



KEY FINDINGS:

- The workshops worked well when combining presentations by experts with open discussion between participants and researchers.
- The workshops were found to engage and empower local residents in taking action by providing technical knowledge, as well as bolster existing positive energy saving behaviours and actions as they were able to visually represent the impacts of physical interventions on individual households energy use, and the wider community's overall carbon emissions.
- Audience members with a professional interest (e.g. the local authority members) felt carbon mapping to be a useful evaluation tool (for previous activities) as well as an effective planning tool for future area-based carbon reduction activities.
- Volunteer-based organisations appeared to feel less able to use carbon mapping; mainly due to a lack of resources, without partnership working with local paid organisations.

1. Introduction

The UK is committed to reducing greenhouse gas emissions by 80% from 1990 levels. In order to meet these commitments, reducing energy use in the domestic sector is critical as it accounts for 29% of the UK's total energy consumption. Recent Government funding and initiatives have aimed to reduce household energy use through behaviour change and increased energy efficiency of the UK's existing building stock. One such programme was the Low Carbon Communities Challenge (LCCC), which funded 22 low carbon community organisations to undertake energy reduction activities in their local community. Its focus was on reducing carbon emissions in these communities as well as stimulating pro-energy behaviours and further energy improvements in individual households through capital funding of physical interventions to homes and buildings, behaviour change campaigns and low carbon living activities.

Making energy 'visible' is a key aspect of changing behaviours and attitudes towards energy. Providing energy feedback, at both an individual household scale, as well as at a community scale is one way of raising awareness of household energy use, and ways in which energy use can be reduced within households. As part of the EVALOC study, trialling different ways of providing energy feedback was used to understand the effectiveness of different approaches to enhancing

understanding of household energy use and behaviours. This document presents the findings of carbon mapping workshops in different communities that were held to provide visual feedback on the energy use and carbon reductions in a local neighbourhood, before and after LCCC interventions, as well as what further action could be taken.

1.1 What is carbon mapping?

Creating a common language for achieving community-led local carbon emission reductions.

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 CO₂ 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.

Carbon mapping is measuring, modelling, and mapping estimated local energy use and resultant CO₂ emissions in order to inspire reduction of household energy use locally. Carbon mapping in the

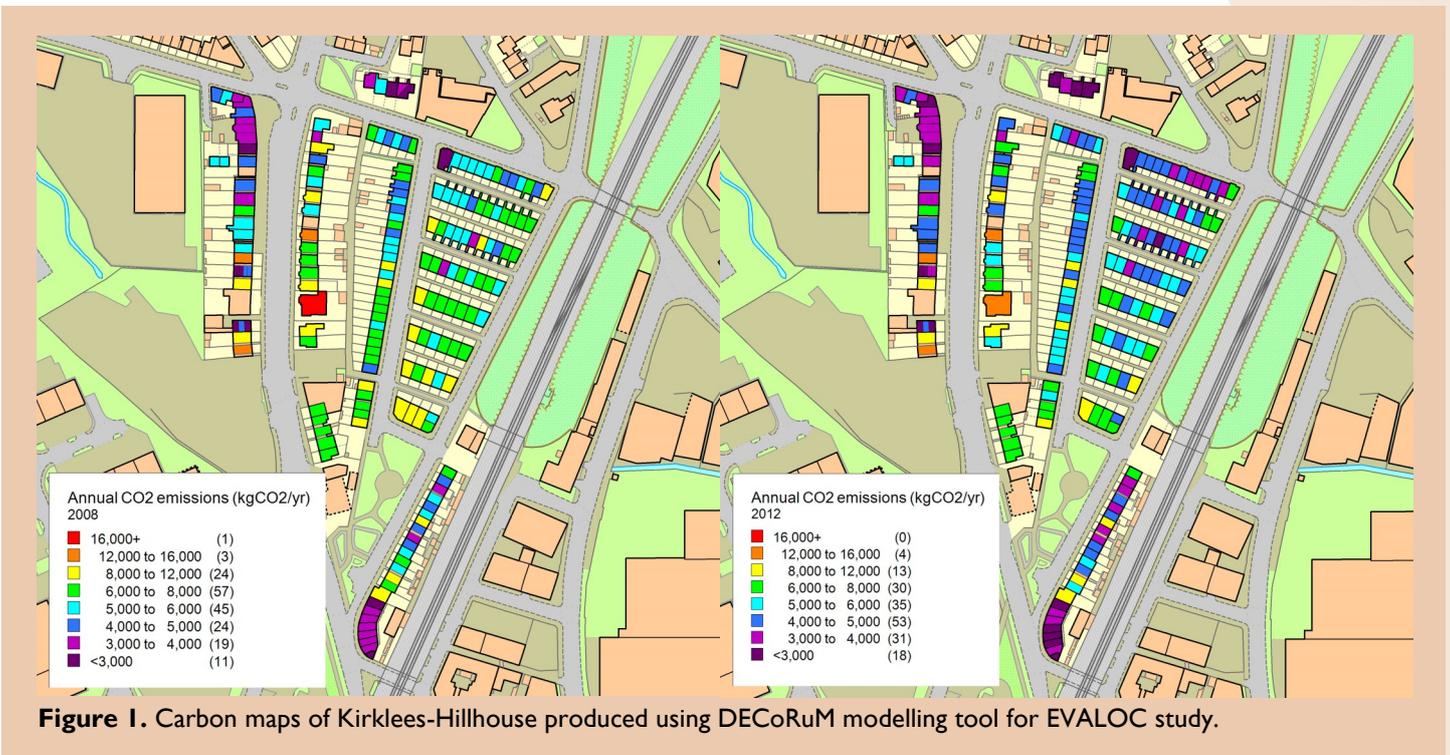


Figure 1. Carbon maps of Kirklees-Hillhouse produced using DECoRuM modelling tool for EVALOC study.

EVALOC project was performed using DECoRuM© (Domestic Energy, Carbon counting and carbon Reduction Model).

Benefits of carbon mapping for different users include:

Householder:

- Makes energy use visible for homeowner in a useful way - influencing energy literacy.
- Increase awareness of energy use in home relative to neighbours.
- Inspires range of changes from behavioural to full retrofits.
- Creates a better understanding of what actions could be taken to reduce carbon emissions.
- Assists in prioritising action and change to home.

Community Group

- Acts as a tool for communication of ideas and plans.
- Engages and empowers community in carbon reduction effort through knowledge of need, capacity and limitations.
- Helps community understand local housing stock and local impact.
- Assists in prioritising action, e.g. pinpointing hotspots of high energy use.
- Influences behaviour change through education and collective action.
- Platform to generate bespoke energy / cost / carbon saving scenarios for communities.

Local Authority

- Allows area based carbon reduction planning.

- Allows prioritisation of carbon reduction by neighbourhoods or districts.
 - Communication tool for change and/or funding.
 - Visual source for organising and categorising what has been done and where: as stock inventory tool.
 - Allows comparison of housing stock to other local authorities or political / geographical boundaries.
- #### *Energy assessor*
- Provides overview of homes most in need and platform for initial estimates of measure impact effectiveness.
 - Provides a complete management tool from briefing to installation of measures.
 - Visual source for organising and categorising what has been done and where: as business tool.
 - Assists in prioritising action.
 - Use of robust filtering criteria to select the most suitable dwellings for each CO₂ reduction measure deployed.

1.2 What is DECoRuM©?

DECoRuM© is a Geographical Information Systems (GIS)-based toolkit for carbon emissions reduction planning with the capability to estimate energy-related CO₂ emissions and effectiveness of mitigation strategies in existing UK dwellings, aggregating the results to a street, district and city level (Figure 1). The aggregated method of calculation and map-based presentation allows the results to be scaled-up for larger application and assessment. 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 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 Government approved method for the assessment of the energy and environmental performance of dwellings. Though not as robust as dynamic thermal simulation (intensive modelling done on a building by building basis), the strength of DECoRuM© is in the ability to rapidly process results for many dwellings and present them on an urban scale. The tool is useful for communicating energy related concepts and identifying potential areas for concern and further investigation, including simulation, house assessment and monitoring.

Some limitations include:

- Time required for data collection and entry; home questionnaires are helpful in reducing this initial effort; however, response rates can be low.
- Behaviour related assessment is limited: occupancy times, heating schedules, window opening schedules, etc. are not available. Different scenarios must be calculated separately and cannot vary within a given timeframe; calculations are static.
- The model does not calculate where specifically a homeowner should insulate walls and whether internal or external insulation is ideal (insulation is simply either solid wall or cavity).
- 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.

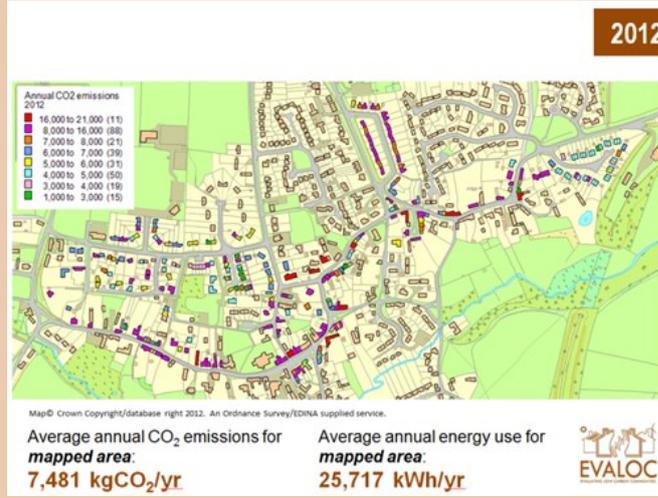
DECoRuM© in the EVALOC project was used to specifically:

- 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 dwelling types 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.

1.3 EVALOC carbon mapping workshops

Carbon mapping workshops were held in five of the six EVALOC communities (all but Blacon due to a lack of resources, people and time, in the area). The workshops consisted of:

- Talk accompanied by a powerpoint presentation (Figures 3 and 4) by EVALOC researcher outlining



	Reductions by house type		
	Fabric improvement Package	Fabric and heating upgrade package	Fabric, heating EE and solar energy systems package
1966 - 1976 Detached	Annual energy cost reduction: £305 Mean total cost per home: ~ £2.5k	Annual energy cost reduction: £708 Mean total cost per home: ~ £5k	Annual energy cost reduction: £1,533 Mean total cost per home: ~ £15k
1966 - 1976 Semi-detached	Annual energy cost reduction: £128 Mean total cost per home: ~ £500	Annual energy cost reduction: £500 Mean total cost per home: ~ £3.2k	Annual energy cost reduction: £926 Mean total cost per home: ~ £9.1k
1982 - 1990 Detached	Annual energy cost reduction: £31 Mean total cost per home: ~ £300	Annual energy cost reduction: £215 Mean total cost per home: ~ £2.6k	Annual energy cost reduction: £1,246 Mean total cost per home: ~ £13.2k

Running cost reductions include FIT and RHI payments for solar systems

Figure 2. Slides from workshop presentation..

the carbon mapping findings;

- Posters on the carbon mapping findings and thermal imaging survey of the EVALOC case study households (Figures 5 and 6);
- Q&A session and open discussion at end of presentation;
- Access to individual household thermal images (with personalised discussion with the EVALOC researcher).

The audience of the workshops varied depending on the community, but included:

- Local low carbon community organisation members (volunteer and non-volunteer)
- Local residents
- Local authority employees and councillors
- Local practitioners in the field of household energy use, including local housing association employees.

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

- Baseline map of annual CO₂ (2008)
- Current map of annual CO₂ (2012)
- Fabric improvement package map of annual CO₂ emissions (2012)
- Fabric and heating upgrade package map of annual CO₂ emissions (2012)
- Fabric, heating and electricity package map of annual CO₂ emissions (2012)

The presentations also included:

- Mean community CO₂ 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.

2. Findings

In total, approximately 105 people attended the five carbon mapping workshops, and a total of 34 evaluation forms were completed. The workshops were generally felt to be a successful way of engaging local residents and organisations, through the combination of the carbon mapping, thermal imaging alongside a talk by an expert (Figures 3 and 4) and open discussion. Carbon mapping itself 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. It was felt that in addition to the overview-like aspect of the mapping, this was also possibly due to the fact that carbon is not a concept that most people are familiar with, and using costs or even kWh would perhaps have engaged people more. Regardless, in some workshops (HNLC and Kirklees Council), the audience could see clearly through the mapping that reductions took place and that the baseline is a meaningful place to begin measuring change (no mention of difficulty with using CO₂ emissions to measure change). In addition, the information provided through the mapping in the workshop in Kirklees, where the audience was mainly local authority employees, it helped justify funding for the PV panels and 'will help guide future investment of the community fund generated by the PV panels.'. Yet in Awel Aman Tawe, where the majority of the audience was local residents who were not actively involved in low carbon community activities, the feeling was that the carbon maps were too estimated and the concentration on community mapping rather than individual house comparison was not appropriate for the audience.

Table I presents the five events and the details of the attendance, organisation and approach along with notes on factors that would have likely affected attendance.

2.1 Evaluation of responses

Awal Aman Tawe (AAT)

In AAT it was felt that the carbon maps were too estimated and the concentration on overall community, rather than individual house comparison was not appropriate for the audience. It may be that this community would benefit more from a smaller knowledge transfer with just the AAT team and councillors etc.

Eco Easterside

In Eco Easterside, the majority of householders were already very aware of all the measures discussed in the workshop (this could be partly biased by the number of people attending in a professional capacity). This indicates that in very aware communities, more complex measures could be discussed or more technical information could be given.

In AAT and Eco-Easterside, people found cost information useful but some still saw cost as a major barrier, making more of identifying which houses would meet the golden rule or identifying alternative means of funding may help to overcome this. This was not the original objective of this workshop, but should be taken into consideration if the carbon map is to be developed as an engagement tool in this community.

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.

Hook Norton Low Carbon

In HNLC all 13 people in attendance reported feeling more motivated following the workshop, although only 8/13 said they were made more aware through the process. Reasons for their feelings of motivation included:

Community	Attendees	Approach	Publicised	Notes
Awel Aman Tawe	12 Comprising mostly local residents	Presentation, posters, Q&A, and group discussion	Invitations sent to all houses in mapped area	<ul style="list-style-type: none"> Evening event held at 19:00; dark with heavy rainfall, windy, which probably reduced numbers of attendees. Event technically outside of village of Cwmllynfell (mapped area) due to unavailability of public building; held in neighbouring town Ystradowen.
Eco Easterside	25 Representatives from Middlesbrough Environment City (MEC), The Erimus Housing Association, Middlesbrough Council and local householders (6no.)	Presentation, posters, Q&A, and group discussion	Organised in collaboration with MEC. MEC sent invitations to stakeholders / EVALOC team sent invitations to houses in mapped area. Posters and flyers displayed at Community Hub weeks preceding.	<p>Timing worked well due to:</p> <ul style="list-style-type: none"> The number of people attending in a professional capacity. The number of retired and unemployed householders in this community. The workshop was held in half term week, so many people may have already made arrangements to have time off work for childcare etc.
Hook Norton Low Carbon	30 Comprising mostly local residents	Presentation, posters, Q&A, and group discussion	The workshop was organised in collaboration with HNLC who assisted the EVALOC team with the distribution of invitations and questionnaires to houses within the mapped area.	The time of the workshop worked well as the audience was made up primarily of local residents who have work or other commitments during the daytime. It was also part of a regular set of meetings by the group for the wider members of HNLC, which ensured a high baseline of attendees.
Kirklees-Hillhouse	16 Kirklees council members and various community representatives	Presentation, Q&A and group discussion	The presentation was placed into an agenda of an already arranged meeting between council members and local community representatives	The meeting did not include any local residents from the Hillhouse (mapped) area.
Low Carbon West Oxford	20 Comprising mostly local residents	Presentation, posters, Q&A, and group discussion	Flyers advertising the event were also posted to the 300 houses invited to complete the questionnaire.	The time of the workshop worked well in this community as the audience was made up primarily of local residents who have work or other commitments during the daytime.

Table 1. Summary of carbon mapping workshops.

- 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'.

In Hook Norton, 10/13 people left the workshop with intentions to reduce their energy use. Almost all of these intentions related to: improving fabric (insulation, draughtproofing, double glazing), improved heating systems and renewables, and demand shifting and changes to behaviour.

Kirklees-Hillhouse

The carbon mapping presentation for Kirklees-Hillhouse was presented to a Kirklees Council meeting. The meeting unfortunately did not involve community members but it opened up the opportunity to voice the concerns of some householders in the Hillhouse area (interviewed the day before) regarding their displeasure with lack of communication from the council regarding current and future plans for the area, and funding from the PV panels. Ideally, the householders and council members would be attending the same event and brought together to discuss concerns and future plans. 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.'

Low Carbon West Oxford

In Oxford, 8/9 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 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.

3. Conclusions

The carbon mapping presentations were generally received well, but equally importantly was the fact that they were combined with expert information and advice. The presentations prompted engaging discussion on the practical implementation of the recommended packages, both within the audience members themselves and with the EVALOC researchers. The workshops were found to engage and empower local residents in taking action by providing technical knowledge, but equally they served to bolster existing positive energy saving behaviours and actions as they were able to visually represent the impacts of physical interventions on individual households energy use, and the wider community's overall carbon emissions. Whilst local residents appeared more influenced by the thermal images of their individual dwellings, in terms of audience members with a professional interest (e.g. the local authority members,



Figure 3. Awel Aman Tawe carbon mapping workshop presentation.



Figure 4. Eco Easterside carbon mapping workshop presentation.



Figure 5. Discussions at the Low Carbon West Oxford workshop.



Figure 6. Discussions at the Low Carbon West Oxford workshop.

local housing association employees and members of low carbon community organisations (non-volunteer)), the carbon mapping was felt to be a useful evaluation tool (for previous activities) as well as an effective planning tool for future area-based carbon reduction activities. Whilst the non-volunteer organisations particularly saw the benefits of the carbon mapping, volunteer-based organisations appeared to feel less able to use carbon mapping; mainly due to a lack of resources to both undertake the required fieldwork to create the carbon mapping but also to develop and build upon the recommendations, without significant help from other organisations such as the local authority.

The knowledge of the audience, in terms of 'standard' improvements (fabric and behaviour), across all the communities, was relatively high. This indicates that in some communities, more complex measures could be discussed, or more technical information given. However, in other communities, feedback comments suggested that explanations could be simplified.

Whilst the visualisations of carbon appealed to audience members who had a professional interest in the field of energy and carbon, it confused others in part due to it being a 'new' concept, and made it more complicated for them to understand the benefits of the improvement packages.

Cost was very much seen as a barrier in terms of installing more significant energy reduction measures, and it was felt that, in the communities where the majority of the audience were local residents, presenting the findings with more of a

focus on cost savings would have provided a more understandable and 'common' language. In one community, the slides on cost savings enabled further engaging discussions on possible funding revenues between the researchers, low carbon community organisation members and local residents. The use of DECoRuM's ability to identify dwellings that would meet the Green Deal's 'golden rule' would have been beneficial in this situation. This reinforces the concern for knowing the audience better and the fact that a single format of carbon mapping presentation may not be appropriate for all communities when working with local communities.

A more detailed report on carbon mapping is available online via the EVALOC ENACT toolkit.



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The EVALOC project seeks to assess, explain and communicate the changes in energy use due to community activities within six selected case study projects under the Department of Energy and Climate Change's (DECC) Low Carbon Communities Challenge (LCCC) initiative, a government-supported initiative to transform the way communities use and produce energy, and build new ways of supporting more sustainable living.



EVALOC is a four-year multi-disciplinary project worth £1.14 million funded by the UK Research Council's (RCUK) Energy Programme. The Energy Programme is a RCUK cross council initiative supported by EPSRC, ESRC, NERC, BBSRC and STFC.

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