisations involved in the six LCCs were mapped and assessed.

#### 3.1 Organisations involved in the LCC

In order to understand the organisations involved in the LCCs, they were asked to map their organisational networks, in focus groups and follow-up interviews. Table 3.1 summarises the main actors in each network.

The mapping reveals that in two of the disadvantaged areas (Kirklees and Easterside) the Local Authority and a wide range of statutory organisations were providing energy services in the project area as part of the LCC. In contrast, in at least two of the LCCs community groups were the main organisations undertaking carbon and energy reduction activities as part of the LCC; although in some cases (e.g. LCWO) the community groups were funded by the local authority to do so. In some of the LCCs the participating organisations contracted private sector companies to install LZTs on community buildings and/or dwellings, whereas in other LCCs residents contracted installers directly. (Energy suppliers and other companies were also likely to be providing efficiency measures and LZTs independently of the LCCs, but this was not captured by this project.) It is unlikely that private sector organisations would be able to substitute for some of the LCC roles identified by the EVALOC research. There were no statutory health agencies involved in most of the LCCs.

#### 3.2 LCC roles

The kind of roles LCCs might typically adopt were first identified and then focus group participants in each were asked to indicate which they were currently undertaking and to add any that had not yet been identified.

EVALOC researchers then categorised the roles according to whether they were carried out 'downstream' with residents, 'midstream' with other actors, or 'upstream' with national government (Parag and Janda, 2014).

The role mapping (Figure 3.1) outlined in Table 3.2, shows that the LCCs were seeking to undertake all the previously-identified roles to some extent. The categorisation showed that the four community-led LCCs were exerting most of their effort downstream with residents, reflecting a perceived lack of opportunity to work with local authorities or other statutory agencies at midstream level<sup>1</sup>. In contrast, the involvement of city-wide local organisations in Easterside and Kirklees meant that these LCCs were able to invest considerable effort at midstream as well as downstream level, enabling them to scale up and replicate projects across the city.



**Figure 3.1** Roles mapping focus group exercise

At midstream level, all the LCCs shared learning with other communities and sought to catalyse action by other local actors, but only two were actively engaged in joint working with other organisations in their areas. At upstream level, all six LCCs engaged in dialogue with DECC about energy policy, but only one (LCWO) was an active member of a national campaign and sought to engage residents in local and national campaigning to influence policy. None of the LCCs were engaged in protest or direct action.

#### 3.3 LCC roles and capabilities

The LCCs were asked to rate how capable they felt of carrying out the identified roles. The results are presented in Table 3.2. Some caution is needed in interpreting the table as the ratings were subjective and from a small number of respondents. However, with a couple of exceptions<sup>2</sup>, the results of the rating exercises correspond to the findings from the wider EVALOC household and community-level research.

<sup>1</sup> LCWO participated actively in joint dissemination projects with the City Council and with Low Carbon Oxford (a city wide partnership of public, private and civil society organisations that seek to reduce the city's carbon emissions) however these initiatives did not benefit residents in Oxford.

<sup>2</sup> E.g. Eco Easterside gave itself a relatively low rating for empowering individuals to reduce energy use compared to Kirklees whereas the EVALOC research suggests it is at least equal to Kirklees-Hillhouse in this regard.



**Table 3.1** Summary of organisational networks at local level

Community	Demographics of local area	Organisations providing energy services	Responsibilities in project area
<b>Awel Aman Tawe</b>	Deprived	Community energy charity and social enterprise	<ul style="list-style-type: none"> <li>Community group (AAT) - lead role in design and implementation of energy generation projects and arts and climate change engagement activities</li> <li>Local authorities and National Energy Action Cymru supports energy efficiency/fuel poverty services</li> <li>Pontardawe Arts centre, Arts Council, Literature Wales, Local Authorities – supporting roles in the arts and climate change activities.</li> </ul>
<b>Sustainable Blacon</b>	Deprived	Sustainable Blacon Community energy group approach. Subsidiary of Blacon Community Trust, working with the support of organisations such as Cheshire West and Chester Council, Chester and District Housing Trust.	<ul style="list-style-type: none"> <li>Community group (Sustainable Blacon) - lead role in design and implementation of energy reduction and fuel poverty projects supported by Blacon Community Trust and other local groups</li> <li>Cheshire West and Chester Council provided some energy efficiency/fuel poverty services in the area</li> <li>University of Chester – expertise, support and research into Sustainable Blacon</li> <li>Chester and District Housing Trust – supporting Sustainable Blacon, with Behaviour Change house.</li> <li>Private sector installers –contracted by SB to deliver household measures</li> </ul>
<b>Eco Easterside</b>	Deprived	Partnership multiple agency approach led by a city-wide environmental charity (Middlesbrough Environment city)	<ul style="list-style-type: none"> <li>Middlesbrough Council – enabling role (provides finance, tenders for installers/contractors, and legal support)</li> <li>Middlesbrough Environment City (MEC) – subcontracted by Middlesbrough Council to lead design and implementation of sustainable and healthy living projects, including energy</li> <li>Erimus Housing Association – helps engage community and deliver energy efficiency improvements to tenants.</li> <li>Residents – co-design projects, help engage the wider community and beneficiaries of projects.</li> <li>Various private sector installers – contracted by MEC to install community and household measures</li> </ul>
<b>Low Carbon Hook Norton</b>	Affluent	Community group	<ul style="list-style-type: none"> <li>Community group (HN-LC) - lead role in design and implementation of energy projects</li> <li>Local Authority – does not deliver energy efficiency/fuel poverty services activities in area but funds Affordable Warmth Network to do so</li> <li>Private sector installers – contracted by community group for community renewables and by residents for household measures</li> </ul>
<b>Kirklees-Hillhouse</b>	Deprived	Local authority led multi agency approach	<ul style="list-style-type: none"> <li>Local authority – lead role in design and implementation of fuel poverty and energy projects</li> <li>Local statutory agencies - communicate and champion the project to residents and provide related services</li> <li>Local residents – mainly beneficiaries of projects</li> <li>Various private sector installers – contracted by Council to install community and household measures</li> </ul>
<b>Low Carbon West Oxford</b>	Medium	Community group	<ul style="list-style-type: none"> <li>Community group (LCWO/WOCORE) - lead role in design and implementation of energy projects in West Oxford</li> <li>Local Authority funds/supports community groups energy projects, but does not directly deliver energy efficiency/fuel poverty services in project area itself</li> <li>Private sector installers – contracted by community group for community renewables and by residents for household measures</li> </ul>

**Table 3.2 LCC roles and capabilities**

Roles <sup>1</sup>	Examples of activities	AAT	SB	EE	HN-LC	KI	LCWO
		LCCs self-ratings of capabilities: C (confident) M (medium) LC (less confident)					
Downstream –to enable residents to reduce carbon emissions							
Community engagement & motivation	offering opportunities to be involved in community projects, financial incentives, technical support	C	C	C	C	C	M
Developing innovative approaches to reducing energy use	developing new ways of engaging, organising and delivery of energy services	M	LC	LC	C	LC	C
Empowering individuals and groups to reduce energy use	increasing agency through collective action, providing the knowhow and the means to take action	M	C	LC	C	M	C
Changing energy related behaviours <sup>2</sup>	provision of energy feedback, face to face advice & support, community-based social learning opportunities, action and learning groups	LC	M	M	M	LC	M
Delivering/promoting physical interventions	Offering free measures, and providing/installing measures	LC	M	C	C	C	LC
Addressing fuel poverty	As above	LC	LC	C	LC	M	LC
Generating community and social and economic benefits e.g. social networks, community spirit, financial benefits, jobs	building and shaping social networks, relations and community benefits that enable and sustain community action	C	M	LC	LC	LC	LC
Midstream – with other local actors at local level to reduce community carbon emissions <sup>3</sup>							
Dissemination to other communities	demonstration, networking, shared learning, peer mentoring	C	M	M	M	LC	C
Catalysing action by other local actors <sup>3</sup>	dialogue, influencing, modelling	M	M	C	LC	C	C
Scaling up	joined- up or partnership working, area- wide delivery of measures	M	LC	C	NA	C	NA
Upstream – with government or national level interest groups to provide a supportive policy environment and address structural barriers to reducing local carbon emissions							
Influencing national policy	E.g. by modelling, dialogue, evidence, public campaigning	M	M	LC	LC	C	C
Cross-cutting activities							
Process roles <sup>4</sup>	management & coordination	✓	✓	✓	✓	✓	✓
Monitoring & Evaluation (M&E) <sup>5</sup>		✓	✓	✓	✓	✓	✓
Notes:							

<sup>1</sup> Each role might include a range of different activities

<sup>2</sup> Behaviour change roles might include group action and learning groups, social learning through community events, building and shaping of social norms

<sup>3</sup> The researchers originally only identified one category for midstream roles: dissemination to other communities. LCCs identified two more midstream roles (catalysing action by others and scaling up through partnership/joint working). These were not included in the self- rating exercises carried out by the other LCCs but they have been added to this table and ascribed a rating which has been checked by the relevant LCCs

<sup>4</sup> Process roles were identified which might include management, coordination of third party installers and partner agencies, marketing, liaison with landlords, legal advice, administration, and maintenance. They could not be included in the self-rating exercises by other LCCs but have been included in the table, as wider research indicates that this is an important role that all groups carry out

<sup>5</sup> M&E was not included in the rating exercises by LCC but has been included for completeness as all LCCs undertake some M&E to a greater or lesser extent

As Table 3.2 shows, the LCCs in Kirklees (multi-agency approach) and Eco Easterside (partnership approach) felt relatively confident about promoting the uptake of LZTs and addressing fuel poverty. This confidence in part reflects the relatively high levels of expertise and resources available to local authorities, statutory agencies and the city wide charity involved in these LCCs, as well as their greater leverage and economies of scale in bidding for energy efficiency grants. As one council officer explained about the DECC funded LCCC project:

*'We have so much in-house expertise - renewable energy experts, marketing and social engagement people, engineering advice, legal teams, contacts in DECC and Ofgem, all of which have come into play in this project'.*

These capabilities have enabled Kirklees and Eco Easterside to access government financial incentives and coordinate the area-wide delivery of free LZTs to people's homes, which is important for ensuring that disadvantaged and vulnerable households can benefit. As one focus group participant from 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'.*

However, the EVALOC household research indicated that commissioning and installation procedures could be strengthened, and that there was a need for provision of ongoing support to households with unfamiliar technologies installed (such as air source heat pumps, solar thermal systems and solar PVs).

The Kirklees and Eco Easterside focus groups felt relatively confident about community engagement, a perception supported by research in these communities. This confidence in part reflected their ability to offer free measures to residents, and the relevant and inclusive nature of their communication messages and engagement methods. It also reflected their efforts to involve residents in their projects. Eco Easterside was able to build on a long history of strong resident involvement in regeneration initiatives and in co-design and implementation of projects. In the Kirklees project area, the community was relatively weak, perhaps due in part to the high levels of private rented accommodation and subsequent transience of the population in the area. However, the Area and Neighbourhood team in Kirklees Council have invested considerable effort in building social capital

and energy know-how among residents through community events and workshops, some of which were supported by EVALOC. The team planned to establish a community fund from the income derived from local renewable installations, to be governed by local agencies and residents.

Kirklees Council and Middlesbrough Environment City (partner of Eco Easterside) felt relatively less confident about their capacity to empower people, change their energy behaviours and develop innovative approaches to reducing energy demand. As one focus group in Easterside said,

*'At the end of the day – we have had fantastic saving money on energy bills. But all the cultural and behaviour change stuff hasn't happened yet.'*

Another said:

*'That is the easy bit, the physical bit, the installation of things. The harder bit is changing people's attitudes and all the things that flow from that, and I think however well we do it, it takes longer because that's the way people change.'* (Focus group participant)

In addition, household interviews in these local authority and partnership LCCs indicated that recipients may not have fully valued or understood, at least initially, the nature of the programmes with their free technical measures and guidance on energy matters. One focus group participant in Kirklees said; *'...We should have got them to commit to come to a set amount of meetings per year'* to help ensure ownership. However, Eastersides' and Kirklees' confidence to empower people and change behaviours appears to have increased over time. As one team member from Easterside said at the final focus group;

*"Just putting those things on won't effect a change... what actually brings the change is that combination of something big [the renewable interventions] that everyone sees and then the drip feeding of activity, these things like the plays, like the energy efficiency workshops, doing a cycle workshop and it's that combination of things."*

In contrast, the four community-led initiatives felt relatively confident about their capacity to engage and motivate people (4/4 LCCs), empower residents to take action (4/4), change behaviours (3/4) and develop innovative approaches to carbon reduction (3/4). These ratings are largely validated by other EVALOC research. All four developed different and creative ways of attempting to reduce local energy demand. They all also achieved relatively high levels

of community engagement, despite the absence of financial incentives in Low Carbon West Oxford and Awel Aman Tawe. However, they did not all succeed in engaging disadvantaged groups, for reasons discussed below.

In relation to behaviour change, Low Carbon West Oxford achieved 10% reductions in estimated carbon footprints as a result of participation in an action and learning group (Low Carbon Living Programme), largely through behaviour changes. Blaen also appears to have been successful in changing energy behaviours by involving residents in monthly meetings on water, food, waste, electricity, white goods and insulation, and providing them with energy displays. These are important achievements: as one community volunteer explained:

*"It takes a phenomenal amount of effort to cut through the noise in people's lives just to get messages heard, let alone for them to translate this into action".*  
(Community volunteer)

However, the community-led initiatives felt relatively less confident about their ability to promote the uptake of LZTs to residents and address fuel poverty (three out of four groups). This in part reflects the difficulties small voluntary groups face in accessing government subsidies for residents (particularly in non-deprived areas), tendering for installers or coordinating area-wide installation of LZTs. Nor did most of the community groups have the time or capacity to conduct home visits, or to address issues that arise from energy outreach work such as benefits, damp and health, negotiations with landlords, legal and administrative matters. Nevertheless the community-led initiatives found innovative ways to get round these constraints. Hook Norton used the DECC capital grant to seed a revolving loan scheme for residents which has enabled uptake of a range of LZTs and other physical interventions by 31 households, although the initial high level of loan uptake has begun to level off. This indicates a need for initiatives to encourage people to get to the point where they consider applying for a loan. Blaen used DECC money to provide residents with a sliding scale of energy efficiency grants up to £2000, conditional on their participation in monthly meetings, as well as training volunteers to provide advice and relatively small interventions such as loft insulation and energy efficient appliances. LCWO used the DECC grant to invest in community renewables and subsequently used the income stream, plus a small annual grant from the local authority, to hire an outreach worker to identify low-income and elderly people and link them to the few options available for energy efficiency grants and affordable warmth services.

### 3.4 Partnership Approaches

The uneven spread and capabilities of organisations involved in the LCCs highlights the need for partnership approaches between local authorities, communities and other agencies. As noted above, the involvement of local authorities, a city-wide charity and other statutory bodies in Kirklees and Easterside enabled these LCCs to overcome some technical and economic barriers to domestic energy reduction. Lessons drawn from the EVALOC-supported shared learning workshops on 'Community-Council Partnerships', 'Carbon Reduction in Communities of Disadvantage' and 'Addressing Pockets of Fuel Poverty in Oxfordshire' include the need for:

- a favourable policy environment;
- community groups with a track record in energy interventions and/or willingness to engage in new initiatives and/or multi-agency approaches and long term investment in community development;
- Councils motivated to act on climate change and prepared to take risks in exploring new partnership approaches;
- intermediary organisations to support community groups and/or deliver direct interventions with households;
- credible and relevant shared vision and messages;
- clarity about roles and responsibilities;
- accountability to people not 'at the table'
- mutual understanding and respect between partners e.g. community groups seen as equal partners with adequate funding rather than cheap delivery agents;
- clarity about strengths/roles/accountability of the partnerships;
- competence and delivery;
- clear structure and timetable.

Workshop participants noted, however, that building partnerships takes time. In both Oxford and Easterside the partnerships were built on the basis of community groups' proven track record and relationships that had been built up in the past decade. In addition, Councils (and Government) may need to provide communities with the resources to ensure they are properly representative of, and accountable to, local residents.

Participants also noted possible risks from Community-Council partnerships. While they can promote greater community participation in the design and implementation of energy interventions, they may also reduce formal accountability by transferring responsibilities away from elected to non-elected partnership bodies or steering groups.

### 3.5 Carbon reduction with disadvantaged communities and households

The shared learning workshops and wider EVALOC research identified the following lessons:

- Carbon reduction programmes offer an opportunity to generate a range of practical benefits for disadvantaged communities and households. These may include increased know-how, savings on fuel bills, warmer homes, and improved health.

- While it makes sense for LCCs to focus their primary communication and engagement messages on immediate practical benefits from energy and carbon reduction, there is also value in secondary messages to emphasise environmental and social benefits of saving energy.

- The need for a supportive local infrastructure including:

- Co-ordinated area-wide delivery of subsidised energy efficiency and renewable measures to homes.
- Complementary interventions including home visits; 'handholding' (e.g. filling in forms, negotiating with landlords, or referrals to other services); technical and behavioural advice; provision of integrated advice and support with cross-referral to relevant agencies about issues including affordable warmth; participatory action and learning groups.

- Resident participation in design and/or delivery of interventions can strengthen understanding, motivation and capacity to reduce energy use and emissions. This might require initial investment in community development and efforts to address barriers to participation such as lack of time, language difficulties, or a sense of not belonging.

- A supportive policy environment including easy-to-access capital grants for energy efficiency improvements for low income and vulnerable groups; low-cost loans for the able-to-pay; revenue funding for the core delivery roles of local actors; a properly-resourced statutory duty on local authorities to reduce carbon emissions and address fuel poverty.

### 3.6 Sustaining LCC activities over time

LCCs require access to sustainable and predictable finance, human resources and technical expertise to sustain their activities and impacts. In relation to *capital* funding, recent DECC capital grants under the LCCC and energy efficiency grants from the

energy supplier obligations (and previously from the Warm Front scheme), have provided important resources for renewable energy generation and efficiency improvements. However, central government has now adopted a more restrictive interpretation of EU state aid rules so that communities are no longer able to receive both a capital grant and the Feed-in Tariff for renewable installations. One of the LCCs (LCWO) has been successful in raising substantial capital from local share offers for renewable installations, but this is likely to be more difficult in disadvantaged areas. The partnership and multi-agency LCCs in Easterside and Kirklees) have been able to access ECO capital grants for household energy efficiency improvements, whereas some of the community-led LCCs have found it difficult to do so. Few LCCs are promoting the Green Deal for the 'able to pay', partly due to the high GD interest rates.

LCCs require reliable and predictable *revenue* funding to finance the core delivery and voluntary coordination roles of LCCs. Most DECC grants for LCCs, including under the LCCC, are short term and contain no ongoing funding for core staff costs or project management. Yet as one focus group participant explained,

*'There was an awful lot of process driven administrative work that whether it be from Ofgem, from DECC, all the rules, all the feed-in-tariff rules, huge amounts of documentation, which really put a damper on the project, and ... you will always need someone to be involved to look after that.'*

In the context of financial cuts to local authority budgets, LCCs have sought to reduce reliance on grants and develop independent income streams. In this regard, the FiT and sales of 'green' electricity provide an important source of income for four of the EVALOC LCCs (Eco Easterside, Kirklees-Hillhouse, Low Carbon West Oxford and Hook Norton Low Carbon). However, net income (after maintenance, insurance etc.) is relatively low in two of these, due to the small size of installations<sup>3</sup>. By the end of the EVALOC project, Awel Aman Tawe had not yet received any income from its wind turbine due to delays and complications in installation. Community groups have been encouraged under the Green Deal to accept referral fees from private providers. However, some feared this would undermine local trust in them as they will no longer be seen as independent parties. There did not appear to be any

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<sup>3</sup> It has been estimated that a £1m investment in renewable energy is required to generate a net income of £30,000, just about enough to employ a part time worker (around £20,000) and provide a small investment for projects.



commercially viable markets for other key aspects of LCC work e.g. community engagement, motivation, behaviour change programmes and complementary projects relating to waste, transport and food. These remain reliant on grant funding.

EVALOC research indicates that the lack of reliable core revenue funding is acting as a significant brake on LCC energy initiatives. As one focus group participant from a local authority said:

*'We have to prioritise where there is funding – which is normally capital projects'...and .... 'the message [internally] is that if there is not a legislative obligation to deliver the project then they won't be doing it anymore'.*

Staff numbers in the environmental unit of Kirklees Council have been reduced significantly, with many valuable staff taking voluntary redundancy. A focus group participant said:

*'In one year's time the Environment Department won't exist [due to cuts]....and.... 'now we are not doing anything on community events – as we have lost over half our staff through voluntary wastage'.*

While the community-led LCCs have been able to achieve a huge amount with volunteers, drawing on an impressive range of technical expertise, the EVALOC research shows that it is difficult for them to sustain their initial high levels of commitment, replenish core volunteers and prevent burn-out. One of the reasons Low Carbon West Oxford and Hook Norton Low Carbon have been able to sustain their activity levels over time is because the income stream generated by their community's renewables and loan fund has enabled them to recruit a part time worker to carry out core administration and project management tasks, *'HN-LC may have survived in some form if we did not have a part-time worker, but we would not have thrived or prospered'*. In contrast, the LCC projects in Blacon have ended because funding for the paid coordinator dried up. There is also a continual risk of resident involvement drying up in Easterside as *'they can't continue running the whole project on thin air'*.

### 3.7 Structural Constraints

LCCs identified the following external constraints on their activities: lack of strong and consistent government leadership and messages on tackling climate change; failure to link growth and green agendas; changes in and uncertainties around the FiT; financial cuts; withdrawal of statutory duties on local authorities; increased scepticism about climate change in part related to media coverage, which influenced the terms of public debate; effects of austerity and recession on local people (e.g. reduced confidence to take on loans); and lack of local infrastructure and capability (e.g. recycling facilities, trusted installers).

### 3.8 Summary

- The ability of LCCs' to reduce local energy use and carbon emissions is constrained by structural influences on energy use that are beyond their control. However, LCCs seek to play a wide range of roles to reduce local energy use, most of which are under-resourced. These roles reinforce each other at 'downstream', 'midstream' and 'upstream' levels. However, they are unable to spend much effort on 'upstream' roles to influence policy makers, despite having valuable intelligence about what policies work and don't work on the ground.

- Many organisations were involved to some extent in reducing local energy use in the six EVALOC LCCs. The distribution of these organisations influenced the capacity, reach and scale of LCC activities. There appeared to be limited involvement by statutory health agencies in most of the LCCs, despite well documented links between household energy efficiency, cold homes and health.

- The LCCs involving a local authority (Kirklees-Hillhouse) or town-based charity (Eco Easterside) were more confident about promoting the uptake of physical interventions and addressing fuel poverty, whereas more purely community-led initiatives tended to be more confident about developing innovative approaches to reducing energy use, empowering residents to take action and enabling them to change their behaviours.



## Chapter 4

### Community engagement and social networks

In this chapter we assess the extent to which the LCCs have motivated and engaged residents to get involved in energy and carbon reduction projects.

#### 4.1 LCC community engagement indicators

The EVALOC literature review on individual and social influences on energy use (Mayne, Darby and Hamilton, 2012) supplied two indicators to assess LCCs engagement methods: LCCs' understanding of the demographic and organisational make up of their communities, and the relevance and accessibility of LCC's communication messages, engagement methods and energy projects.

##### 4.1.1 Numbers engaged

All the LCCs succeeded in engaging and motivating significant numbers (Table 4.1) to get involved in their activities, including people who would not have otherwise been able to afford efficiency measures or LZTs, and/or would not have previously considered themselves 'green'<sup>1</sup>.

##### 4.1.2 LCC understanding of the communities

The LCCs all demonstrated a broad understanding of the demographic and organisational make up of their communities and sought to address some obstacles to participation. Some had detailed understanding of local demographics, either by using local authority data (Kirklees-Hillhouse), academic data (Sustainable Blacon) or census data (as used by Low Carbon West Oxford to compare the membership of its Low Carbon Living Programme with wider community demographics). None of the LCCs had the capacity to undertake a mapping of social networks in their community.

##### 4.1.3 Nature of energy messages

A recent review of behavioural economics in relation to environmental policy (Dawnay and Hetan, 2011) points out that people are more likely to get involved

in a project if they feel the issue it addresses is salient and relevant to their lives and if messages are tailored to the audience. It also suggests that care should be taken in using messages that only emphasise **extrinsic** values (those directed to external approval or rewards such as money and status) as they may crowd out **intrinsic** values (those which are considered rewarding to pursue for their own sake, or for altruistic reasons, such as concern for the environment or for social justice) (Schwartz, 1992).

EVALOC LCCs used a range of types of messages to engage residents. In Table 4.2 the messages were categorised according to whether they are designed to activate extrinsic or intrinsic motivations.

As Table 4.2 shows, two LCCs used mainly or only intrinsic messages (relating to climate change and carbon emissions), two used mainly or only extrinsic messages (saving money on fuel bills, fuel poverty, and warm homes) and two used a mix. Two of the LCCs in disadvantaged communities used extrinsic rather than intrinsic messages, one (Easterside) used both, and one used extrinsic messages although it was not running household energy-saving projects.

Overall, both intrinsic and extrinsic messages appeared to resonate with residents. The household research showed that they got involved in LCC activities for a mix of intrinsic and extrinsic reasons. As a respondent from one of the disadvantaged communities explained:

*"Finance, environment and future.  
Future for the rest..."*

<sup>1</sup> In some LCCs, this finding is corroborated by complementary research. For example, in Sustainable Blacon, research by the University of Chester indicated a shift in the self-perception of participants using the DEFRA classification from 'sideline supporters' to 'positive greens'. Alexander, R. and Hunt, T. (2012) Evaluation of Energy Management Systems Trial for Blacon Smart Energy Community LCCC Programme. Final Report. University of Chester.

**Table 4.1** Indication of numbers engaged

Community	Numbers and demographics of households reached since LCC inception
<b>Awel Aman Tawe</b>	<p><b>General engagement</b></p> <ul style="list-style-type: none"> <li>- Mailing about arts and climate project to 13,000 local householders, plus Welsh arts networks.</li> <li>- 20,000+ flyers and e-flyers distributed about poetry competitions through Literature Wales, local schools, libraries, journals, writers groups, plus adverts in newspapers, email lists and social media.</li> <li>- Over 750 participants in DECC-funded arts and climate change programme</li> <li>- 700 entries for poetry competition in 2012, 350 entries in 2011 (from Wales and internationally)</li> <li>- 450 visitors to Green Routines exhibitions</li> <li>- Pre-2011 mobile educational demonstration to engage public with energy conservation and sustainable living</li> <li>- 13,000 people consulted about community windfarm in 14 villages in 2000 – 2001</li> </ul> <p><b>Household energy projects</b></p> <ul style="list-style-type: none"> <li>- Pre-2011: hundreds of households received support from Energy Efficiency Advisors</li> <li>- 27 buildings (private houses and local community centres) received solar thermal</li> </ul> <p><b>Other energy-related projects</b></p> <ul style="list-style-type: none"> <li>- Launched <i>Egni</i> solar energy co-operative, installed solar PV on seven community buildings in 2014</li> </ul> <p><b>Demographics</b></p> <ul style="list-style-type: none"> <li>- Deprived – a large number of residents are in the top 40% of Welsh Index of Multiple Deprivation</li> <li>- The arts and climate change projects and Green Routines exhibition, attracted participants from outside the local community, with more varied demographics.</li> </ul>
<b>Sustainable Blaon</b>	<p><b>General</b></p> <ul style="list-style-type: none"> <li>- Whole community (~5,600 households) through leafleting</li> </ul> <p><b>Household energy projects</b></p> <ul style="list-style-type: none"> <li>- 150 participants in energy management programme</li> <li>- 200 visitors to the eco-demonstration homes</li> <li>- 800 households reached with advice on energy saving and energy efficiency, practical home support</li> </ul> <p><b>Other energy-related projects</b></p> <ul style="list-style-type: none"> <li>- Furniture and bike recycling</li> <li>- Maintenance and promotion of the Blaon Greenway cycle route</li> </ul> <p><b>Demographics</b></p> <ul style="list-style-type: none"> <li>- Deprived (over half the residents in the top 20% of index of multiple deprivation)</li> <li>- 41% of Blaon Energy Management Programme participants in fuel poverty according to University of Chester report<sup>2</sup></li> </ul>
<b>Eco Easterside</b>	<p><b>General</b></p> <ul style="list-style-type: none"> <li>- Newsletters to whole community (1,350 households)</li> <li>- Leafleting and door knocking to whole community (1,350 households)</li> <li>- Community events: 1000 + people attending Eco Gala day; 25 people attending 1<sup>st</sup> primary school play; 50 people attending 2<sup>nd</sup> primary school eco-performance</li> </ul> <p><b>Household energy projects</b></p> <ul style="list-style-type: none"> <li>- 20 households receiving 10 Solar PV, four heat pumps and six solar thermal installations</li> <li>- 600 people receiving free energy displays</li> <li>- 225 loft insulations and 129 cavity wall insulations in 2011 for households that were just above benefit-qualifying level</li> <li>- 244 cavity wall insulations and 284 loft top ups insulated by Go-Warm in 2009-2010 for households on benefits</li> </ul> <p><b>Other energy related projects</b></p> <ul style="list-style-type: none"> <li>- Approx. 600 participants in other sustainable food and transport projects</li> </ul> <p><b>Demographics</b></p> <ul style="list-style-type: none"> <li>- Disadvantaged (ranked in top 20% of disadvantaged neighbourhoods in country)</li> </ul>

<sup>2</sup> Evaluation of Energy Management Systems Trial for Blaon Smart Energy Community LCCC Programme: Follow-up Report

<b>Kirklees-Hillhouse</b>	<p><b>General</b></p> <ul style="list-style-type: none"> <li>- Whole community (~800 households) through general communications</li> </ul> <p><b>Household energy projects</b></p> <ul style="list-style-type: none"> <li>- 53 households received solar PVs</li> <li>- Selected households visited by Handyman scheme</li> <li>- 80 households received free energy displays</li> <li>- Previously 51,000 homes fitted with insulation</li> <li>- Approximately 380 + residents attending EVALOC-supported community energy related events</li> <li>- Previously 51,000 homes fitted with insulation across the whole of Kirklees(Warm Zone) including project area</li> </ul> <p><b>Demographics</b></p> <ul style="list-style-type: none"> <li>- Deprived (over half the residents in the top 20% of index of multiple deprivation)</li> <li>- ~65% of residents from minority ethnic groups - mainly of Asian origin, with significant numbers of African, Caribbean, Polish, Chinese, Kurdish and mixed heritage, and a transient population of asylum seekers.</li> <li>- 100% of beneficiaries of the DECC-funded solar PV panels were low-income households</li> </ul>
<b>Hook Norton Low Carbon</b>	<p><b>General engagement</b></p> <ul style="list-style-type: none"> <li>- Newsletter to whole community (1,100 households)</li> </ul> <p><b>Household energy projects</b></p> <ul style="list-style-type: none"> <li>- 31 households benefiting from revolving loan</li> <li>- 30 households per month attending bi-monthly open meetings, where technical support offered</li> <li>- 21 people received technical support at open event at Library</li> <li>- 34 people attended open home event</li> </ul> <p><b>Other energy-related projects</b></p> <ul style="list-style-type: none"> <li>- 25 people benefiting from car club</li> <li>- 200 people attending bi-annual swap shops</li> </ul> <p><b>Demographics</b></p> <ul style="list-style-type: none"> <li>- Affluent (in the least deprived decile using Index of Multiple Deprivation) but with pockets of disadvantaged households: 80% of households owner-occupied, 7% social rented and 7.5 % privately rented (2011 census)</li> </ul>
<b>Low Carbon West Oxford</b>	<p><b>General</b></p> <ul style="list-style-type: none"> <li>- Whole community (1,550 households) through newsletter, leafleting, door knocking</li> <li>- 270 members and supporters</li> </ul> <p><b>Household energy projects</b></p> <ul style="list-style-type: none"> <li>- 100 plus provided with household energy advice/support &amp; energy displays through LCLP</li> <li>- 112 households with vulnerable and elderly residents identified and contacted</li> <li>- Approximately 30 visits receiving home visit from outreach worker or technical advisory, 15 receiving technical and behavioural advice at 'Bring and Take' event</li> <li>- 10 households received free solar PV (five social housing, five participants in LCLP)</li> </ul> <p><b>Other energy related projects</b></p> <ul style="list-style-type: none"> <li>- 200-500 participants at bi-annual 'Bring and Take' event and 60 at annual 'Swish' event</li> <li>- 170 residents using local Zip car club</li> </ul> <p><b>Demographics</b></p> <ul style="list-style-type: none"> <li>- Middle income community (ranked as medium in index of multiple deprivation) but with pockets of disadvantaged households. ~14% social housing and 27% private rented (2001 census)</li> <li>- 24 % of participants of two cohorts of participant in Low Carbon Living Programme had below-average incomes (self-assessment)</li> </ul>

**Notes:**

- The purpose of the table is to give an indication of scale and reach of selected activities. The data relating to household energy is measured or estimated by EVALOC; the data relating to general engagement and other energy-related projects is reported by LCCs.
- The table does not include community renewable installations and the people who may view or benefit from them.
- The table includes data from the DECC -funded LCCC projects but in most cases it is difficult to isolate these from the LCC wider activities during 2010-12, as most LCCs had designed their LCCC projects to integrate with their ongoing activities.



**Table 4.2** LCC messages

Community	Type of message	
<b>Awel Aman Tawe <sup>1</sup></b>	Mainly intrinsic	
<b>Disadvantaged</b>	<b>Intrinsic</b> <ul style="list-style-type: none"> <li>Combating climate change</li> <li>Helping address fuel poverty</li> </ul>	<b>Extrinsic</b> <ul style="list-style-type: none"> <li>NA</li> </ul>
<b>Sustainable Blacon</b>	Mainly extrinsic	
<b>Disadvantaged</b>	<b>Intrinsic</b> <ul style="list-style-type: none"> <li>NA</li> </ul>	<b>Extrinsic</b> <ul style="list-style-type: none"> <li>Saving money, keep warm, fuel poverty</li> </ul>
<b>Eco Easterside</b>	Mix of intrinsic and extrinsic	
<b>Disadvantaged</b>	<b>Intrinsic</b> <ul style="list-style-type: none"> <li>One Planet sustainable living</li> </ul>	<b>Extrinsic</b> <ul style="list-style-type: none"> <li>Healthy living, saving money, warmer homes</li> </ul>
<b>Hook Norton Low Carbon</b>	Mainly intrinsic	
<b>Affluent</b>	<b>Intrinsic</b> <ul style="list-style-type: none"> <li>Reducing carbon footprints</li> </ul>	<b>Extrinsic</b> <ul style="list-style-type: none"> <li>Maintaining/improving quality of life</li> </ul>
<b>Kirklees-Hillhouse</b>	Mainly extrinsic	
<b>Disadvantaged</b>	<b>Intrinsic</b> <ul style="list-style-type: none"> <li>NA</li> </ul>	<b>Extrinsic</b> <ul style="list-style-type: none"> <li>Immediate priorities such as saving money, well-being, affordable warmth and comfortable homes, and health</li> </ul>
<b>Low Carbon West Oxford</b>	Mix of intrinsic and extrinsic	
<b>Middle income</b>	<b>Intrinsic</b> <ul style="list-style-type: none"> <li>Combating climate change/reducing carbon emissions of individuals and community</li> <li>Taking part in a community initiative</li> </ul>	<b>Extrinsic</b> <ul style="list-style-type: none"> <li>Local flooding</li> <li>Saving money, warm homes</li> <li>Meeting friends and neighbours</li> </ul>
<b>Notes:</b>		
<p>1. AAT was mainly running creative outreach activities during the research period, so we refer to these messages. They also set up of <i>Egni</i>, the South Wales Valleys Solar Photovoltaic co-op, with both intrinsic and extrinsic messaging.</p>		

Figure 4.1 shows high levels of concern about climate change, energy security and rising energy prices and fuel bills in all LCCs (across the 88 case study households) and high levels of motivation to reduce household energy use, ranging from 86% (12/14) in Low Carbon West Oxford to 100% in Sustainable Blacon, Hook Norton Low Carbon and Kirklees-Hillhouse; and to a slightly lesser extent community energy use, ranging from 59% in Awel Aman Tawe to 88% (15/17) in Hook Norton Low Carbon.

The research at the 17 EVALOC supported community events shows that respondent's motivations to reduce energy use include a mix of both extrinsic and intrinsic motivations (see Figure 4.2 - *Reasons given for increased motivations to save home energy*). 76% of respondents said that the events had increased their motivation to save energy in the home (n=345). Of the 130 respondents who gave a reason for their increased motivation 17% said it was due to extrinsic reasons such as saving money, 19% said it was due to intrinsic environmental or social reasons (e.g. 'Don't want to leave a ruined planet to the children'), and a further 38% said it was due to their increased understanding of the change process. These include an improved understanding of how change can be achieved at individual or community level, and the sense of being part of a wider movement (e.g. 'The exhibition made me feel [my] effort is not futile').

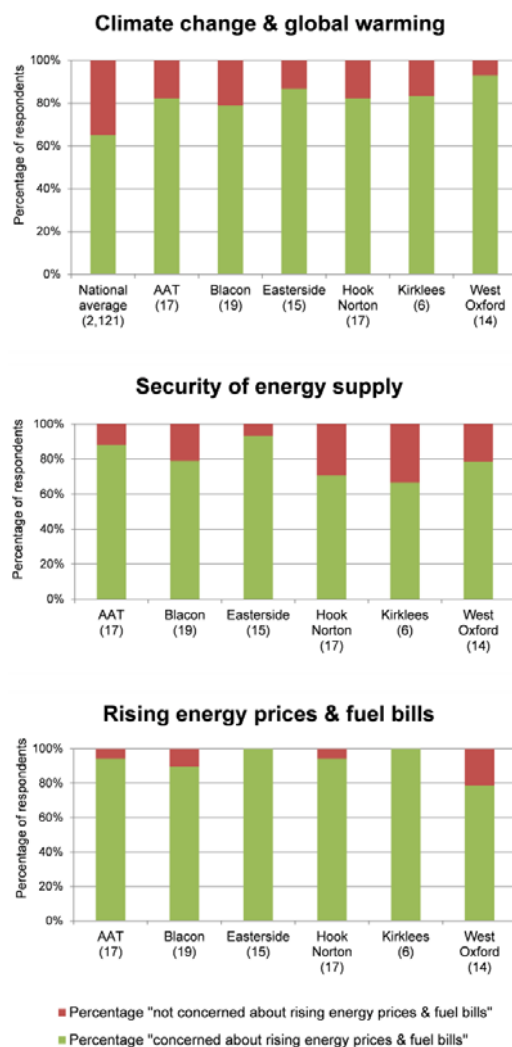


Figure 4.1 Concern levels in case study households

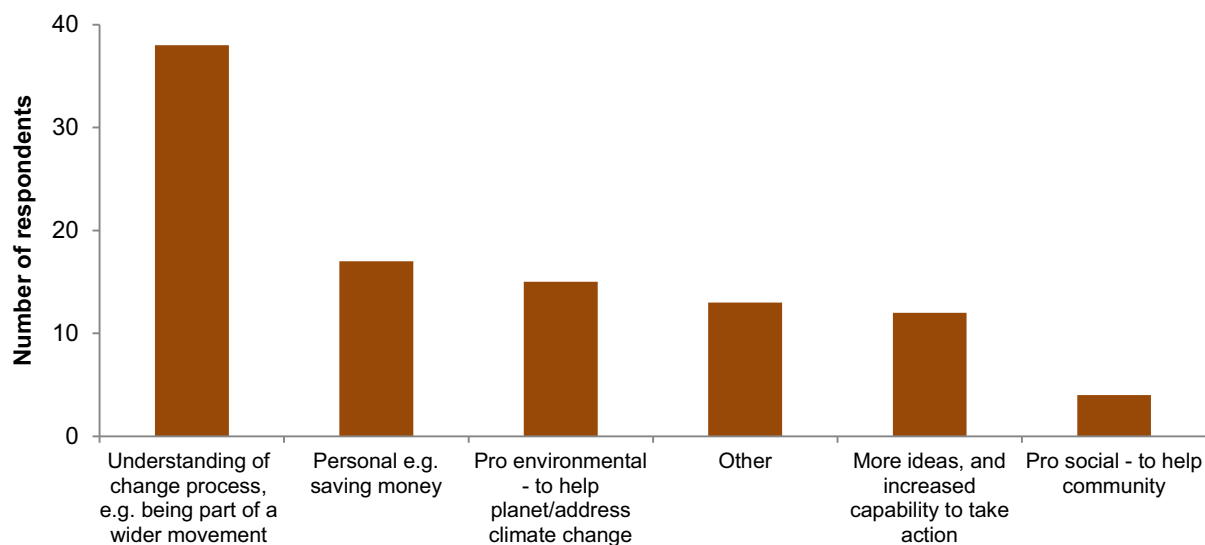


Figure 4.2 Reasons given for increased motivations to save home energy use following community events

#### 4.1.4 Engagement Channels

The LCCs used mutually reinforcing methods to engage and motivate residents to get involved in the energy and carbon reduction initiative, including:

- opportunities to benefit from free energy efficiency or renewable measures, technical support and advice;
- opportunities to learn from neighbours and experts;
- complementary food, transport and waste projects;
- financial incentives;
- door knocking, letters, newsletters and posters;
- stalls at community events, including those led by other organisations;
- community events led by the LCC;
- demonstrations, e.g. renewable installations on community buildings or homes; open homes; 'show and tells' in public spaces.
- community champions;
- word of mouth;
- recruitment at community hubs such as schools;
- media and flash mob stunts

A key difference between the LCCs was the number of organisations involved in the project. In LCCs with a partnership, multi-agency or joint working approach, the messages were magnified and the engagement opportunities widened. Door-knocking was highlighted by some LCCs as the most effective way of widening engagement.

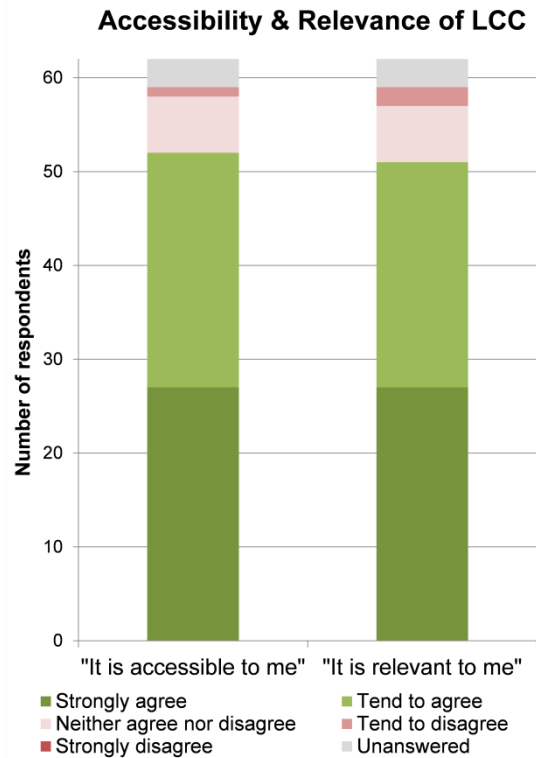
The LCCs noted a number of difficulties in widening engagement relating to *the nature of the LCC, design of the project interventions, the nature of the community, and external constraints* such as lack of access to free measures.

#### 4.1.5 Relevance and accessibility of project design

The majority of respondents in household interviews strongly agreed or tended to agree that LCCs activities were relevant and accessible to them (Figure 4.3), and that the LCCs were bringing benefits to the community (discussed further in Chapter 6).

The relevance and accessibility of LCC projects varied according to organisations involved, capabilities and project design. Most of the LCCs sought to address barriers to participation through some of the following: financial incentives/grants, technical support, a range of activities, group-based learning opportunities, thoughtful timing of meetings, and language translation. (See individual community reports). However only three (Eco Easterside with a partnership approach, Kirklees-Hillhouse with a multi-agency approach, and Sustainable Blacon,

training volunteers) had the capacity to coordinate area-wide delivery of energy efficiency and renewable measures to homes or to provide the handholding which can be important to enable disadvantaged and vulnerable households to benefit from projects.



**Figure 4.3** Responses from 62 case study households involved in LCC activities

## 4.2 Community events, shared learning and social learning

One common way LCCs engage and involve their wider community in energy issues is through community events. EVALOC researched how far community events contributed to social learning.

### 4.2.1 Methods

The EVALOC action research was organised around supporting the LCCs to hold a series of community events along with shared learning events between LCCs, over a four year period. These events had the objectives of supporting LCC energy activities, whilst providing opportunities for conducting research into the effectiveness of community-based social learning for stimulating energy-saving. The events were devised by key members of the LCC in collaboration with EVALOC researchers and agencies such as schools, faith-based organisations, and Councils.

In total, 17 EVALOC-supported events took place. They are summarised in Figure 4.4, with the full list included in Appendix C.

The events were designed to cover different styles of learning:

- *Knowledge building* – presentations, talks, information sheets, training courses
- *Show and Tell* – learning through observation of others; practical 'how to' demonstrations; presentations; practical training course; a play; video; poetry.
- *Participatory or interactive learning* - workshops.

The events could be divided into 'community events', aimed 'downstream' at the local community, and 'shared learning events', aimed at exchanging ideas and strategies. The latter primarily occurred between LCCs, although shared learning could also take place within a LCC, with group development, reflection, and development of an action plan or strategy.

Research methods included participant feedback forms and online surveys, participant observation, and documentation through photos, videos and notes. Additional data was collected through surveys of participants from Awel Aman Tawe's Arts and Climate Change project, which was funded as part of the LCCC.

Case Study Box A and B outline two of the events in terms of description and key learnings. In total, 2,155 people participated in the EVALOC-supported community events, and 486 survey responses were collected. Reports on the events were fed back to the LCCs.<sup>3</sup>

#### 4.2.2 How were the events publicised?

Although a key objective of the EVALOC-supported community events was to enhance and support LCC energy activities, most of the LCC events were advertised as being about having fun (e.g. Eco Easterside's Eco Gala), a community celebration event (e.g. Kirklees-Hillhouse fuel poverty events), or a creative activity (e.g. Awel Aman Tawe's art and climate change projects).



**Figure 4.4** Poster outlining the community events supported by EVALOC and the output types

<sup>3</sup> Note the separate working paper available through the EVALOC Energy & Communities toolkit, 'Motivating and enabling behaviour change through community events'.

## Community event case study box A:

### Hillhouse centre and local services: celebration event



**Type of learning:** knowledge and information;  
participatory/interactive learning

**Event participants:** local residents

**Key aims:** provide a free, informal, and fun event offering practical support and information on local services as well as showcase the Birkby Community Centre.

**Event description:** The event offered residents the opportunity to talk to and get advice from experts running the information stalls about energy saving, jobs, credit union, benefits, home improvements etc.). The main learning methods were discussions with stall holders and interactive activities such as a pictorial energy saving quiz, and art activities. These learning methods were supplemented by displays, posters, information pamphlets, leaflets.

The main energy saving information was an energy saving quiz at Kirklees Council's Environment Unit stall which involved showing people pictures of different energy using activities in the house and asking them to guess how much money it could save them per year.

**Attendees:** approximately 80 people

**Feedback forms completed:** 14

**Key learnings:** The event demonstrated how an informal and creative event with interactive activities, and free food, can attract large number of people and enable them to learn about energy and local services while enjoying themselves and having a chance to socialise with other residents. The feedback forms showed that respondents were able to recall and give concrete examples of what they had learnt, including energy saving tips. Most respondents acquired information through the interactive activities and talking to stall holders, supplemented by written information and leaflets. A pictorial energy saving quiz seemed particularly effective in this respect which shows how cheap simple and carefully tailored interactive activities can enable learning even when there are language barriers.

The idea of only allowing people to enter the tombola and raffle after they had visited the information stalls provided an important incentive to people to visit stalls, although this might not work well in all communities. Many of the respondents said that they felt more motivated and able to save energy as a result of the event and intended to make changes to their energy use in their home. The main reason given was to save money but one person said it was because they learnt that 'small changes can make a difference'. A number expressed concern and/or interest about climate change and requested more information about it and energy efficiency products.

The event provided important social benefits for attendees. It also generated some interesting incidental learning about the community and process of change: one person said they had learnt that there are people who can help them and another said they had learnt the importance of helping other people (as they had helped look after someone else's children at the event).



## Community event case study box B:

### Easterside Primary School Eco-Play



**Type of learning:** show and tell

**Event participants:** primary school children and parents

**Key aims:** to spread messages about energy saving, recycling and climate change to adults in the community

**Event description:** The play was performed in the School Hall by Year 3 children plus a number of older children who were 'eco warriors'. The play was about a group of penguins in Antarctica who are sad because the ice is melting. They go to the North Pole to find more ice but find it is also melting there. The Polar Bears explain that the humans are making the planet too hot. They then travel to UK, the US, Brazil and Australia and in each country sing a song to persuade people to stop driving so much, stop using so much energy, stop sending so much waste to landfill sites and stop chopping down the rain forest. Each time the people listen to the penguins and change their behaviours the planet cools down a little more until all the ice returns to Antarctica.

**Attendees:** approximately 25 people

**Feedback forms completed:** 21

**Key learnings:** The school play offered an entertaining, effective and motivating way of getting messages about climate change across to people. It reached and engaged parents/carers who might not otherwise have attended an event about energy or climate change. The involvement of children in the play also meant that parents/carers were engaged on an emotional level. The play also contained practical ideas for action.

Most people said they felt more motivated, and able to make changes to energy use as a result of seeing the play, and intended to reduce their energy use.

A possible risk of the play was that people might be put off by being preached at or the feeling that their children are being 'used' to get a message across that they may not agree with. The humour in the play appeared to have helped reduce this risk, as well as the deputy head teacher's upbeat, upfront and inclusive comment to the audience at the end of the play: '*Wasn't that a brilliant way to get the message across?!*'

It was subsequently suggested that the play might be staged in Middlesbrough town centre or at another local primary school, and another of the EVALOC LCCs explored the possibility of holding an eco-play at the local primary school.

#### 4.2.3 What did participants learn at community and shared learning events?

The main learning outcomes from the events were awareness and know-how about energy issues and action, as shown in Table 4.3. In addition, a relatively high proportion of respondents agreed that they learnt about the *process* of change, for example understanding why their actions mattered, and how many other people or organisations were seeking to make change happen. This type of learning mainly occurred at shared learning events, but also at some of the single-community events. In addition respondents mentioned learning about environmental issues and climate change (for example *'I don't want to leave a ruined planet to our children'*), as well as about the nature of their communities (*'this is a good community'*).

#### 4.2.4 How did participants learn?

The most common way participants learnt was as expected from social learning theory: through participative activities and discussions, followed by demonstrations. However, other forms of communication such as exhibitions, posters and leaflets provided useful forms of communication. The findings also suggested that when people are given space to engage with, process and integrate information about energy, discussing energy and comparing experiences in a non-judgemental way, this can be very productive in terms of learning.

#### 4.2.5 Impact of events

The majority of respondents to post-event surveys said that the events had strengthened their know-how, motivation and ability to take action on energy, and 90% said they intended to make changes to their energy usage. Of these, 75% indicated that they intended to take various forms of action on household and community energy, and other pro-environmental actions including lobbying. Strengthened intentions do not necessarily translate into actual action, although some of the research literature suggests that they can contribute to behaviour change (Mayne, Darby and Hamilton, 2012).

The community events helped establish and reinforce social relationships and networks, whilst linking participants to sources of energy action and support. A number of respondents commented on these benefits, for example:

*'I saw friends and talked'*

*'I am new to this country so this was useful;*

*'Good to get people together and children to play'*

*'There are people who can help'*

The events also created a space, and permission, to discuss energy issues, and increased participants' sense of agency by reminding them that they belonged to a wider movement for change, reminding them why and how their actions matter, and providing an opportunity to recall latent 'good intentions'. At some events, participants reflected that the event was *'preaching to the converted'*. However, this does not negate the finding that these events did appear to galvanise action, and that even those already interested or engaged still gained some motivation, inspiration or support to take action. As one participant commented,

*'I realise that there are lots of contradictions in the beliefs I hold and my behaviour in practice. Involvement with others exploring the dilemmas and challenges helps me feel I'm not alone and gives a feeling of creative solidarity.'* (AAT Pilot arts and climate change project).

#### 4.2.6 Shared learning events between communities

The shared learning events helped strengthen know-how within a wider 'low carbon community of practice'. For many LCCs, the events were an important opportunity to discuss and reflect on their change strategies or their involvement in the Low Carbon Communities Challenge. They learnt about *what* needs to change and *how* to achieve change, as well as identifying ideas for future activities and projects. The events also helped to validate LCC experiences, for example

*'It was a privilege to come to the event and share our thoughts ... and to feel I was valued and had something to contribute'.*

While feedback from the shared learning events demonstrated the value of learning from each other, it also revealed frustration among LCCs about their lack of capacity and resources to devote more time to their activities.

### 4.3 Creativity, climate change and energy

Awel Aman Tawe and Eco Easterside used creative methods to engage their community with energy and climate change issues, as listed in Table 4.4 (full details in Appendix C).

As with the community events reported above, these five creative events engaged participants and audience with the issues of climate change and energy, and offered some solutions. At Awel Aman Tawe events, information about these topics formed the most useful or significant thing that people said they had learned.

**Table 4.3** Learning outcomes from community and shared learning events

What was the most useful thing you learnt at this event? (n=428)	
Topic learnt	Number of responses
Energy information/awareness/action	180
Change process, how to make change happen, what others are doing	97
Climate change/environment	36
Social e.g. nature of the community, new contacts	24
Saving money	5
Other	92

**Table 4.4** Creative methods used by Awel Aman Tawe and Eco Easterside to engage their community with energy and climate change issues

Number, name and date of event	Description of event
<b>1b. December 2011 – Jan 2012</b> <b>1b. Follow-up questionnaire from DECC activities (Awel Aman Tawe - AAT)</b>	Questionnaire to capture the experiences of involvement in DECC-funded engagement
<b>1a. 'We're oil in this together' event November 2011 (AAT)</b>	Theatre performances, community choir, storytelling and art, plus display
<b>5. School play #1 (Eco Easterside)</b>	An Easterside primary school produced a play
<b>12a and b. Green Routines exhibitions, May 2013 and Feb 2014 (AAT)</b>	Interactive exhibition installed in National Trust in May 2013, and in the Senedd (National Assembly) building in Feb 2014
<b>17. School play # 2. (Eco Easterside)</b>	An 'eco production' at a second primary school in Easterside.

At performances in Easterside, the most useful thing people claimed to have learned was about energy actions, followed by some understanding of processes of change (i.e. what they could do to help and why their actions matter), and knowledge about climate change/planet/environment. The value of the creative events appeared to be achieved through:

**Widening engagement:** For Awel Aman Tawe, the arts and climate change work widened their community of support, engaging those in the arts with local energy issues, some of whom went on to support Awel Aman Tawe's wind farm. In Easterside, the school plays reached and engaged parents and carers who might not otherwise have attended an event about energy or climate change.

**Deeper engagement:** Involving people in a creative process such as acting or writing scripts appeared to deepen their engagement. As one participant mentioned:

*'It is impossible to tell what was most significant for me, but the participation was a major factor.'* (AAT)

Opportunities for social learning were maximised through participation, as people shared and developed their knowledge and opinions on energy and climate change issues. Mediating information about climate change through everyday experiences also seemed to deepen engagement. This was particularly true in the case of the 'Green Routines' exhibition (Awel Aman Tawe, see Figure 4.5) and the 'eco production' at St Thomas More primary school in Easterside.

**Emotional engagement:** Many participants in the Awel Aman Tawe creative processes reported that they engaged at an emotional level with issues of climate change and energy. This occurred through writing a poem or play script, acting in a play, or listening to the Green Routines audio recordings, and enabled participants to comprehend the negative science projections and to acknowledge that taking action wasn't always easy or simple. One participant from Awel Aman Tawe's 'Play in a day' (*We're oil in this together*) mentioned

*'Discussions during the script in a day were particularly good in clarifying the problem of how we react to being hectored [by other people]'*

This has implications for LCCs energy messages, particularly with regard to the issues of stigma revealed in the social network analysis, discussed later in this chapter.



**Figure 4.5** Engaging with the 'Green Routines' exhibition, Senedd, Cardiff

Similarly, the involvement of pupils in the Easterside school play and 'eco performance' deepened both children's and parents/carers emotional engagement in the issues of climate change, while increasing their motivation and knowledge. In addition, the eco production at St Thomas More primary school used a talk show format to invite 'guests' onto the platform, to question and challenge them about their everyday behaviours from a largely moral and altruistic concern for the planet. The key message was that there is one planet, and that we must look after it, which was reflected in the audience's reasons afterwards for feeling more motivation to reduce energy use: *'I want to help save the planet'*.

**Space for reflection:** Whilst new knowledge about energy and climate change is important, making space for participants to assimilate new information with what they already knew was also valuable. For example, one participant mentioned their relationship with oil, and their motivation to take action on energy and climate change issues:

*'The realisation that to generate the gut energy, the heart for change (and to encourage, support and motivate other people) we need to embrace and get to know oil - not project it outwards as a curse or a*

*problem, and build a mythology, an intimacy with this energy drug we are addicted to...' (We're oil in this together' participant)*

**Impacts:** Over 90% of post-event respondents in both Awel Aman Tawe and Eco Easterside said that they intended to make changes in their lifestyle to reduce their energy usage.

Whilst other LCCs also used creative methods to engage their community, these were not researched. For example, Low Carbon West Oxford has conducted a number of photo stunts and flash mobs to raise awareness of its work and of international processes such as UN negotiations on climate change, and Sustainable Blaenau has used art from recycled objects in their eco-home exhibitions.

## 4.4 Social networks

Informal social networks influence how energy know-how is diffused through communities, and the LCCs had a broad understanding of their local social networks. They communicated energy messages through newsletters, door knocking, energy champions, demonstration projects, learning and action groups, energy feedback, and the installation of energy efficiency measures. The LCCs also sought to build and shape social networks and social norms through community events. However, they lacked detailed knowledge of who people were speaking to and what they were saying about energy, which is where EVALOC research focused.

EVALOC's Social Network Analysis (SNA) was conducted with 86 households across the LCCs, as part of the semi-structured interviews conducted in 2012.<sup>4</sup>

### 4.4.1 Promoting energy messages

The EVALOC SNA found that all but one of the 86 interviewees discussed energy with their personal social networks in some form. However, family members make up almost two thirds of the people with whom the respondent discussed energy, which could indicate a reluctance to raise energy issues with those outside the family.

General conversations about energy covered a range of topics, contained in Table 4.5. These topics were mainly focused on novelty (e.g. experiences of LZTs) and practicality (e.g. sharing new knowledge about energy efficiency). Twenty-three interviewees mentioned that they thought they had influenced the behaviour of other people.

<sup>4</sup> A more detailed examination of the SNA will be presented in a working paper available through the EVALOC website.

**Table 4.5** Energy issues discussed in 86 case study households

What energy issues were discussed	Number of respondents who discussed these issues
<b>Energy efficiency</b>	47
<b>Prices and bills</b>	37
<b>LZTs and fabric measures</b>	36
<b>Information from groups</b>	17
<b>Energy display monitors</b>	10
<b>Global warming / environmental issues</b>	9

- However there were also constraints on transmission of energy messages and know-how through personal social networks. Interview evidence indicated that energy was not necessarily a neutral subject that could be discussed anywhere. Twenty-three interviewees mentioned contexts where energy wouldn't be discussed. These included instances where they perceived that there were other things to talk about (8); other people whom interviewees considered weren't interested, or there would be no point in bringing the topic up as they would not change their behaviour (6); or where there are too many obstacles to engaging with energy issues, as when people have enough to deal with without worrying about energy (4). The transmission of energy messages did not happen automatically through personal and social networks but required individuals to actively 'navigate' through the attitudes and experiences of those they were talking to. Thus 'energy messages' appeared to be spread more easily where there was a novel topic (such as a new solar panel or energy display monitor (EDM)), and some practical payoff (for example, when people could be referred to sources of grants and support, or the installation of a solar PV system).

Moreover, energy discussions can contain elements of judgement and stigma. This was noted by 17 of the interviewees, in only four of the case study areas, so this was by no means a predominant view. It nevertheless raises some important points for consideration in the planning of future community energy campaigns and interventions. From the interviews we identified three types of reference to stigma in relation to energy, namely:

- a) an awareness of stigma but communicating energy messages regardless (7) (e.g. *'I will bring the subject round...and talk about what people are doing to save energy... a bit like preaching'*)
- b) Self-censorship (6) (e.g. *'there is a fine line you walk between trying to promote something and being an evangelist and people getting [annoyed] with you'*);
- c) Judgement and perceived judgement from others (3) (e.g. *'I remember his response when he first moved here and ...was doing up his house... oh, you know, the low carbon police'*). No-one wanted to be thought of as a bad person because they were not thinking about energy or climate in the approved manner.

There was also evidence of a general feeling that was 'geeky' or 'a bit sad' to have an interest in energy.

#### 4.4.2 Personal social networks

We found that 80% of the case study household interviewees were consulted about energy issues by members of their personal social networks. These consultations tended to be practically focused, sometimes asking about what someone had learnt through participating in an LCC activity.

When interviewees were asked about energy, interestingly, there was no sense of 'impression management' or stigma: *as people had been asked about energy, there was permission to talk about it*. This suggests that the LCCs efforts to train energy champions who are involved in several different activities and to establish demonstration projects may be useful ways of spreading energy messages and know-how. Feedback from the interviewed energy champions in Easterside also suggests that sustained leadership and structured guidance are necessary to encourage their continued involvement.

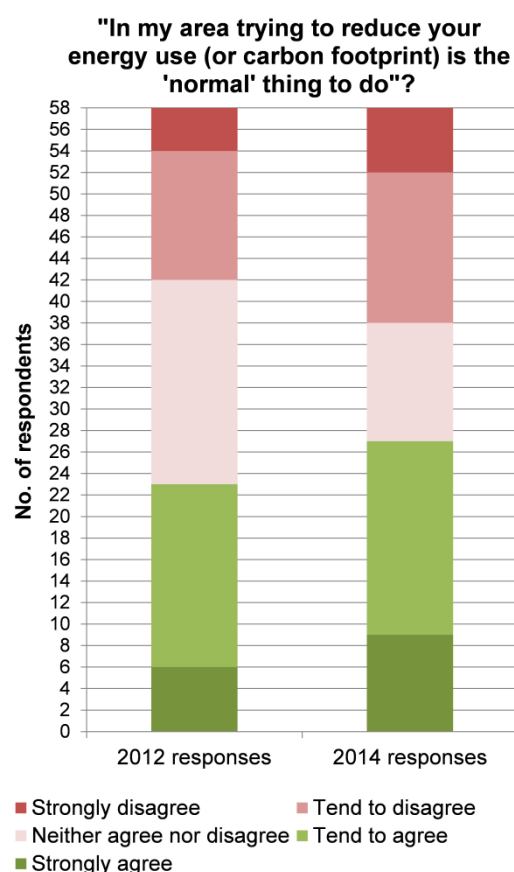
87% of the interviewees said that they consulted other people and organisations about energy issues. Although friends and family feature highly among those consulted about energy, interviewees said that they also felt comfortable approaching and discussing energy issues with other organisations. They generally felt more comfortable discussing energy issues with LCCs than with sources of information such as Council officers, and energy companies, although this was not always the case. Some interviewees felt they might be judged, or needed to forge a relationship before discussing energy with a LCC. There is, however, limited evidence of conversations influencing the actual energy behaviours and/or take up of new energy technologies in the communities.



## 4.5 Social Norms

Some behavioural economics research proposes that people are more likely to do something if they think other people like them are doing it i.e. if they think it is a 'social norm' (Cialdini, 1993). LCCs can strengthen energy saving social norms by framing their communications to convey the message that energy saving is a normal activity.

In 2012, the respondents in the household interviews were split in their views on whether or not reducing energy use (or carbon footprint) was a normal thing to do in their community. By 2014, the numbers agreeing or tending to agree that reducing your energy use (or carbon footprint) is a 'normal' thing to do in the community had increased, suggesting a positive change in the 'social norms' in the community. However, in four of the communities the views became more polarised, as reflected in Figure 4.6.



**Figure 4.6** Responses from 58 case study households from first round interview (summer 2012) and follow-up interview (summer 2014)

In one community, some of the residents pointed to all the low carbon activities happening on their estate such as the 'solar panels, electric car that people could borrow'. At the other extreme, one resident felt that social norms were not changing:

*'No one will save energy on this estate. They all have big fifty inch tellies'.*

There was a sense from some residents that community involvement needed to be widened particularly with people who weren't part of the project initially:

*"I'd like to see more done in that area [targeting people outside the project]".*

## 4.6 Summary

- The LCCs use mutually reinforcing methods to engage and motivate residents to get involved in community-based initiatives on energy and carbon reduction

- All the LCCs have engaged and motivated significant sections of their communities to get involved in their activities. Their reach and capacity varies according to the organisations involved, their capabilities, and project design. All LCCs faced difficulties in widening engagement relating to the nature of the LCC, the design of the project interventions, the nature of the community and external constraints.

- Community-based social learning through events can play an important role in stimulating energy reduction, by increasing know-how, motivation, ability and intentions to take action.

- The added value of creative events was to widen and deepen engagement, and to allow for emotional engagement, creating space for people to learn and reflect on new information about energy and climate change and to integrate it with their existing knowledge.

- 'Energy messages' were transmitted through personal social networks, mainly to close friends and family. Fear of judgement or stigma could impede the dissemination of energy messages. But LCCs were able to use personal social networks to promote energy know-how by providing space for energy conversations in a variety of contexts, and through identifying and training community champions and other messengers.

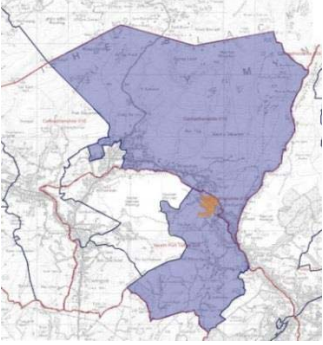
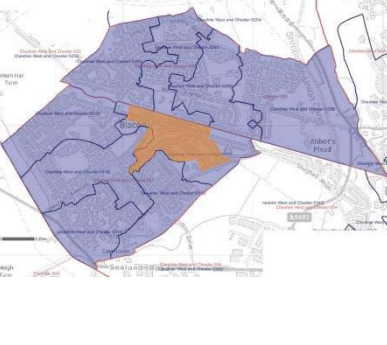
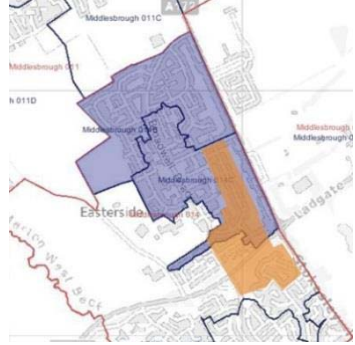
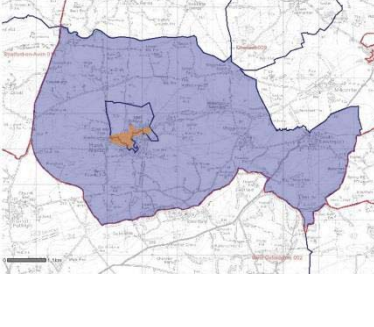
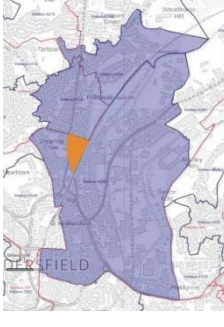
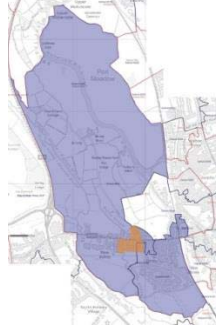
## Chapter 5

### Community carbon reductions and energy savings

This section presents the carbon savings in the communities due to the installation of localised renewable energy generation through the local low carbon community projects. In addition, it outlines the energy (gas and electricity) trends across a five-year period (2008-2012), covering before-and-after LCC activities at:

- wider community level (~ 1,070 to 5,590 households)
- local neighbourhood level (approximately 300 households)
- individual households (79 households)

The areas and numbers of households included are shown in Figure 5.1. It must be noted that the focus of this chapter is on domestic energy use (gas (or equivalent fossil fuel) and electricity) and as such the CO<sub>2</sub> emission/savings figures are only based on this. It does not include the emissions/savings from wider carbon-related behaviours relating to transport, water, food, waste and lifestyle that were the focus of some of the LCC household energy projects (e.g. LCWO).

<b>Awel Aman Tawe:</b> 	<b>Sustainable Blacon:</b> 	<b>Eco Easterside:</b> 
<b>LSOA:</b> approx. 1,175 households	<b>LSOA:</b> approx. 5,590 households	<b>LSOA:</b> approx. 1,160 households
<b>Carbon mapped area:</b> 311 households	<b>Carbon mapped area:</b> 385 households	<b>Carbon mapped area:</b> 242 households
<b>EVALOC case studies:</b> 16 households	<b>EVALOC case studies:</b> 19 households	<b>EVALOC case studies:</b> 15 households
<b>Hook Norton Low Carbon:</b> 	<b>Kirklees-Hillhouse:</b> 	<b>Low Carbon West Oxford:</b> 
<b>LSOA:</b> approx. 1,070 households	<b>LSOA:</b> approx. 2,235 households	<b>LSOA:</b> approx. 1,540 households
<b>Carbon mapped area:</b> 274 households	<b>Carbon mapped area:</b> 184 households	<b>Carbon mapped area:</b> 275 households
<b>EVALOC case studies:</b> 13 households	<b>EVALOC case studies:</b> 6 households	<b>EVALOC case studies:</b> 10 households

**Figure 5.1** Areas and households mapped from wider community to individual case study households in each LCC

The 2008 baseline is taken to account for some LCC activities taking place before the DECC-funded projects, which were mainly instigated between 2010 and 2011.

The wider community-level energy data is taken from publicly available sub-national longitudinal domestic gas (weather-corrected) and electricity use (not weather-corrected) data. The datasets used are based on the Lower Layer Super Output Areas (LSOAs), which are defined geographical areas that provide boundaries for the collection and publication of small area statistics. LSOAs were first used in 2001 and have, on average, 1,500 residents and 650 households within them. Measures of proximity and social homogeneity (dwelling and tenure types) are also included in the LSOA boundaries. The overall energy figures presented in this section are based on the energy data of at least two LSOAs per community, covering the physical area that the LCCs cover as best as possible. In some cases this is larger (Kirklees-Hillhouse) than the area defined in Table 2.1 and in some it is much smaller (Awel Aman Tawe) due to the LSOA boundaries not meshing well with the reach and location of the LCC activities. In the case of Kirklees-Hillhouse, the area defined is larger due to the community centres benefitting from the DECC LCCC being outside the defined 'Hillhouse' area, as well as the locations of many of the community events and workshops that Kirklees Council undertake.

Energy use and carbon reductions at the local neighbourhood level were estimated using DECoRuM (Domestic Energy, Carbon counting and carbon Reduction Model), a geographical information system (GIS) based carbon mapping modelling tool. The background calculations of DECoRuM are performed by BREDEM-12 (Building Research Establishment's Domestic Energy Model) and SAP 2009 (Standard Assessment Procedure), both of which are dynamically linked to create the model. BREDEM is a methodology for the calculation of the energy use of dwellings based on characteristics; it is suitable for stock modelling. It shares some features with the SAP methodology, but allows users to adjust inputs which are fixed in SAP (BRE, 2014). SAP, based on BREDEM, is the UK Government approved method for the assessment of the energy and environmental performance of dwellings. It used self-completion questionnaires and Energy Performance Certificates (EPCs) to estimate energy use in the baseline year (2008) and the energy use in 2012.

The annual energy data from 2008 to 2012 for 79 of the 88 case study households were received from the Department of Energy and Climate Change (DECC). The data are based on the actual (or estimated, depending on whether or not access to the household was possible) annual meter readings of the individual households. The datasets that these are from are also used to provide the sub-national energy statistics. The national data figures used for comparison are based on the subnational data also, and therefore cover the same annual periods as the LSOA data and the case study household longitudinal data.

### 5.1 Carbon savings due to community renewable energy projects

Four out of the six LCC projects studied involve localised renewable energy generation installations, on both community buildings and individual households. Table 5.1 outlines the total and average annual carbon savings due to these installations in each community (installed from 2010 onwards), which were either funded through a variety of means depending on the LCC model (e.g. DECC LCCC capital costs, community share raising, or rolling loan fund, initially seeded by the DECC LCCC funding). The combined total carbon saving of 738 tonnes of CO<sub>2</sub> is equivalent to 1,757,143 miles (driven by average vehicle) or the carbon sequestered by 605 acres of forest in one year (U.S. EPA, 2014).

### 5.2 Changes in domestic energy use of wider community

Whilst it is not possible to directly relate changes in the domestic energy use of the wider community to LCC activities due to the many factors affecting household energy use, longitudinal data provide an overview of energy trends and possible 'ripple' effects of the LCC projects across the wider community. In addition, LSOA data can provide useful area-based energy data (particularly when combined with dwelling and household data) that can enable LCCs to target their activities and focus to best suit the local context. As Table 5.2 outlines (**bold** indicates greatest percentage reductions), generally the percentage reductions between 2008 and 2012 across the communities were greater than national reductions, despite most of the communities having lower baseline (2008) domestic average gas and electricity use than the national average, which can limit the possibility of reducing energy use further. This suggests that it is likely LCC activities are contributing in some way to domestic energy reductions in their area.

**Table 5.1** Generation and carbon emissions from LZTs installed by the LCCs

Location	Type	Annual Generation <sup>3</sup> (kWh)	Annual carbon savings <sup>2</sup> (tonnes CO <sub>2</sub> )	Total Generation <sup>1</sup> (kWh)	Total carbon savings <sup>2</sup> (tonnes CO <sub>2</sub> )
<b>Eco Easterside (actual)</b>					
<b>Community buildings</b>	Wind turbines (2 x 6kW), Solar PV (2 x 2.6kW)	15,239	8	54,094	28
<b>Dwellings</b>	Solar PV (10 x 1.11-2.0kW)	17,231	9	66,195	34
<b>Total:</b>		<b>32,470</b>	<b>17</b>	<b>120,289</b>	<b>62</b>
<b>Hook Norton Low Carbon (predicted only)</b>					
<b>Community buildings</b>	Solar PV (1 x 3.0kW, 1 x 17.4kW)	18,558	10	74,775	39
<b>Dwellings</b>	Solar PV (12 x 1.1kW-4.0kW)	25,490	13	99,464	51
<b>Total:</b>		<b>44,048</b>	<b>23</b>	<b>174,239</b>	<b>90</b>
<b>Kirklees-Hillhouse (actual)</b>					
<b>Community buildings</b>	Solar PV (3 x 3.4-8.2kW)	7,970	4	24,322	13
<b>Dwellings</b>	Solar PV (52 x 1.7-2.1kW)	67,249	35	206,855	107
<b>Total:</b>		<b>75,219</b>	<b>39</b>	<b>231,177</b>	<b>120</b>
<b>Low Carbon West Oxford (predicted only)</b>					
<b>Community buildings</b>	Wind turbine (1 x 6kW), Solar PV (4 x 11-100kW)	184,250	95	842,750	436
<b>Dwellings</b>	Solar PV (9 x 1.1-3.3kW)	14,501	7	59,210	31
<b>Total:</b>		<b>198,751</b>	<b>102</b>	<b>901,960</b>	<b>467</b>
<b>Total across communities (actual):</b>		<b>107,689</b>	<b>56</b>	<b>351,466</b>	<b>182</b>
<b>Total across communities (predicted):</b>		<b>242,799</b>	<b>125</b>	<b>1,076,199</b>	<b>557</b>
<b>Total across all communities:</b>		<b>350,488</b>	<b>181</b>	<b>1,427,665</b>	<b>739</b>

**Notes:**

<sup>1</sup> From commissioning date to 30/01/2015

<sup>2</sup> Calculated using carbon emissions factor of 0.517 (SAP 2009) and the following calculation: Carbon savings = carbon factor\*energy used

<sup>3</sup> Based on total generation and months installed.

N.B: - solar thermal installations not included due to lack of data.

In particular, it is interesting to highlight Blacon, which has seen a significant 21% reduction in the average domestic gas use (from 2008-2012, and despite having the lowest baseline figure across all communities). The focus of Sustainable Blacon was demand reduction through behaviour change and physical interventions such as new heating systems, loft and cavity wall insulation (i.e. focused on reducing gas use). However, it must be noted that, as an area, Blacon has seen significant community-wide fabric-related energy improvements since 2008, mainly through Government schemes such as Warm Front, CERT (Carbon Emissions Reduction Target) and ECO (Energy Company Obligation), which target areas of deprivation and relatively 'simple', low-cost fabric measures such as loft and cavity wall insulation, and so such reductions cannot all be attributed to LCC activities. The reduction in average household electricity use in Kirklees-Hillhouse is also significantly greater than the national reduction (12% to 4%), which does imply that the focus of Kirklees Council in terms of investing significant funds for localised energy generation (including the LCCC-

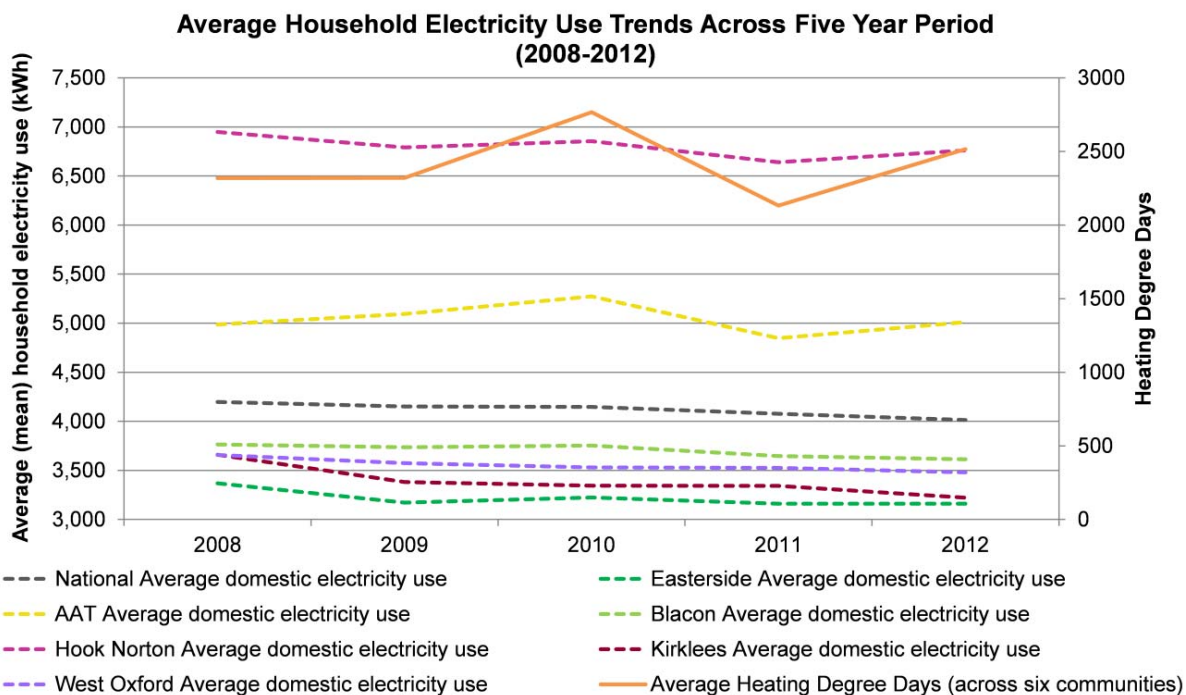
funded Greening the Gap project) is contributing in some way to reductions in both carbon emissions and grid electricity use.

Analysis of the year-by-year changes (Figures 5.2 and 5.3) in domestic average electricity and gas use in the individual communities shows no clear correlation between DECC-funded LCCC activities (2010-2011) and the wider community energy use. However, it does indicate that there are reduction trends across the communities, particularly in terms of gas use; only one community increased their gas use between 2011 and 2012 (most likely due to increased cold weather in 2012 and assumed fewer numbers of insulated dwellings, due to the main dwelling construction being solid brick in this community). Furthermore, there were significant gas reductions in all communities between 2008 and 2009, which is likely indicative of socio-economic factors such as the recession that influence household energy use.

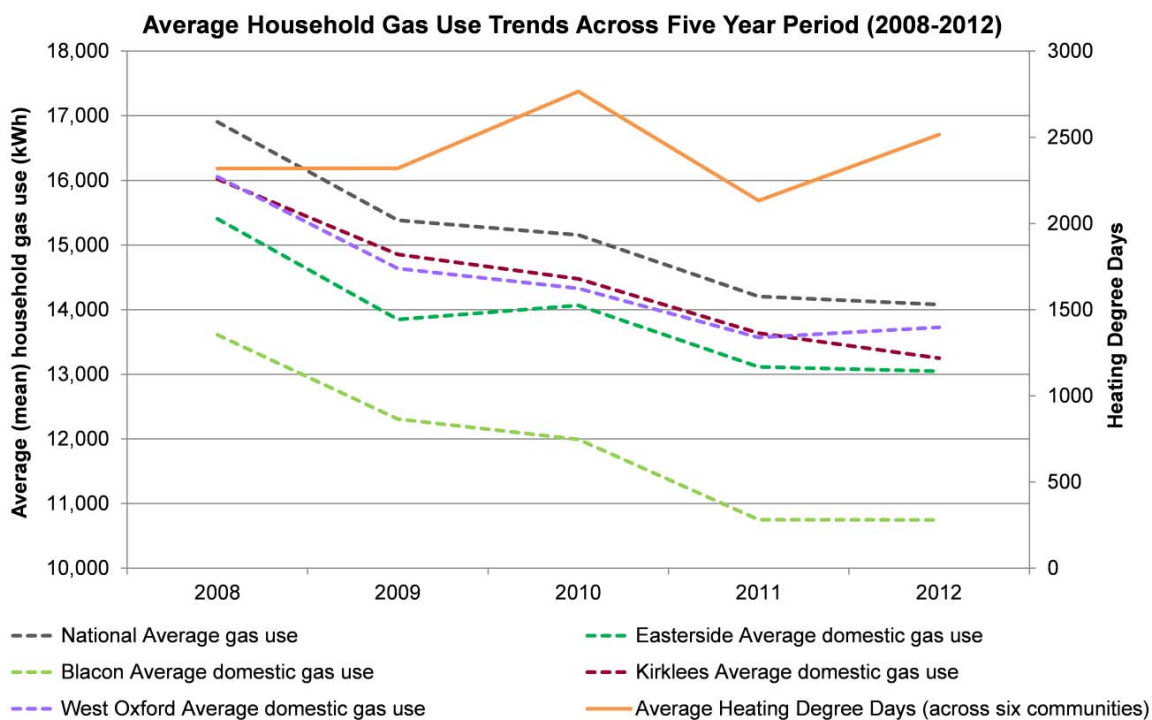
**Table 5.2** Changes in average household energy use from 2008 to 2012 across wider community in which LCCs are based

	National	Awel Aman Tawe	Sustainable Blacon	Eco Easterside	Hook Norton Low Carbon	Kirklees-Hillhouse	Low Carbon West Oxford
Household sample no. (approximate) (2011)	25.6mil	1,175	5,590	1,160	1,070	2,235	1,540
2008 Baseline average electricity use (kWh)	<b>4,198</b>	4,987	<b>3,765</b>	<b>3,368</b>	6,949	<b>3,660</b>	<b>3,658</b>
2008 Baseline average gas use (kWh)	<b>16,906</b>	-	<b>13,613</b>	<b>15,407</b>	-	<b>16,020</b>	<b>16,057</b>
Percentage reduction in AVERAGE domestic carbon emissions	<b>12%</b>	-	<b>14%</b>	12%	-	<b>15%</b>	11%
Percentage reduction in AVERAGE energy use	<b>14%</b>	-	<b>17%</b>	<b>14%</b>	-	<b>16%</b>	13%
Percentage reduction in AVERAGE energy use (electricity)	<b>4%</b>	1% increase	4%	<b>6%</b>	3%	<b>12%</b>	<b>5%</b>
Percentage reduction in AVERAGE energy use (gas)	<b>17%</b>	-	<b>21%</b>	15%	-	<b>17%</b>	15%





**Figure 5.2** Average (mean) household electricity use trends across five year period (2008-2012)



**Figure 5.3** Average (mean) household gas use trends across five year period (2008-2012)

### 5.3 Local neighbourhood energy reductions

DECoRuM carbon mapping, as described above, is used to model and map the local neighbourhood energy reduction by estimating energy consumption on a dwelling-by-dwelling basis. DECoRuM in the EVALOC project was used to specifically:

- Estimate domestic carbon emissions and energy use on a house-by-house level both pre- and post-LCCC action
- Predict potential energy, carbon and cost savings for selected local housing archetypes for each case study community group to help identify appropriate measures for energy improvements.
- Further predict what action can be taken by LCCs to reduce household energy use by having mass installation of a single or combination of measures, so communities can plan and target future action

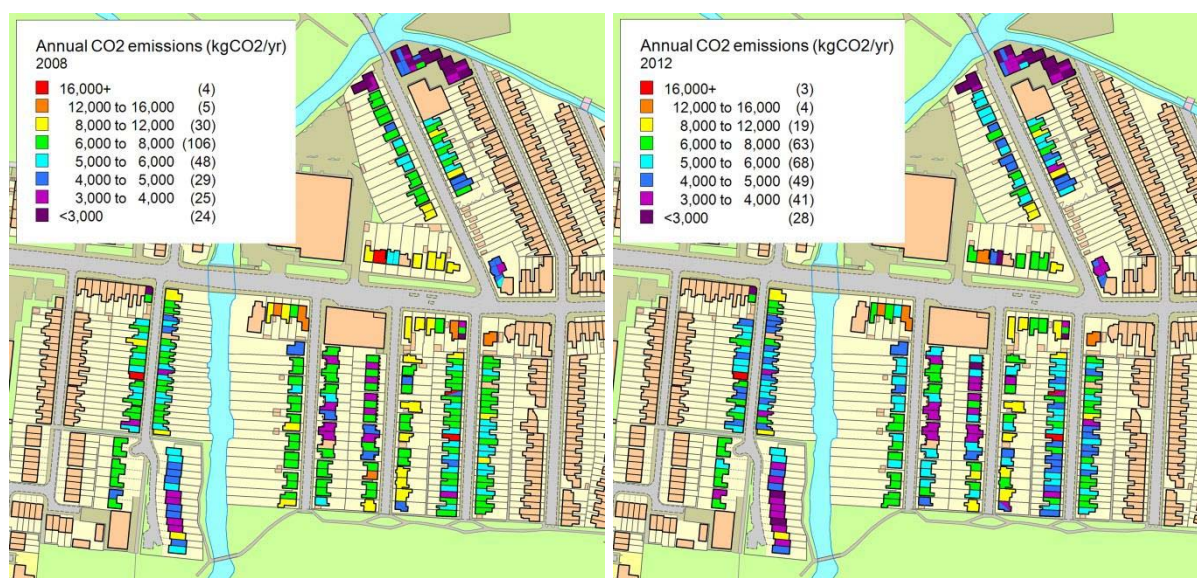
There are different levels of estimation and in some cases, actual consumption values (DECC data of case study households) are known and represented. Because not all households in the mapped areas or 'local neighbourhood' received physical measures, and not all households that did receive physical measures are in the areas mapped, the results are, again, too broad to make definitive associations with the low carbon community project outcomes. In addition, because DECoRuM calculates energy consumption at dwelling level only (bottom-up), community level energy generation installations (i.e. installations not on a dwelling) are not included.

In the DECoRuM model, CO<sub>2</sub> emissions are the result of heat loss calculations from fabric and ventilation, estimated energy use from heating, domestic hot water and electricity use. To inform the model, actual dwelling characteristics are gathered from historic and current maps, on-site assessment, home occupant questionnaires, Energy Performance Certificates (EPCs), and literature describing home characteristics based on age and typology. As examples: occupancy, unless known, is calculated from floor area using the BREDEM-12 method; street-facing windows and frames are directly observed but all other unseen windows are assumed to be the same; wall construction and U-values (unless known, e.g. reported in EPCs) are based on the age of the home where construction methods are well documented (e.g. BREDEM-12 reference tables). Verification is performed by calibrating the aggregated results to DECC's LSOA energy data for England and Wales. The results for each household are displayed on a map using GIS software; in this instance MapInfo. GIS allows any variable to be mapped for visual communication, e.g. kWh/year, CO<sub>2</sub> emissions/m<sup>2</sup>/year, homes in need of cavity wall insulation, PV suitability, etc. One main benefit of carbon mapping for communities is to identify and target areas of potential future action (e.g., areas with single glazed windows, cavity wall uninsulated, and south facing roofs) and plan for mass energy improvements of a single or combination of measures. Furthermore, DECoRuM enables tracking of performance change as measures are installed.

Figures 5.4 and 5.5 display the annual CO<sub>2</sub> emissions of Kirklees-Hillhouse and Low Carbon West Oxford respectively as examples.



**Figure 5.4** DECoRuM carbon maps of Hillhouse showing the baseline (2008) (left) and post-LCCC action (2012) (right)



**Figure 5.5** DECoRuM carbon maps of Low Carbon West Oxford showing the baseline (2008) (left) and post-LCCC action (2012) (right)

All communities' carbon emissions reduction maps are available to the individual communities in their specific *Carbon Mapping Community Case Study*. Table 5.3 indicates the reduction in both energy and CO<sub>2</sub> emissions for the mapped areas of the six communities (**bold** indicates greatest percentage reductions). The reductions generally follow the same pattern as the reductions found for the wider community; however, they are slightly smaller.

This may be due in part to the DECoRuM model not being able to take into account the behaviours of the occupants. As such the changes in estimated energy use and carbon emissions (for the majority of the

households) shown in the carbon mapping are due mainly to physical interventions. The intent in defining the mapped area was to capture as many LCCC beneficiary dwellings as possible, but also to capture a wide variation in dwelling type (age and built form). Including or excluding dwellings can change the reductions. Though definitive associations are difficult to make, Kirklees-Hillhouse is unique in that a large number of households benefitted from LCCC action and are grouped together in a small area.

**Table 5.3** Reduction in energy and carbon emissions in the mapped areas of the six communities

	Awel Aman Tawe	Sustainable Blacon	Eco Easterside	Hook Norton Low Carbon	Kirklees- Hillhouse	Low Carbon West Oxford
Household sample no.	311	373	242	274	184	275
LCCC beneficiaries	0	4	34	6	53	4
2008 Baseline average energy use (kWh)	25,530	<b>23,077</b>	22,079	27,123	<b>25,274</b>	25,652
2012 Average energy use (kWh)	22,891	<b>19,816</b>	19,336	24,098	<b>21,776</b>	22,727
Percentage reduction in AVERAGE domestic carbon emissions	11%	<b>13%</b>	11%	11%	<b>14%</b>	12%
Percentage reduction in AVERAGE energy use	10%	<b>14%</b>	12%	11%	<b>14%</b>	11%



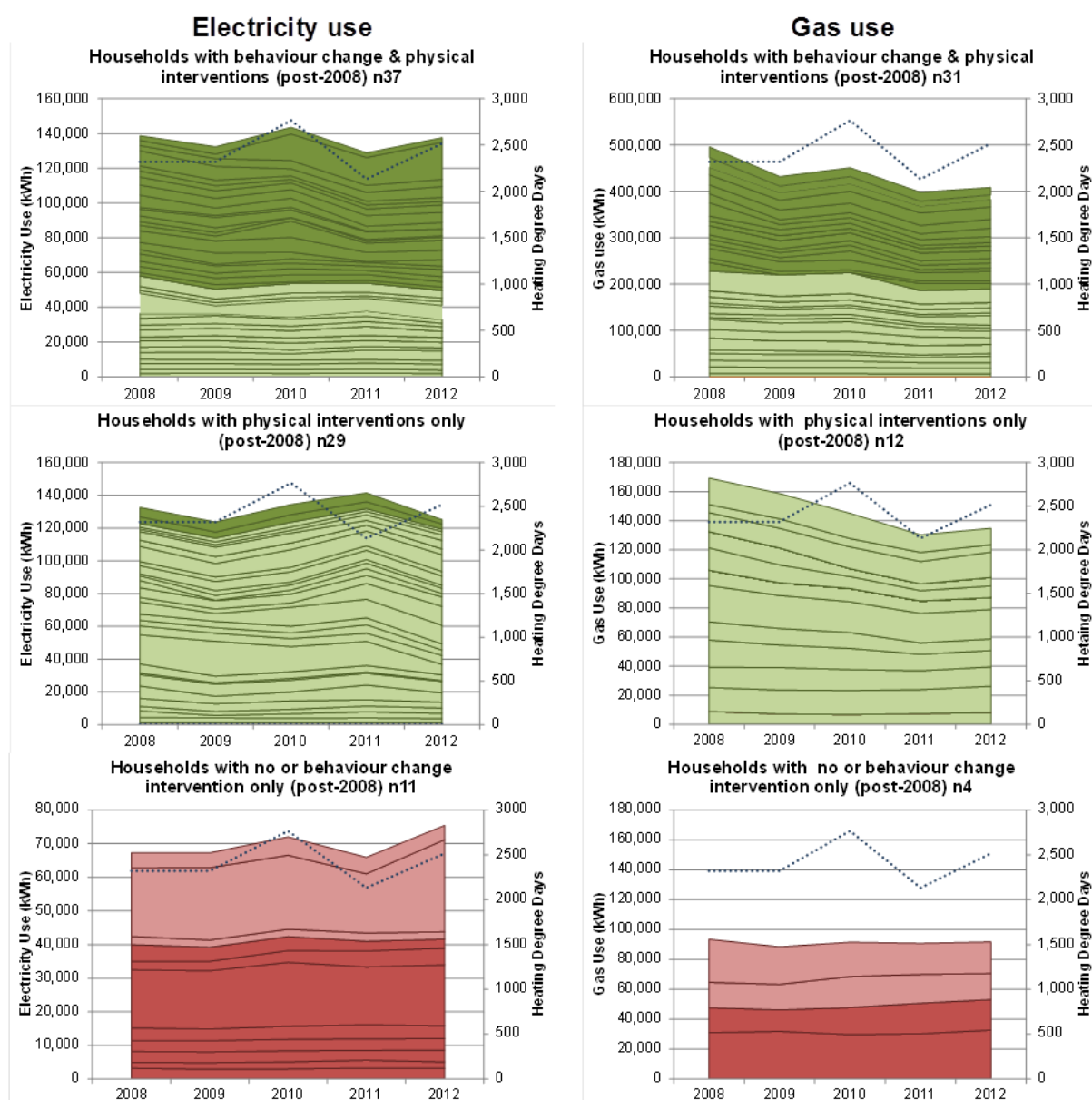
## 5.4 Changes in gas and electricity use of case study households

Five year annual electricity data were collected for 77 of the case study households and five year annual gas data were collected for 47 households. Full energy data (gas and electricity, or just electricity where applicable) was collected for 46 of these households. The households were grouped in terms of the interventions undertaken post-2008, rather than just by the type of LCC-led intervention. This is due to many of the households undertaking 'standard' energy improvements as part of necessary upgrading and/or refurbishment projects.

As the results show (Table 5.4 & Figure 5.6) there are significant differences in the changes in energy use of individual households, particularly in terms of electricity, as demonstrated by the wide disparity between the mean and median percentage change figures. The reasons for these are varied, and often very specific to the individual household. Examples of this include H53, which has seen a 619% increase in electricity between 2008 and 2012. This is most likely due to the installation of an air source heat pump system (from an oil boiler) and a significant increase in usable floor area (almost double what it was previously), despite both solar thermal and solar PV systems being installed.

**Table 5.4** Changes in annual electricity and gas use (2008-2012) across case study households, grouped according to the interventions within the household undertaken post-2008

Post-2008 intervention type	Behaviour & Physical	Physical only	None / Behaviour only
<b>Sample No. (Electricity)</b>	37	29	11
Average baseline electricity use (2008)	3,747 kWh	4,572 kWh	6,121 kWh
No. of households experiencing electricity reductions (2008-2012)	25 (68%)	16 (55%)	3 (27%)
Worst percentage change in electricity use	619% increase	322% increase	99% increase
Best percentage change in electricity use	87% reduction	65% reduction	47% reduction
Mean percentage change (electricity use)	6% increase	9% increase	9% increase
Median percentage change (electricity use)	12% reduction	3% reduction	5% increase
<b>Sample No. (Gas)</b>	31	12	4
Average baseline gas use (2008)	15,995 kWh	14,108 kWh	23,360 kWh
No. of households experiencing gas reductions (2008-2012)	25 (81%)	10 (83%)	1 (25%)
Worst percentage change in gas use	82% increase	32% increase	21% increase
Best percentage change in gas use	55% reduction	48% reduction	27% reduction
Mean percentage change (gas use)	13% reduction	19% reduction	1% increase
Median percentage change (gas use)	16% reduction	21% reduction	5% increase



**Key for Figure 5.6**

<span style="display: inline-block; width: 20px; height: 15px; background-color: #2e5c2e; border: 1px solid black;"></span>	- Households with LZTs present
<span style="display: inline-block; width: 20px; height: 15px; background-color: #90ee90; border: 1px solid black;"></span>	- Households with physical and/or behaviour change interventions
<span style="display: inline-block; width: 20px; height: 15px; background-color: #f08080; border: 1px solid black;"></span>	- Households with behaviour change interventions only
<span style="display: inline-block; width: 20px; height: 15px; background-color: #cd5c5c; border: 1px solid black;"></span>	- Households with no interventions

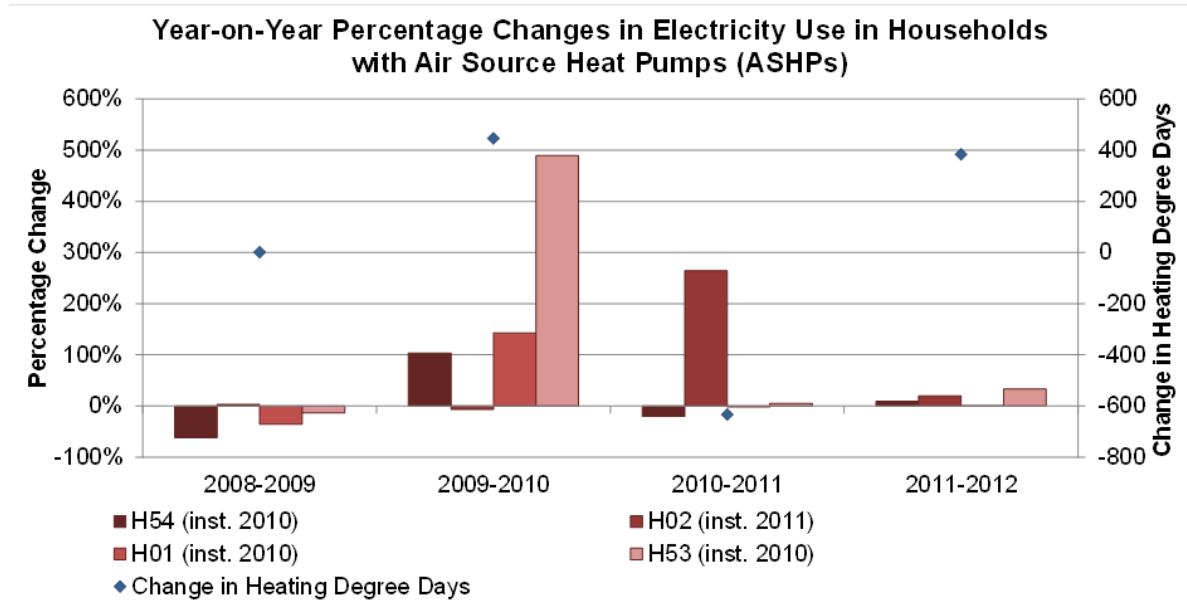
**Figure 5.6** Annual gas and electricity use for case study households from 2008 to 2012



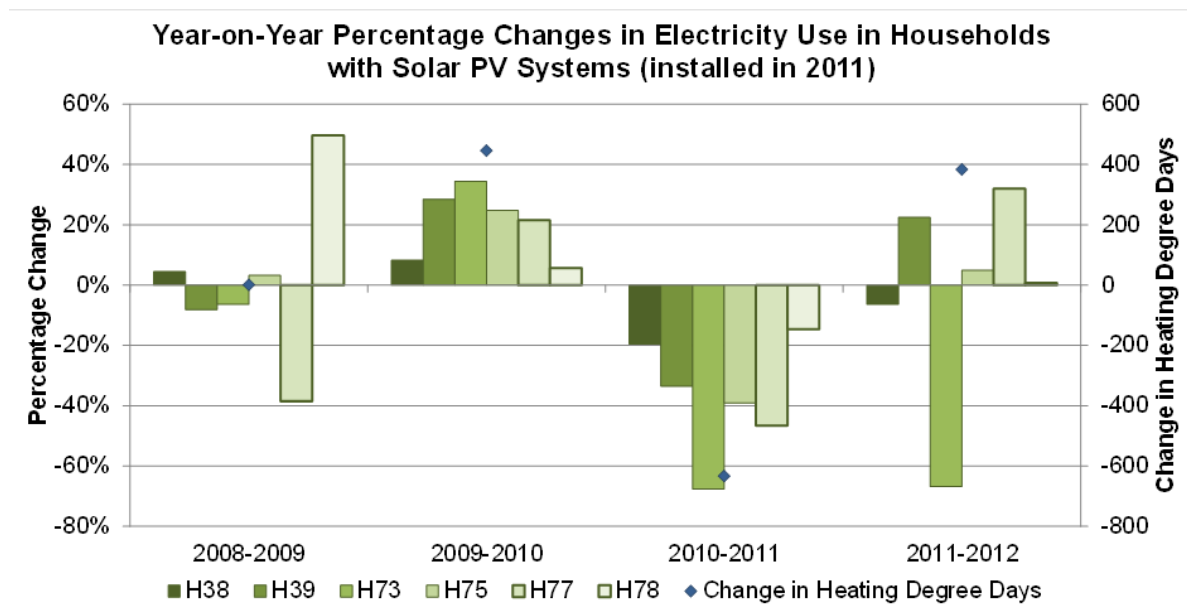
### 5.4.1 Electricity use

The impact of air source heat pump installations and renewable systems such as solar PVs are fairly clear when looking at the year-on-year percentage changes in electricity use (Figures 5.7 and 5.8). In the case of the households with ASHPs, three out of the four shown in Figure 5.6 have changed from oil as their primary heating fuel to electricity, which explains the dramatic increase in electricity use, but does not necessarily equate to increased carbon emissions and total energy use. H54, however, has

gone from electric storage heaters to ASHP. The 104% increase in electricity use in this household between 2009 and 2010 (from 4,494kWh to 9,149kWh) suggests that the ASHP uses more electricity than the storage heaters. However, in 2009, there was no heating other than the wood burning stove due to major renovation works being undertaken in the dwelling and as such it is unfortunately difficult to draw measured conclusions on the impact of the ASHP in terms of changes in electricity use.



**Figure 5.7** Year-on-year percentage change in annual electricity use in four case study households with ASHPs installed



**Figure 5.8** Year-on-year percentage change in annual electricity use in six case study households with solar PV systems installed

In terms of the households with solar PV systems installed, (and where longitudinal meter data are available (n=19)), the majority (13) saw reductions in electricity use from the mains grid. However, through the continuous monitoring of the electricity use in a sub-group of the PV households (n=10), it was possible to calculate the comparative *total* annual electricity use (from grid electricity and from the solar PV systems) in 2013 (end of January 2013 to end of January 2014) rather than just the electricity imported from the national mains grid (as shown in the longitudinal data). Whilst not a wholly accurate comparison due to the different data sources, Table 5.5 shows that most households are using similar or less total electricity than they were prior to the installation of the solar PV systems, and only two are using significantly more (figures highlighted in ***bold italics***); suggesting that in the EVALOC case study households, there is little evidence of the ‘rebound’ effect.

**The Rebound Effect:**  
When energy efficient improvements make energy services cheaper, and so consumption of these services increases (a direct rebound effect), or due to the savings made from the energy efficient improvements, the consumer then uses other, but equally energy consuming services (indirect rebound effect) (Sorrell, 2007).

**Table 5.5** Electricity use over six year period of 10 case study households with solar PV systems installed, highlighting impact of PVs on household use of grid electricity

Hsd	PV system installed (year)	Grids electricity use only (kWh)						Total electricity use (kWh)
		2008	2009	2010	2011	2012	2013	2013
H03	mid 2011	5,680	6,088	6,165	5,382	2,591	3,355	4,722
H04	mid 2012	4,081	3,774	4,629	<b>4,213</b>	3,277	5,722	<b>6,686</b>
H38	mid 2011	3,583	3,744	4,053	3,261	3,054	2,150	2,525
H39	mid 2011	3,050	2,802	3,599	2,394	2,933	2,883	3,780
H40	mid 2011	4,140	4,251	<b>3,110</b>	2,500	4,146	4,174	<b>5,087</b>
H52	mid 2011	2,665	4,143	3,831	2,652	2,620	2,593	3,018
H72	late 2010	4,068	6,534	3,840	-	3,701	4,423	5,302
H75	mid 2011	6,677	6,890	8,598	5,238	5,494	3,764	4,045
H77	mid 2011	7,021	4,315	5,244	2,800	3,696	4,066	4,634
H78	mid 2011	2,999	4,487	4,739	4,047	4,076	3,611	4,655

#### 5.4.2 Gas use

In terms of gas use, the longitudinal data indicate that the majority of households with physical (10 out of 12) or physical and behaviour change interventions (25 out of 31) appear to have reduced their gas use over time, suggesting the positive impact of such interventions (Figure 5.8). However, what is clear from the data are the impacts of other factors relating to occupants, that influence overall household energy use, particularly in relation to heating behaviours, health and comfort requirements. An example of this is the fact that four out of the six households with both physical and behaviour change interventions that actually

increased their gas use (from 2008-2012) had heating-related physical and behaviour change interventions (not just energy display monitors). The reasons for such increases are often very specific to the individual households, but include changes in occupancy numbers and patterns due to family circumstances and/or health or in some cases, due to the complete change in occupants (some households moved into the dwelling post-2008). The factors influencing household energy use are discussed in greater detail in Chapter 6.

## 5.5 Summary

- Four out of the six LCC projects studied involved localised renewable energy generation installations, on both community buildings and individual households. Across these four LCCs a combined total of 738 tonnes of CO<sub>2</sub> has (or is predicted to have) been saved.
- Although accessing the publicly available subnational data is relatively easy, the different geographical boundaries rarely correspond with the reach and focus of the LCCs meaning that it is difficult to both identify and assess the areas potentially influenced by the local LCCs activities.
- Furthermore, it is not possible to directly relate changes in the domestic energy use of the wider community to low carbon community activities due to the many factors affecting household energy use. Despite this, the longitudinal data show general energy reduction trends in all six LCCs across the wider community.
- The percentage reductions in gas and electricity use (and associated carbon emissions) from 2008 to 2012 across the wider communities are mixed across the LCCs in relation to national average percentage reductions. However, results such as those in Sustainable Blacon and Kirklees-Hillhouse (where there are significant percentage reductions in the energy source targeted by the LCC) suggest that the LCCs can have a positive effect on both energy and carbon reductions, if the focus and approach taken is suitable for both the dwelling types and local residents. The carbon mapping indicates similar results to the wider community level findings.
- The changes in the gas and electricity use of the case study households clearly highlight the effect LZTs can have on electricity use, both in terms of reducing it (solar PVs) and increasing it (ASHPs) mainly due to the switch in primary fuel (mainly from oil to electricity).
- The individual case study households' longitudinal energy data also highlight the variety in both energy use and changes in energy use over time, independent of the type of intervention/s undertaken within the household. The factors behind such variety are very specific to the individual household, which reflects wider research findings both through EVALOC and other studies.
- When the longitudinal data are compared to monitored data collected through in-depth monitoring of the energy use in households with solar PVs, there is little evidence of the 'rebound' effect in terms of increased actual electricity use.

## Chapter 6

### Effectiveness and impacts of community-based home energy improvements and behaviour change initiatives

This chapter outlines the findings from the 88 case study households, with a focus on 62 in-depth case study households in terms of the effectiveness (performance) and impacts of physical and behaviour change interventions upon a) occupant energy-related behaviours and control, b) the indoor environment and comfort levels of the occupants.

Physical interventions include both fabric measures (energy efficiency measures to upgrade the physical fabric of a dwelling) and technical measures (improvements to the services and systems within a dwelling, including LZTs).

Whilst it is difficult to generalise from a relatively small sample, the use of the case study approach reveals the trends and provides a close examination of the key influences on domestic energy use:

- The physical environment (inside and outside),
- The technical context (the controls, services and systems),
- The occupants (behaviours, motivations, capability etc.),
- The interactions and relationships between these factors.

In addition, the role of the LCCG activities within this context is assessed and evaluated particularly in terms of overcoming limiting influencing factors and helping households change energy-related behaviours and, subsequently, reduce their energy use.

The chapter first outlines the monitoring and evaluation methodology used before discussing the findings from the study. It must be noted that the findings in this chapter relate only to the domestic energy use of the case study households, i.e. gas (or other fossil fuel where applicable) and electricity use within the household. It does not evaluate the households in terms of their overall carbon footprint.

### 6.1 Monitoring and evaluation methodology

To provide evidence relating to the impacts and understanding of household energy use and energy behaviours, a robust mixed method monitoring and evaluation (M&E) framework to gather quantitative and qualitative data on energy use and energy behaviours was developed and applied to the 88 case study households, across the six communities. It drew together methodologies from building performance monitoring of energy use and environmental conditions, social surveys of households and physical surveys of the dwellings<sup>1</sup>. This approach enabled the collection of both quantitative and qualitative data and allowed a close examination of the key influences of domestic energy use, as outlined above.

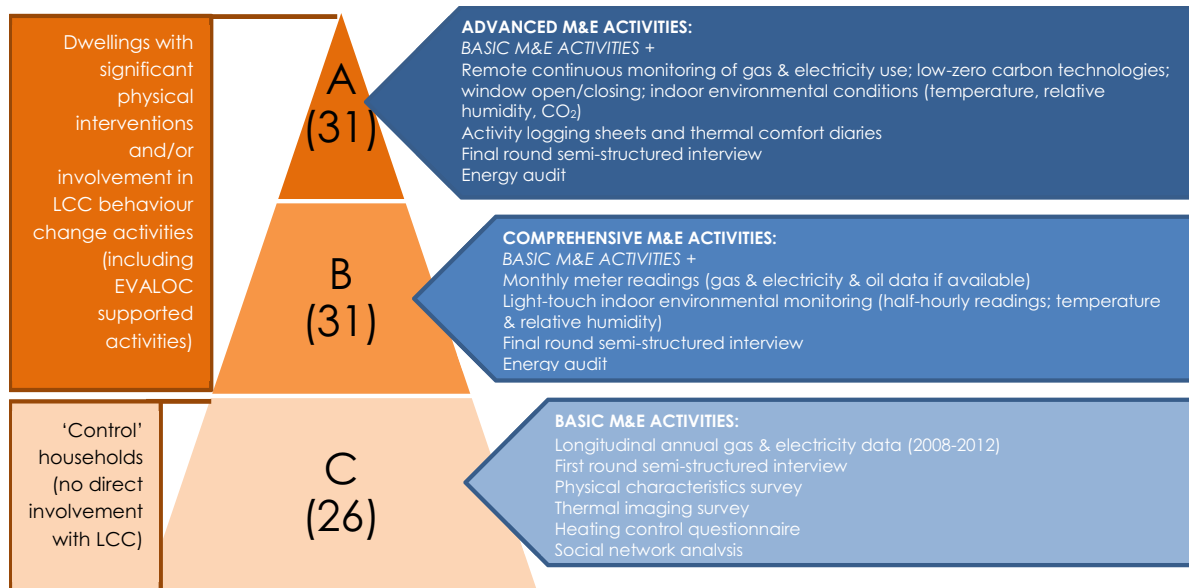
To provide consistency across the research, a single main respondent from each household was recruited (either the main occupier or the partner of the main occupier), but in some situations, particularly during interviews, more than one occupant was present. Whilst the focus was on the main respondent, the views of the second occupant have also been recorded.

A graduated M&E approach (Figure 6.1) was undertaken from the beginning of the study, in order to provide detailed in-depth study of the 62 households that have either undertaken physical energy improvements and/or participated in LCC behaviour change activities (including EVALOC-supported activities such as energy display trials), as well as gather basic household, dwelling and energy data on 26 'control' households across the six communities. The groupings enabled the researchers to distinguish between the different levels of M&E taking place in the households, with Group A households participating in intensive monitoring and evaluation methods. The focus of this chapter is on the 62 case study households (unless otherwise specified), but the total sample number used in each subsection varies due to data availability and reliability as well as relevancy and practical constraints relating to the installation of the monitoring equipment (particularly within social housing dwellings), and even participant drop-out (as discussed in Chapter 2).

An example of this is the monitoring and evaluation of the solar PV systems. Not all 62 households had solar PV installed; indeed only 21 did.

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<sup>1</sup> Further detail on the survey techniques and sample numbers can be found in Appendix A.



**Figure 6.1** Graduated M&E approach

Of these 21 systems, annual generation data was available for 19 (90%) due to lack of available data in one household and non-participation of the occupants in another. Of these 19, 14 had sub-metering installed to monitor generation and export data every 5 minutes (67% of total case study systems). Further to this, the export meters in four of these households have not produced reliable data, leaving a subset of 10 households to be analysed in terms of their daily and weekly use of the solar PV generated electricity.

The following sections outline the findings from the case study households.

## 6.2 Effectiveness of building fabric upgrades

The performance of a dwelling in terms of increasing its overall efficiency is dependent upon the effectiveness of its physical elements (walls, floor, roof, windows and doors) in reducing heat escaping from the indoor environment to outside. Increasing the performance of existing dwellings is particularly tricky due to the unknown quantities involved in retrofitting existing elements; for example the condition, cleanliness and thickness of a cavity wall (Doran and Carr, 2008) as well as the practical limitations of working within existing physical confines.

Thermal imaging surveys of the 88 case study households highlighted the following, as shown in the images in Table 6.1:

- Inconsistencies in the appearance of cavity wall dwellings with wall insulation appear common, and are indicative of issues relating to missing or

defective retrofitted insulation (Images A-E) particularly around window openings and infills panels. This could be for a number of reasons including;

- Low compactness of insulation
- ‘Mortar snots’ and other blockages/debris within the cavity
- Incorrect settings of the machinery leading to lack of insulation
- Too wide spacing of drill holes leading to possible voids in insulation layer
- Insulation not spreading into cavity but gathering around injection hole
- Poor quality of inner leaf leading to crumbling brickwork

- ‘Smooth’ finish generally found in dwellings with cavity wall insulation installed at original point of construction (Image F), suggests good quality level of construction, and no reduction in effectiveness of performance of the building fabric elements.

- ‘Lower’ temperatures above loft line than wall below suggests less heat escaping through loft space, and highlight the positive effect of loft insulation in terms of reducing heat loss through the roof (Image B).

- Several examples of areas of heat loss in both cavity and solid wall dwellings around original doors and fanlights above, indicating lack of or deterioration of draughtproofing (Images E and G) around openings in the dwelling structure.

- Localised areas of likely heat loss in uninsulated solid wall dwellings predominantly under windows (Images G-I) appear common, particularly in solid



brick dwellings. This is most likely due to the location of radiators and lack of insulative fabric in this area (where there are higher temperatures).

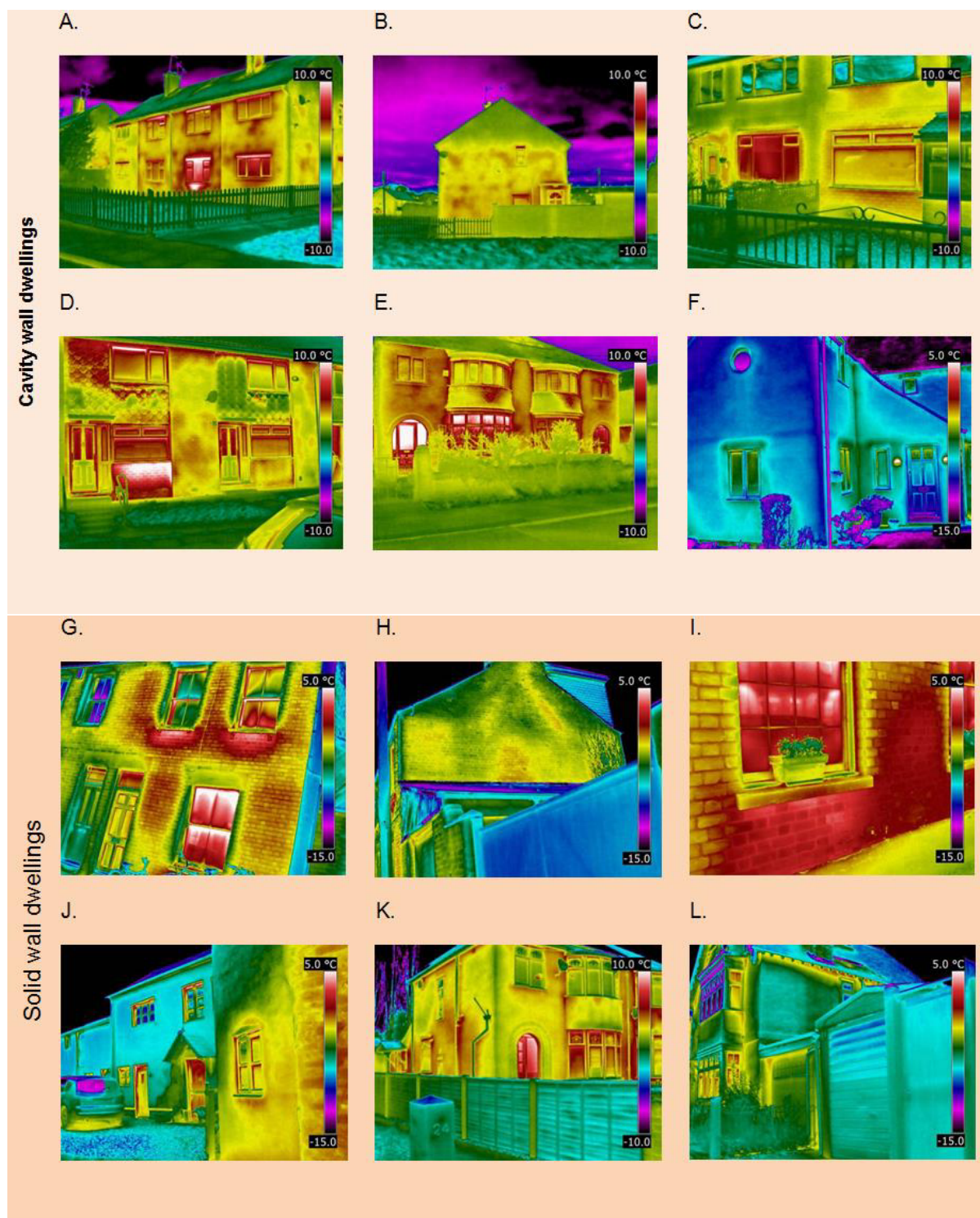
- 'Smooth' finish to solid walls with retrofitted external wall insulation (Image J) suggests effective installation in terms of reducing heat loss.

- Inconsistencies in the appearance of solid wall dwellings with internal wall insulation (Images K and

L), highlight difficulties in retrofitting insulation, particularly around 'hard' details such as corners, bay windows and eaves.

More detailed reports on the thermal imaging surveys, key findings and recommendations can be found in the EVALOC Energy & Communities web-based toolkit: [www.evaloc.org.uk](http://www.evaloc.org.uk).

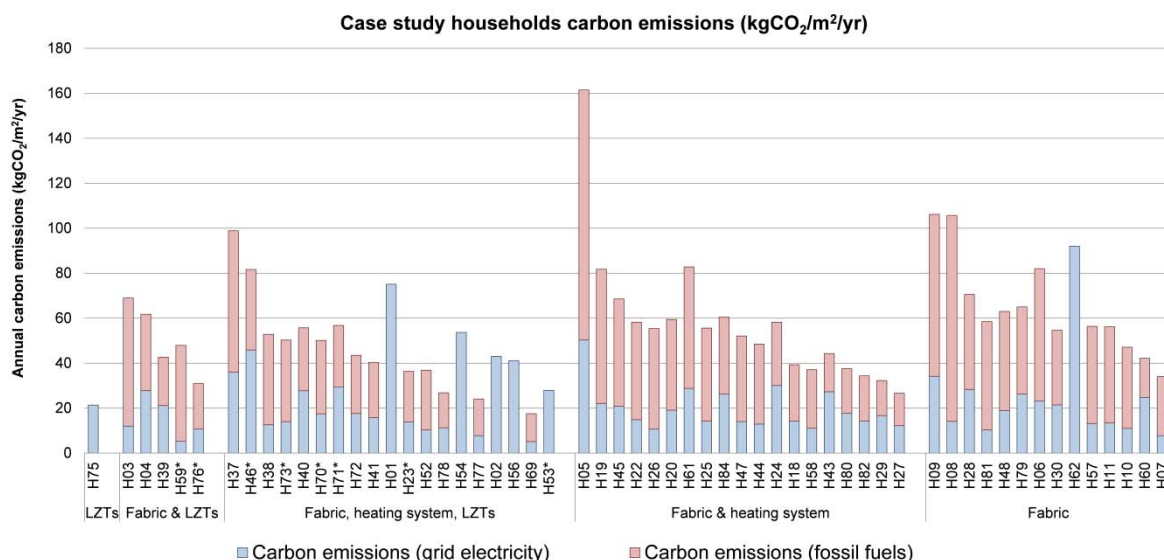
**Table 6.1** Thermal images highlighting typical issues with building fabric uncovered in cavity and solid wall dwellings.



### 6.3 Carbon emissions, energy use and demand profiles

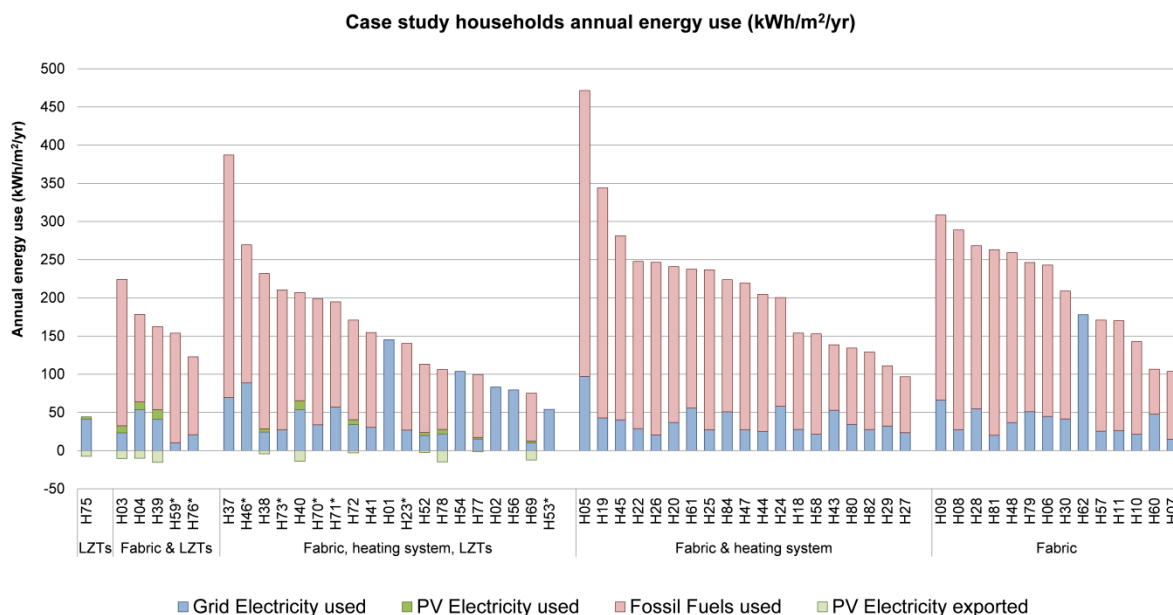
In order to understand the long-term effectiveness and impacts of physical and behaviour change interventions, data was gathered on the annual energy use and carbon emissions of 58 households that have had either physical interventions, behaviour change interventions or a combination of both. The data (for the period December 2012 to November 2013) highlights the range in carbon emissions ( $\text{kgCO}_2/\text{m}^2/\text{yr}$ ) and energy use ( $\text{kWh}/\text{m}^2/\text{yr}$ ) across 58 of the case study households (Figures 6.2 and 6.3) involved in EVALOC and LCC activities. When comparing carbon emissions from the use of fossil fuels (gas, oil and coal) and grid electricity, 38 out of the 58 (66%) households (for which annual data are available) have lower carbon emissions than their equivalent dwelling type average (based on DOMEarm<sup>2</sup> estimated benchmark figures). In addition, when the carbon savings due to the on-site PV-generated electricity are taken into account (i.e. the zero-carbon PV generated electricity offsetting the carbon emissions from the use of fossil fuels and grid electricity on site), three households (H23, H69 and H75) are almost carbon neutral.

In terms of energy use, as Figure 6.3 demonstrates, there appears to be lower total energy use in households with a greater number (and range of types) of physical interventions (improved fabric, heating system and LZTs present). However, there is no strong significant correlation. In terms of comparison to averages and benchmarking, 37 out of the 58 (64%) households are using less than their equivalent dwelling type average energy use (using DOMEarm estimated benchmark figures). Only one household (H75) is using less than its equivalent 'best practice' figure. Whilst this is most likely due to a combination of reasons, it is worth noting that the occupant was very active in terms of energy reduction and participated in the local Low Carbon Living behaviour change programme, yet has the fewest fabric measures across all the case study households. The findings also imply that further energy reductions within these households are desirable (and possible), either through further physical improvements and/or through behaviour change interventions. Furthermore, a comparison of Figures 6.2 and 6.3 highlight the fact that low energy use does not necessarily translate into low carbon emissions, particularly in relation to dwellings with electric heating, and emphasises the need to combine LZT measures in these cases (e.g. air source heat pump with solar PV system) in order to offset the increased use of carbon intensive grid electricity.



<sup>2</sup> DomEARM (Domestic Energy Assessment and Reporting Methodology) was developed in 2009 by Arup & Partners Ltd in collaboration with the Oxford Institute for Sustainable Development, Oxford Brookes University. It provides the estimated breakdown of electricity end-uses in the dwelling, such as lighting, appliances, cooking, space heating and computer electronics. The primary source for the modelled breakdown is a physical survey and review of the electrical equipment in the dwelling with the occupant present.

**Figure 6.2** Graph showing annual total carbon emissions of 58 EVALOC case study households (December 2012 – November 2013) in relation to type of interventions present.



**Figure 6.3** Graph showing annual energy use of 58 EVALOC case study households (December 2012 – November 2013) in relation to type of intervention present. Note: - Households marked with \* have solar PV but data for generated electricity used on site is not available, therefore total energy use will be higher.

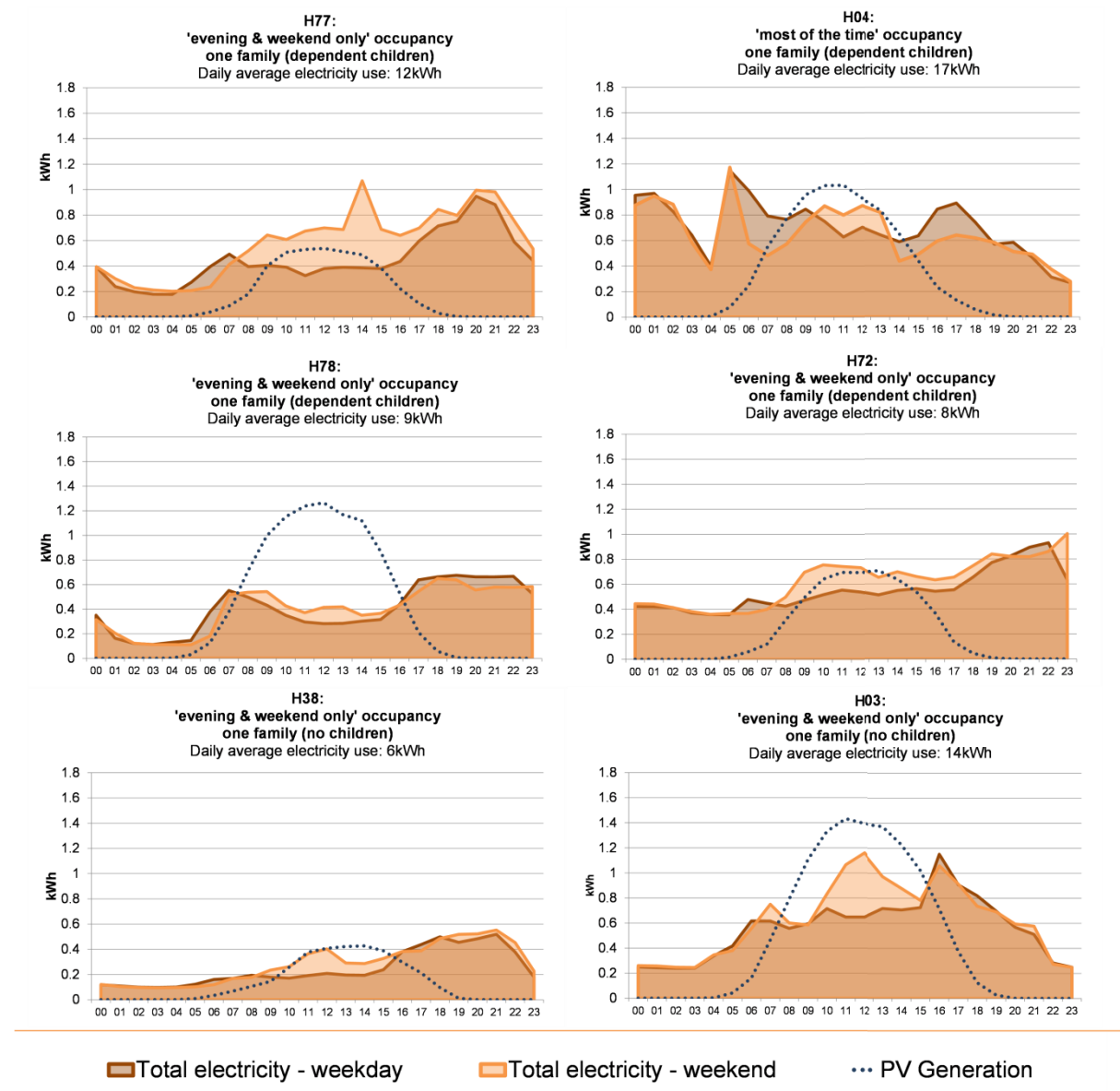
### 6.3.1 Electricity demand profiles

Daily demand profiles (gas and electricity separate) enable further investigation of *when* energy is used in the households. Daily and weekly electricity demand profiles were available for 22 households. As Figure 6.4 demonstrates, the electricity demand profiles of the households vary, even within households with similar occupancy patterns and number of occupants. However, they also highlight key traits in electricity use that can be seen in the majority of the households; most specifically increased use in the evenings. This emphasises the impact of the occupant's habits and lifestyles upon both total electricity use and use of grid electricity (electricity from national grid). Of particular interest are the demand profiles of households with solar PV, six of which are shown in Figure 6.4; even in the households that are occupied most of the time (and therefore more able to make use of the PV generated electricity), grid electricity is still used due to practical and lifestyle factors (such as cooking food, and lighting when it is dark) requiring electricity at times when the solar PV is not generating (evenings and mornings). On average, 45% of the PV-generated electricity is being used on site (highest use on-site is 68%). However, in

households that are occupied mainly only at evenings and weekends, this can drop significantly; to 19% in one household. Whilst this percentage is obviously dependent on the households overall electricity use and size of PV systems, such demand profiles still highlight the need for localised energy storage facilities to enable the households to take full advantage of the locally generated electricity, which will ultimately reduce demand upon the national grid.

### 6.3.2 Gas demand profiles

Gas demand profiles, logically, differ between heating and non-heating seasons. Daily and weekly gas demand profiles were available for 18 households. Comparison of similar dwellings (but different occupant characteristics), as in Figure 6.5; highlight the variety in gas use, which is generally indicative of heating patterns. What is particularly interesting to note in Figure 6.5 is H37, which although it is mainly occupied in the evenings and weekends only, shows that the heating is on continuously. This is most likely why the average daily gas use during the heating season of this house is 113kWh (1.3kWh/m²) compared to a similar dwelling type (H38) which only uses 77kWh (0.8kWh/m²) daily on average.



**Figure 6.4** Typical daily non-heating season electricity and PV generation profiles (Apr – Sept 2013) for six case study households

## 6.4 Heating and non-heating related behaviours

Previous research (Gram-Hanssen, 2010) suggests that the occupants, particularly in terms of their habitual, everyday behaviours can significantly affect the overall energy use of a household. In some cases, the behaviours of occupants can influence the energy use of a household by a factor of three or more in identical homes (Janda, 2011). Therefore, understanding the heating-related and non-heating related habitual behaviours of household, and changes in these following physical and behaviour change interventions is critical to assessing the success of behaviour change and household energy reduction programmes.

Due to the retrospective nature of the EVALOC study it was not possible to make a quantitative *before* and *after* comparison of the household's habitual behaviours. However, the following section outlines the qualitative responses from the occupants and also outlines quantitative findings relating to both heating and non-heating related behaviours post-intervention; providing an understanding of reported and actual behaviours (the 'doings' vs the 'sayings'), and ultimately, seeking to answer the question of whether or not energy-saving behaviours can be sustained.



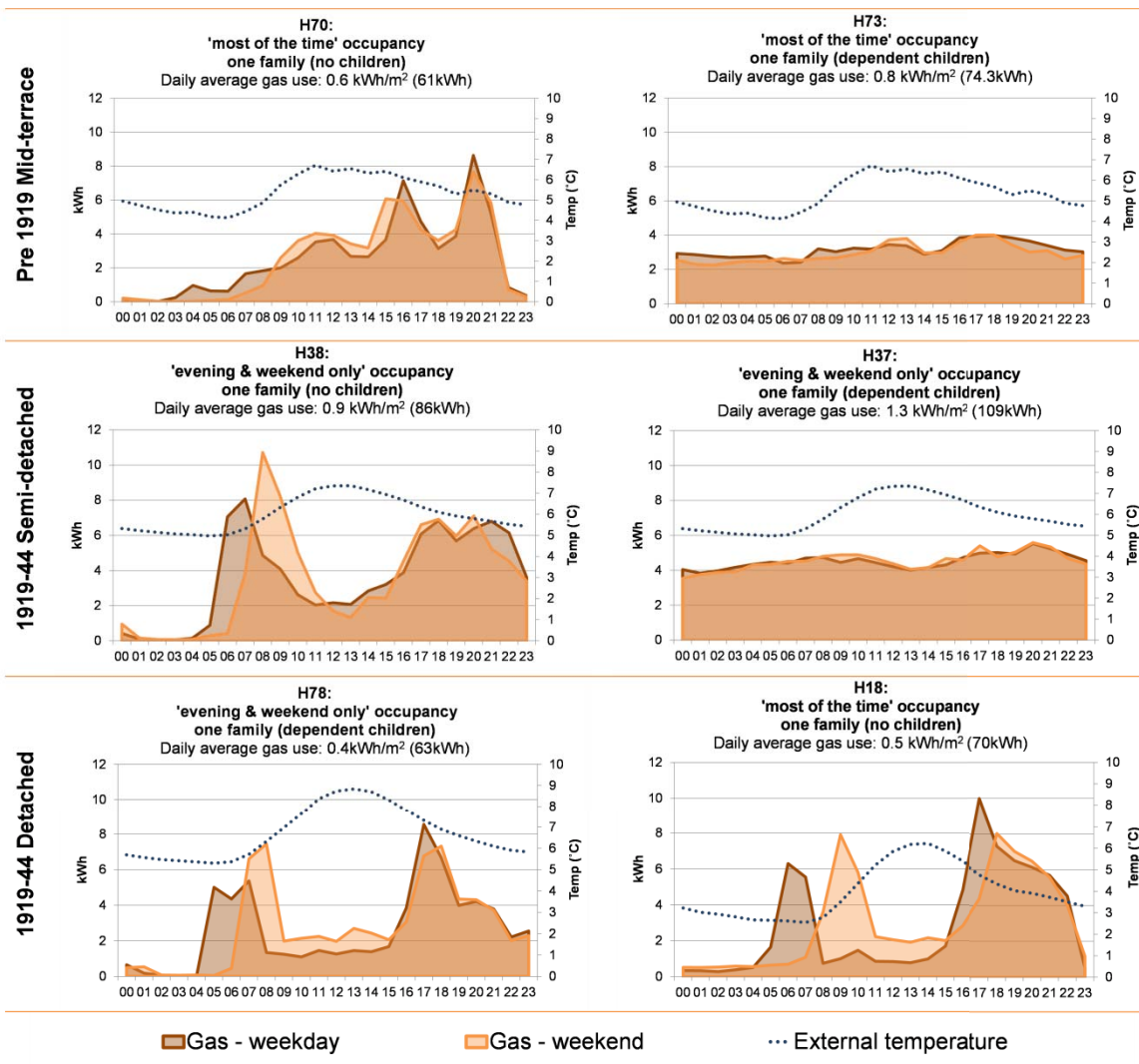


Figure 6.5 Typical daily heating season gas use profiles (Jan-Mar & Oct-Dec 2013) for six case study households

#### 6.4.1 Heating behaviours

It must be noted, in the first instance, that a high number of the households (across the communities) stated that they already undertook positive energy-related (both heating and non-heating related) behaviours before any type of intervention. However, many commented that the behaviour change interventions (from energy display monitors to the more intensive low carbon living programmes) helped reinforce these behaviours, particularly through peer-to-peer discussion (and pressure), rather than changed them;

*"I guess my behaviour is affected but I think some of it I used to do before...but it...reinforced it."* - (household with behaviour change intervention)

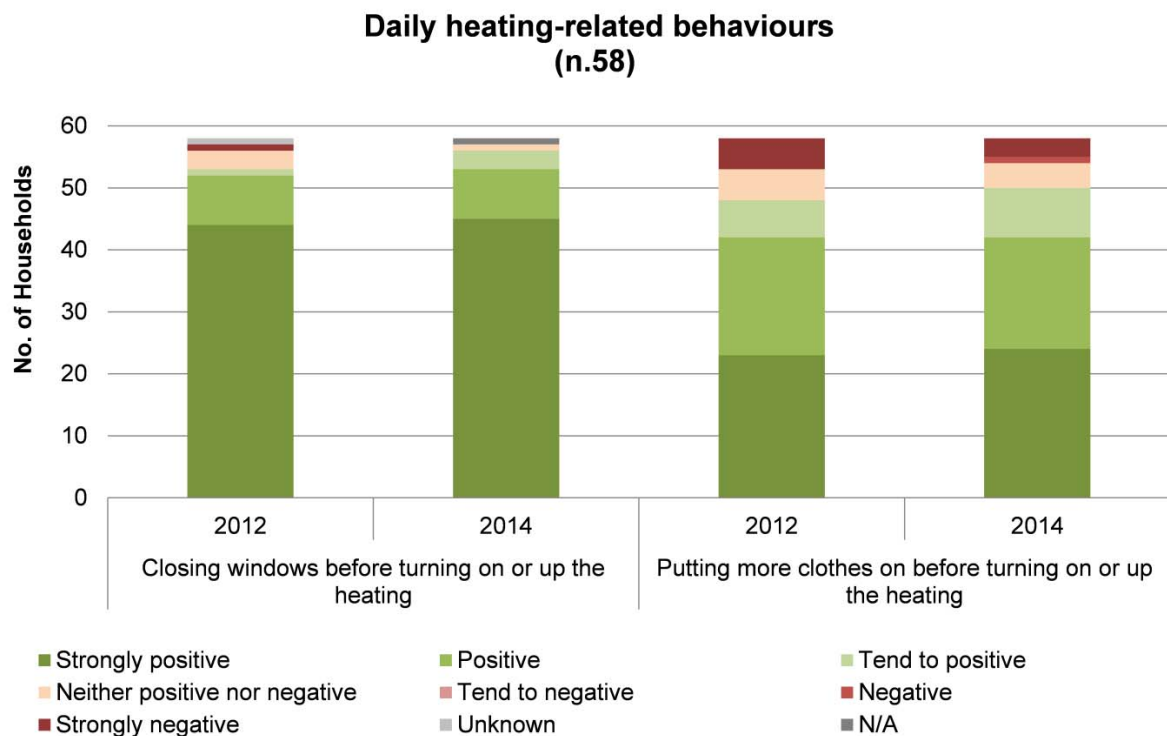
In terms of heating behaviours, the semi-structured interviews with occupants highlighted the generally

positive impact physical interventions, in particular, have had on the occupant's heating related habitual behaviours, often indirectly due to a perceived increase in warmth;

*"We didn't need to have the heating on continuously."* - (household with double glazing and wall insulation)

Figure 6.6 outlines the comparative 2012 and 2014 responses to questions relating to heating-related behaviours, which suggest that the households not only have high levels of positive heating behaviours, but that these are generally sustained (e.g. 54 out of the 58 households have maintained or increased their positive heating-related behaviour in terms of closing windows when turning on or up the heating, and 42 out of 58 have maintained or increased their positive behaviours in relation to putting more clothes on before turning on or up the heating).





**Figure 6.6** Comparative responses relating to heating behaviours from 58 case study households from first round interview (summer 2012) and final interview (summer 2014)

#### 6.4.2 Window opening

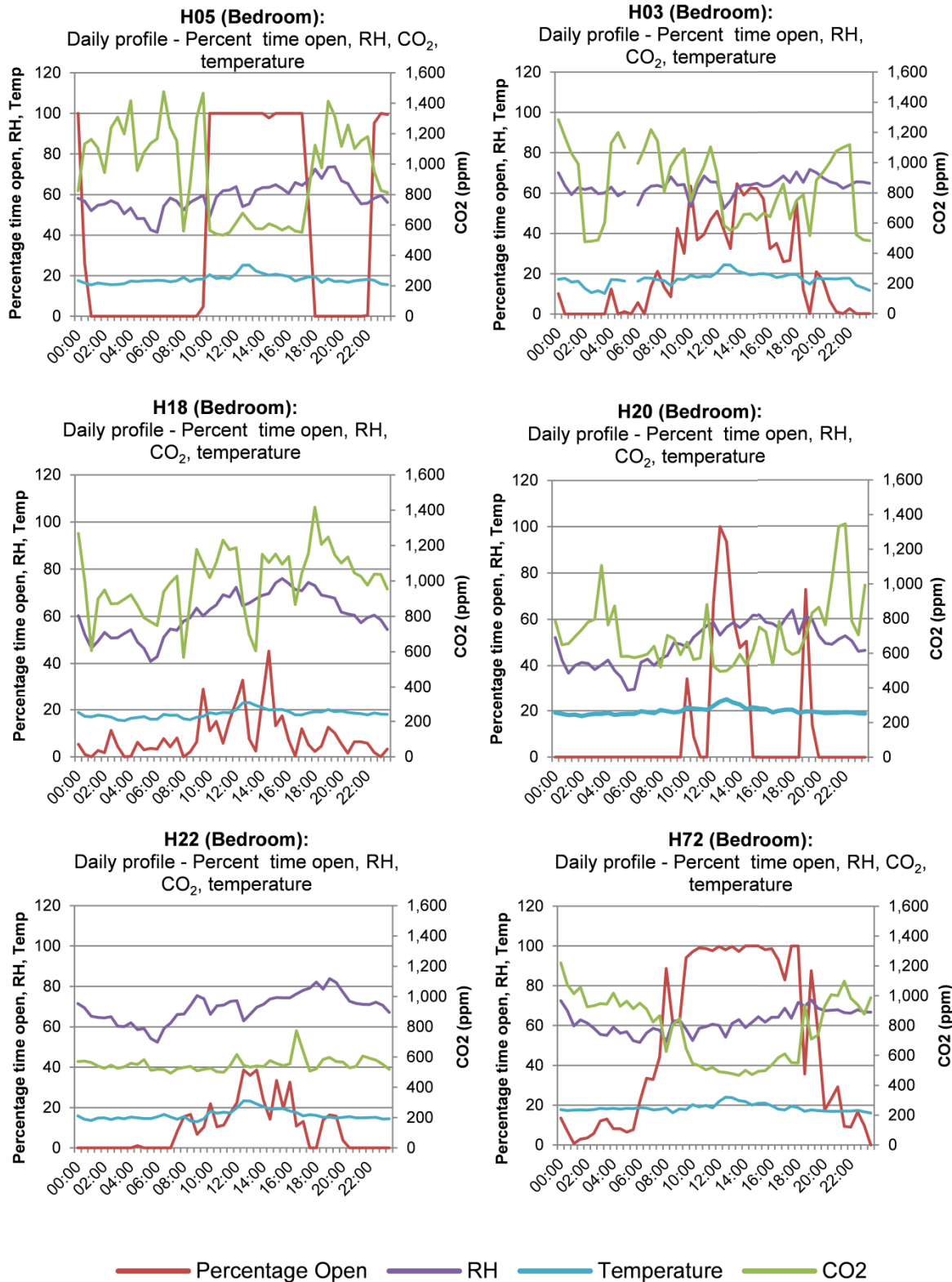
Such behaviours are corroborated through the analysis of the window opening and closing monitoring data (n=20), which suggests that fewer households open their windows for extended periods of time in the winter than the summer. Furthermore, analysis of the window opening and closing monitoring data indicates that the majority of the households actively control their environment, though results have diverged from received wisdom that window opening is temperature-related, as illustrated by Figure 6.7.

The usefulness of the window-opening sensors is restricted in that they cannot detect the extent to which the window has been opened. Moreover, as the number of sensors to be installed was restricted, their usefulness may also be reduced by the choice of window for their installation, which is that which is least used by the occupants.

The dwellings available were restricted to those where more than 90% of data for window sensors contained valid values and where the carbon dioxide, relative humidity and temperature sensors were in the same room. This reduced their numbers to some 20 out of the 28 dwellings, of which a sample of six are presented in Figure 6.7. Within these dwellings, the results from the main bedrooms were selected, on the basis that there are fewer disturbances - entries and exits - to this room than the living room, which was the alternative.

It would appear from these results that the indoor environmental condition characteristic most influenced by the opening of windows is the CO<sub>2</sub> level (an indicator of indoor air quality), which falls substantially at the time of opening, reflecting the speed with which the concentration of the gas can change because of its high volatility. It is also notable that the CO<sub>2</sub> level rises fairly quickly again - within an hour - after the window is closed, indicating that its level remains high in the rest of the dwelling. Thus, while occupants can have high level of control over CO<sub>2</sub> in a single room, the lack of ventilation in the rest of the dwelling means that an attempt to reduce 'stuffiness' by opening a window or windows in one room will be defeated by the levels of CO<sub>2</sub> elsewhere. Opening windows appears to have little effect on humidity levels. For the occupants, this could mean that opening windows to reduce damp and humidity levels will have little effect, with damp remaining in other parts of the dwelling.

Another apparent association with window opening appears to be a counter-intuitive increase in internal temperature, which could be caused by external temperature influencing the thermostatic radiator valves to raise the room temperature, but has no other obvious cause.



**Figure 6.7** Daily window opening and indoor environmental conditions profiles for six case study households

### 6.4.3 Non-heating related behaviours

The semi-structured interviews with occupants highlighted the generally positive impact both behaviour change and physical interventions had on the occupant's non-heating related behaviours, either directly or indirectly;

*"I think I'm more conscious of it, I'm more aware of it, I do think to shut the door after me, I do think to turn the light off so there are changes on that level." - (household with behaviour change intervention)*

*"That's one thing we learned from the course, cooking in bulk, we made eighteen lasagnes the other day so it's cooking all in one go." - (household with behaviour change intervention)*

*"We'll put the washing machine on when it's sunny and try to do things in series." - (household with physical and behaviour change interventions)*

However, the interventions do not always have a positive impact on non-heating related behaviours, suggesting evidence of the 'rebound effect' upon behaviours;

*"When it's been sunny I've thought oh it's going to be free so I'll put them in there [the tumble dryer]." - (household with physical and behaviour change interventions)*

Despite this reported 'rebound effect' it appears to have had minimal impact on the actual energy use in households with PVs as shown in Table 5.5 in Chapter 5.

Figure 6.8 outlines the comparative 2012 and 2014 responses to questions relating to non-heating-

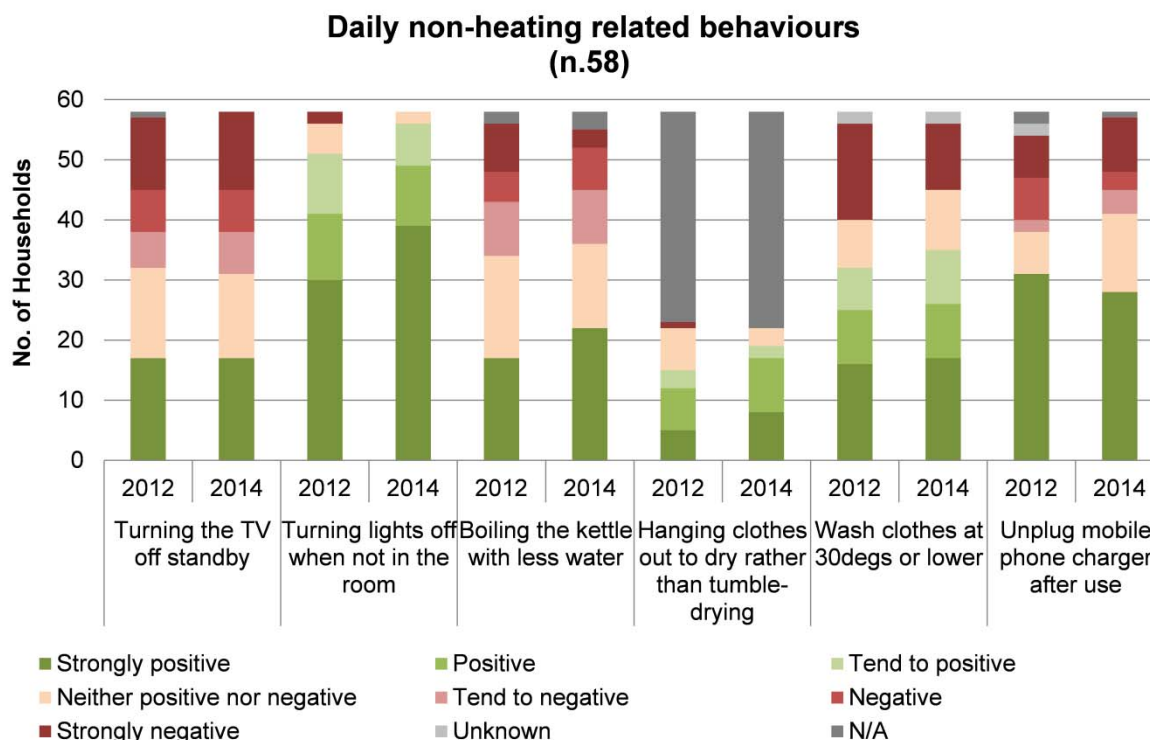
related behaviours, which suggest that fewer households were partaking in conscious non-heating behaviours than heating behaviours. Despite this, there was an increase in positive behaviours from 2012 to 2014 suggesting that such behaviours can be changed and maintained.

### Electricity end uses

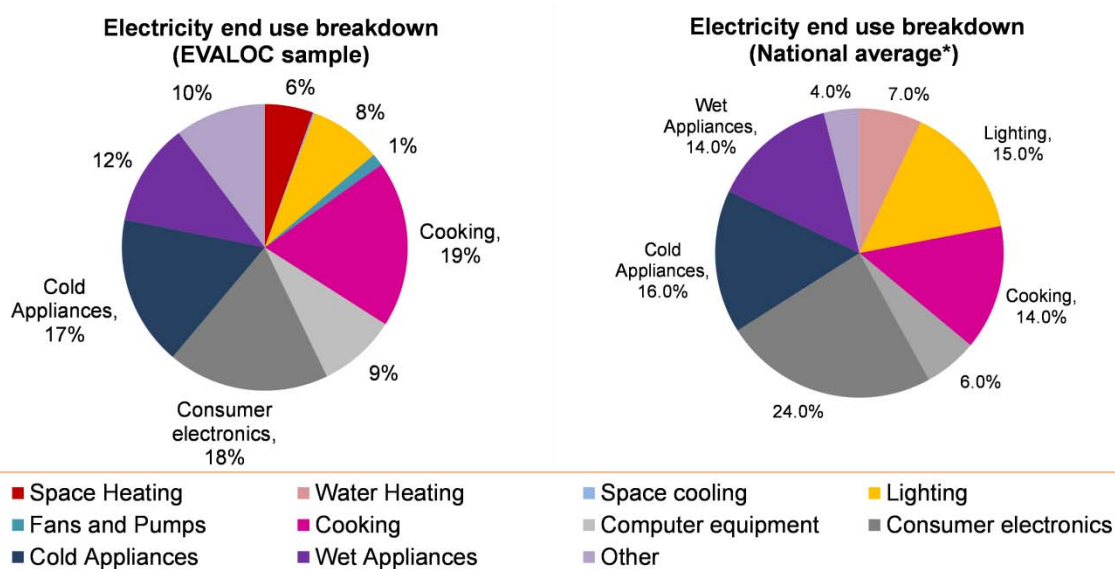
To understand the relative energy use of non-heating related behaviours, energy audits were conducted using DomEARM<sup>3</sup> survey techniques. The findings provide clear insights into how and where electricity is used in households. The top three electricity end-uses in the EVALOC households were cooking, consumer electronics and cold appliances, which are very similar to the results of DECC's national Household Electricity Survey (Zimmerman *et al.*, 2012) (Figure 6.9). Although the results are similar, there are interesting differences; namely the comparatively lower percentage of lighting in the EVALOC households in comparison to the national survey results.

Further investigation of individual households, namely the highest and lowest annual electricity consumers highlights the variety of end-use breakdowns, even in dwellings of similar occupancy (H61 and H26). Furthermore, it may be expected that the lower electricity users have end-use profiles with greater percentages of 'always-on' end-uses such as cold and wet appliances, in comparison to higher electricity users consuming more 'leisure-related' end-uses. As Figure 6.10 demonstrates, this does not seem to be the case, and particularly in the case of H61, which has a very high percentage use of cold appliances, the impact of the technologies such as inefficient refrigerators is clear to see.

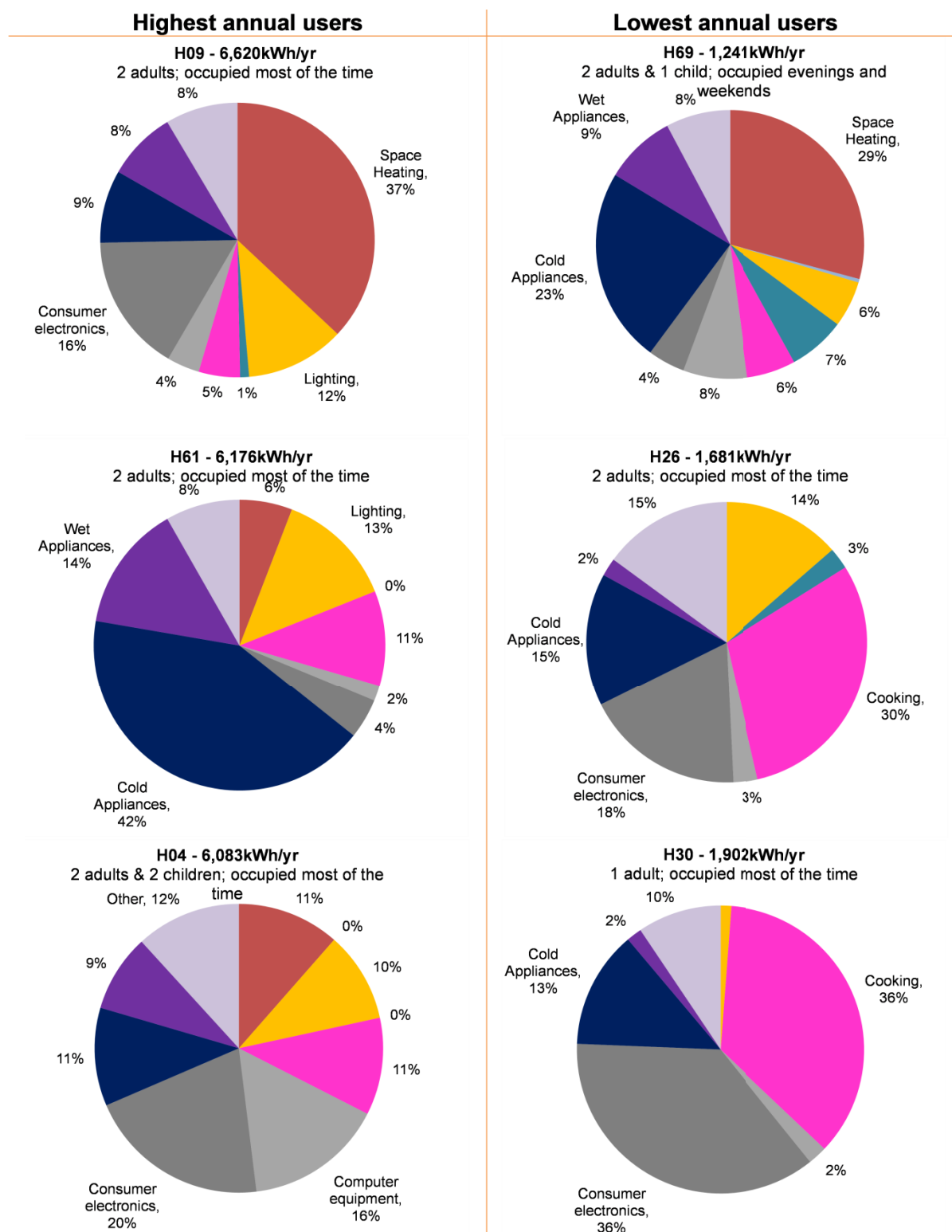
<sup>3</sup> DomEARM (Domestic Energy Assessment and Reporting Methodology) was developed in 2009 by Arup & Partners Ltd in collaboration with the Oxford Institute for Sustainable Development, Oxford Brookes University. It provides the estimated breakdown of electricity end-uses in the dwelling, such as lighting, appliances, cooking, space heating and computer electronics. The primary source for the modelled breakdown is a physical survey and review of the electrical equipment in the dwelling with the occupant present.



**Figure 6.8** Comparative responses relating to non-heating behaviours from 58 case study households from first round interview (summer 2012) and final interview (summer 2014)



**Figure 6.9** Average electricity end use breakdown for EVALOC case study households (n=40) and national average electricity end use breakdown (Zimmerman et al., 2012)



**Figure 6.10** Electricity end use breakdowns for highest and lower annual electricity users



## 6.5 Performance of low and zero carbon technologies (LZTs)

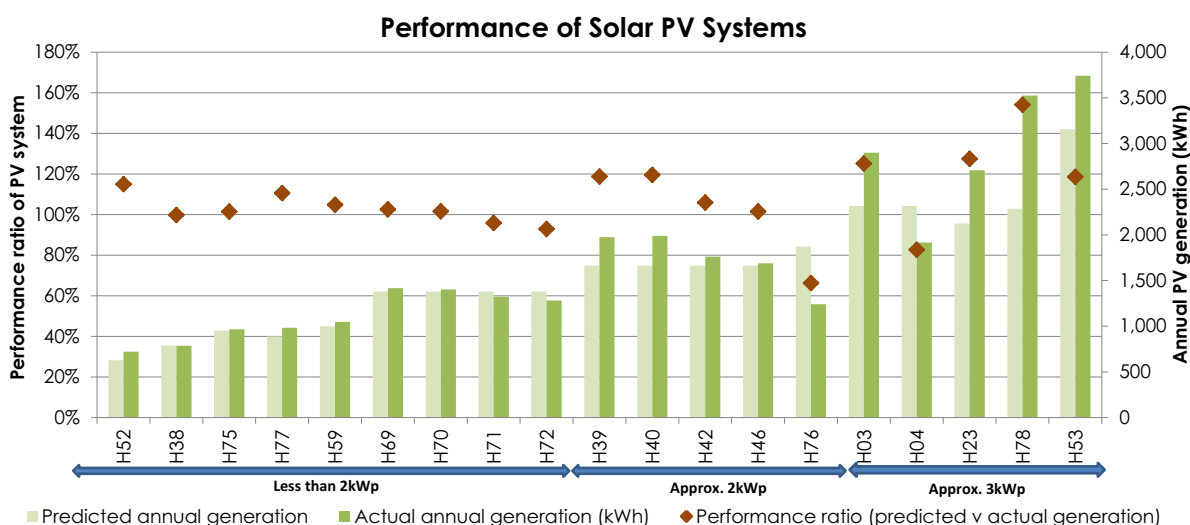
Of the 26 households with low-zero carbon technologies and renewables (LZTs) involved in the study, 22 had direct input from local LCC activities, either in terms of the LCC directly funding and installing the LZTs or providing technical advice and support. In total, 21 solar PV systems, six solar thermal systems and five air source heat pump (ASHP) systems were included in the study.

The aim was to monitor all systems every five minutes using continuous monitoring equipment for approximately two years. Due to practical issues relating to installation of the remote monitoring equipment, as well as some data accuracy and reliability issues, this was not possible in all households. Although monitoring equipment was installed to monitor the solar thermal systems, the data is felt to be too unreliable to be included in this report. The following sections outline the performance of the solar PV and air source heat pumps (ASHPs) as well as factors uncovered during the study that affect the performance of these systems.

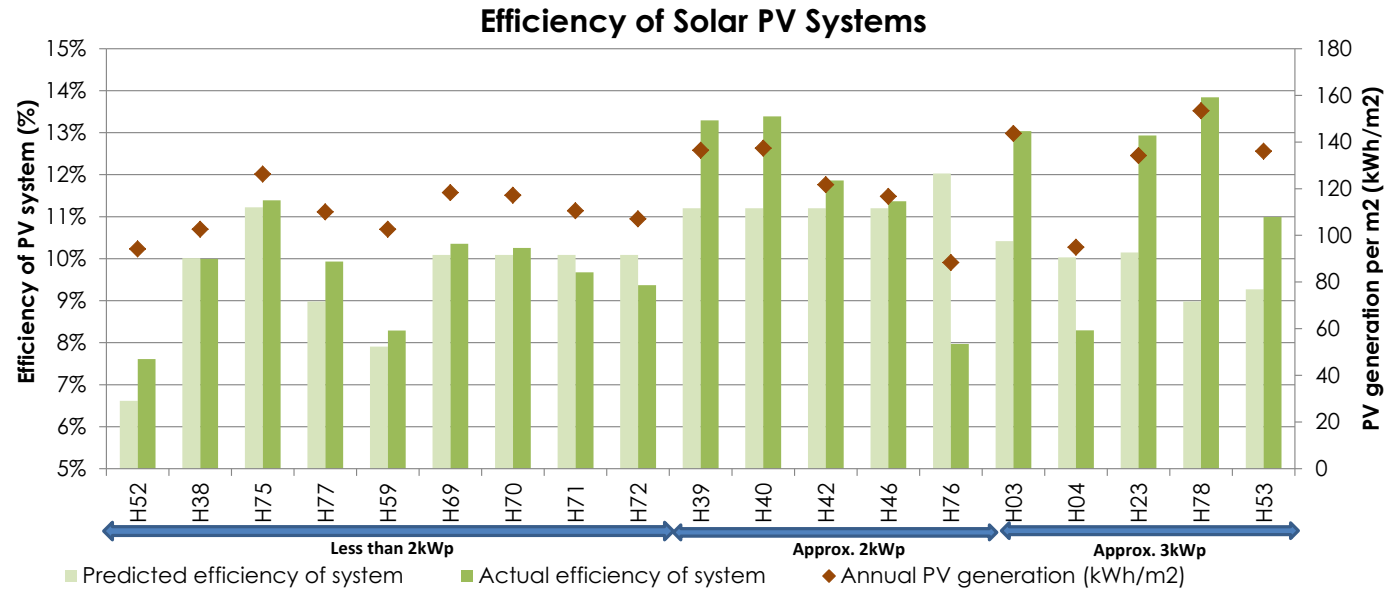
### 6.5.1 Efficiency and performance of solar PV systems

As previously noted, full data for all systems was not able to be collected (sample numbers are outlined in Appendix A). Nineteen (out of 21) solar PV systems were assessed in terms of both their performance (direct ratio of actual output divided by the expected output) and efficiency (ratio of output (electricity generated) divided by input (solar irradiation)). Table 6.2 outlines the main characteristics of the systems.

As Figure 6.11 shows, in terms of performance, 15 out of the 19 PV systems (for which data are available) are generating more than or as predicted (79%). In terms of efficiency (Figure 6.12), seven are achieving the same system efficiency as expected and nine are achieving a better system efficiency than expected. There appears to be little correlation between orientation and performance. However, both performance and efficiency appear to increase with the size of the system. The data highlight issues with specific systems, namely H76 and H04 (later section discusses factors affecting performance of LZTs).



**Figure 6.11** Graph showing predicted vs. actual annual generation as well as the performance ratio (actual output divided by predicted output)



**Figure 6.12** Graph showing predicted vs. actual efficiency (output divided by input) of solar PV systems in study as well as comparative PV generation (kWh/m<sup>2</sup>)

**Table 6.2** Main characteristics of solar PV systems monitored in study

SNo	H52	H38	H75	H77	H59	H69	H70	H71	H72	H39	H40	H42	H46	H76	H03	H04	H23	H78	H53
Orientation	SW	SW	S	S	SE	SW	SW	SW	SW	SE	SE	SW	SE	S/ SW	SW	SE	SE/ SW	S	S
PV Type	Pol	Mo	Mo	Mo	Mo	Pol	Pol	Pol	Pol	Pol	Pol	Pol	Pol	Mo	U	U	U	Mo	Pol
No of Panels	6	6	6	7	8	8	8	8	8	9	9	9	9	11	12	12	12	18	21
System Size	1.1	1.1	1.1	1.3	1.5	1.7	1.7	1.7	1.7	2.0	2.0	2.0	2.0	2.0	2.8	2.8	2.8	3.3	3.7
S=south; SW=South West; SE=South East; Pol=Polycrystalline; Mo=Monocrystalline; U=Unknown																			

### 6.5.2 Performance of air source heat pump systems

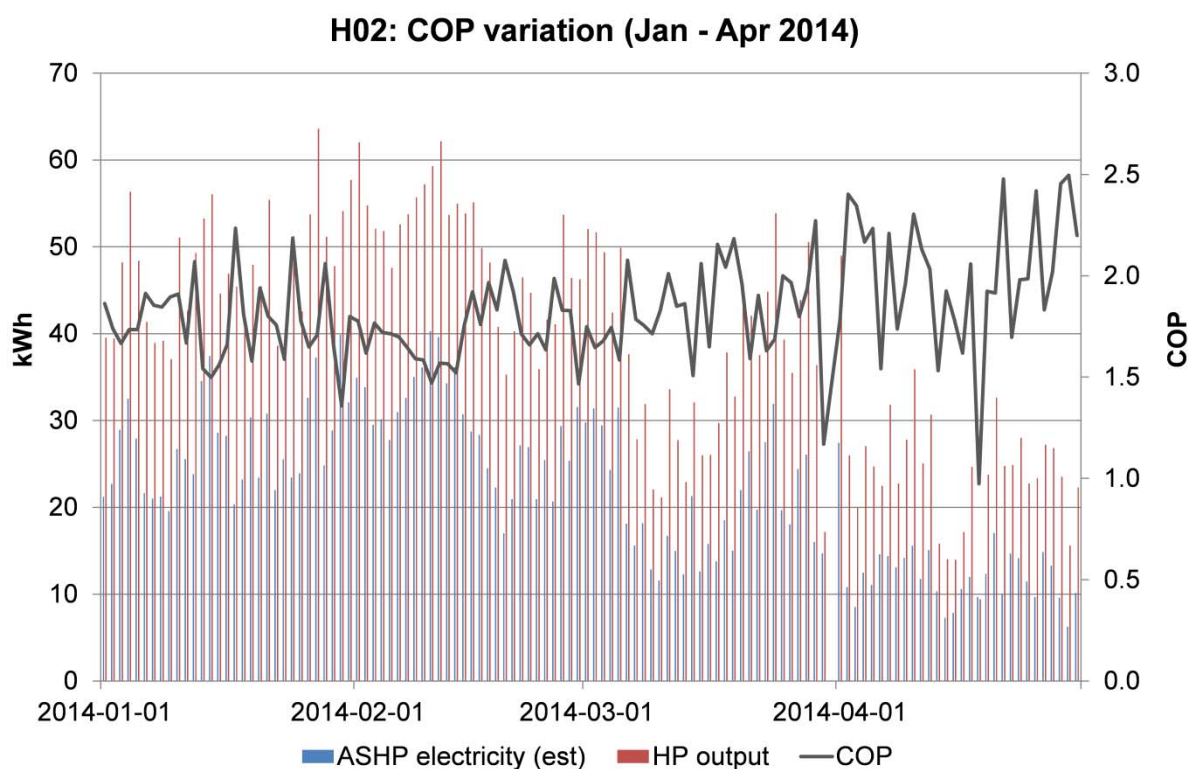
Due to deficiencies in the installation of the monitoring equipment, it has not been possible to calculate the Seasonal Performance Factors for the systems directly. However, data available for H02 indicates that the estimated daily Co-efficient of Performance (COP) does not rise above 2.00 for any significant part of this period, which does not indicate any significant carbon emission savings based on the current carbon-intensity of generation. Figure 6.13 shows very little relationship between COP and heat pump energy use, with only a slight trend towards a higher COP as heating load decreases throughout the heating season. Furthermore, the data suggest that it is rarely achieving the predicted COP of 2.11 (minimum, for external dry bulb temperatures of -3°C) to 4.18 (maximum, for external dry bulb temperatures of 7°C or higher).

### 6.5.3 Factors affecting performance of low-zero carbon technologies

Building science research (Gupta, Gregg and Cherian, 2013; Gupta and Kapsali, 2014; and EST, 2013) shows that often LZTs do not perform as expected. The reasons for this are many and varied. However, most issues relating to the performance of LZTs are due to:

- Incorrect installation and lack of adequate commissioning procedures for new and unfamiliar energy technologies;
- Lack of knowledge & understanding in occupants relating to the operation and use of technical systems;
- Lack of ongoing maintenance.

As referred to in the previous sections, the EVALOC study has uncovered evidence of both good and under-performance of the LZTs involved in the study; solar PV systems, ASHPs and solar thermal systems. Table 6.3 outlines the main issues uncovered during the study.



**Figure 6.13** ASHP electricity consumption, heat output and Co-efficient of Performance (COP) for H02 (Jan-April 2014)

**Table 6.3** Issues relating to performance of low-zero carbon technologies uncovered during study

## Installation & commissioning

### ASHPs and solar thermal systems

- Expansion vessels found not to be fixed to either wall or ground.
- Insulation around external pipework incomplete/missing.
- Incorrect pipework fittings used resulting in corroded pipework and blocked filters.
- Incorrect glycol ratio mix or lack of it.
- Leaking coil in one ASHP system led to compressor breaking down and entire new system unit installed.
- One solar thermal system was commissioned with the system valves closed (resulting in a closed loop, and as such no actual benefit being received by household).

**Note:-** *although not necessarily a performance related issue, it was found in a number of dwellings that the expansion vessels were not securely fixed, which can pose a safety issue as well as exacerbate problems if there is an issue with the pressure of the system.*

### Solar PV Systems

- Incorrect size of inverter installed (resulting in likely early replacement) and lack of isolator (could cause safety issues).

**Note:** *- although not necessarily affecting the performance of the technologies, several households with solar PV installed were found to not have upgraded electricity meters. In these cases, the meter runs backwards when PV-generated electricity is being exported. This can result in a false low reading, and if the energy supplier finds this out they can retrospectively charge for estimated additional use. The responsibility of checking the need for upgrading the meter and then informing the supplier lies with the installer or household. However, of the households in which this is the case, the occupants were unaware that this was even an issue.*

## Operation & in-use

### ASHPs and solar thermal systems

- The awareness and knowledge of the respondents relating to operation and use of ASHPs and solar thermal systems was very mixed, as was the interaction between occupants and systems.
- Whilst some households felt the new heating systems and controls enabled good control over their heating and hot water, others found them complex and left them alone completely. Whilst this may actually ensure the system performs most efficiently, it does remove control from the occupants, which either distances them from their surroundings and environment or causes them to take other adaptive measures, which could result in higher energy use.
- The lack of feedback available from the LZTs meant that householders have no way of knowing whether these were working or not, nor engaging with and optimising their use of the technology and resulting cost/energy savings.

### Solar PV Systems

- Most occupants with solar PVs were aware of how to maximise use of PV generated electricity. However, in reality they were unable to do this, due to limiting factors such as occupancy patterns and cooking and showering that are undertaken when the PVs are generating least (evenings).

## Ongoing maintenance & support

- Lack of awareness in many households (particularly in relation to ASHP and solar thermal systems) in terms of ongoing maintenance requirements.
- Whilst some households with solar PV self-monitor the generation through their meter readings, others appear to have a 'fit and forget' attitude to the systems.
- Two out of the four community organisations that helped install LZTs are monitoring the long-term performance of the solar PV systems. However, none are monitoring the performance of ASHPs and solar thermal systems, which can lead to problems being undetected. This highlights the need for ongoing physical on-site maintenance checks.
- As discovered through the EVALOC project, and similar research projects, monitoring the long-term performance of ASHPs and solar thermal systems is notoriously difficult due, in most part, to a lack of adequate knowledge and expertise in the monitoring and installation industry and availability of reliable and cost-effective equipment. Yet ongoing monitoring is critical for on-going maintenance and support, in terms of highlighting changes in performance, and detecting the source/s of problems that are causing these changes.
- Households in communities that do not have a dedicated project support officer appear to have suffered from lack of ongoing support from the installers. In some cases, the relationship between households and installers has deteriorated and they are no longer on speaking terms, so that accessing advice and support in terms of maintenance and possible issues is difficult and time-consuming.

## Household case study box A:

### Household with physical interventions only

#### Household & dwelling characteristics:

<b>Occupants:</b>	1 adult (over 65)
<b>Occupancy patterns:</b>	Occupied 'most of the time'
<b>Dwelling type &amp; age:</b>	Pre-1919 Semi-detached
<b>Internal floor area:</b>	106m <sup>2</sup>
<b>Wall construction (predominant):</b>	Solid exposed stone wall
<b>Fabric measures:</b>	Loft insulation, double glazing
<b>Technical measures:</b>	Air source heat pump (installed 2011)

Annual electricity used:	Annual daily electricity baseload:	Average daily electricity used (heating season):
8,825kWh (83kWh/m <sup>2</sup> )	5kWh	34kWh

#### Motivations and reasons behind physical interventions:

*"Speaking to [local friend with ASHP] to begin with you know I hadn't heard about it until then so she put the idea in my mind."*

*"There were lots of reasons for giving up oil. I had the tank up at the top of the garden. Now the tanks that they install now are different and there are lots of rules ... which meant I was going to have a tank bang in the middle of my garden ... the price of oil, also the political implications of oil I was fed up of wars and everything you know."*

#### Impacts of interventions:

**Energy use:** 322% increase in electricity use from 2008 to 2012

**Fuel bills:** *"It's still cheaper than buying oil."*

#### Control & heating behaviours:

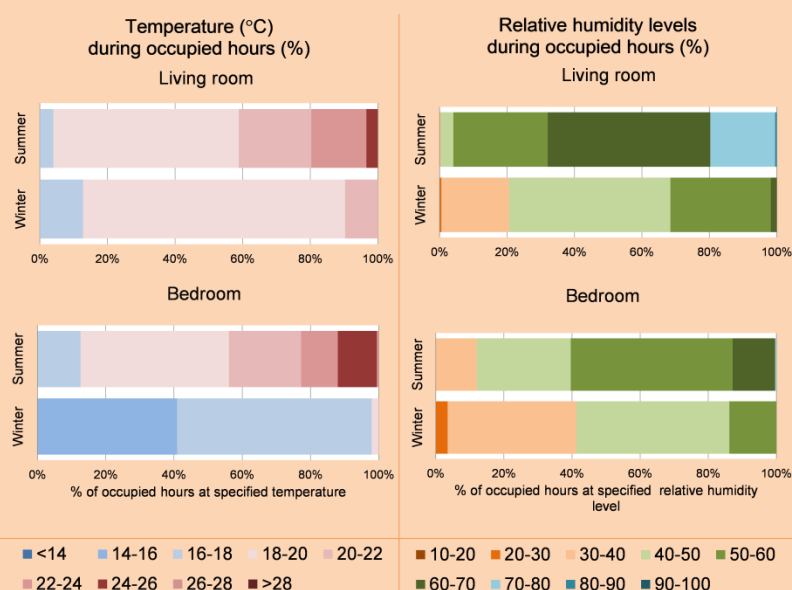
*"It's easier to monitor the temperature you know with the oil heating sometimes it was too hot and then you turned it down and then it got cold and then you turned it up."*

*"I have very little knowledge - I know only how to use the main thermostat and the TRVs."*

#### Comfort & indoor environmental conditions:

*"With the oil central heating the two front rooms... They were always cold because they're north facing and I couldn't get them warm."*

*"They're [temperature in different rooms] all more or less constant."*





## 6.6 Impacts on indoor environmental conditions and comfort

Physical interventions can have both positive and negative impacts upon the indoor environmental conditions of a dwelling, and subsequently upon the occupant's thermal comfort. The idea is to increase the stability of temperatures and relative humidity levels, enabling the occupants to reach their desired comfort levels, whilst reducing the need for heating-related energy use. However, an anticipated but unintended consequence of installing fabric measures and subsequently improving the air-tightness of the dwelling is the potential for detrimental side effects on both health and thermal discomfort due to overheating in the dwellings (Hacker, Belcher and Connell, 2005), particularly if there is a lack of adequate ventilation improvements. This is a particular cause for concern due to the future predictions of the increased likelihood of prolonged intense heatwaves (IPCC, 2012), and growing evidence of increased excessive deaths in summer months due to heat stress (Public Health England, 2013).

Whilst a *before* and *after* quantitative comparison is not possible, the monitoring data enable a comparison of indoor environmental conditions between households with different heating-related interventions, namely fabric measures, improved heating systems and controls and heating-related behaviour change activities. Data are available for 60 households in total; 27 with fewer than three 'standard' fabric measures and 33 with 3 or more fabric measures, including partial solid wall insulation in three of the dwellings. In terms of temperature and relative humidity total range, there appears to be relatively little difference between dwellings, even with improved heating systems and fabric measures taken into account. However, as Figure 6.14 indicates, although there does appear to be some correlation between increased fabric improvements and greater likelihood of achieving indoor environmental conditions within temperature and relative humidity comfort ranges (as indicated by box in graphs), a high number of all households have winter mean temperatures below recommended comfort levels, which may indicate lower thermal comfort expectations in the case study households. Although there is no apparent difference in the summer mean average temperature in dwellings with more fabric measures than those with fewer (22°C), there is a one degree difference in the winter mean average living room temperature of dwellings with more fabric measures than those with fewer (19°C to 18°C). Furthermore, Figures 6.15 (a and b) suggest that dwellings with increased fabric improvements have more 'stable' levels of comfortable environmental conditions.

Further investigation into the percentage of occupied hours that temperatures are above recommended figures<sup>4</sup> (an indicator of overheating) in living rooms shows that there is a higher significantly higher percentage of dwellings with more fabric measures (30%, 10 out of 33 dwellings) are at risk of overheating than dwellings with fewer fabric measures (15%, four out of 27 dwellings) in the summer. More concerning is the potential for overheating in bedrooms; 58% (15 out of 26 dwellings) of the dwellings with fewer than three fabric measures are at risk, whilst 84% (26 out of 31 dwellings) of the dwellings with more than three fabric measures are at risk.

In terms of qualitative feedback from the occupants in relation to the impacts of the physical interventions upon comfort and indoor environmental conditions, the majority appear to have had positive experiences. Many respondents commented positively on the improvements in terms of heat and improved warmth following fabric measures, such as double glazing, cavity wall insulation and loft insulation, and improvements to the technical services and systems within the dwelling (such as heating system and controls):

*"...that little front bedroom was very cold and... it was getting mould on the walls... and so yes...I think the house is generally much warmer." - (household with cavity wall insulation installed)*

*"...you pick your heat and it stays there...there aren't any hot or cold areas anymore." - (household with ASHP installed)*

<sup>4</sup> 26°C in bedrooms and 28°C in living rooms for more than 1% of occupied hours is an indication of potential overheating according to CIBSE (2007) Environmental design: Guide A. London: CIBSE.

In addition, several of the respondents commented on the wider positive impacts on their physical environment due to fabric measures and improved heating systems, particularly in terms of reducing noise and condensation:

*"I couldn't sleep on a night because with it being a main road we could hear every bit of traffic but once we got the double glazing it stopped all the noise."*

And;

*"...before the central heating they [the windows] were really bad for it [condensation]."*

However, in a few cases, the occupants experienced detrimental changes in the indoor environmental conditions, such as mould appearing on ceilings and walls following insulation measures:

*"...free insulation but since they did that I've started [to notice] mould on my ceiling." - (household with loft insulation installed)*

This suggests that the installation of such measures has impacted upon the hygrothermal properties of the dwelling and highlights the need for appropriate ventilation strategies alongside fabric improvement measures. Such outcomes can have a damaging impact on the health of the occupants and the building itself, as well as the overall energy use within the home; one household bought a dehumidifier to mitigate issues with condensation and mould following the installation of double glazing (without trickle vents):

*"Well they say condensation is a lack of ventilation. So you either open a window or we eventually had to buy a dehumidifier which is excellent."*

One household noted the adverse effects upon the building's structural elements as well as health concerns following the installation of cavity wall insulation. Due to the seriousness of the issue, the installers are believed to have removed the cavity wall insulation through extraction. Whilst unlikely to be the insulation itself to have caused the damage, the age and construction of the dwelling, as well as

the location (exposed, in a known damp and windy climate) suggests that there may have been water penetration from the outer leaf of the cavity. This highlights the need for thorough investigation of the cavity prior to installation of insulation, as well as ensuring that there is adequate ventilation. Furthermore, the occupants now refuse to have any wall insulation and are wary of further fabric improvements to their home.

## 6.7 Sustaining household energy reductions: influencing factors

The findings from the monitoring and evaluation of the case study households highlight the difficulties in reducing energy use, and sustaining those reductions. This is due to the many and varied influencing factors upon energy use relating to:

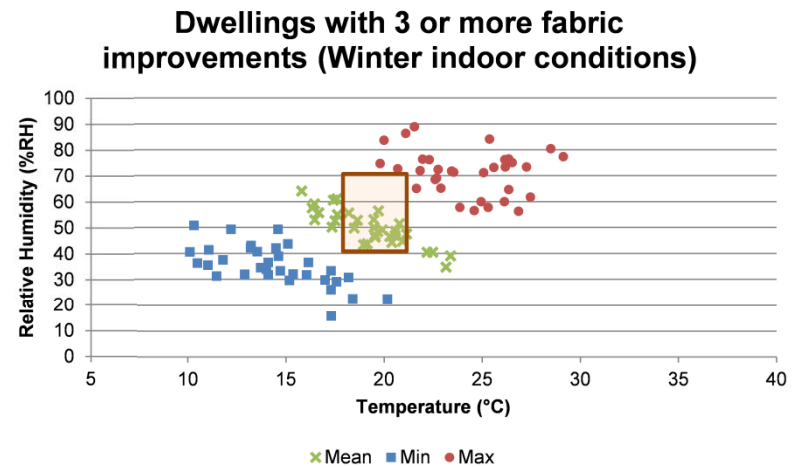
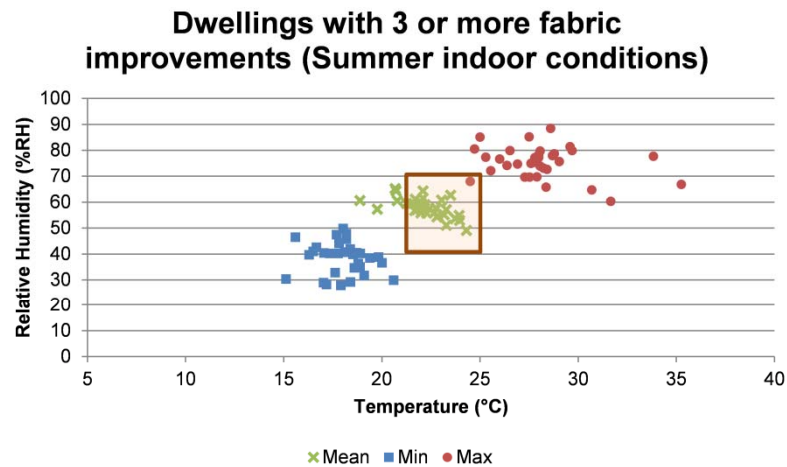
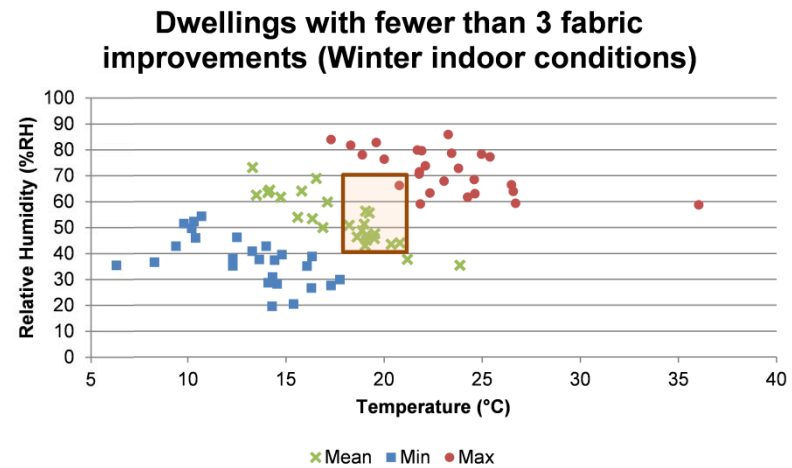
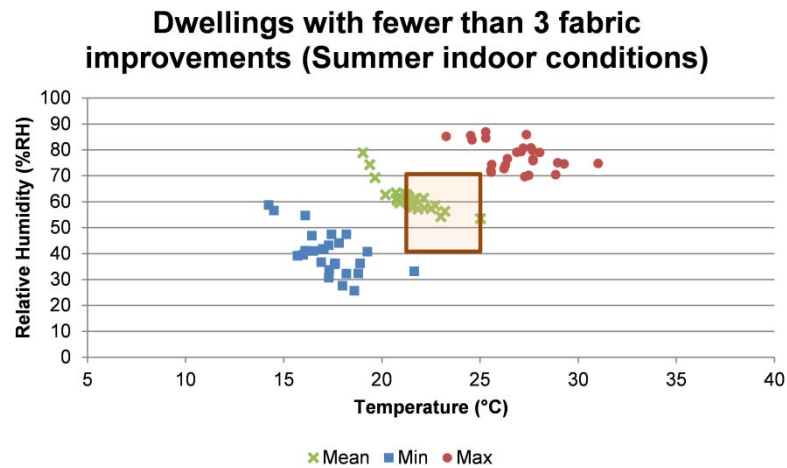
- a) the technical services and systems within the dwelling,
- b) the physical environment,
- c) the occupants and most fundamentally,
- d) the interactions between these.

Previous sections have discussed the direct influences of technical services and systems, as can fabric measures upon energy use in the household. However, these also have indirect influences upon energy use, an example of which is the impact of fabric measures upon the thermal comfort of the occupants leading to changes in heating behaviours:

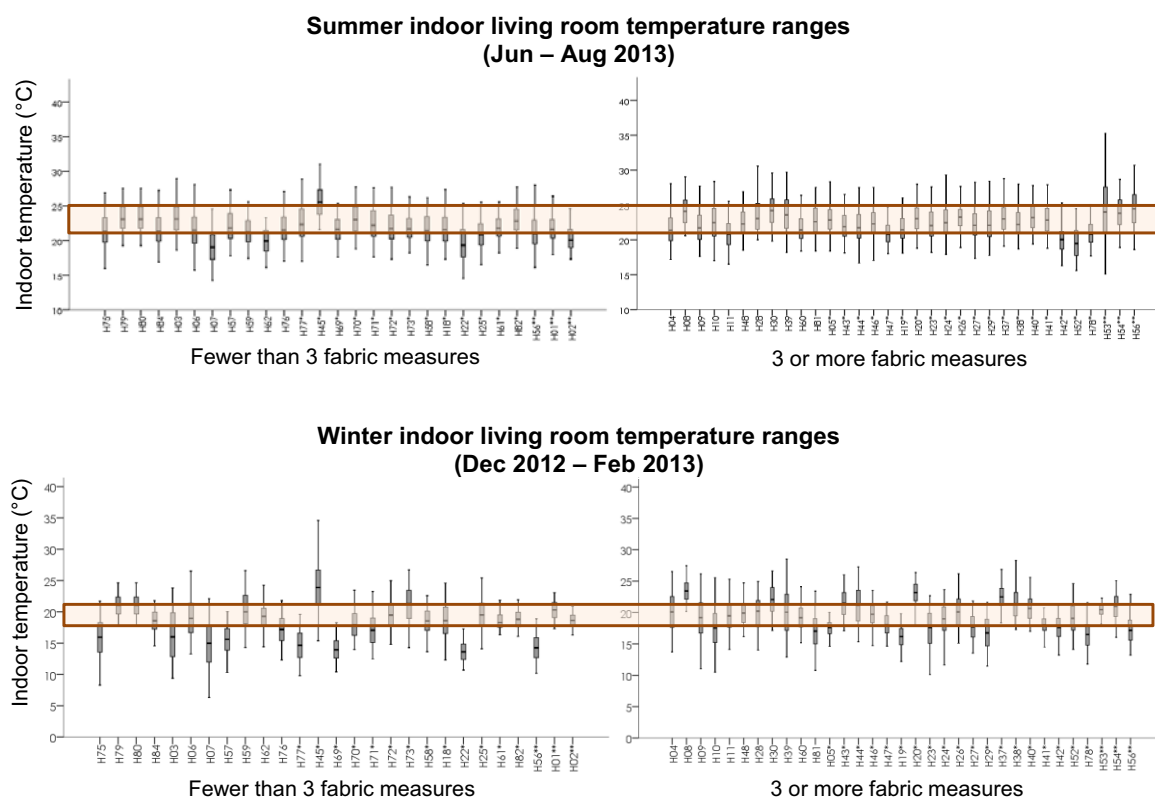
*"We felt as if it was warmer and so we could indeed turn the radiators down a little after that time..."*  
(dwelling with cavity wall insulation installed).

An indirect influence technical systems can have upon the energy use of the household is through the control they afford the occupants. An example of where this was improved was the case of a household having a new boiler installed:

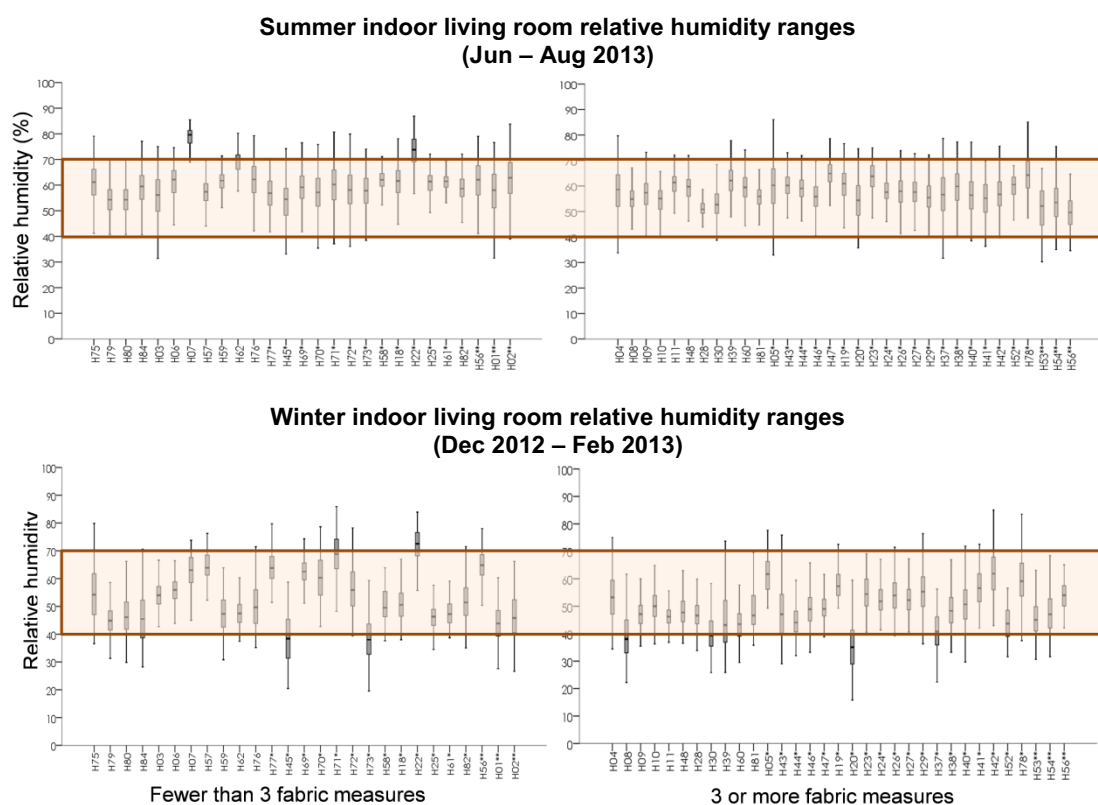
*"The only way to control the heating before was to go out to the utility room where the boiler is and I could never be bothered so I turn me heating down a lot more than I used to." - (household with new boiler installed)*



**Figure 6.14** Graphs showing minimum, mean and maximum temperature and relative humidity levels in the living room during summer and winter in case study households with fewer than three fabric improvement measures (27) and households with three or more fabric improvement measures (33). Note: the comfort ranges (highlighted by the orange boxes) are based on guidelines from CIBSE Guide A (2007), Public Health England (2014) and SAP 2009 (BRE, 2011).



**Figure 6.15a** Temperature ranges for EVALOC case study households. The comfort ranges (highlighted by the orange boxes) are based on guidelines from CIBSE Guide A (2007), Public Health England (2014) and SAP 2009 (BRE, 2011).



**Figure 6.15b** Relative humidity ranges for EVALOC case study households. The comfort ranges (highlighted by the orange boxes) are based on guidelines from CIBSE Guide A (2007). Note:- \* Dwellings with improved heating systems; \*\* Dwellings with improved heating systems (air source heat pumps).

## Household case study box B:

### Household with physical and behaviour change interventions

#### Household & dwelling characteristics:

**Occupants:** 2 adults

**Occupancy patterns:** Occupied 'most of the time'

**Dwelling type & age:** 1919-44 Semi-detached

**Internal floor area:** 79m<sup>2</sup>

**Wall construction (predominant):** Cavity wall (exposed brick)

**Fabric measures:** Full fill cavity, loft insulation, double glazing, draughtproofing, radiator reflector panels (all 2010-2011)

**Technical measures:** Gas condensing boiler (2006), energy efficient appliances (2011), energy efficient lighting (2011)

**Behaviour change interventions:** Energy management programme, energy display, community events

**Annual electricity used:**

3,358kWh (43kWh/m<sup>2</sup>)

**Annual daily electricity baseload:**

8kWh

**Average daily electricity used:**

9kWh

**Annual gas used:**

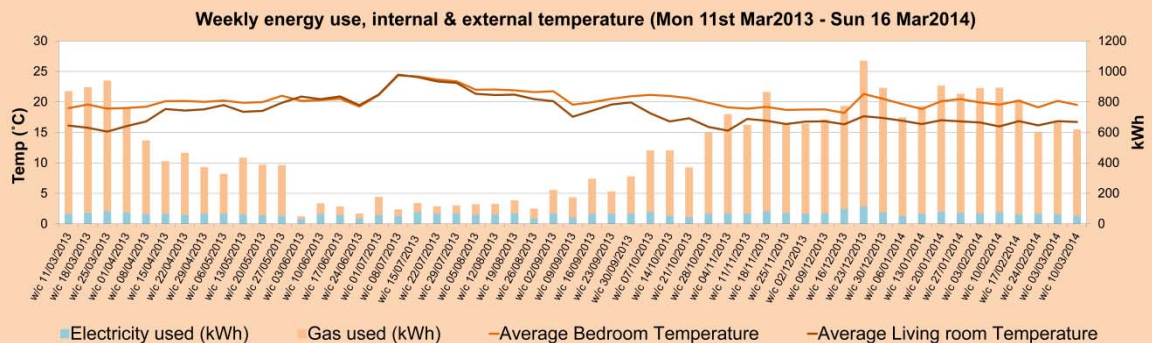
23,670kWh (300kWh/m<sup>2</sup>)

**Annual daily gas baseload:**

11kWh

**Average daily gas used (heating season):**

90kWh



#### Motivations and attitudes:

*"We always were pretty careful and well probably about ten years ago we weren't but once you've because of all the information that's come out about climate change and your carbon footprint we have been much more careful."*

#### Impacts of interventions:

**Energy use:** 22% reduction in gas use, 12% reduction in electricity use from 2008-2012

*"...made quite a significant difference having more efficient [...] freezer."*

**Fuel bills:** *"I'm sure we've saved some money, but I don't tend to sort of quantify it really."*

#### Energy behaviours:

*"We only try and fill the kettle up with what we actually need. We switch off all electrical appliances when they're not in use[.] I wash at thirty degrees whenever possible, don't keep things on standby."*

*"We do switch the heating down because I know that's probably the largest bill and we do try and keep it as low as possible."*

#### Knowledge, awareness and capability:

*"There were a lot of things that we learned about while we were there, an awful lot of information. ...all sorts of topics, it was really good."*

#### Comfort & indoor environmental conditions:

*"There's definitely not the draught that we had before and there is a little bit of condensation but nothing like there was before... I think the house is generally much warmer."*



Occupants are a key factor in household energy use, and their influence in terms of sustained energy reductions cannot be ignored (as the previous sections evidence); particularly in respect to their 'one-off' behaviours ('purchasing' or 'consumer' behaviours such as installing loft insulation) as well as habitual (everyday) behaviours and how they use technologies which may increase or reduce energy and carbon savings from energy efficiency improvements. Yet, there is a range of enabling and constraining factors influencing how people behave. Evidence from the EVALOC study suggests that the key influencing factors upon occupant energy-saving behaviours, and subsequently sustained energy reductions include:

- **Personal factors** such as attitudes and motivations, feelings of capability (the ability to make changes) and knowledge and awareness of energy use.
- **Financial factors** such as capital costs required for energy efficiency improvements and cost benefits (both in terms of capital costs required for energy efficiency improvements and cost benefits from energy efficiency improvements).
- **Social factors** such as occupant lifestyles, occupancy patterns and relationships between other occupants and social norms.
- **Environmental factors** such as health and comfort.
- **Technological and physical (practical) factors** such as lack of control over or understanding of technical services and systems within dwelling and the 'hassle' factor of undertaking home improvements.

A key influence upon individuals appears to be their feelings of capability or agency, know-how and motivations when it comes to taking action and changing behaviours in order to reduce energy use. The findings from the study are interesting to note in this respect, with 18 changing their opinions on their feelings of capability in terms of reducing energy use between 2012 and 2014, of which 15 negatively changed their views. Many commented that this was because they had 'done all they could' to reduce as much as they could (or wanted to), and that it was now more about **managing** their energy use rather than reduction.



#### Influencing factors on energy behaviours:

*"I think I probably [am] aware but whether I put it into practice. It's a bit like the Slimming Club isn't it, I know what I should and shouldn't eat but..."* **(personal factors)**

*"We have reduced energy in some ways anyway but more knowledge would lead [to more] yes, absolutely."* **(personal factors)**

*"...being an electrician I know where the money goes but you get to the point where you start penny-pinching...the effort overcomes the gains."* **(personal factors)**

*"There's a sense of well-being and homeliness thing about [lights being on] I find and you know I don't like to always have the rest of the house in darkness if I'm in there in winter time particularly. ...It just feels safer."* **(personal & social factors)**

*"It's got to the point where it's difficult to reduce it right down without cutting out everyday things that we use or that we enjoy. The only real way to do anything more now is quite expensive changes"* **(social & financial factors)**

*"If there was only me on my own I would but because I live with other people it's not so."* **(social factors)**

*"Purely from the point of view of X's medical needs so our heating bill is our biggest."* **(health factors)**

*"I tried that...but then you have to put them on a hotter wash because...they do start to smell."* **(environmental factors)**

*"I've tried nineteen as a setting and it's not comfortable enough. I'm finding I have to turn it up that one degree."* **(environmental factors)**

*"I haven't got a thirty degree wash on my washer."* **(technological factors)**

*"...It could be a bit of a minefield ripping all the boards up."* **(practical factors)**

*"You've got to try and bend your hand at a very awkward angle there is a push button that you can use to switch it off. But it is not convenient [for] every day usage."* **(practical factors)**

## 6.8 Role of low carbon communities

Of the 62 households studied in depth, 48 benefitted directly from the LCC project activities. Of these 48, 43 stated that they felt the support and/or advice from the local LCCG had helped them reduce their energy use (Figure 6.16), even though this does not always appear to have translated into actual energy reductions according to the longitudinal data.

However, the success of the LCCs appears to be in enabling them to undertake action and/or change behaviours. For some, it was practical and financial help in terms of facilitating the installation of physical interventions:

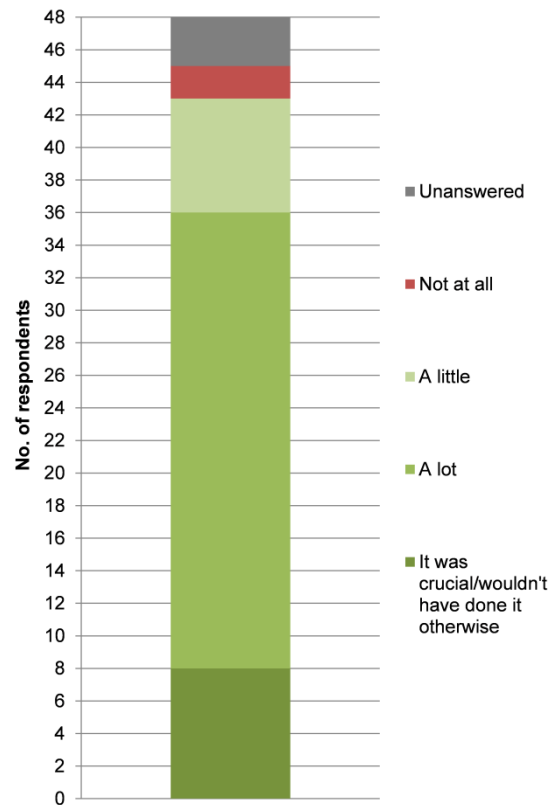
*"The physical manual help that we had from them did get us to do a job that we'd wanted to do for ages. [Also] the money that they put into us as part of the project which helped us to do things like the LED lighting and the energy efficient fridges."*

For others, it appears to have been due to increased knowledge and awareness, particularly from the behaviour change interventions:

*"Well, we're more conscious of using electricity... because we had the Wattson meter. I never used to worry about not filling the kettle up, I used to fill it right up...whereas now I tend to guess about two mugs of water and put it on."*

*"I think just talking to other people and getting little ideas that other people did that was helpful."*

**"Overall, how important would you say the LCC's advice and/or support has been in helping reduce your home energy use?"**



**Figure 6.16** Responses from case study households on how important the LCC was in terms of helping reduce their energy use

The behaviour change interventions appear to have a specific role in terms of providing 'safe' space for open dialogue and learning between peers. Furthermore, LCC activities appear to have increased motivation and agency within the participants in terms of undertaking further (self-funded) physical improvements following their involvement in the LCC activities;

*"[The LCC] ...certainly gave me the inspiration to get the new heating system put in, to get the loft insulation, to phone up and be cheeky and get a four percent reduction on me gas bill."*

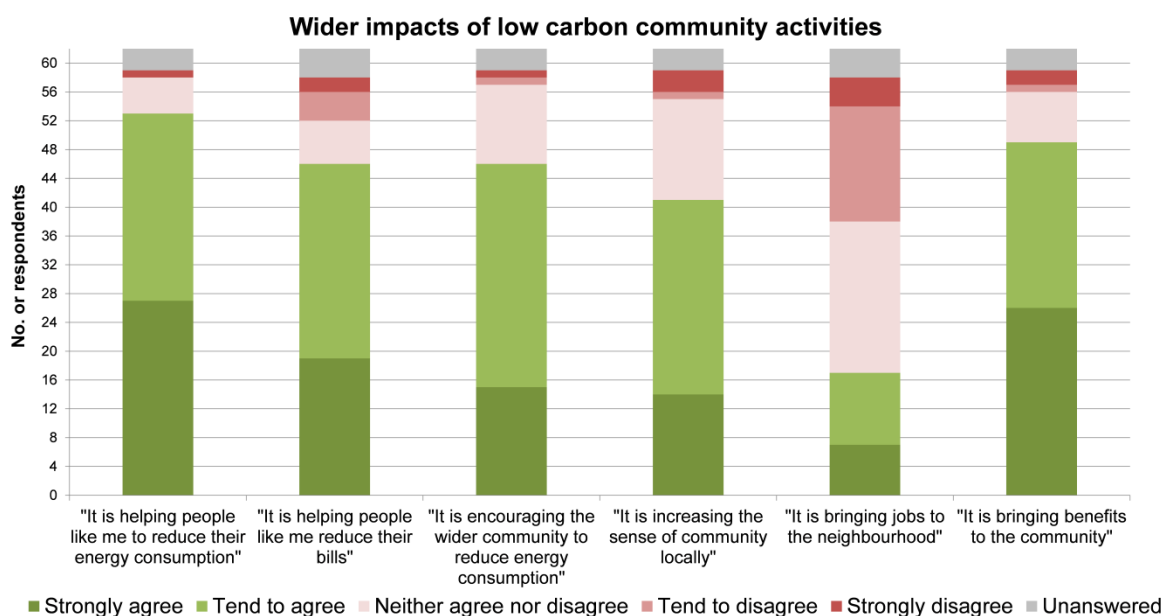
*"...when we went out for the washing machine we were able to, with confidence, pick a decent one."*

The role of the LCCs appears to be particularly relevant in terms of providing local residents with the knowledge, awareness and increased motivation; thus enabling them to make their own informed choices regarding energy use. As *trusted messengers*, and often known to local residents, they are in a unique position to dispel myths and negate confusion and mixed messages surrounding 'new' technologies as well as provide space for dialogue around demand reduction and local energy generation.

Moreover, the majority of the 62 case study households stated that they felt the LCC activities had wider socio-economic impacts and benefits (Figure 6.17) than just reducing energy use, not just for them personally, but also in terms of social cohesion across the wider community:

*"We've made more friends, we've got involved in the community which we wanted to do, we've saved money."*

*"Because it's got people together... it has brought people from all aspects and all walks of life together."*



**Figure 6.17** Wider impacts of low carbon community activities

## 6.9 Summary

### 6.9.1 Household energy use and carbon emissions

- The majority of the households' annual energy use and carbon emissions over the monitored period (December 2012 to November 2013) was below average for their dwelling type and size, but only one achieved a lower energy use than 'best practice', which highlights the need for further interventions if national carbon reduction targets are to be met.

### 6.9.2 Effectiveness of building fabric upgrades and low-zero carbon technologies

- Inconsistencies in the appearance of cavity wall dwellings with wall insulation appeared common, and were indicative of issues relating to missing or defective retrofitted insulation, particularly around window openings and infills panels.

- 'Smooth' finish to solid walls with retrofitted external wall insulation suggests effective installation in terms of reducing heat loss.

- 'Lower' temperatures above loft line than wall below suggest less heat escaping through loft space, and highlight the positive effect of loft insulation in terms of reducing heat loss through the roof.

- Inconsistencies in the appearance of solid wall dwellings with internal wall insulation, which could be indicative of issues relating to missing or defective retrofitted insulation, particularly around 'hard' details such as corners, bay windows and eaves.

- Majority of solar PV systems appear to be performing as or better than predicted, some even two years post-installation.

- However, issues relating to the installation, commissioning as well as maintenance of air source heat pump and solar thermal systems were uncovered, which has either led to reduction in performance or significant upheaval and expense to fix in some cases.

- In addition, there is evidence of a lack of knowledge in relation to the controls and use of these relative 'new' technologies in some households, which can lead to the systems being less effective.

### 6.9.3 Impacts on behaviours

- Both behaviour change and physical interventions had positive impacts on changing occupants' heating related and non-heating related behaviours. However, physical interventions such as solar PVs can lead to less positive energy behaviours (including increased use of appliances).

- Positive energy behaviours were present in the majority of the households and appeared to be sustained even two to four years after direct involvement in behaviour change interventions.

### 6.9.4 Impacts on indoor environmental conditions

- Although before-and-after indoor environmental conditions data are not available, comparisons of dwellings with different levels of fabric measures suggest that dwellings with more fabric measures have more stable temperatures and relative humidity levels, and that these remain within the comfort expectations of the occupants.

- Qualitative feedback from the occupants also suggests that the majority of fabric measures improved the stability of indoor environmental conditions and comfort levels within the home. However, there is evidence that poor installation of loft and cavity wall insulation led to increased condensation and mould in some dwellings. This is most likely due to adequate ventilation not being provided following the fabric improvements.

### 6.9.5 Sustaining household energy reductions: influencing factors

- Sustaining household energy reductions is difficult, as evidenced by many of the case study households stating that they felt they had done all they could, within their capabilities.

- The findings from the study also affirm wider research into the many and varied influences upon energy use, particularly in relation to the occupant and their know-how, motivations and agency. Such influences include social factors such as social norms, occupancy patterns and intra-household relationships, financial factors such as capital costs required and cost benefits, environmental factors such as health and comfort, as well as technological and physical factors such as lack of control or understanding of systems within the dwelling and the 'hassle' factor of undertaking physical home improvements.

### 6.9.6 Role of low carbon communities

- Although the meter readings suggest mixed effectiveness in energy reduction in the case study households following physical and/or behaviour change interventions, most of the households involved directly in the LCC felt that it had helped them to some extent in reducing their energy use.

- The biggest area in which the LCCs appear to have helped facilitate energy and carbon reductions is through *enabling* the households, in terms of undertaking physical interventions and changing habitual behaviours.

# Chapter 7

## Energy feedback approaches

Since moving away from solid fuel and candles, most home energy use, has been mostly invisible to householders. With only infrequent bills for feedback (often estimated), it becomes difficult or impossible to know how much electricity or gas is being used for different purposes and what sort of difference can be made by changing day-to-day behaviour.

There are some consistent themes in the research literature on energy feedback – that is, devices or programmes designed to give energy users better information about their energy use than they can get from a standard bill. The first research studies, in the 1970s, established that feedback (mostly via display monitors) had measurable effects and was worth adopting. As time went on, feedback was increasingly seen as a tool that allowed energy users to teach themselves about energy management through experimentation. It was useful on its own, typically leading to increased awareness and small-scale average savings; and it was useful in combination with further information and advice, helping to achieve better understanding and control.

**Scope of the review:** During the EVALOC study it became obvious that the majority of the households actively wanted feedback, from the research and from the LCC organisations themselves, not only in terms of advice on how to further reduce energy use but also in relation to monitoring progress during and after the project. More specifically, they wanted follow-up support and advice on the performance of the physical interventions. As part of the EVALOC project, a number of energy feedback approaches were used, at household and community level. This chapter outlines what activities were undertaken, an evaluation of the activities (using participant feedback), and key learnings.

### 7.1 Carbon mapping

Carbon mapping has emerged as a valuable approach for strategic planning, evaluation and implementation of community and neighbourhood scale domestic refurbishments by rapidly measuring, modelling, mapping and managing energy use and CO<sub>2</sub> emission reductions on a dwelling-by-dwelling level. Bespoke site-specific mapping of past (baseline) or current energy consumption and visualisation of the potential for energy savings can establish the impact of carbon reduction measures and encourage the uptake of further measures. Carbon mapping is useful for comparing current to baseline conditions, predicting future improvement, and visually communicating these changes, as shown in Chapter 5.

Carbon mapping events were held in five of the six EVALOC communities (all but Sustainable Blacon). In these events maps of baseline conditions, current conditions and predicted future impact of further energy and CO<sub>2</sub> reducing measures were presented to local residents along with thermal images of local dwellings and an introduction to the web-based energy and environmental visualisation tool.

The presentation formats used for communicating the findings from carbon mapping included a PowerPoint presentation and a poster (Figure 7.1) showing the maps of the community. Specifically the maps presented to the attendees included:

- Baseline map of annual CO<sub>2</sub> (2008)
- Current map of annual CO<sub>2</sub> (2012)
- Fabric improvement package map of annual CO<sub>2</sub> emissions (2012)
- Fabric and heating upgrade package map of annual CO<sub>2</sub> emissions (2012)
- Fabric, heating and electricity package map of annual CO<sub>2</sub> emissions (2012)

Further information, not mapped but calculated as a result of the modelling:

- Mean community CO<sub>2</sub> emissions reduction as a result of Individual measures, e.g. cavity wall insulation, air source heat pump, photovoltaics (where appropriate).
- Upfront cost and cost reduction per dwelling for the different packages among the four most common dwelling types in each community.





Figure 7.1 DECoRuM carbon map poster from the Eco Easterside event

### 7.1.1 Findings

In total, approximately 105 people attended the five carbon mapping events, and a total of 34 evaluation forms were completed. The carbon mapping did not hold as much interest as the thermal images (see below), though the interest varied among the communities. It was felt that this was possibly due to the fact that carbon is not a familiar concept to most people, and using costs or even kWh would perhaps have engaged people more. In Low Carbon West Oxford, feedback comments indicated people might not be interested in technical aspects of carbon savings and communication of these concepts should be simplified. Elsewhere however, (Hook Norton Low Carbon and Kirklees Council), participants could see clearly through the maps that reductions took place and that the baseline is a meaningful place to begin measuring change (no mentioned difficulty with measuring change using CO<sub>2</sub> emissions)

In Awel Aman Tawe, it was felt that the carbon maps were too estimated and the concentration on community mapping rather than individual house comparison was not appropriate for the audience. On the other hand, the information provided through mapping to Kirklees Council helped justify funding for the PV panels and *'will help guide future investment of the community fund generated by the PV panels.'*

With regard to specific measures:

- In Oxford, 8 out of 9 people left the workshop with intentions to reduce their energy use. Almost all of these intentions related to energy used for space heating and improving fabric, and installation of LED lighting.
- In Hook Norton, 10 out of 13 people left the workshop with intentions to reduce their energy use. Almost all related to improving fabric (insulation, draught-proofing, double glazing), improved heating systems and renewables, and demand-shifting\* and changes to behaviour.

In Hook Norton, all 13 people reported feeling more motivated following the workshop, although only 8 out of 13 said they were more aware. Reasons for their feelings of motivation included being encouraged by the results and realising that they can make a difference, having a baseline from which to work, and the fact that some of the measures appear 'affordable', offer practical solutions and would be 'easier to achieve some changes than previously thought'.

\* That is, shifting electricity use away from peak demand times and/or using electricity when there is a plentiful supply from renewable sources, including the user's own solar PV.

It must be noted that there was no distinction between whether the carbon mapping or thermal imaging increased motivations. Following the event for Eco Easterside, Middlesbrough Environment City were interested in how the carbon mapping could be used to identify the benefits of interventions in social housing, and to encourage private landlords to undertake the same work.

## 7.2 Thermal imaging

Thermal imaging surveys enable heat losses through the building fabric to be visualised, and are increasingly been seen not only as a diagnostic tool but also as an awareness-raising tool. Within the EVALOC project, thermal images were used both for diagnosis and awareness-raising in individual households. In terms of a diagnostic tool, the findings within the study can be found in Chapter 6. In this section, the use of thermal imaging as an awareness-raising tool is described and evaluated.

The thermal images taken as part of the survey were used at both community and individual household level using a variety of methods and presentation:

- Posters and the thermal imaging camera taken to a community event (run by Kirklees Council).
- Slides within main carbon mapping presentation and posters highlighting the

key findings relevant to the specific communities displayed at the carbon mapping workshops (5 community workshops) (Figure 7.2).

- Discussions with groups and/or individuals at carbon mapping workshops regarding individual household thermal images (4 community workshops) using digital images on a laptop.
- Individual household discussions with printed thermal images (58) (Figure 7.3).

The individual household discussions took place in summer 2014 during the second round survey with 58 households. This involved the use of a printed individual home energy report (see below) which included a page on the thermal imaging survey of that household. Alongside the image(s), the key findings and comments were bullet-pointed.

### 7.2.1 Findings

The community event organised by Kirklees Council in winter 2014 provided EVALOC researchers with an opportunity to test the potential of thermal imaging. The camera proved very popular with all ages, and children in particular would experiment with taking images of themselves and their friends and family. This enabled the researcher to discuss thermal imaging and potential heat losses, as well as solutions with their parents/supervising adults.

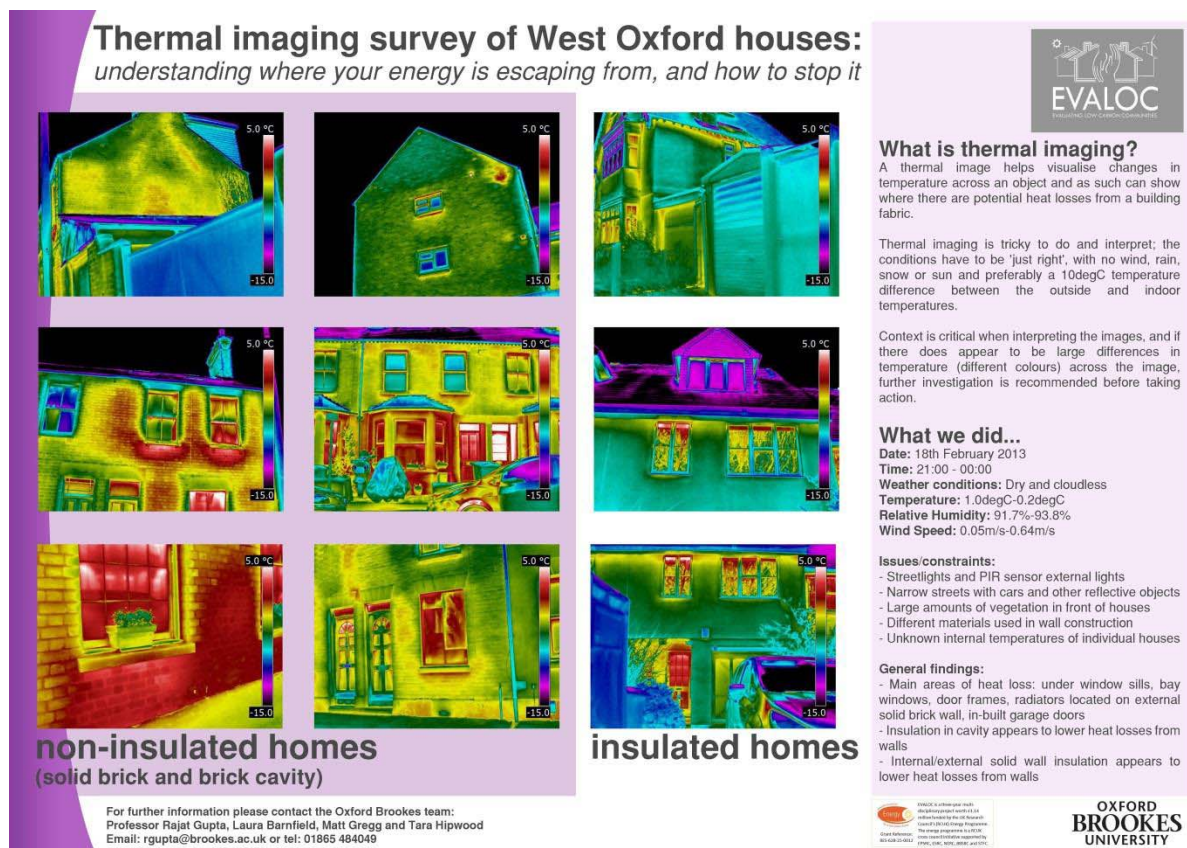
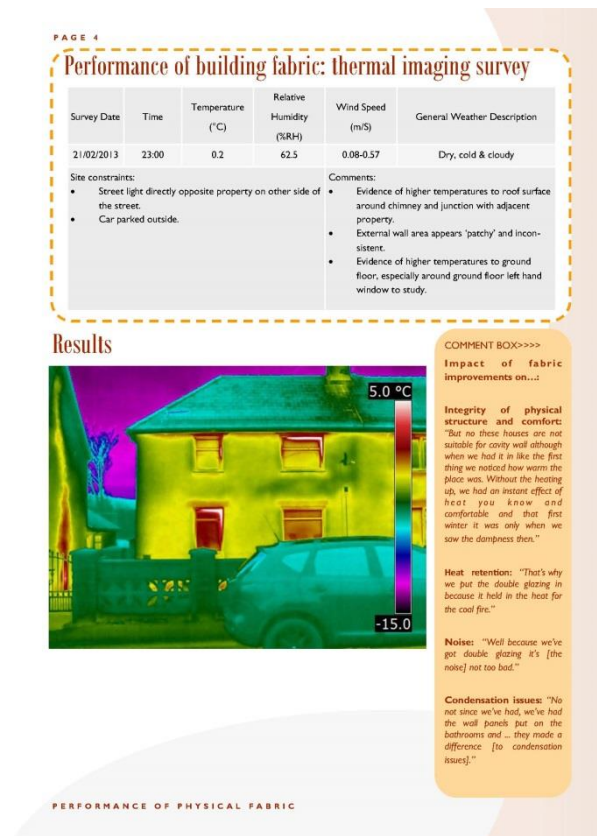


Figure 7.2 Example of a thermal imaging poster displayed at a carbon mapping workshop





**Figure 7.3** Example of a thermal image used during discussion of a home energy report

The thermal imaging posters and access to individual household images on the laptop at the public carbon mapping workshops proved to be very successful engagement tools, prompting discussions not only between the researcher and individuals but also wider discussions involving other householders. Eight out of 28 responses expressly stated that the most useful thing learnt at the workshop was the use of thermal imaging to identify heat losses, despite this being a minor part of the overall presentation. A particularly useful aspect of the presentation method (all images for all households stored and accessible on laptop) was that it allowed the researcher to show the householders 'good' and 'bad' examples of similar dwellings that had been thermally imaged, further emphasising the potential of physical measures, and also highlighting issues of which to be aware.

Perhaps even more successful were the individual household discussions with printed thermal images that were undertaken during the second round interviews; this enabled the feedback (the thermal image) to be put into context through a 'sense-making' conversation and creating a basis for action. Although all the households had received the report containing the thermal images ahead of the interview, most still asked the researcher to outline the key findings and appeared to appreciate the

chance to query the images. This technique also benefitted the researcher as it enabled them to clarify inconsistencies or abnormalities in the images, either through physically inspecting areas or by asking the residents what the problem or anomaly could be. Even in households in which there did not appear to be many anomalies, the thermal imaging was still felt to be useful as it provided evidence that the fabric measures that had been undertaken were effective. Indeed 10 out of 58 expressly stated that the thermal imaging was the most useful activities they had participated in as part of the EVALOC study.

*"Well I was very interested and very taken with that infrared photography. I'm not very good at numbers and sums, and so a lot of it was just dancing in front of me and not meaning anything but that picture told, it just helped me understand what the situation with the house is."*

And,

*"A picture tells a thousand words..."*

Furthermore, several householders reported using the findings to:

- Undertake necessary remedial works; "By the way, the unidentified cold spot on the corner of the front bedroom window was the result of dampness caused by crumbling pointing between the stones. Thanks to you I can have it restored – I would never have known about it otherwise."
- Undertake further energy improvements; "The other thing that was striking was the thermal imaging of the front of the house where one sees extremely clearly the heat radiating massively out of the living area and all of the unglazed windows. ...so actually putting one of those reflective things [behind the radiator]... so there is something I can do about it."
- Take to their Housing Association to report on the findings; "I took the pictures into the local housing trust because the flat below, it had a big light spot under the window, and I took it in and showed it them but they didn't do anything about it."

## 7.3 Web-based energy and environmental visualisation tool

As part of the study, the energy and environmental monitoring data for 61 households was uploaded onto a web-based visualisation platform (Figure 7.4), hosted by EnergyDeck (www.energydeck.com). The aim was to provide the householders with real-time (or near-real-time) energy and environmental data. The platform provided comparative benchmarks and allowed the user to search for specific dates and times. It also allowed users to select different variables (i.e. gas data and living room temperature) and display these on one graph together.

Invitations were sent to 50 of the households by email. Due to 11 households not having (or not providing) an email address, postal invitations along with a guidance brochure (Figure 7.5) were also sent to all 61.

### 7.3.1 Findings

In setting up the web-based platform, the researchers found that it was very difficult to find the expertise required to create the 'ideal' site, based on wider research and learnings from the case study households themselves. Whilst there were several organisations working on real-time web-based platforms, few had worked with large energy and environmental datasets, particularly in terms of suitable presentation for the public. Most sites are

set up for an energy management audience, which implies a certain level of knowledge and interpretive skills. It became obvious that further work in this area is required, if web-based platforms are to be widely used as energy feedback methods.

Of the 61 households that were sent invitations, 22 signed up. If a household had not signed up within a week, a reminder email was sent out. Approximately five of these required significant help in accessing and logging on to the website from the researchers. Notably, it was generally the households with occupants over 45 years old that found access most difficult. Furthermore, at least three households did not have a computer, and therefore the web-based platform was irrelevant to them.

When queried about the use of the website, few said that they had looked at it more than once, with many put off by the huge variety and perceived complexity of the site (even though they found the guidance helpful). Whilst some stated that it needed simplifying, others appreciated the options available and were disappointed more by the fact that it was not 'real-time'. It was notable that these were generally households with high levels of energy management knowledge (indeed, some worked in the energy sector themselves).



Figure 7.4 Web-based visualisation of home energy use



**Figure 7.5** Guidance brochure for EnergyDeck visualisation platform

Of those that did not sign up to the site, the main reason appeared to be lack of time and motivation to log in to ‘yet another’ website, but many stated that they were simply unaware of the website. This suggests that the means of contacting the households (through post and via email) were not always successful. A simple yet potentially very effective suggestion was that personalised reports should be generated weekly (or monthly) and automatically sent to the individual’s email address, thus providing the individuals with a direct prompt, rather than requiring them to ‘actively’ seek the information.

*“I had tried to log on and couldn’t get on and so I actually haven’t used it. It would have been, instructions were sent round with an e-mail but I couldn’t get it to work so that was that.”*

*“I’ve been online. And I still don’t understand it.”*

*“I gave [the researcher] hell actually because the software didn’t [work]... anyway I rather suspect I’m one of the very few people that have pushed through to have a look at it but I found it very interesting.”*

*“I think probably the access to the online data should have been the most useful if I got round to actually looking at it.”*

## 7.4 Personalised home energy report

An alternative approach to the web-based platform used within the study in order to feedback energy and environmental information to the individual households was the personalised home energy report (Figure 7.6). Using the learnings from the web-based visualisation tool, the researchers aimed to develop a succinct and clear way of visualising quite complex information on:

- household energy use (including over time and against benchmarks/national figures);
- environmental data (including temperature, relative humidity and CO<sub>2</sub> levels);
- the performance of low-zero carbon technologies and solar PV systems (if present).

The main difficulty faced was the need to appeal to both non-technical and technically minded households.

The report was sent in draft form to 57 households by post approximately 1-2 weeks prior to a scheduled visit by a researcher. During the visit, the occupants were asked whether or not they had read it, and if they wanted to discuss it further. For reference, the researcher carried an additional copy of the report.

### 7.4.1 Findings

The report was found to be a useful way of provoking discussion between the researcher and occupants on their energy use. It also prompted the occupants to discuss the reasons *why* their energy use and/or environmental conditions were the way they were. An example of this was the use of a graph showing annual energy use from 2008 to 2011. This generally acted as a trigger for the occupants to remember relevant contextual details that had otherwise been forgotten and not mentioned when they had been asked about any changes over the years. As such, it afforded the researchers greater contextual insight into the changes in dwelling and household characteristics.

Many of the occupants also stated that they found the report interesting, but often it was found too technical and simpler graphs were required. Yet for some, the report did not go into enough detail. Furthermore, it appears that many who did not understand the graphs tried to view them in terms of ‘good’ and ‘bad’ (i.e. better or worse than it ‘should’ be) but the graphs had no comparative data in them to give the occupants this information, and so the occupants were unable to understand what the graphs were supposed to be telling them. As mentioned previously, the thermal imaging section within the report was a particularly well-discussed



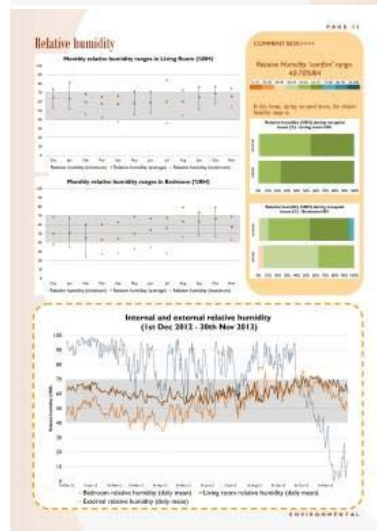
A number of households had not looked at the report at all, stating that they had simply been too busy, or had forgotten about it. Yet even in these households, when the report was shown to them during the researcher's visit, it prompted discussion and interest. This highlights the importance of a physical presence in terms of ensuring information is transferred and communicated fully.

*"Yes I've read it but I don't understand everything in it."*

The diagram shows a cross-section of a house with various energy-saving measures indicated by arrows pointing to specific parts of the building. The measures are grouped into two main categories:

- Physical and technical improvements**: These include measures like installing space heaters, upgrading insulation, sealing windows, improving doors, upgrading lighting, and upgrading heating systems.
- Behavior and awareness interventions**: This category includes behavioral changes such as turning off lights when leaving a room, turning off water when brushing teeth, and taking shorter showers.

The diagram also includes a section for "Behavioral context with LDC," which highlights the importance of understanding how behavior affects energy consumption.



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## 7.5 Energy display monitors

An energy display monitor (EDM) (also called an in-home display or IHD, especially when linked to a smart meter) (Figure 7.7) is a small gadget that shows how much electricity or gas people use in their homes and what it costs. It can also show, in real time, how much electricity different appliances are using. Research over the last two decades has shown that displays help householders to understand and reduce their energy usage, and that the outcomes include small average percentage reductions in consumption. However, these outcomes vary widely according to household circumstances and factors such as display design, feedback quality, and availability of additional advice, information and other support (Darby *et al.*, 2015).

Provision for better energy feedback through displays and bills has been incorporated into GB policy for rolling out smart meters: every customer who has a smart meter installed will also be offered an in-home display by an installer who has been trained to explain how to use it (DECC, 2015a). The Foundation Stage is already under way, with large-scale rollout planned to begin in 2016.



**Figure 7.7** An Energy Display Monitor (EDM)

EDMs were supplied to the EVALOC case study households, as part of the behaviour change research, although some had already received EDMs through the local LCC, energy supplier and other sources. There are data on EDM use from 53 of the households, in all communities. The EDMs most commonly used were 'Owls' (26) with smaller numbers from AlertMe (4), British Gas (6), Efergy (1) Eco-eye (3), Geo (1), Npower (2), Onzo (2) Saveometer (1) and Wattson (6, some of which were linked to solar PV). A few households had used more than one type of display, and there is no information on the type used by four households, because they had forgotten about them by the time of the interview.

All of the EDMs showed electricity use in real time, and this was the 'first screen' on all, the screen that

everyone would have seen. There was quite a range in complexity between the different models, from the Eco-eye offering a very simple, clear screen to the Saveometer, with many screen options offering a great deal of real-time and historical data. Some EDMs could be used in conjunction with a USB to download data and display it online. Gas use was only shown on the Saveometer and on some of the EDMs that were offered by energy suppliers.

By the time they were interviewed for the project, the households had had their EDMs for between seven and 21 months; most had had at least a year in which to get accustomed to them. The interview findings therefore offer a guide to the experience of those who only used their EDM for a short period, and to those who 'domesticated' it, making it part of their everyday life.

### 7.5.1 EVALOC-supported display libraries

As part of its action research approach, the EVALOC project encouraged and supported some of the communities to set up libraries to create a buzz in the community and stimulate people to borrow and use energy display monitors. Residents could borrow an energy display for up to six weeks. All the displays contained instructions to help the borrowers install and use them, and the librarian or LCC were able to provide some guidance if asked.

Libraries with ~20 energy displays of various designs (chosen by LCC members), were set up in four of the six EVALOC communities. They offered technical and behavioural support as outlined in Table 7.1 below.

### 7.5.2 Findings: case study households

Only three of the 53 respondents reported technical malfunctions. Three had difficulty getting their EDM to do what they wanted – for example, inputting the correct tariff – and five said that they could not understand their display. At least seven of the 53 had not used their display at all.

Table 7.1 summarises, in very broad terms, the reported outcomes from households with an EDM. (More detailed accounts are given in the separate community reports.) Most had taken on an EDM relatively recently (within the previous few months), although a few had had one in their home for a year or more.

When interviewed, roughly two thirds (31) of the respondents with EDMs said they had learned from the experience and 19 of them cited specific examples, mostly to do with the electricity consumption of their kitchen appliances. Interestingly, most of those who said they had learned something from their EDM (31) also said that

**Table 7.1** Summary of early experience with EDMs - EVALOC respondents

	Respondents with EDMs	Help with installation / use?	Looked at EDM at least once a day	Claimed to have learned from their EDM	Discussed their EDM /energy matters with others
AAT	7	-	1	-	-
SB	10	4	6	6	6
EE	12	6	6	6	4
HN-LC	8	3	3	6	7
KI	5	-	1	3	3
LCWO	10	1	9	10	6
<b>Total</b>	<b>53</b>	<b>14</b>	<b>26</b>	<b>31</b>	<b>27</b>

they talked about their displays, or about energy issues in general, with others within or beyond the household. This indicates how an EDM can form part of a process of social learning, acting as a talking-point, whether that involves passing on know-how to friends and neighbours or using the EDM more formally with an energy adviser.

Most of the respondents said they had not had any help with installing their EDM or setting it up. Help was often available though it was not necessarily called upon. For example, in Sustainable Blacon a staff member coordinated volunteers who provided practical advice, encouragement and support to households about using their EDMs, arranging a home energy assessment, switching energy suppliers, and the fitting of simple measures such as draught proofing, power-down plugs and low energy light bulbs, while in West Oxford, EDMs were incorporated into the Low Carbon Living Programme which provided a structured programme of support to residents in a group based setting over a year to support them to reduce carbon emissions.

*'It wasn't easy [to install the EDM]. My husband was an electrician for 60 years, so it wasn't easy. To be fair on the person that left it for us, I think we did say we'd manage it, and to be honest we didn't...we don't look at it. we just pick it up and dust under it, and that's it'*

*'Very easy to install. A young lady who was with me did everything. [I look at it] quite often, to see how the money mounts.'*

However, it seems from the interviews in all five communities that more assistance at or around the

time of installation could have boosted the levels of usage and learning: there were respondents in each who mentioned specific problems, in addition to a number who did not get round to using their display at all, situated it in an out-of-the-way place in their homes, or lost interest after a few weeks.

Assistance did not have to come from a LCC source: for example, Easterside residents mentioned that family members (in three cases) and a friend (one) had helped them set up their EDMs, while two had had help via their energy supplier. However, some more formal help would seem to be valuable in the early stages of introducing a self-teaching tool such as an EDM, to help build up knowledge in a community. Once there is a critical mass of people who understand how to use it, more knowledge will be passed on informally by word of mouth.

### 7.5.3 Using EDMs in the short and longer term

A recent large-scale national survey of households with and without smart meters and displays – the Smart Metering Early Learning Project survey (DECC, 2015b) has identified two main ways in which householders use energy displays. There is the 'information driven' approach, in which people use the display to identify which of their appliances use the most energy. They often lose interest once they have done this. The other mode of use is 'monitoring', when the display is used to keep an eye on energy use day to day, as part of normal housekeeping routine. Close to half of the smart-metered respondents in the national survey were classified as 'monitors', with many of them having moved on from the 'information driven' approach once they had learned the basics about their appliance use. These were the householders who were most likely to say that they were benefiting from their smart meter plus display, and that they were making energy savings

The EVALOC findings, from a much smaller sample, are broadly consistent with those from the national

survey. They indicate that half the respondents with EDMs (26) were checking their display at least once a day, and that most of these (18) were using it several times a day. They typically kept the EDM in a well-used part of the house – kitchen, living room, or by the front door – and some commented that they had a specific use for the display, in that they would check it just before leaving home, or at bedtime, to see that nothing was switched on unnecessarily. These would seem to be actual or potential ‘monitors’. Of the remaining respondents, eight said that they hardly ever used their displays and five that they had never done so. There is no information on this from the remaining six.

On average, householders typically make energy savings of the order of a few percent when they adopt energy displays and use the feedback from them. However, this average figure covers a wide range of outcomes – not surprising, considering the huge variety of [changing] circumstances in which people live from year to year. It is striking that in one community, the EVALOC case study household with the largest decrease in electricity use post-LCC interventions (47%, from 4,115kWh in 2010 to 1,982kWh in 2012) had no significant changes in occupancy or technical measures such as solar PV installed during that time. They did however, receive an EDM, and commented that,

*“Well, we’ve been doing a lot at the school about it so we have started doing a lot more to try and save on the energy.”*

This indicates what can be achieved by rethinking household habits, and also suggests that the EDM helped to guide the changes, partly by confirming that they were worthwhile and that electricity use was indeed falling. The EDM ‘works’ through a very simple action: it makes energy use visible. Thus a core volunteer from Sustainable Blacon said that

*‘I was not originally at all interested in energy/environmental issues – but was converted by seeing how much energy the kettle used [on the energy display monitor] – and how much I could save. I now sing [about it] from the rooftops.’*

It is worth noting that Sustainable Blacon involved residents in monthly meetings to discuss and learn about water, food, waste, electricity, white goods and insulation. EDMs were provided in this highly-supportive context.

Another Blacon resident commented that,

*‘it was seeing how much energy my kettle actually used when I switched on the energy display monitor, and how much that cost, that got me hooked. I then took it to work to show them. ...and I’m now a volunteer.’*

In summary, the EVALOC experience with EDMs is similar to that recorded recently for the UK population. While no firm conclusions can be drawn from this small sample of households, the findings do illustrate the social nature of adopting a new technology (the EDM), even when that technology is designed primarily for individual use. Project participants often needed to talk to someone while working out how to use their EDM. If they put their EDM to use and learned from it, they tended to talk about it with others. The talking and the learning seemed to go hand in hand, and the outcomes seem to have been largely positive.

Many of the ‘adopters’ had been offered some guidance by a family member, utility installer, or LCC member when they received the EDM. The findings illustrate how simply offering an EDM, even if it comes with written guidance, may be unproductive unless there is an opportunity to discuss it with at least one other person.

#### 7.5.4 Findings: display libraries

Table 7.2 shows somewhat disappointing outcomes from the display libraries, although there were some positive experiences. The main organisational difficulty was finding institutions or individuals with time to run the libraries and provide technical support to borrowers. There were no resources for this. In Kirklees-Hillhouse, for example, the secondary schoolteacher in charge of the display library was excited about taking on the project and sent about it systematically, discussing the concept with the Student Council, who were keen and supportive. She reported that the children in years 7-11 who had borrowed displays had ‘loved the displays’ and been ‘really keen to be involved’. They were ‘mostly interested in them helping them save money but also loved the technology’, and were ‘very keen and reliable’. She and the children ended up working out how to use the monitors themselves. *‘It was difficult ...but they managed’*. However, only eight displays were lent out, primarily because she had many other calls on her time and was not resourced to take on this extra task. To ensure continuity, the teacher suggested that EVALOC ask the school library to run the display library, and the science department to incorporate the idea into their lessons, but neither idea was taken up.



**Table 7.2** Energy Display Libraries

Community	Demography	Library Host	Start Date	Librarian and technical support	Outcomes; types of research feedback
LCWO	Middle income, urban	Low carbon community group volunteer	November 2012	<p>Librarian: LCWO volunteer</p> <p>Tech support: LCWO volunteer</p> <p>Part of structured residential carbon reduction project</p>	<p>16 displays borrowed by participants in Low Carbon Living Programme</p> <p>9 feedback forms, in-depth interviews with households, and verbal feedback from librarian.</p>
		Primary School	April 2012	<p>Librarian: Teaching assistant &amp; Eco-warriors (a group of students who champion environmental issues I)</p> <p>Tech Support: LCWO volunteer</p>	Interested in lending displays and getting kids to use activity sheets at home with families. But none borrowed. The teaching assistant left, there was a new head teacher, and LCWO tried to re-stimulate interest
KI	Deprived, multi ethnic, urban	Secondary School	January 2012	<p>Librarian: Teacher, and school council</p> <p>Tech support: Teacher and children worked out how to use EDMs themselves</p>	<p>8 displays borrowed by students via Student Council.</p> <p>Verbal feedback received from librarian about borrowers' experiences.</p>
EE	Deprived, suburban	Community Library	April 2012	<p>Librarian: Librarian</p> <p>Tech support: Paid worker from Middlesbrough Environment City</p>	<p>Only one display was borrowed by a household involved in the EVALOC research because there had previously been so many distributed free to the community.</p> <p>Interview with 1 household</p>
HN-LC	Affluent, rural	Primary school	Feb 2012	<p>Librarian: Teacher</p> <p>Tech support: HN-LC volunteer</p>	<p>3 displays borrowed in first and 3 in second term</p> <p>Interviews with 3 households</p>
		Baptist Church Care Group for elderly people	Spring 2012	<p>Librarian: HN-LC volunteer</p> <p>Tech support: HN-LC volunteer</p>	<p>6 displays borrowed.</p> <p>Verbal feedback from librarian about borrowers' experiences</p>

It could also be difficult to motivate residents to use the displays unless:

- the EDMs were part of an established programme of activity, such as the West Oxford Low Carbon Living Programme, which provided a structured programme of action and learning groups involving carbon measurement and feedback through carbon footprints; learning, practical advice and support from neighbours and local experts; goal setting; and signposting to grants. The LCWO librarian commented that the EDMS helped make energy physical, but it needed to be part of a package /

process of activities, e.g. they learnt about transformers, which '*continually suck energy ... if they're left on.*'

- the librarian or an assistant could demonstrate how displays worked at the point of borrowing or, ideally, in the home. For that, though, the borrower needs to ask for help. This seems to have happened only rarely. One of the librarians in Hook Norton, for example, explained that while three people 'stuck with the energy display monitors', three EDMs were quickly returned as people found them 'difficult to use'. One didn't use the display because 'she



thought it needed to be used with a computer' and another thought that 'it kept setting off her door alarms'. The librarian tried one of the displays out herself but 'couldn't get on it with' and found it *'ever such a fiddle. Even my son found it difficult to set up'*. It was not long before she felt she had reached the limit of what the library could do.

As with the EDMs in the case study homes (and, indeed, with the LZTs used in the project), the library experience illustrates the need to pass on knowledge along with technology. It also reflects the challenge of setting up and maintaining initiatives that rely purely on volunteers.

### **7.5.5 Community energy and smart meter rollout**

As smart meters are rolled out, the EVALOC experience with energy displays has shown how there has been a social element in learning how best to use them. It lends support to the view that there can be a role for community-based assistance for householders with new meters and in-home displays, to help them make the most of what they have to offer. Grounding in energy advice and in smart metering will be needed.<sup>1</sup> The idea of a library as a community knowledge resource is still one that can be developed.

## **7.6 Summary: raising awareness and changing practices through energy feedback**

Feedback on energy use, or on the state of the buildings and appliances through which energy is used, raises awareness by making visible what was hard to see before – for example, the loss of heat through windows and uninsulated walls, the rate at which a solar PV panel is generating, or the high power demand of an electric shower compared with, say, a radio. It gives people a way of understanding their energy use better, and allows them to see some of the consequences of actions such as raising the temperature indoors, or turning off a video game. In this way, feedback helps with learning how to live comfortably without using unnecessary fuel or electricity. It is most effective when it focuses attention on specific tasks, and shows the effects of any changes (Kluger and Denisi, 1996).

This project offered feedback in a number of forms and at different scales, summarised in Table 7.3. From the growing body of research into metering, customer engagement and energy management, it is reasonable to expect feedback to be more effective

when it comes from several different sources, or when supported by advice and information, than when it is only available from a single source (Lewis *et al.*, 2012; van Dam, 2013). What EVALOC has shown, by offering feedback that is complementary in time and application, is the potential for covering the whole spectrum of home energy use in a single programme, using a range of media.

This feedback research has offered confirmation of the importance of face-to-face communication about both energy-related information and new technologies, whether this involves introducing someone to possible ways of using an EDM, or interpreting thermal images of a home. It is difficult to raise awareness or to prompt durable carbon reductions through technology alone: knowledge and practical know-how need to be transferred along with feedback technology, and personal contact is usually the most effective way of achieving this. The case study households found the single most useful aspect of the EVALOC study to be the interviews and researcher visits, during which they could discuss their own data with an expert interpreter (something which typically benefited both parties). The EVALOC interviews also showed how householders spread knowledge through their social networks, sometimes using their feedback as a means of developing their understanding.

### **7.6.1 Carbon mapping**

Particularly in communities using heating sources other than gas, the importance of local and contextual knowledge is highlighted in order to understand specific needs regarding improvements. In highly-aware communities, more complex measures could be discussed or more technical information could be given. If the carbon map is to be developed as an engagement tool in communities with few resources to draw on, the EVALOC experience suggests a need to combine carbon mapping with the identification of what physical interventions would meet 'golden-rule'-type requirements, and pointers to how householders might be able to meet the upfront costs.

A light touch web-based version of DECoRuM would be useful for communities and householders to self-conduct with minimum data, rapid energy assessment of their house, street or neighbourhood, and predict the potential of energy, CO<sub>2</sub> and cost savings from appropriate energy saving measures.

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<sup>1</sup> Smart Energy GB would be one source to consult for the latter: <http://www.smartenergygb.org/>

**Table 7.3** Feedback types used during the EVALOC study

Feedback type	Level	Frequency	Timescale	Comments
<b>Carbon mapping</b>	Community	Occasional	Indefinite	Diagnostic + showing potential for change.
<b>Thermal imaging</b>	Community + household	Occasional	Indefinite	Especially effective when combined with one-to-one discussion (at both community and household level).
<b>Home energy reports</b>	Household	Illustrated history	Months - years	Integrated presentation of information on state of home (thermal images), energy use, environmental data and performance of low-carbon technologies. Generally, language and visuals should be simple.
<b>EDMs</b>	Household	On demand	Real-time (instantaneous) and historical	Useful awareness-raiser, once people know how to use it as part of housekeeping routines. Ideally, should be introduced by someone who knows how to use it to good effect. Can be useful talking-point.
<b>Web-based visualisation</b>	Household	On demand	Day-late, historical	Few looked at this more than once; those most interested already had high levels of energy knowledge. Complexity put people off, plus the need to seek out the site.

### 7.6.2 Thermal imaging

Thermal imaging proved a very successful and powerful engagement tool in terms of motivating individuals through increased awareness, particularly if combined with expertise in interpreting the images. It was able to provide clarity and peace-of-mind that fabric measures had been undertaken successfully, and could provoke interesting discussion and active learning when using comparative images amongst a group of householders, not just when discussing with individuals. Discussion of thermal images with household occupants, particularly on site to enable physical inspection, was able to provide the researchers with invaluable insight into any apparent anomalies within the thermal images.

### 7.6.3 Web-based energy and environmental visualisation tool

The project findings highlight the fact that a web-based feedback approach is not suitable for all individuals<sup>2</sup> and that feedback methods should be carefully thought through in terms of accessibility and readability. The level of interaction appeared to be due to the type of individual and their familiarity and use of computers and the internet, rather than which community they belonged to. For example, very high and very low interactions were both observed in Hook Norton Low Carbon and Sustainable Blacon. The EVALOC experience suggests that web-based platforms should be designed to be pro-active in reaching individuals (for example, through the use of personalised reports delivered to the individual's email address), rather than relying on the individuals to access and use them.

<sup>2</sup> This is borne out by research elsewhere: it is very unusual to have more than a few percent of utility customers using online feedback. e.g. Smart Grid Consumer Collaborative (2013) <http://smartgridcc.org/wp-content/uploads/2013/11/SGCC-Consumer-Pulse-Wave-4-Summary-Report.pdf>. For a thorough analysis of the effectiveness of web- and paper-based feedback in a trial that achieved average savings of over 4%, see Schleich, J., Klobasa, M., Götz, S., and Brunner, M. (2013) Effects of feedback on residential electricity demand—Findings from a field trial in Austria. *Energy Policy* 61, 1097-1106

#### 7.6.4 Personalised home energy reports

Whilst the report on its own appeared to have been read by the majority of the households, some had forgotten about it and visit and subsequent discussion with the researcher prompted a review that would not have happened otherwise. This proved very useful. The report acted as a memory aid to many of the households and enabled the researcher to gather more insight and contextual information surrounding the energy use, environmental conditions and comfort levels within the household.

Easy-to-read graphics with minimal text were essential for the information to be read and understood. Complex graphs should be avoided, unless the audience requires it or a suitable and clear explanation is available.

#### 7.6.5 Energy display monitors

The social contexts for energy display monitors (EDMs) were the communities in which the EDMs were introduced and, at the smallest scale, the household itself. The EVALOC findings come from a small sample of households and statistically valid conclusions cannot be drawn from them. Nonetheless, they fit with what has been learned elsewhere in the UK about the use of home energy displays, summarised in a recent review<sup>3</sup>:

- most householders are willing to try out an EDM, and can gain some benefit from it in terms of better understanding of their energy use.
- outcomes are variable, but EDM users typically claim raised awareness, some shift in behaviour, and (where this is measured) make energy savings of a few percent on average.
- it helps to have some prior knowledge about EDMs ahead of installation, so that householders have some idea of what to expect, and how the display might help them;
- the basic design needs to be very simple, with more complexity available for people who want to 'dig deeper' into their energy data;
- even with good design, many people will not find it easy to set up and use their

EDM<sup>4</sup>. It helps to have advice and information from trusted sources, during or after installation;

- people use displays in two basic ways. Some do so primarily to find out how much electricity each of their appliances uses, after which they often lose interest. Others progress to using their display as part of their housekeeping routine, for example by checking that appliances are switched off at bedtime, or monitoring usage over time to see whether their energy-saving efforts are effective.

A 'monitoring' approach offers the best prospect of satisfaction with the display and reductions in energy usage.

The EVALOC findings help to inform knowledge of how EDMs can be used in parts of the country where there is already a 'community conversation' about energy. The case study home interviews, and the feedback from EDM libraries, shows how EDMs

- created 'lightbulb moments' by making energy use visible.
- became talking-points and part of a process of social learning.
- prompted changes in everyday energy use, especially with kitchen appliances.

The EVALOC evidence also shows how rare it is for EDMs to 'work' in isolation (that is, when the householder is simply given the device and left to get on with it); and how important it is to introduce new technology along with the knowledge needed to make sense of it and operate it. Thus the most enthusiastic references to EDMs mostly came from householders who belonged to groups that experimented with different aspects of low-carbon living. Failing that, it could be useful to have a little support and advice at or around EDM installation, from a technically-savvy family member or part of the LCC team.

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<sup>3</sup> In particular, see AECOM (2011) Energy Demand Research Project: final analysis. Raw G and Ross D, AECOM, London; Darby, S.J., Liddell, C., Hills, D. and Drabble, D. (2015) Smart Metering Early Learning Project: synthesis report. For the Department of Energy and Climate Change, London

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<sup>4</sup> The EVALOC researchers had difficulty in setting up some of the EDMs used in the project.

# Chapter 8

## Measuring impact of community energy action

This chapter outlines the findings from EVALOC in terms of monitoring and evaluating local carbon community energy action. It draws from an evaluation of the six case study LCCs own Monitoring and Evaluation (M&E) experiences and approaches, as well as reflections on using an action research approach to M&E.

*'For community energy to realise its full potential, communities need to be able to evaluate the impact of their projects. Measuring impact will help government to develop policy that best supports community energy and maximise the contribution to energy and climate change goals. In addition, this will help communities learn from their own and others' experience, building on the best and avoiding unproductive ideas' (DECC, 2014b, pp10.).*

### 8.1 Monitoring and evaluation of community energy outcomes and impacts

The Community Energy Strategy highlighted the importance of measuring the impacts of LCC projects at local and national level, and acknowledged that conducting robust M&E at a local level was difficult. At the start of EVALOC, LCCs were asked what M&E they were already conducting, and difficulties they experienced.

All the LCCs involved in the EVALOC project have evaluated their work to different degrees. All have been evaluated by external organisations, such as funders and academics. Whilst some LCCs conduct minimal self-evaluation, other groups have highly developed M&E in place to capture the impacts of their project on those involved.

#### 8.1.1 EVALOC LCCs experience of evaluation

An overview of the M&E experience is shown in Table 8.1.

All EVALOC LCCs stated that they would like support to help them define (and where appropriate implement) their own M&E frameworks, aiming to be robust and rigorous. Due to the wide range of benefits LCCs may generate, the M&E undertaken should encompass not only the quantitative measurement of impacts but a qualitative understanding of processes and outcomes.

Whilst LCCs would like to conduct M&E, a number of constraints were identified in initial interviews, which are detailed in Table 8.2. Through the flexible design of the Action Research approach, we were able to address some, but not all, of the constraints in our research.

Table 8.2 shows that a large amount of evaluation of the EVALOC LCCs has been undertaken, with a range of external partners. Less self M&E has been done but one LCC used an approach that informed the development of a complementary knowledge exchange project, Monitoring and Evaluation for Sustainable Communities (MESC)<sup>1</sup>.

Prior to the external evaluations undertaken by Big Green Challenge, DECC and EVALOC, LCWO had developed its own self-evaluation system based on a step by step approach informed by a theory of change approach (Coe and Mayne, 2008). This involved experienced members of the LCC identifying:

- a) the principles and purpose of the M&E;
- b) who should be involved in design and implementation;
- c) the key questions and priority projects to monitor;
- d) impact pathways and change assumptions;
- e) indicators to track outcomes and test change assumptions plus 'how', 'why' and open questions to capture unintended outcomes; and
- f) data collection methods.

Group members designed data collection methods, carried out subsequent analysis of data and communicated findings to stakeholders.

Drawing on evidence from EVALOC's second round of focus groups, it was found that two LCCs have devoted significant amounts of time to sharing their knowledge and expertise about developing community energy projects with other LCCs. This 'midstream' learning formed an important element of their effectiveness. The LCCs felt that the research data could be used to communicate their impact to wider audiences, including their local communities, policy makers and potential funders. One LCC considered how they could use their research findings to influence government policy (Group 3, FG3):

*'there's the opportunity when we've got the research and ... validation of what we're doing to actually think about how to [influence government policy]'.*

<sup>1</sup>See <http://www.geog.ox.ac.uk/research/technologies/projects/mesc/>

**Table 8.1** Overview of LCC's M&E experience

LCC	M&E experience since 2010	M&E Partners
<b>Awel Aman Tawe</b>	<b>Self M&amp;E</b> <ul style="list-style-type: none"> <li>Previous data from funded projects, installations</li> <li>Have used the EST Green Communities tool. This requires access to large amounts of household data, and is not accurate for communities off the gas network.</li> <li>Use the Carbon Trust tool to measure own impact.</li> <li>Query whether DECC used data for LCCC carbon footprint was gathered in the correct area</li> </ul> <b>External M&amp;E</b> <ul style="list-style-type: none"> <li>EVALOC</li> <li>LCCC DECC evaluation (survey and focus groups?)</li> </ul>	Oxford Brookes University University of Oxford University of Swansea PhD and MSc students
<b>Sustainable Blaon</b>	<b>Self M&amp;E</b> <ul style="list-style-type: none"> <li>Feedback forms from the Eco houses</li> </ul> <b>External M &amp; E</b> <ul style="list-style-type: none"> <li>EVALOC</li> <li>Blaon Energy Management Programme in partnership with the University of Chester.</li> <li>LCCC DECC evaluation</li> </ul>	Oxford Brookes University University of Oxford University of Chester University of Strathclyde PhD students
<b>Eco Easterside</b>	<b>Self M&amp;E</b> <ul style="list-style-type: none"> <li>Self M&amp;E of cycling projects; town hall meal and internal health check, supported by University of Oxford led MESC project (Monitoring and Evaluation of Sustainable Communities)</li> </ul> <b>External M &amp; E</b> <ul style="list-style-type: none"> <li>EVALOC</li> <li>DECC LCCC evaluation (surveys and focus group)</li> </ul>	Oxford Brookes University University of Oxford DECC
<b>Kirklees-Hillhouse</b>	<b>Self M&amp;E</b> <ul style="list-style-type: none"> <li>DECC LCCC evaluation (survey and focus group)</li> <li>Internal review of energy display monitor project</li> <li>Internal evaluation of Warm Zone project</li> </ul> <b>External M &amp; E</b> <ul style="list-style-type: none"> <li>External evaluation of Warm Zone Project</li> </ul>	Oxford Brookes University University of Oxford DECC Carbon Descent
<b>Hook Norton Low Carbon</b>	<b>Self M&amp;E</b> <ul style="list-style-type: none"> <li>HN-LC 2010 energy survey of 200 households</li> </ul> <b>External M&amp;E</b> <ul style="list-style-type: none"> <li>EVALOC</li> <li>DECC LCCC evaluation</li> <li>'Smart Hooky' monitoring project</li> </ul>	Oxford Brookes University University of Oxford DECC Smart Hooky
<b>Low Carbon West Oxford</b>	<b>Self M &amp; E</b> <ul style="list-style-type: none"> <li>Low Carbon Living Programme(LCLP): (a)before and after carbon footprints of 100 plus household (b) one and two year on data for some households (c) behavioural survey of 100 plus participants (d) annual reporting of carbon reductions for overall projects where data available (household, waste, tree planting and transport projects)</li> </ul> <b>External M&amp;E</b> <ul style="list-style-type: none"> <li>EVALOC</li> <li>DECC LCCC evaluation</li> <li>Big Green Challenge</li> </ul>	Oxford Brookes University University of Oxford DECC Big Green Challenge



**Table 8.2** Constraints in conducting M&E identified by LCCs

Technical and data constraints	How we addressed the constraint through EVALOC
<p><b>Lack of baseline data:</b> it is often difficult for external evaluations to obtain 'hard' evidence of the impacts of community energy projects due to the lack of baseline data.</p>	<p>EVALOC researchers were able to access annual baseline energy data for individual households through DECC (five years of electricity data to be collated for 77 of the 88 households, and gas data for 47 households). This is publicly accessible but requires written consent from the individual households.</p>
<p><b>Lack of longitudinal data:</b> risk of missing longer -term impacts and outcomes of the projects.</p>	<p>At the initial LCC meeting, we compiled a background case study to consolidate information from previous projects, activities, and research.</p>
Process of M&E	
<p><b>Time and resources:</b> most of the LCCs lacked sufficient resources to undertake their planned activities, let alone monitoring and evaluation (M&amp;E).</p> <p>Many LCCs felt that existing community M&amp;E tools require a significant amount of additional work to collect data, such as household energy data, which is particularly challenging for volunteer groups. Collection of household data is unlikely to be collected by LCCs unless it is an integral part of their existing projects (e.g. in learning and action groups or collecting meter readings).</p>	<p>Worked with LCCs to identify and shape M&amp;E that would be mutually beneficial.</p> <p>Provided M&amp;E at community events.</p> <p>Household M&amp;E provided energy data and feedback on the performance of LZTs.</p>
<p><b>Consistency:</b> Donor- or academic-led evaluations do not necessarily have consistent methodology, making longitudinal comparison or comparison between LCCs difficult.</p>	<p>To aid comparability, we used existing question sets where possible for the household surveys and community event feedback forms.</p>
<p><b>Extractive evaluations:</b> Some external evaluators have used an extractive approach which fails to involve the LCCs in the research design and analysis and reduces relevance of the research to LCC and potential for LCC learning and understanding. In one case, a donor-led evaluation required the LCC to undertake a burdensome M&amp;E which duplicated its existing monitoring system.</p>	<p>Community event evaluations and focus groups were devised in collaboration with the LCCs, with opportunities for LCCs to input into research design.</p> <p>Emerging research findings were fed back to and discussed with the LCCs.</p> <p>Developed complementary knowledge exchange M&amp;E project to support LCCs to self-evaluate, which was offered to all EVALOC LCCs and taken up by Eco Easterside (Monitoring and Evaluation of Sustainable Communities).</p>
<p><b>Evaluating wider and indirect impacts.</b> Evaluating the impact of LCC projects on those not directly involved, and capturing indirect impacts (such as economic or health impacts) has been beyond the capacity of LCCs.</p>	<p>This was beyond the scope and capacity of the EVALOC project.</p>

### 8.1.2 Lessons from the research

Drawing on the EVALOC research and a survey conducted to discover the current state of M&E with a wider group of LCCs<sup>2</sup> (n=102), further support at a general level which can enable LCCs to better evaluate their projects and collect evidence of wider outcomes and benefits in the future has been identified.

This research shows that whilst 'off the peg' comparable and up to date M&E tools are important, it is also important that LCCs are provided with the mentoring and support to enable them to develop M&E which meets their own needs and those of key

stakeholders, and is comparable with other LCCs for agreed key outcomes. Support or expert input is important at the beginning of the M&E process, and could be delivered in a variety of ways, such as through regional workshops with access to follow-up support.

### 8.1.3 Using action research when working with LCCs

Part of the EVALOC research involved investigating how 'Action Research'<sup>3</sup> (AR) methods can be used to produce good-quality research, whilst assisting the LCC's learning, reflexivity and agency for change. Our AR approach focused on developing a cycle of action, reflection and (modified) action with

<sup>2</sup> Data taken from Community Monitoring and Evaluation methods survey Report and analysis. March 2013 Available from EVALOC website.

<sup>3</sup> Action research refers to cycles of planning, action and reflection.

the LCCs on specific issues. AR involved the community events (detailed in Chapter 3) which were assessed in terms of their role in social learning about energy, and a series of three focus groups in each LCC with key stakeholders which were used to research specific questions, to feedback emerging findings from community and household research, and to plan future research activities (Figure 8.1).

The three rounds of focus groups provided an overview of the LCC's development over the four years of research and enabled and tested some participatory M&E methods on roles and relations with other organisation and time lines (contained within Chapter 4). The topics covered included:

- Identity of the community,
- Impact of DECC grant,
- Which organisations they work with,
- Key beneficiaries,
- Community engagement methods and barriers,
- Roles and relations with other actors,
- Activities/impacts/influences as well as future activities.

The Action Research approach meant that researchers and LCCs needed flexibility to determine how the research at community events

would integrate and complement the focus and nature of their work. The evidence that this approach helped to increase the learning, reflexivity and agency for change of the participating LCCs is in the following sections.

#### 8.1.4 Increased Learning

Working in an AR and collaborative capacity has increased the LCCs' learning in a number of ways, and focus groups enabled them to reflect on their activities. The methods used included:

- interactive discussion which enabled reflection on issues such as the identity and composition of the LCC;
- activity timelines (see Figure 8.2), which aided the assessment of strategy design, wider impacts, external influences; and
- a roles and responsibilities mapping, a participatory and visual exercise to elicit the roles of LCCs in reducing energy and carbon, and their relations with other local actors.

This promoted discussion about the focus of the LCCs' work, and about which other organisations should be taking action on specific energy issues at a local level. The complementary MESC project introduced participating LCCs to a wider range of approaches and tools.

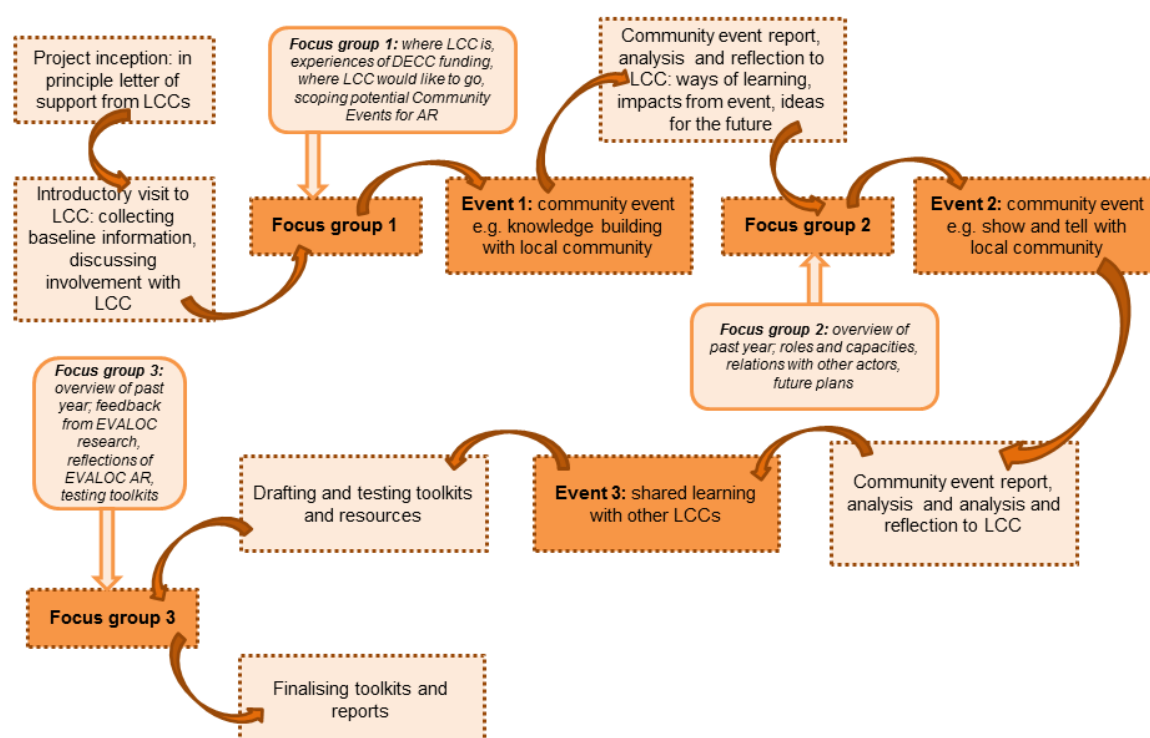
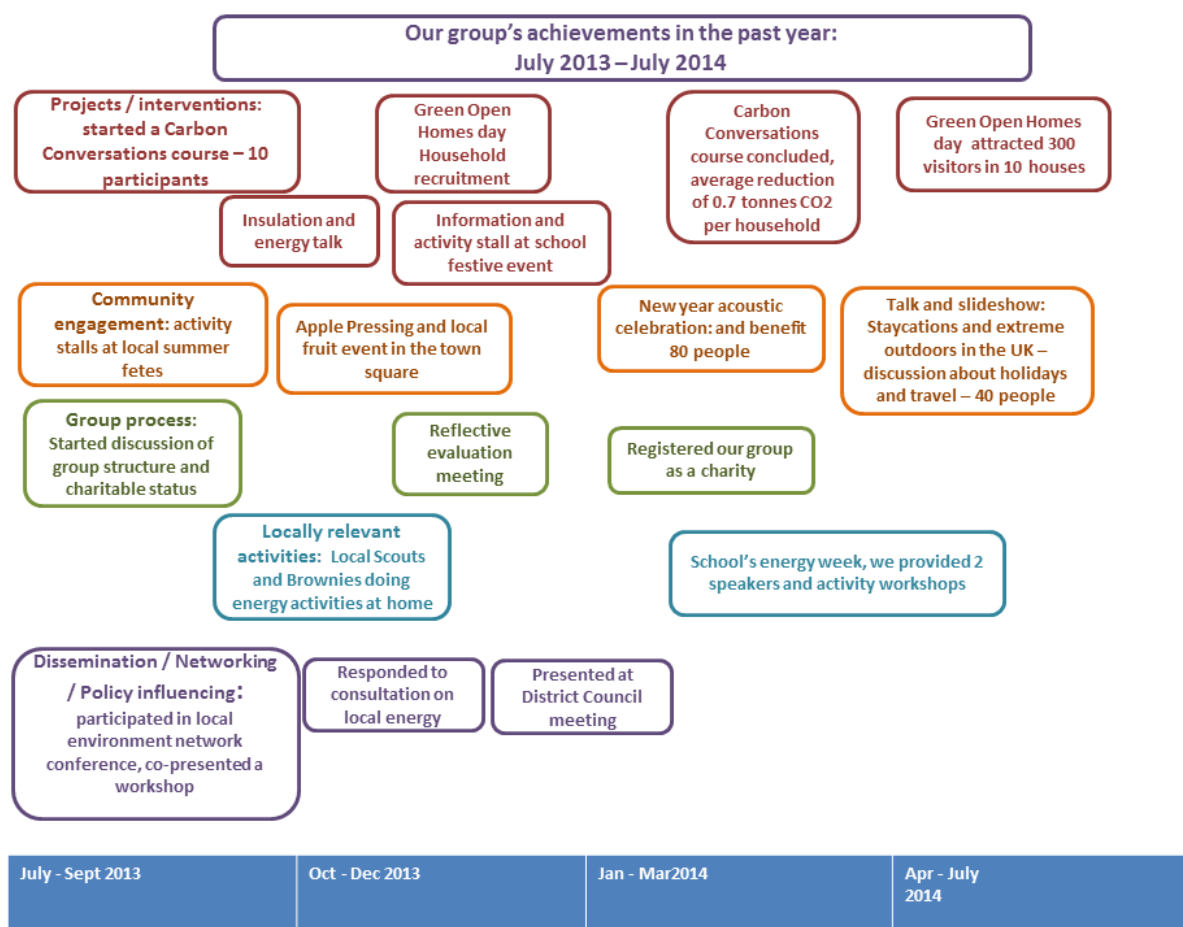


Figure 8.1 Overview of the Action Research with LCCs



**Figure 8.2** Activity Timeline used in focus groups

EVALOC research data from community events has proved useful for some LCCs to learn from and shape future activities and projects. Through collaboratively organising community events or shared learning workshops, the AR has produced research of benefit to both the LCCs and EVALOC. For example, from event feedback, one LCC modified the engagement and communication materials given to event attendees. Another mentioned that as a result of participating in a shared learning event, they had learnt from other LCCs which led them to:

*'start[ing] to catalyse local authority to do more to address pockets of fuel poverty in their area' and 'work much more with the Affordable Warmth Network'. (Group 6, Focus Group 3).*

For the EVALOC researchers, the value added of collaborative research improved quality and accuracy of research produced.

### 8.1.5 Learning from reflection

The AR approach has increased learning from reflection in both researchers and LCCs. For

example, in response to feedback given about a shared learning event to explore the impact of installation of Solar PV on a local school, one participant mentioned that;

*'I think there's a real use in doing this sort of [research and reflection] actually. I think it's telling us a real message actually, a real story.'*  
- (Focus Group 2 participant)

Another responded to the timeline of activities presented:

*'it is nice to see [all our activities] in a simplified form because it ... straightens out in your head ... all the... [time that] networking and stuff takes up' -*  
(Focus Group 2 participant).

Sharing emergent findings with the research participants and their wider community networks has improved the quality of the research, increasing learning about how change happens, testing assumptions and biases and aiding the reflection of both LCCs and researchers.

There is also evidence from the research events of participants strengthening their strategy in relation to participating local actors. For example, one external participant in a shared learning event subsequently notified the researchers:

*'Just to keep you informed, firstly how grateful I am for the EVALOC study this obviously has clear links with the work that I project manage. I have noted a number of shortcomings outlined by the report, and recommendations for future work. I'm very keen to ensure that positive outcomes arise from the report, and as such I have arranged a 'working group' meeting ... to run through two main topics addressed.'*

However, engaging with national actors such as central government policymakers remains a challenge (see Chapter 9).

#### 8.1.6 Limits of the Action Research approach

During the course of research, limitations of the AR approach were encountered. Time constraints meant the academic researchers were not able to involve LCCs in detailed co-design at the start of the project, and some research questions reflected academic rather than LCC priorities. In part, this was compensated by having a flexible research design and giving LCCs the opportunity to add their own questions to event feedback forms and focus groups.

The participation of the LCC core group was limited by their time and resources. The academic researchers sought to address this by providing financial support where possible, and aimed to ensure that the resulting data addressed the needs of the research along with the practical needs of the LCCs, such as developing their own strategies. As one LCC member said:

*'the EVALOC [financial] contributions to the Eco Easterside project really helped to support us and made it much easier to justify our involvement in the research to our trustees'.*

## 8.2 Monitoring and evaluation of household energy use and interventions

Following on from the previous section that outlined the monitoring and evaluation lessons learnt in terms

of the LCCs themselves, and the AR approach, this section outlines the findings and learnings from the study in terms of the monitoring and evaluation of household energy use and interventions only.

### 8.2.1 Community level: carbon mapping and baselining

DECoRuM community carbon mapping offers a visual and rigorous approach to communities and householders to calculate energy use and carbon emissions, on a dwelling-by-dwelling level and also on a community scale, both pre- and post-intervention stage. By showing the baseline energy data, and comparing it to a 'current' map showing the area's post-improvement measures, the LCCs can visualise their impact, and communicate their effectiveness in a visible way within, and outside the community. The DECoRuM carbon mapping approach can also identify 'hotspots' of energy use that can be targeted for improvement, and assess the technical and economic feasibility of deploying a suite of best practice carbon reduction measures that can be deployed. This can help communities in targeting future actions on household energy reduction.

Carbon mapping provides a way to quantify energy and carbon savings (in terms of domestic energy use) but is subject to constraints due to its reliance on the availability and accessibility of data on a large number of individual dwellings, which is often difficult to collect without the input of the individual households. In addition, due to the background calculations of DECoRuM being based on BREDEM-12, it does not fully allow for the impact of occupant behaviours on household energy use, which means it can under- or over-estimate energy and carbon savings. As such, when seeking to evaluate LCC activities that have had a focus on behaviour change interventions rather than the installation of physical interventions, such housing stock modelling tools may not be the most appropriate approach.

Despite this, there are other ways in which LCC activities can be measured in terms of energy and carbon reductions. One simple way to understand long-term energy trends across areas in which LCCs operate is through publicly available data (LSOA). Whilst it may be difficult to match the LSOA boundaries with the 'boundaries' of the LCC, such data is based on actual or estimated meter readings of the households. This enables relatively accurate baseline energy data, and therefore subsequent annual changes in energy in the area to be gathered and evaluated. However, it cannot be used in terms of assessing the *actual* impacts of LCC activities (due to the many other factors that affect household energy use).

### 8.2.2 Household level: monitoring of individual case study households

The EVALOC study has shown the value of a case study approach to household monitoring, as this offers insight into household activities and priorities, as well as the changes in energy and carbon. It is critical to ensure that the M&E methods and approaches enable ‘unanticipated’ impacts to be uncovered, for example in relation to potential changes in environmental conditions in the home due to improved fabric and air tightness, which may have a knock-on effect on health, behaviours and comfort levels.

A longitudinal study is preferable to a short-term study, in order to establish ‘normal’ patterns and periods of abnormal activity/energy use (for example, if an occupant is ill, or if visitors are present). However, this does not mean that all survey techniques have to be continuous; a number of aspects can be determined through one-off measurements (such as the performance of the building fabric), but it is desirable to repeat some of these one-off measurements to capture any significant changes, or indeed no change. Therefore, as Figure 8.3 demonstrates, the ideal data collection framework should incorporate both continuous monitoring but also waves of one-off measurements. The number of waves is dependent on the depth of investigation required, as well as availability of resources (particularly time and costs). This variety in survey techniques requires a mixed method active research approach to ensure both qualitative and quantitative data are gathered and cross-analysed. This is also important due to the very complex socio-psycho-technical nature of household energy use.

Many survey techniques and methodologies can be used to gather relative baseline, output, outcome and impact data. However, not all survey methods need to be used in every case study, and generally the selection of methods is dependent on:

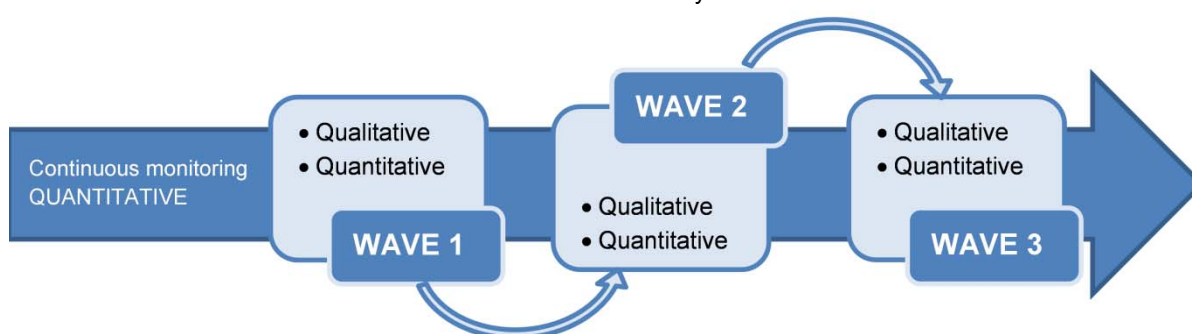
- the level of detail required within the case studies
- the level of involvement needed and/or desired by the participant
- the timeframe of the study
- the time, human and skills resources available
- the amount of funding available

As such, as part of the EVALOC study, a graduated approach to household energy use M&E was used, but based on experience an ‘ideal’ graduated approach to household M&E was developed and is outlined in Figure 8.4. The key survey techniques are outlined in Table 8.3.

The scalability of the approaches, in terms of sample size, is taken into consideration with recommendations as follows:

- Basic Approach: 50 households
- Comprehensive: 10-20
- Advanced: 5 or fewer

It is felt that these three approaches would enable interested parties to undertake or lead an M&E study of household energy use, from community groups themselves (in partnership with academics and specialists for certain aspects of the M&E) to other practitioners and academics looking for a consistent and robust approach to undertaking M&E on a case study basis.

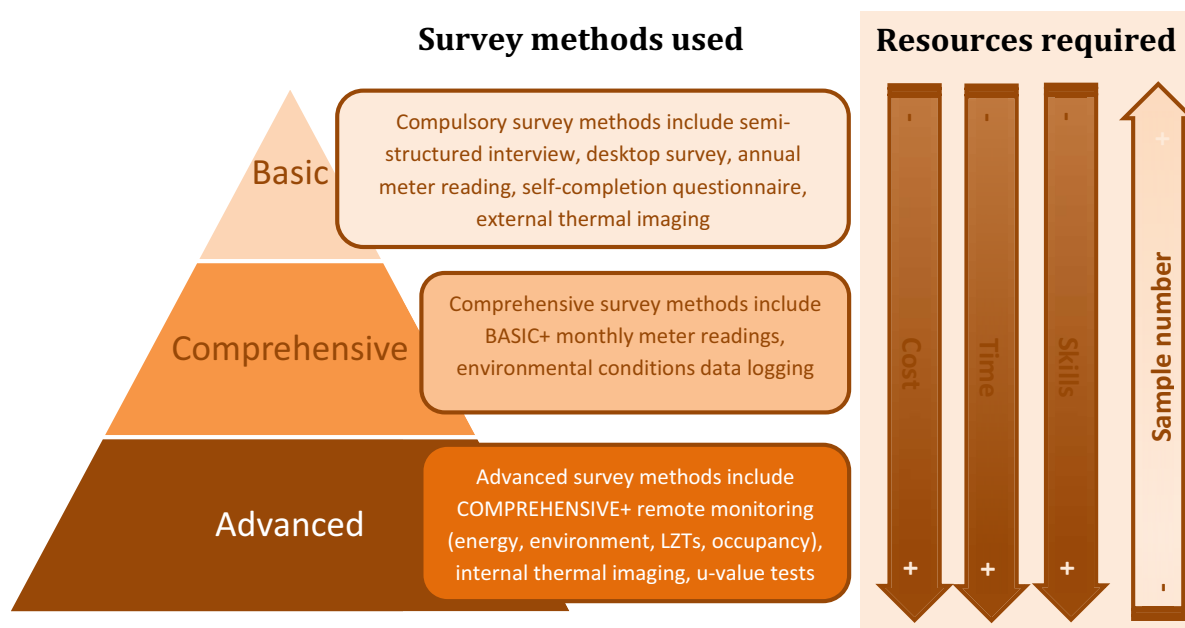


**Figure 8.3** Data collection framework for M&E of household energy use



**Table 8.3** Key M&E survey techniques

Survey methods	Resources		
	Cost	Time	Skills
<b>Basic approach</b>			
Desktop survey	£	⌚	👤
Heating control questionnaire	£	⌚	👤👤
Metered energy readings (annual)	£	⌚	👤
Photographic survey	££	⌚	👤👤
Self-completion questionnaire	£	⌚	👤👤
Semi-structured interview	££	⌚⌚	👤👤
Spot measurements	£££	⌚	👤👤
Thermal imaging (external)	£££££	⌚⌚	👤👤👤👤
<b>Comprehensive approach (additional survey methods)</b>			
Activity logging sheets*	£	⌚⌚	👤👤
Data logging (environmental)	£££	⌚⌚	👤👤
DomEARM survey*	£££	⌚⌚	👤👤👤
Metered energy use & generation (monthly)*	£	⌚	👤
Remote visual inspection*	££	⌚	👤👤👤
Social network analysis*	£	⌚	👤👤👤👤
Thermal comfort diary*	£	⌚⌚	👤👤
Walkthrough*	£	⌚	👤👤
<b>Advanced approach (optional survey methods)</b>			
Air permeability test	£££	⌚⌚	👤👤👤👤
Assessment of guidance material	£	⌚	👤👤
Co-heating test	£££££	⌚⌚⌚	👤👤👤👤
MVHR performance measurement	££	⌚	👤👤
Observation of user induction	£	⌚	👤👤
Remote monitoring (energy use)	£££££	⌚⌚⌚⌚⌚	👤👤👤👤
Remote monitoring (environmental)	££££	⌚⌚⌚⌚	👤👤👤👤
Remote monitoring (LZTs)	££££	⌚⌚⌚⌚	👤👤👤👤
Remote monitoring (occupancy/interact)	£££	⌚⌚⌚⌚	👤👤👤👤
Thermal imaging (internal)	£££££	⌚	👤👤👤
U-Value tests	£££££	⌚⌚⌚	👤👤👤👤
Video diary	££	⌚⌚	👤👤
<b>Key:</b> <b>Cost:</b> £ (less than £25) → £££££ (£1,000 or more) <b>Time:</b> ⌚ (hours of work) → ⌚⌚⌚⌚⌚ (months of work) <b>Skills/people:</b> 👤 (little specialist skill required) → 👤👤👤👤 (specialist skills & equipment required)			
<b>Notes:</b> * Survey methods that should also be used within an advanced approach, in addition to all basic approach methods. Further learnings on the survey techniques used in household level M&E can be found in the separate EVALOC report 'Guidance to the monitoring and evaluation of household energy use: insights from the EVALOC low carbon communities project'.			



**Figure 8.4** An 'ideal' graduated approach to M&E

## 8.3 Summary

### 8.3.1 Undertaking community level M&E

- To maximise learning, LCCs need to be able to contribute to the design of their M&E and have opportunities to learn from the research findings. Action research provides a useful way of conducting M&E. However, LCC participation in AR can be constrained by lack of time and resource.

- Longitudinal data collection (over 5-10 years) is needed where possible to give a more accurate appraisal of impacts and sustainability. LCCs lack the guaranteed long-term capacity to do this. Annual reflection on the LCC's group processes, as well as outcomes and impacts, can aid group cohesion.

- Tools such as carbon mapping can be used to quantify and estimate energy and carbon savings in the community. However, care should be taken in choosing an appropriate base-lining and measuring tool to suit the focus and approach of the LCCs activities.

- M&E of LCCs should take account of 'downstream' impacts (e.g. on those directly involved with LCC projects and activities); 'midstream' impacts (e.g. on local partnerships, and other LCCs); and their 'upstream' impacts (e.g. on influencing government policy).

- Participative and visual materials can help qualitative group evaluation processes.

- The research identified the following support and resource needs to assist LCCs with M&E:

- Provision of energy data at a more granular level from DECC e.g. at street level) would enable LCCs to assess their impact on overall energy consumption in smaller geographical areas.
- Support from academics, skilled M&E mentors or peer mentors to help LCCs design and implement their own M&E programmes.
- Support and resources to help LCCs implement longitudinal surveys of residents involved in projects, and also those not involved.
- M&E resources such as guides and sample questionnaires.

### 8.3.2 Undertaking household-level energy M&E:

- Household M&E takes time and requires a large amount of preparation. The choice of survey method is critical to ensuring maximum relevant data are gathered for minimum resource(s) spent:

- Semi-structured interviews and physical surveys are a good way of gathering a variety of data, but must be fully prepared prior to the visit.

- Annual energy data give a good overview of the energy use within a household. However, the easiest source of such data is energy bills and it was found that often records are not retained for longer periods than six months - one year. This meant that retrospective annual energy data collection through this means was difficult. Within EVALOC it was found that the most direct method of accessing annual energy data was through the use of the

MPAN and MPRN numbers for each house. These are unique codes for the gas and electricity meters within the household. Records for these are retained within the Department of Energy and Climate Change (DECC), and can be accessed as long as full consent has been given by the occupants.

- A key concern from occupants when the EVALOC researchers were undertaking a survey was that photographs would provide a judgement on them. It was necessary to assure them that the photos were being taken simply to help build a picture of the physical and technical aspects of the home. Once this was clarified, the researchers were able to take photos of most areas freely, and without feeling intrusive. Furthermore, the external photographic survey potentially posed the biggest issue, in that it at times aroused neighbours' suspicions and did not give a good first impression to the respondent. As such, it was agreed that external images should be taken after the interview itself where possible, as both the respondent and researcher were much more relaxed with the situation by then; on occasions, the occupant would also come out with the researchers and point out aspects of their home which would have been missed without their contextual knowledge.

- The installation of the continuous remote monitoring equipment was not a smooth process due to a number of practical issues including:

- Limited space available in utility cupboards for additional metering equipment
- Several independent specialists required (monitoring, electrical and gas engineers) creating co-ordination issues
- Lack of information on circuitry and wiring within homes

- Retrofitting monitoring devices (heat meters, electricity sub-meters) to measure actual performance of LZTs (especially solar thermal and heat pumps) is neither particularly easy nor cheap. Such difficulties highlighted the need for a sophisticated protocol and programme in place prior

to any works taking place, as well as the need for both technologies and specialisms to 'join-up' to provide an alternative, less intrusive monitoring system, preferably one that was either built into the system or fitted at the time of installation.

- The processing of the data required significant time and specific software skills as the data was being collected every 5 minutes, meaning that over an 18-month period, one sensor in one household created over 150,000 data points. This raised challenges in terms of both data management and analysis, which are both critical aspects of M&E. Without good

management, the data cannot be analysed to its full potential and the information collected will not be disseminated and used to inform future work and add to the body of evidence relating to household energy use.

# Chapter 9

## Conclusions

This chapter presents the key findings and conclusions from the EVALOC research. It revisits the research questions posed in Chapter 1, and draws findings from across the study to provide new insights into the impacts, effectiveness and success of low carbon communities, with the caveat that the findings are specific to their time and context, and that the field of LCCs is rapidly changing and dynamic. The research has revealed several key issues to be addressed when considering the further development of the LCCs sector, and hence the implications of the work are discussed for policy and practice. A new energy and communities toolkit has been developed to ensure the legacy of EVALOC project.

### 9.1 Synthesis of findings

EVALOC research shows that LCCs are contributing to energy and carbon reductions at community and household level, *directly* through their own activities, and *indirectly* through spin off or ripple effects such as the growing numbers of solar PVs installed by households in an LCC area, or the insulation of local tower blocks resulting from a chance meeting between an LCC member and council officer. Percentage reductions in average household annual gas and electricity use in the Lower Layer Super Output Areas (LSOAs) containing the six case study LCCs, are favourably comparable to national percentage reductions in average household gas and electricity use over the same period of time (January 2008 to December 2012), with two of the LSOAs showing strikingly higher reductions (Sustainable Blacon for gas consumption; Kirklees: Hillhouse for grid electricity). This is particularly significant as four of the LCCs had low starting baselines, which can indicate reduced potential for percentage savings in average household energy use.

LCCs also generated a range of related social and economic benefits at both the household and community level. At the individual household level, benefits included increased agency, energy know-how/skills, financial savings, warmer and more comfortable homes (and hence improved health). While at the community level, some of the benefits included volunteering and resident participation in energy activities (including people who would not otherwise been able to afford interventions and/or would not have previously considered themselves 'green'), the creation of community-owned assets

and related income streams, skills and jobs, social relations and networks that enabled and sustained LCC action, and community pride.

Using the findings from the various strands of EVALOC project, the research questions posed in Chapter 1 are answered in turn below:

#### ***What are the roles, capabilities and limits of LCCs in reducing local energy use?***

- EVALOC research has revealed that LCCs seek to play a wide range of roles to reduce local energy use, most of which are arguably under-resourced. At least ten interlinked and mutually reinforcing roles were identified that all the LCCs undertook to a greater or lesser extent to reduce local energy use at *downstream* level (with local residents), *midstream* level (with other local organisations and LCCs), and *upstream* level (with government and policy makers).

- Most LCC effort was spent at *downstream* and *midstream* level to enable residents to reduce their energy use and carbon emissions. Lack of time and resources meant that LCCs were unable to spend much effort on *upstream* roles to influence policy makers, despite having valuable intelligence about what policies work and don't work on the ground.

- The capabilities and limits of the LCCs to undertake the identified roles and reduce energy use, depended in part on the types of organisations involved in the LCC and their mandates, powers and resources.

- The organisations directly involved in reducing local energy use in the six EVALOC LCCs included local authorities, city-wide and local charities, social enterprises, community groups, residents, housing associations, other statutory agencies and private sector companies contracted by the LCCs to install community and household physical interventions. There did not appear to be much active involvement from statutory health agencies despite the well documented links between household energy efficiency, cold homes and health. However, there was an uneven distribution of organisations involved in the LCCs. In some LCCs, community groups were the principal actors involved in carrying out carbon and energy reduction activities in their neighbourhoods (e.g. LCWO and HN-LC).

- The LCCs involving an active local authority (Kirklees-Hillhouse) or town-wide charity (Eco Easterside) were more confident about promoting the uptake of physical interventions and addressing fuel poverty than the others, whereas community-led initiatives tended to be more confident about

developing innovative approaches to reducing energy use, empowering residents to take action and enabling them to change their behaviours. Two of the community-led LCCs (Sustainable Blacon and Hook Norton Low Carbon) were also relatively confident about promoting the uptake of physical interventions (although no LZTs were funded in Sustainable Blacon). All LCCs were confident at community engagement and dissemination.

- Partnership and multi-agency approaches helped increase the pace, scale and reach of energy efficiency and renewable programmes by combining the resources and strengths of different organisations. However, these approaches were not present in all case study communities.

- The ability of LCCs to reduce energy use and carbon emissions is constrained by a range of structural influences on energy use that are beyond their control. Some of these mentioned by LCCs include: changes in and uncertainties around the Feed-in-Tariffs (FiT); financial cuts; withdrawal of statutory duties on local authorities; effects of austerity and recession on local people (e.g. reduced confidence to take on loans); and lack of local infrastructure and capability (e.g. recycling facilities, trusted installers).

### ***What is the role and influence of community-based social learning and shared learning for stimulating energy-related change?***

- Community-based social learning through community events was found to play an important role in stimulating the conditions for energy reduction, by increasing participants' know-how, motivation, ability and intentions to take action on energy. The EVALOC community events enabled participants to learn about energy saving and energy generating technologies, behaviours and practices through informal interaction with others in social settings. They also increased participants' belief that their actions were meaningful, and hence their motivation and intention to act. As importantly, the events created a space, and permission, for conversations about energy, and provided an opportunity for individuals to develop a more publicly-minded conversation about energy. The most effective social learning methods were found to be participatory and interactive activities, which provided opportunities for people to discuss and share experiences of energy and carbon reduction, as well as demonstrations.

- A limitation to social learning through community events appeared to be the limited resource and capacity of some of the LCCs to provide

complementary and structured programmes of outreach and support to residents, so as to help them overcome the other technical and economic influences on energy use.

- Shared learning events and activities between LCCs helped them increase their understanding of complex challenges and strengthen their change strategies. Intermediary organisations were able to play an important role in developing a low carbon community of practice, by supporting and enabling shared learning activities.

### ***How useful is carbon mapping in baselining, predicting, visualising and communicating domestic energy use and carbon savings to communities?***

- Carbon mapping LCCs using the DECoRuM model, was found to be a useful approach for rapidly and visually measuring, modelling, mapping and managing energy use and carbon emission reductions on a dwelling-by-dwelling level, and aggregating to a community scale. Spatial maps showing carbon emissions of the local housing stock helped LCCs to identify areas of high energy use that could be targeted for future action. Carbon mapping also helped LCCs to:

- Cross-relate energy performance of houses with actual heat loss shown through thermal images, to improve energy literacy and awareness.
- Estimate domestic energy use and carbon emissions pre-LCCC (baseline) and post-LCCC, thereby quantifying the energy and carbon savings achieved from the implemented domestic carbon reduction measures, and also what the energy demand would have been had the LCCs interventions had not taken place.
- Evaluate the potential for further energy, carbon and fuel cost reduction in dwellings, using a whole range of best-practice energy efficiency measures and low/zero carbon technologies, either singly or in combination (packages). The potential improvement measures that were most popular included wall and roof insulation, draught-proofing, double glazing, improved heating systems, renewables, LED lighting, and thermostat-setting changes.

- Outputs from DECoRuM carbon maps of estimated energy use and carbon reduction potential of individual dwellings were used to provide energy feedback to householders (on a community level) through workshops, wherein the local community also had access to expert information and advice on how to take action on energy and carbon reduction through individual discussions and group presentations. These workshops were found to



engage and empower householders in taking action by providing technical knowledge on carbon reduction; and also influence behaviour change through education and collective action. The workshops also helped to gather more data from householders (using questionnaires), to further refine the carbon model.

- By identifying what house can take up which carbon reduction measure at what cost, carbon mapping can help local authorities, LCCs, housing associations and householders prepare for policy mechanisms such as the national Green Deal/Energy Companies Obligation (ECO) programmes, and 'scaling up' energy improvement measures and retrofits. Moreover carbon maps can also link with other datasets, for instance, these can be used to track the effect of energy improvements on fuel poverty.

- Although not explored in the EVALOC project, carbon mapping offers LCCs the capability to update and track the effectiveness of energy improvement measures on an individual dwellings and community scale (formative assessment). Figure 9.1 illustrates the overall capability of DECoRuM carbon mapping approach for both house-level and community-scale retrofit approaches. All results (using either approach) can be fed back into the model allowing energy use to be tracked over time, and to assess the differences between expected and actual energy savings achieved.

***What are the effects and impacts of community-based home energy improvements (related to building fabric, energy systems, controls and LZTs) and behaviour change initiatives on household energy use, indoor environmental conditions and energy behaviours?***

- The analysis of longitudinal gas and electricity data (January 2008 – January 2013) showed that the majority of households with physical interventions (related to building fabric, energy systems, controls and LZTs) and/or behaviour change interventions achieved reductions in both electricity and gas use. This corroborates findings from the occupant interviews which revealed that 90% (43/48) of those that directly benefited from LCC activities felt that the LCC had helped them reduce their energy use. However changes in energy use varied greatly across different households due to changes in number of occupants, thermal comfort expectations, health amongst other reasons, thereby reinforcing

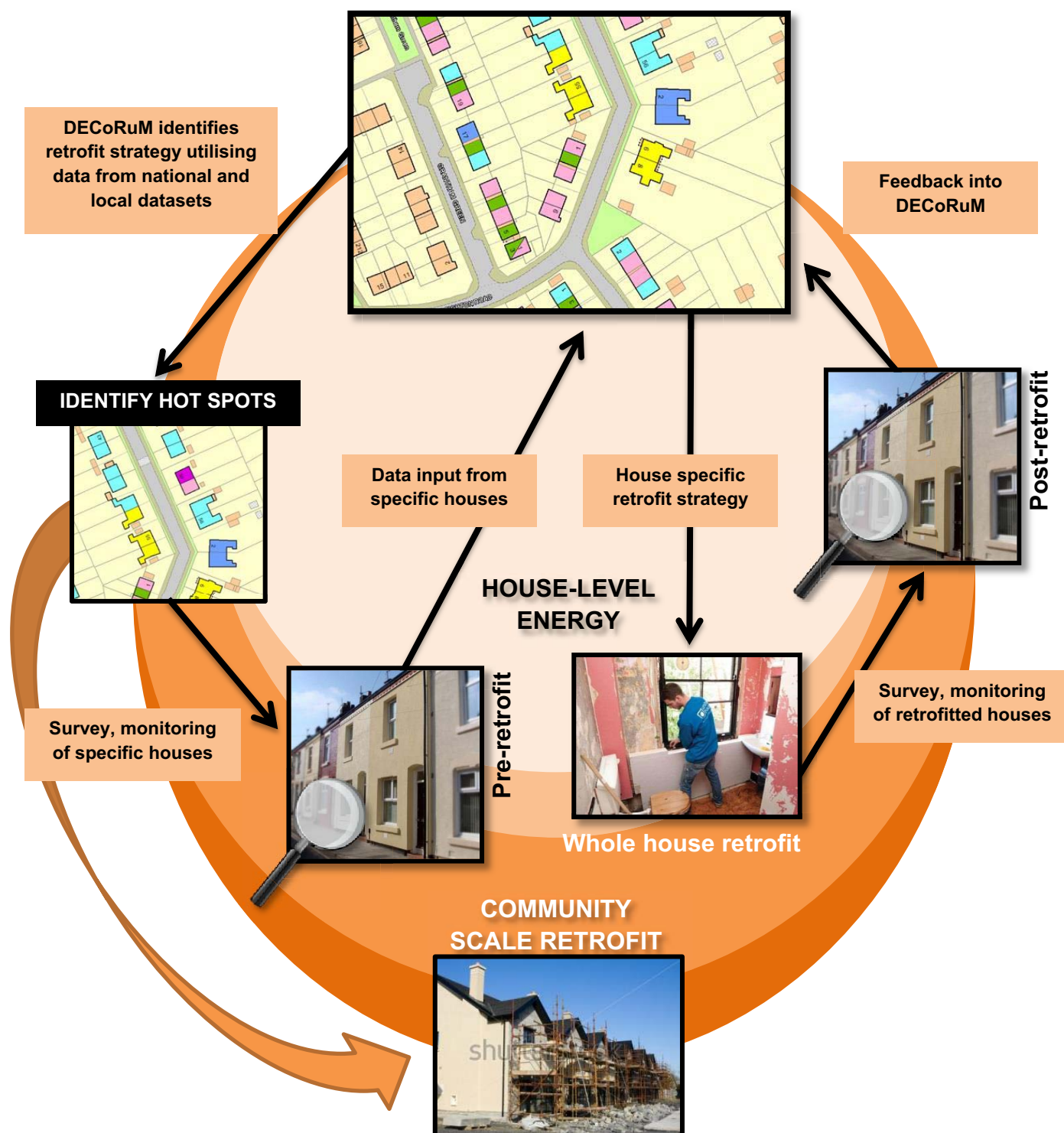
the case study based monitoring and evaluation approach that the project adopted.

- The impact of LZTs on grid electricity use is particularly evident; where increases of nearly 500% can be seen in electricity use of households with ASHPs, as well as reductions of up to 65% in mains electricity after solar PVs were installed.

- Monitored electricity generation data from solar PV systems indicated that they performed as well as, or better than predicted. This implies that solar PV systems have had a positive impact on reducing carbon, either directly (by reducing the amount of electricity supplied from the grid), or indirectly, by exporting zero-carbon electricity to the grid.
- ASHPs also had a positive impact through enabling some residents in rural areas to switch away from expensive oil to a relatively efficient form of electrical heating. However, physical monitoring of ASHPs' performance, indicated that there were no significant carbon savings, based on the current carbon intensity of mains electricity.

- The majority of the case study households experienced increased comfort levels since they installed physical interventions (both fabric measures and technical measures such as improved heating systems and controls). Unsurprisingly more stable and warmer indoor temperatures and lower relative humidity levels were measured during the heating season in dwellings with more than three fabric measures, than in dwellings with fewer fabric improvements. However dwellings with relatively high levels of fabric insulation were found to be at a greater risk of overheating, particularly in the bedrooms, during summer. Some unintended consequences of 'poorly installed' fabric insulation (loft and wall) were seen through the occurrence of condensation and appearance of mould in some cases.

- Households with solar PV systems showed signs of adapting their behaviours, where possible, to use their 'free' electricity, either by undertaking electricity-using activities during the daytime, or even putting the washing machine or dishwasher on a timer so that it came on during daytime. This indicates potential interest of householders in engaging with demand side response (load shifting) to reduce peak demand, an area that will gain salience with smart grids and smart meters. PV systems, however, did not always inspire energy-saving behaviours. Some households commented that since having the PVs, they started using their dishwasher or even putting their clothes in the tumble dryer rather than hang them out in the sun.



**Figure 9.1** Overall framework of DECoRuM carbon mapping approach for enabling house-level and community-scale energy retrofits

- Overall it is found that physical energy improvements and behaviour change initiatives have had significant impacts on energy-related (habitual and 'one-off') behaviours within the homes in which these took place. These include direct and indirect impacts, and appear to be generally positive. Overall LCC-led home energy improvements have been effective: by channelling technical and financial help to install physical interventions, providing the residents with the motivation, and agency to undertake physical measures, and/or reinforcing habitual energy-saving behaviours.

- However the difficulty of installing monitoring equipment in homes with LZTs in order to gather quantifiable data on performance, showed that retrofitting monitoring devices (heat meters, electricity sub-meters) for measuring actual performance of LZTs (especially solar thermal and heat pumps) was neither particularly easy nor cheap. It would be better if such devices were either built into the system or fitted at the time of installation, so that householders also receive feedback on the performance of LZTs to motivate further behaviour change.

***How useful are techniques such as thermography, community carbon maps, web-based energy-environmental feedback and personalised household energy reports in providing feedback to householders and raising awareness? How are energy display monitors used in a social context, and how can they be used to best effect to raise awareness and change practices?***

- Energy feedback was recognised as an important aspect of this research study, not only in terms of how the LCCs provided it as a means of supporting learning and behaviour change, but also in terms of how the results of the research were fed back to a) the communities and wider public and b) to the case study households involved. A variety of techniques were trialled within the study. What EVALOC has shown is, that by offering feedback that is complementary in time and application, there is a potential for covering the whole spectrum of home energy use in a single programme, using a range of media.

- At community level, carbon mapping and thermal imaging workshops aimed to feedback community-wide findings in terms of changes in carbon emissions and energy use, as well as pointing to possible future activities. Carbon mapping was relatively successful, but was felt to be aimed more

at community groups and organisations rather than individual householders, and as such did not engage the local residents as much as thermal imaging.

- The majority of the feedback approaches used were able to some extent, engage, raise awareness and motivate households into action. Different feedback techniques appealed to different households, and this did not necessarily depend on the community in which they lived. However, even in households with high levels of engagement both with energy use and the research study, often the posted or emailed home energy reports were forgotten or 'put in a drawer for later'. Yet, when combined with a researcher's visit, they created the opportunity for discussion and 'sense-making' conversation, using the feedback as a prompt which appeared to increase engagement through contextualising the feedback for the occupants, and also created an awareness of energy on a very personal level for the household.

- The social contexts for energy display monitors (EDMs) were the community in which the EDMs were introduced and experimented with and, at the smallest scale, the household itself. The EVALOC findings come from a small sample of households therefore statistically valid conclusions cannot be drawn from them. Nonetheless, they fit with what has been learned elsewhere in the UK about the use of home energy displays, and help to fill out knowledge of how EDMs can be used in parts of the country where there is already a 'community conversation' about energy. The case study home interviews and the feedback from EDM libraries show how EDMs:

- Created 'lightbulb moments' by making energy use visible
- Became talking-points and part of a process of social learning
- Prompted changes in everyday energy use, especially with kitchen appliances.

- The EVALOC evidence also shows how rare it is for EDMs to 'work' in isolation (that is, when the householder is simply given the device and left to get on with it); and how important it is to introduce new technology along with the knowledge needed to make sense of it and operate it. Thus the most enthusiastic references to EDMs came from householders who belonged to 'sense-making' groups, looking at different aspects of low-carbon living. Failing that, it could be useful to have a little support and advice at or around EDM installation, from a technically-savvy family member or part of the LCC team.

- The EVALOC research on energy feedback has shown that it is difficult to raise awareness or to

prompt durable carbon reductions through technology alone: knowledge and practical know-how need to be transferred along with technology. Where feedback is concerned, some degree of personal contact was usually needed to make the most of what the feedback technology was able to provide in the way of information.

***What is the role of social networks in promoting or suppressing the communication and take-up of new energy technologies, and how far do these interconnect with local community networks?***

- 'Energy messages' (conversations about any aspect of energy and carbon reduction) were transmitted through personal social networks, mainly to close friends and family. They mostly took the form of discussions concerning general energy efficiency, energy prices and bills, and low carbon technology. The transmission of energy messages did not happen automatically through personal and social networks, but required individuals to actively 'navigate' through the attitudes and experiences of those they were talking to.

- Energy was not necessarily considered a neutral subject by the interviewees: they may consider it as novel (e.g. new solar panels or EDMs), a practical issue (e.g. how to get a boiler upgrade) or an issue which implies judgement (e.g. the feeling of not being 'green' enough). This influenced whether, and to whom, they communicated energy messages, and the contexts where energy was discussed. Fear of judgement or stigma could impede the dissemination of energy messages. No-one wants to be thought of as a bad person because they are not thinking about energy or climate in the approved manner.

- LCCs used personal social networks to promote the communication and uptake of energy messages and know-how, e.g. by holding community events to provide a focus and space for conversations, by identifying and training community champions, by word of mouth, and by demonstration projects. LCCs can aid the dissemination of energy messages by creating a range of opportunities in different contexts where energy conversations can be catalysed and seen as permissible. There is some anecdotal evidence that energy conversations have influenced energy behaviours and/or the take up of new energy technologies in the communities.

***How can LCCs best monitor and communicate their own effectiveness at energy demand reduction and learn from their work?***

- To maximise learning, LCCs need to be able to contribute to the design of Monitoring and Evaluation (M&E) and have opportunities to learn from, and reflect on the research findings. Action research approach in the EVALOC project, provided a useful way of conducting M&E, and also increased the quality of the research. However, LCC participation in research can be constrained by lack of time and resource, and it needs to be resourced appropriately.

- Annual reflection on the LCC group processes, as well as outcomes and impacts, aided group cohesion. Participative and visual materials helped with qualitative group evaluation processes, and the dissemination of results in a clearly-understandable format was essential for communicating effectiveness.

- For M&E of LCCs to be effective, it should take account of their downstream impacts (related to their activities with community members such as householders); midstream impacts (e.g. on local partnerships, and other LCCs); and upstream impacts (e.g. on influencing government policy). In this way, M&E could pave the way for 'scaling up' impacts of LCCs through aggregation of outcomes, without LCCs losing their local character.

- Support from academics, skilled M&E mentors or peer mentoring would help LCCs design and implement their own M&E programmes, including assessing longitudinal changes. This would help to build a more comprehensive picture of the impacts and outcomes from LCC projects across the UK.



## 9.2 Implications for policy and practice

The research results show that LCCs have a significant potential to secure greater public participation in energy and carbon reduction projects than conventional 'top-down' approaches to promoting energy efficiency and distributed generation. LCCs are closer to their local communities, more able to call on trusted local volunteers and able to use more varied engagement techniques (from children's theatre to carbon mapping) than government or business actors. They treat people as more than consumers; they can adopt different business models (e.g. social enterprises); they have different and broader social networks, and therefore can reach different people and secure different outcomes. Ideas that people are inevitably just "disengaged consumers" or "will never change their behaviour" are simply not valid in this more local, civic society context.

The results therefore tend to support the underlying ideas behind the Government's Community Energy Strategy. LCCs can be more effective than other actors (such as national government, energy suppliers and private sector organisations) in engaging and motivating local communities. This is an important finding. There have been major reductions in energy efficiency activity in the UK since 2012, due to the failure of nationally operated commercial programmes. Future energy and carbon reduction policies need to do more to harness the power of more locally engaged actors. The working assumption of recent years that public-facing energy programmes are best delivered by energy suppliers, who are relatively remote from consumers and communities, is not consistent with the research findings. The governance model of ECO, FITs, RHI etc should be re-examined to allow and resource much more diverse actors to take more mainstream roles in delivering sustainable energy solutions.

However, LCCs in their current form are not a panacea. Although the LCCs studied were all competent at delivering energy projects, in some cases their ability to undertake large-scale programmes consistently and reliably over time was constrained by the lack of involvement of key local organisations, resources, skills or mandate. LCCs should be viewed as an important complement to business and government, not a substitute for them. The LCCs studied have a history of unusually good resourcing, and are therefore unusually effective. In many cases, particularly when a partnership or multi-organisation approach is not used or available, LCCs do not currently have the capacity to engage effectively with major programmes (e.g. ECO). A more consistent approach to funding LCCs would be

helpful, both to ensure reasonable levels of staffing and enable more effective engagement with major funding programmes. This suggests that what will be needed to help deliver high levels of investment in local energy efficiency and renewable energy schemes is a new cadre of 'community energy workers', competent across the relevant range of technical, legal and commercial issues.

It seems unlikely that this can be done by the voluntary sector alone. Moreover, at least in England, national government is seen as too remote to provide effective support directly. This points to a bigger role for local government. The results indicate that political approval and effective support from local government is always helpful; it is probably essential to the operation of LCCs in disadvantaged communities, where they can also play important delivery roles. In the major cities, at least, there is clearly increased interest in a municipal re-engagement with energy, but this needs further support in national public policy, both from DECC and DCLG. Greater support from other government departments with related policy goals (notably Business, Innovation and Skills (BIS) and Health) would also be helpful. More widely government needs to ensure there is a strong, consistent policy framework in place that supports, enables and incentivises both the needed physical improvements to people's homes and changes to energy behaviours.

The LCCs influence on reducing energy use across the majority of EVALOC case study households, suggests that broader community action and support provided a valuable socio-technical context, within which action on household energy use could be undertaken. This means that DECC policies aimed at encouraging community-based household energy improvements/retrofit programmes, will need to allow LCCs the scope and flexibility to continue to adopt multidimensional partnerships and socio-technical strategies for reducing energy. It was also found that houses with energy generation technologies (such as solar PVs) showed signs of adapting their behaviours (load shifting), for instance using most of their 'free' electricity during the daytime. This could have relevance in a range of domains, such as the smart meter roll-out as well as other energy demand management policies.

Comprehensive evaluation of the contribution of LCCs has proved extremely complex. A number of the goals of LCCs, e.g. in developing the local economy, creating stronger communities and improving energy knowledge and awareness, lie outside the scope of most traditional energy evaluation exercises. Quantifiable metrics focussing entirely on energy and carbon are important, but not



the whole story for most LCCs. Moreover, most LCCs are interested in using evaluation to improve their activities (formative evaluation) rather than purely to measure past performance. Evaluation goals and processes therefore need careful consideration in order to meet the differing needs of different stakeholders.

Even where the goal of monitoring is focussed on energy and carbon, LCC activities are difficult to evaluate well. They tend to include multiple measures (physical and behavioural) and to occur over long periods of time and with imprecisely defined groups of people. Effects may spill over a range of different energy uses, including in homes, businesses and transport. Very precise evaluation techniques using carefully defined control groups are therefore neither feasible nor even desirable. Statistically robust evaluations will be difficult and there is no realistic prospect of them being done by non-expert LCCs. More specialist quantitative monitoring and evaluation work is therefore justified.

The monitoring of physical performance of LZTs in the EVALOC LCCs, showed that a number of installation, commissioning and maintenance issues may have impacts on their long-term performance. The interaction between these technologies and the householders, in terms of the suitability of the controls as well as the knowledge and capability of the users, suggested that often these technologies are simply left to their own devices, with potential defects not discovered until too late. Since the performance of LZTs has implications for the FiT and RHI programmes, the changing role of building performance monitoring to act as building performance diagnostics is particularly important here.

Overall LCCs have a varied approach to attempting to influence local and national practice. Groups with relatively high levels of social capital and energy expertise (technical, social and policy) feel more comfortable engaging with policy processes. The majority of LCCs, however, unsurprisingly, focus their efforts on their influencing local activities and sharing experience and expertise with other LCCs.



**Figure 9.3** Development of the toolkit with the communities was undertaken during focus groups

The result is that the experience of LCCs, even where relevant to policy formation, may not naturally filter its way through to policymakers. Understanding the achievements and problems of LCCs will require increased policymaker effort.

### 9.3 Legacy of EVALOC: Energy and Communities toolkit

A key objective of the EVALOC project proposal was to develop an *open source and accessible toolkit*, which includes activities and approaches for energy demand reduction in communities, as well as tools for M&E that can be used and developed by LCCs. This objective has been reinforced by the project findings on the need to share knowledge and findings, not only with the case study LCCs, but also more broadly with those involved in energy and community activities at both the national and international stage. The CES strategy (DECC, 2014a) emphasised the need to develop capability and capacity, and stated that a key action was to provide a 'one stop shop' information resource to allow the community energy sector to 'self-help'. Since then, a new Community Energy Hub has been seed-funded by DECC and developed by the Energy Saving Trust Foundation, Project Dirt, SE2 and Community Energy England (DECC, 2015c).

As such the learning and insights from the various strands of EVALOC research have been captured into a web-based sharing and learning resource that can be linked to this wider network. With community-facing tools, guidance, case studies, as well as detailed reports based on the findings on various aspects of the project, the EVALOC energy and communities (ENACT) toolkit seeks to provide tools that can be used and developed by communities to further their understanding and allow a broader comparable basis for LCCs projects.

The interactive ENACT toolkit is a web-based version, accessible from the EVALOC website ([www.evaloc.org.uk](http://www.evaloc.org.uk)), and provides easy access to downloadable content (Figure 9.2) based around six main themes that came out of the research questions and work streams of the project:

- Community projects: roles and strategies
- Community engagement, communication and social networks
- Understanding energy behaviours
- Home energy improvements
- Energy feedback approaches
- Monitoring and evaluation



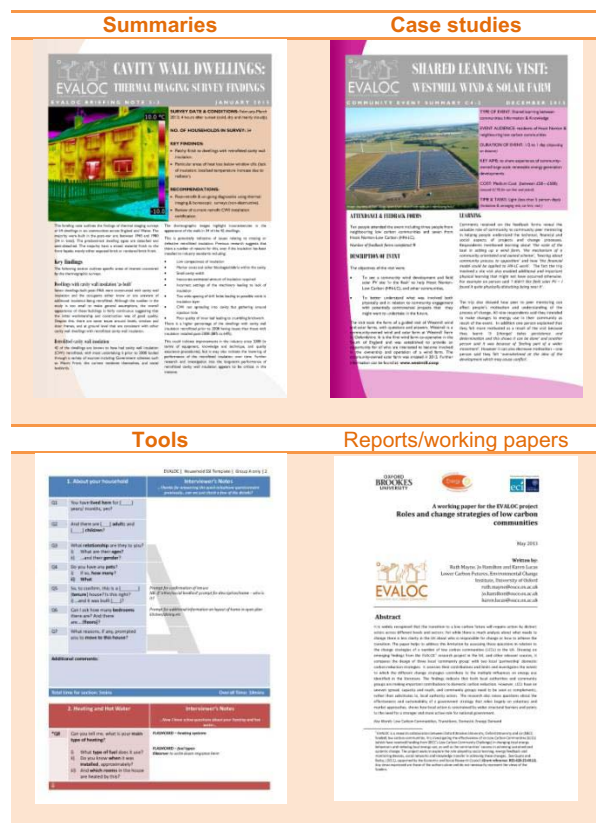
**Figure 9.2** Conceptual diagram of EVALOC ENACT web-based tool, showing six key themes.

To make the toolkit as accessible as possible, the content in the toolkit is available through a range of outputs which were developed based on feedback from third-round focus groups (Figure 9.3):

- **Briefings/Summaries:** Community and policy-facing summaries to provide a quick overview of main findings (such as the findings from the carbon mapping workshops and energy display monitor trials).
- **Case studies:** to provide more insights about a specific case study (such as case study households with significant interventions, specific community event types).
- **Tools:** to provide specific guidance/tools to help communities undertake their own activities (such as the monitoring and evaluation of household energy projects and setting up an energy display library).
- **Technical report/working paper:** detailed description about a certain topic such as carbon reductions in disadvantaged communities.

Within the toolkit, the content varies from community specific case studies and summaries (such as carbon mapping findings in each community) to cross-cutting summaries and reports such as summaries on the findings from the thermal imaging surveys of the case study households and a detailed report on the roles and change strategies of low carbon communities. The case studies aim to provide overviews of a specific case study, at both

community and household level, with key learnings and findings (Figure 9.4). Whilst the summaries and case studies aim to provide overviews, the reports offer more in-depth description of the findings.



**Figure 9.4** Types of outputs available in the ENACT toolkit

The EVALOC project has answered some key questions about the impacts, effectiveness, success and limits of LCCs on achieving carbon reduction and changing localised energy behaviours, using an action research based M&E approach. The project has recommended that support from academics, skilled M&E mentors or peer mentoring would help LCCs design and implement their own M&E programmes, including assessing longitudinal changes. Ultimately it is hoped that the tools, methods, learning and insights arising from the EVALOC research will help the LCC sector continue to flourish and achieve its potential as a key player in the transition to a low carbon future.





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## Appendix A

### Research methods and sample numbers

Research Method (community level)	Research Objective	Sample No.
Literature review	Review existing academic and evaluation literature	N/A
Research Method	Research Objective	Sample No.
<b>Community-level research</b>		
Baseline data collection	To collect base line data about community and LCC context, characteristics, roles and responsibilities, project design, M&E	Review of grey literature Semi structured interviews with 6 key stakeholders
Focus Groups	To (a) investigate: identity of community; the impact of DECC funding on the LCC and wider community; community engagement; roles and relations with other organisations; LCC activities, impacts and external influences; (b) feedback and discuss emergent research findings and (c) discuss ideas for future energy activities and research.	17 focus groups 76 participants from core team, wider community and stakeholder organisations
Community events	To investigate whether and how the community event contributed to social learning	10 events 2,043 participants 414 feedback forms
Shared learning events with other communities	To investigate whether and how the shared learning event contributed to social learning about energy behaviours Note: 6 were with other LCCs, 1 was within a LCC	7 events 112 participants 72 feedback forms
Community feedback events (carbon mapping workshop)	To provide feedback to the communities and assess how useful DECoRuM is in measuring, visualising and communicating carbon savings	105 participants 34 feedback forms
Supplementary data collection	To supplement information from baseline, focus groups, and community events	Ongoing correspondence and phone calls with 18 key stakeholders
Energy data collection (2008-2012)	Assess changes in energy use at wider community level to understand energy trends and potential 'ripple' effects of LCC activities	Approx. 12,774 households (using MPRN and/or MPAN data)
Carbon mapping (DECoRuM)	Estimate changes in energy use at wider community level to understand energy trends and potential 'ripple' effects of LCC activities	1,659 households mapped [101 (min) LCC-involved households] 167 energy questionnaires completed

Research method (household level)	Research Objective	Sample No.
Physical survey (summer 2012)	<i>Provide data relating to physical characteristics of dwelling as well as assess physical changes following energy improvements</i>	- 88 households
Energy data collection (2008-12)	<i>Assess changes in energy use in order to understand individual household energy trends and effects of LCC activities</i>	- 77 [47 gas] households
Monitoring of electricity use (2013-14) - Monthly data - 5 minute data	<i>Investigate energy use in relation to national and community averages. Provide understanding of household energy use in relation to wider factors</i>	- 57 grid only [49 total] households - 28 grid only [22 total] households
Monitoring of gas use (2013-2014) - Monthly data - 5 minute data	<i>Investigate energy use in relation to national and community averages. Provide understanding of household energy use in relation to wider factors</i>	- 35 households - 15 households
Monitoring of environmental conditions (2013-14) - Half hourly data (Temp & RH) - 5 minute data (Temp & RH) - 5 minute data (CO <sub>2</sub> levels)	<i>Provide understanding of indoor environmental conditions and occupant comfort levels</i>	- 56 living rooms [54 bedroom] - 30 living rooms [27 bedrooms] - 27 living rooms [28 bedrooms]
Monitoring of user interaction (2013-2014)	<i>Provide quantitative data relating to occupant behaviours (heating and ventilation)</i>	- 21 households
Activity logging sheets and thermal comfort diaries (winter & summer 2013)	<i>Provide understanding of occupant behaviours (heating and non-heating) and comfort levels during winter and summer</i>	- 20 households [summer] - 18 households [winter]
Heating control questionnaires (winter 2013)	<i>Provide understanding of heating behaviours within the household</i>	- 65 households
Energy audit (summer 2014)	<i>Provide understanding of electricity-related behaviours</i>	- 54 households
Monitoring of solar PVs (2013-2014) - Annual generation data - Annual export/use data - 5 minute generation data - 5 minute export/use data	<i>Investigate effectiveness and performance of low-zero carbon technologies</i>	- 19 households - 11 households - 14 households - 10 households
First round semi-structured interviews (summer 2012)	<i>Provide baseline information and assess impacts of LCC activities upon individual households</i>	- 88 households
Second round semi-structured interviews (summer 2014)	<i>Investigate changes in household (physical and behavioural) and influencing factors upon energy behaviours</i>	- 58 households
Thermal imaging survey (winter 2013)	<i>Investigate performance of fabric improvements</i>	- 88 households
Social network analysis (summer 2012)	<i>Provide understanding of individual's social networks</i>	- 85 households

## Appendix B

### Case study dwelling and household characteristics

	Awel Aman Tawe	Sustainable Blacon	Eco Easterside	Hook Norton Low Carbon	Kirklees- Hillhouse	Low Carbon West Oxford	All case study households
<b>Dwelling age</b>							
Pre-1919	4	0	0	7	6	9	26
1919-44	7	5	4	0	0	2	18
1945-64	0	8	9	1	0	0	18
1965-80	3	5	2	5	0	1	16
1981-90	2	1	0	4	0	2	9
post 1990	1	0	0	0	0	0	1
<b>Dwelling type</b>							
End-terrace	0	2	5	2	1	1	11
Mid-terrace	1	6	3	2	5	9	26
Semi-detached	5	7	7	3	0	1	23
Detached <sup>1</sup>	10	3	0	10	0	2	25
Flat <sup>2</sup>	1	1	0	0	0	1	3
<b>Wall construction type<sup>3</sup></b>							
Solid wall	6	3	1	7	6	11	34
Cavity wall	10	16	14	10	0	3	53
<b>Dwelling useable floor area</b>							
Less than 50m <sup>2</sup>	0	2	0	1	0	1	4
50-69m <sup>2</sup>	2	3	4	0	0	0	9
70-89m <sup>2</sup>	6	13	4	2	0	4	29
90-109m <sup>2</sup>	3	0	4	1	4	3	15
110m <sup>2</sup> or more	6	1	3	13	2	6	30
<b>Tenure type</b>							
Owner occupied <sup>4</sup>	17	12	9	16	6	14	74
Social rented	0	6	5	1	0	0	12
Other <sup>5</sup>	0	1	1	0	0	0	2
<b>Household type</b>							
One family household (dep. child)	3	1	6	5	5	8	28
One family household (lone parent, dep. child)	0	1	1	0	0	0	2
One family household (no dep. child)	1	1	3	1	1	0	7
One family household (no child)	11	12	3	8	0	2	36
One person household (under 65)	1	0	1	0	0	2	4
One person household (over 65)	1	4	1	3	0	1	10
Two or more unrelated adults	0	0	0	0	0	1	1
<b>Primary heating fuel</b>							
Gas	0	19	15	0	6	13	53
Electricity	3	0	0	5	0	1	9
Oil	13	0	0	12	0	0	25
Coal	1	0	0	0	0	0	1
Total	17	19	15	17	6	14	88
Notes:							
<sup>1</sup> Includes 8 bungalows							
<sup>2</sup> Includes one converted flat and two purpose-built flats (low-rise)							
<sup>3</sup> Wall construction of one dwelling is unknown							
<sup>4</sup> Includes one shared ownership household							
<sup>5</sup> Includes one private rented and one household living rent free							

# Appendix C

## Full list of EVALOC community events

### Full list of EVALOC community events

Name and number and type of event	Community	Description	Number of participants	Process	Method / materials	Data collection method	Data collected
<b>1a. 'We're oil in this together'.</b>	AAT	Theatre performances, community choir, storytelling and art, plus display by group in the foyer	135 in total. Approximately 70 in audience, 65 participants	LCC led and planned, involving script writers, actors, artist, community choir, youth theatre and workshop participants	Mainly performance, copies of the art prints, brief information about the LCC at the stall	Questionnaires, participant observation, photographs, reflection in a focus group post event	44 Feedback forms, observations from event, audio recordings, photos
<b>1b. Follow up questionnaire from DECC activities.</b>	AAT	Questionnaire to capture the experiences of involvement in DECC funded engagement	44 responses	LCC led	Questionnaire	Questionnaire posted to 240 participants in arts and climate change engagement events	44 Feedback forms collated onto spreadsheet
<b>1c. And this Global Warming.</b>	AAT	Poetry reading, prize giving and launch of 'And this Global Warming' anthology'	120 in total, 12 reading poetry	LCC led and planned. Poetry competition	Film screening, poetry reading	Questionnaire at the event	16 feedback forms collected
<b>2. Fuel poverty event.</b>	KI	Informal event about fuel poverty and energy for local residents	45 local community members attending	LCC led,	Informal stalls, energy quiz, interactive activities, creative activities	Questionnaire to participants, participant observation	Feedback forms, observation notes
<b>3. Community and Local Authority Partnerships for Local Energy reduction.</b>	EE, KI, LCWO	Workshop	45 in total, consisting of LCCs, Local Authorities, Low Carbon Communities Network	EVALOC idea co-designed with LCCs	Presentations and small group discussions, copies of slides and handouts	Questionnaire to event participants, participant observation, slides, photographs, notes from the discussions	21 feedback forms plus notes from event

<b>4. Feedback event from energy management project.</b>	SB		40 LCC core group, University plus programme participants	LCC led	Presentations from evaluators, small group work and discussion to develop energy messages	No feedback forms (administratively difficult as staff changes), observations from the evening	Observations and write up from the evening
<b>5. School play.</b>	EE	Local primary school produced and performed a play about climate change involving pupils	25 audience LCC, school, EVALOC	LCC led with local school, prompted by EVALOC	Performance	Observation on the evening, questionnaire from audience and participants	22 feedback forms
<b>6. Solar PV learning day at local school.</b>	LCWO	Learning and reflection convened at secondary school which had Solar PVs installed	18 LCC member, school staff and pupils, Local Authority, school energy service provider, another LCC	EVALOC led from LCC idea,	Short presentation, facilitated small group work with flip charts, discussion and reflection	Questionnaires at the event	10 feedback forms, write up from flip charts and discussion at the workshop
<b>7. Facilitated board meeting.</b>	HN-LC	Discussion about next directions for the group	10 LCC board members	Requested by LCC, led by EVALOC	Planning workshop with facilitated discussion	Reflections after the event from board members	
<b>8. Shared learning for community loan scheme.</b>	HN-LC		10 LCC, plus representatives from neighbouring LCCs	LCC led	Short presentations	Feedback forms, observation form, a few photos	9 feedback forms
<b>9. Feedback and reflection on Eco-homes.</b>	SB	Workshop and discussion from LCC volunteers involved in demonstration eco-homes	10 volunteers LCC coordinator, plus survey of visitors	EVALOC led with LCC	Discussion and reflection at eco- home, going through visitor information	Participant observation at workshop, notes from discussion	13 feedback forms
<b>10. Carbon reduction in communities of disadvantage.</b>	SB,EE, KI, LCWO		LCC core members and volunteers, both community and Local Authority	LCC idea, co-designed with EVALOC	Workshop with discussion and reflection	Participant observation, questionnaire	5 feedback forms



<b>11. Creativity and climate change.</b>	AAT, EE, SB, LCWO	Two day workshop on using creative methods in low carbon communities	28, 20 from EVALOC LCCs, 10 from artists and LCCs in Manchester	EVALOC led with stimulus from LCCs	Workshops, presentation, small group discussions, practical exercises	Participant observation, questionnaire, write up notes from presentations and emerging creative material	19 feedback forms
<b>12a and 12b. 'Green Routines' exhibitions</b>	AAT	12 a) Interactive exhibition installed in National Trust in May 2013, and b) in Welsh Assembly Govt in Feb 2014	450 visitors to exhibition, 282 participants in AAT's survey participants in survey for the content	LCC led	Completion of initial survey, information – visual and aural at exhibition	Participant observation at exhibition, questionnaire for visitors	163 in total: 146 feedback forms from 12a, plus 19 feedback from 12b
<b>13. Eco gala day.</b>	EE	Gala day	~ 1,000 local residents	LCC led		Feedback form, observations, photos from the day	35 feedback forms
<b>14. Fuel poverty in higher income areas.</b>	LCWO	Workshop for LCCs, LA, and energy agencies in Oxfordshire	14 participants LCC member, Local Authority	LCC led with EVALOC support	Information on Fuel poverty schemes, short presentations, small group discussions	Participant observation, feedback forms, transcriptions, write up from notes	9 feedback forms
<b>15. Shared learning visit to Westmill Windfarm.</b>	HN-LC	Community event for members of the LCC	10 participants.	LCC led	Visit to community owned wind farm with opportunity for questions, discussion and reflection	Feedback forms and report from organiser	9 feedback forms
<b>16a and b – Fuel poverty community event and follow up campaign.</b>	KI	Community event for local residents	150 participants: LCC, Local authority, local residents	LCC led with EVALOC providing energy stall	Informal discussion at stalls, interactive activities	Participant observation, feedback forms	24 feedback forms
<b>17. School play # 2</b>	EE	Eco performance at a different primary school	55 participants	LCC led	Performance		32 feedback forms



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