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Energy Efficient Scotland – Phase 1 pilots evaluation final report

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Executive summary

In 2015, the Scottish Government announced a commitment to treat the energy efficiency of the building stock as a national infrastructure priority. The aim is to deliver significant economic, social, environmental and health benefits, including the removal of poor energy efficiency as a contributory factor to fuel poverty. The Energy Efficient Scotland programme focuses both on improving every building and on developing low carbon heat. It is fundamental to meeting Scotland's climate protection commitments, set out in the Climate Change Plan 2018. The Plan includes ambitious targets for reductions in heat demand and growth in low carbon heat supply by 2032 (Figure 1 below)

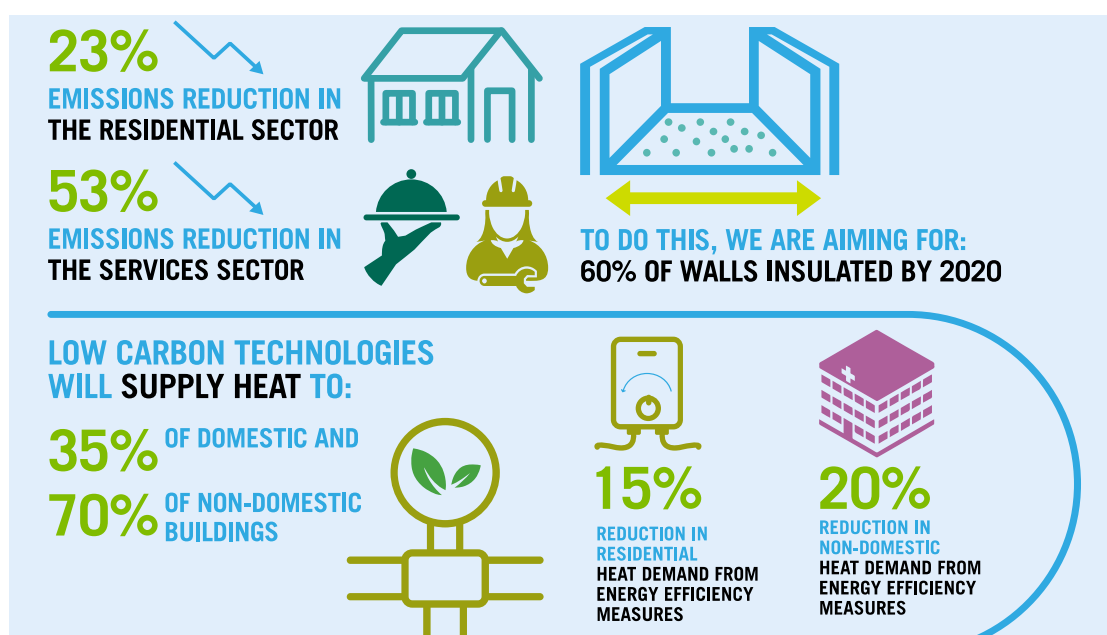


Figure 1: Scotland's Climate Change Plan – 2032 targets ¹

Funding for Local Authority-led pilot projects, designed to inform development of the full programme, was announced in 2016. This report evaluates the first phase of projects.

The evaluation of Energy Efficient Scotland (EES)² Phase 1 pilots used quantitative and qualitative data to assess the **technical and social impacts** of energy efficiency refurbishments in domestic and non-domestic buildings, and to understand the **organisation** of nine local authority pilot projects. These projects delivered energy efficiency and low carbon heat measures in 1,456 domestic buildings and 47 non-domestic buildings, including mixed-use tenement blocks, owner-occupied hard-to-treat homes, community centres, schools and office blocks. Lessons and implications from the pilots for scaling up activities to meet the ambitions of the national programme are considered in this report.

¹ Scottish Government, 'The Scottish Government's Climate Change Plan, Third Report on Proposals and Policies 2018-2032 (RPP3)', 2018 <<https://www.gov.scot/Publications/2018/02/8867>> [accessed 20 August 2018].

² The programme was called Scotland's Energy Efficiency Programme (SEEP) at the start of the pilots, but the name was later changed to Energy Efficient Scotland (EES). This report will use the current name and abbreviation EES throughout.

The evaluation used social surveys, interviews, and monitoring of internal and external temperature, humidity and energy consumption in buildings, before and after installation of energy efficiency measures. This was the first time that local authority managers of energy efficiency projects had undertaken such detailed and comprehensive data collection to inform an evaluation. The process presented challenges which resulted in only partial data collection being achieved in several projects. Nevertheless, the findings demonstrate the diversity of experiences and impacts, which highlight areas of good practice as well as areas in need of innovation and development.

Key findings from evaluation of non-domestic and domestic programmes are summarised below and the implications for skills and resources required to achieve the ambitious goals of Energy Efficient Scotland are considered.

The pilot projects

Funding for this first phase of projects was allocated from two existing Scottish Government funding streams: The Home Energy Efficiency Programme Scotland Area Based Scheme (HEEPS ABS)³ and the Low Carbon Infrastructure Transition Programme (LCITP)⁴, and the projects were required to meet the existing criteria of each of these funding streams. Funding for the nine projects was intended to enable testing of innovative approaches to integrating domestic and non-domestic energy efficiency and low carbon heat programmes on an area basis.

Table 1 provides a brief overview of the nine pilot projects. It details the types of domestic and non-domestic buildings and the measures that were successfully installed.

Table 1: Summary of pilot projects' planned and completed domestic and non-domestic projects

Local authority	Domestic buildings		Domestic measures	Non-domestic buildings		Non-domestic measures
	Planned	Completed		Planned	Completed	
Aberdeen City Council	781	781	External solid wall insulation.	7	4	External solid wall insulation, connection to district heating network, installation of large scale heat pump
Aberdeenshire Council	100	100	External solid wall insulation.	4	3	Underfloor heating, loft insulation.

³ Scottish Government, *Home Energy Efficiency Programmes for Scotland: Delivery Report 2016-2017* (Glasgow, UK, 2018) <<https://beta.gov.scot/publications/home-energy-efficiency-programmes-scotland-delivery-report-2016-17/>>.

⁴ Scottish Government, 'Low Carbon Infrastructure Transition Programme', 2018 <<https://www.gov.scot/Topics/Business-Industry/Energy/Action/lowcarbon/LCITP>> [accessed 18 September 2018].

Local authority	Domestic buildings		Domestic measures	Non-domestic buildings		Non-domestic measures
	Planned	Completed		Planned	Completed	
City of Edinburgh Council	340	287	Cavity extraction and refill, internal solid wall insulation.	8	15 (Funding for additional buildings was transferred from a planned project that could not proceed (with council match funding))	Building energy management systems, LED lighting, draught proofing.
Fife Council	44	52	External solid wall insulation, loft insulation, draught proofing.	5	4	LEDs, biomass network extension and installation of a biomass boiler on additional heat network
Glasgow City Council	106	Project cancelled (See Appendix C.1)	Mix of internal wall insulation and external wall insulation	16	3 (remaining projects cancelled - See Appendix C.1)	External solid wall insulation, connection to district heating network, installation of heat pump
Midlothian Council	111	83	External solid wall insulation.	2	2	Replacement windows, loft insulation and upgrading of lighting
Shetland Islands Council	30	30	Top-up loft insulation, internal wall insulation, underfloor insulation, double glazing, and door replacement	10	9	Heat exchanger maintenance, building energy management systems, LED lighting, TRVs and loft insulation.
South Lanarkshire Council and NHS Lanarkshire	68	68	External solid wall insulation.	4	4 (Including 3 NHS buildings)	Replacement of lighting with LED lighting.
West Lothian Council	43	43	External solid wall insulation.	2	2	Flat roof insulation, external solid wall insulation.

Key findings: Non-domestic buildings

Non-domestic project design

The pilot projects included public sector and non-public sector buildings. Local authority managers had a high level of expertise in organising large, complex non-domestic retrofit projects within the local authority estate, and the pilots were able to test innovative technologies for building management and low carbon heating. However, designing non-domestic retrofit projects beyond public sector buildings was a new activity for many of the managers and the necessary knowledge and skills were lacking.

Non-domestic funding and finance

Short funding timescales resulted in Local Authority funding bids that avoided complex or large scale projects, in order to ensure timely completion. Future projects will need to be more ambitious in order to test innovative and unfamiliar approaches.

For the small businesses selected to participate in pilots, difficult economic circumstances meant that the proposed energy efficiency investments were perceived as unaffordable, which prevented work from proceeding.

Non-domestic project delivery for buildings outside the public sector

The organisations responsible for these non-domestic buildings often had complex consultation and decision-making arrangements, requiring considerable time to plan building upgrades. There were particular challenges with mixed-use and multi-property buildings, where agreement to proceed involved multiple parties.

Procurement routes for works were also *ad hoc* in many cases. This was highlighted as a challenging area for future larger scale non-domestic programmes.

Non-domestic project impacts

Nine of the target sample of 48 non-domestic buildings had full technical monitoring data suitable for analysis. According to the available technical monitoring data, energy use was reduced in all buildings with new insulation. Results of LED lighting installations were less clear cut: two buildings showed a saving with LEDs, whereas the third showed an increase in consumption, suggesting an increase in the number of light fittings, the area lit and/or lighting use. In these cases, installing measures potentially triggered review of current provisions and completion of additional works at the same time. Remedial work, increased fixtures and fittings or additional systems could have increased energy consumption.

EPC data for non-domestic properties was received from only one of the pilots, showing information from 11 buildings. However, much of this data was limited to pre-installation EPCs and so a direct comparison was not able to be made about the impacts of the works on the EPC rating of the property. Pre- and post-installation EPCs were received for 3 properties (see

Figure 2); and from this data there was no suggested change in EPC rating. This was due to the methodology used to determine the EPC rating, rather than a lack of improvement in the energy performance of the building (see section 7.1.4 for more details).

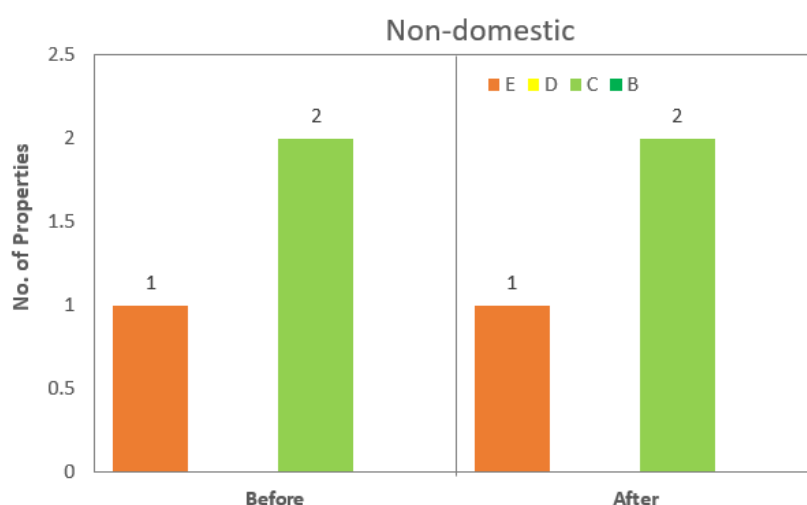


Figure 2: Comparison of complete pre- and post-installation EPC data received for non-domestic buildings in one of the pilots.

Non-domestic social survey data showed that building occupants attributed value to the works over and above carbon emission reductions and energy savings. In particular, visible improvements were valued highly: e.g. LED lighting improved the atmosphere of a space, and external wall insulation improved the aesthetics of the buildings. The short timescales, and subsequent delays and reductions in project scope, however, meant that project managers perceived difficulties in maximising the potential for carbon emission reductions

Key findings: Domestic buildings

Domestic project design

Well-established procedures were in place for domestic energy efficiency programmes through the existing HEEPS ABS programmes. Local authorities were able to successfully adapt these procedures to the data analysis and project design requirements of the EES pilots, sometimes working with contractors to access additional resources and expertise. Project managers highlighted that the existing project design procedures worked because of high quality data, held by local authorities and their contractors, about ex-council houses, as well as accumulated area-based knowledge. The detail and accuracy of other domestic data sets, were perceived as requiring improvement. This included the Home Energy Efficiency Database, which is needed for the detailed planning required to deliver EES Particularly, particularly for areas not yet targeted in existing programmes (which focus on reducing fuel poverty).

Domestic funding and finance

Domestic programmes in communities unfamiliar with HEEPS ABS needed more time for engagement, in particular to build trust in the grant and loan funding offer in order to secure sign-ups.

Project officers highlighted the importance of designing programmes to achieve a lower total price by offering contractors higher certainty about the number of measures to be delivered. As programmes move beyond grant-funding into encouraging take up of loans or private investment, these opportunities to reduce contractual costs through area-based delivery may become more difficult, since contractors will face uncertainty about numbers and locations of works.

Domestic project delivery

Several factors were cited as influential in encouraging uptake of measures including home energy advice services, works completed by local authority-endorsed contractors, and quality assurance after works were complete. These different actors, and their sponsor organisations, were trusted by householders. However, evidence of a change in householder energy practices after the installation of measures was limited, suggesting scope for more systematic education and information at the point of change to a dwelling, in order to ensure energy savings. In addition, the 'before and after' comparison took place over a short period; in the longer term, changes in energy use may result.

Domestic project impacts

The social survey data indicated a reduction in people feeling cold at home after the works had taken place. Fewer people needed to take serious actions such as cutting down on food or going to bed early in order to keep warm. Housing conditions associated with damp, mould and condensation were perceived to have significantly improved between pre- and post-installation. The social survey data was collected too soon to tell whether householders' understanding of how to control their heating systems had improved.

The domestic technical monitoring showed no uniform trends, although it should be noted that successful technical monitoring data collection was limited to 20 households out of a target sample of 419. Beyond the specific homes monitored, no statistically reliable conclusions can be drawn. (Technical data collection was led by the pilot project managers and was challenging to complete. This is discussed in detail in Appendix G). Some of the 20 monitored households achieved energy savings, but this pattern was not consistent, and some increased energy use. This, together with the social survey results, suggested that in many cases the savings that could notionally be achieved were taken in comfort; internal temperatures following insulation were sometimes higher than the recommended 21 degrees

Celsius. Despite some potential savings being negated by increased indoor temperatures, there were potential reductions in fuel poverty and/or increased comfort for occupants⁵.

Thirty-five domestic properties had full EPC data for both pre and post installation (see Figure 3). The average improvement in SAP scores was 11, with a range of 4 to 23. This high range was due to the existing wide range of energy efficiency levels before the works began (i.e. a property that was already energy efficient had less potential to achieve an improvement in SAP score than an inefficient property). The median of the range is 13.5, which suggests that more properties experienced smaller SAP score improvements, i.e. more of the properties were already somewhat energy efficient before any installations happened.

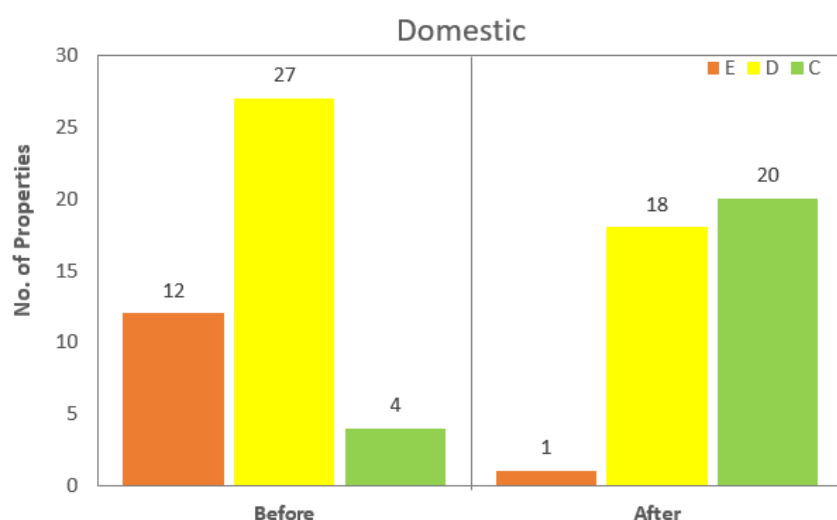


Figure 3: Count of domestic EPC ratings before and after installation.

Skills and resources for EES

When considering scaling up to more complex and innovative energy efficiency programmes, essential local authority staff resources and skills were perceived as lacking. Expertise to engage with non-domestic organisations beyond the public sector is one particular gap. Another is the expertise to work with households who will need to borrow or use savings to upgrade property. This extended cross-sector intermediary role for local authorities on energy use in buildings is unprecedented and will require new types of organisation, networks and procedures.

Conclusions

The first phase of EES pilot projects has provided significant evidence about local authority and delivery partner expertise and good practice, but also significant lessons for improved structures and governance to ensure that the national programme can meet its ambitious targets for climate protection and short term societal benefits. Project management for retrofit

⁵ For more complete technical assessments of similar home energy efficiency programmes in Scotland, see the following report: Energy Agency, *Area Based Schemes Wall Insulation Evaluation 2016 – 2018 - Executive Summary Prospective Study (Part 2)* (Ayr, Scotland, UK, 2018) <https://www.energyagency.org.uk/en/research-evaluation-project_46663/>.

of public sector buildings was well established, with impressive examples of innovation to maximise potential energy savings. Management of grant funded area-based domestic programmes was also at a very high standard, with established routes for procurement and highly skilled and experienced staff working on community engagement, quality assurance and management of contractors.

This is all however on a relatively small scale and the following points need to be taken into account in developing the national scale programme to ensure substantial progress:

Non-domestic lessons

- At present, non-domestic insulation projects require significant lead-in time to engage with building owners and decision makers in order to develop a common understanding and agreement about what the works would entail and what the results should be. Long term resources are needed to support these activities and to ensure systematic understanding of organisations' circumstances and decision timescales in advance of project planning and delivery.
- Long-term clarity about, and flexibility in, the funding regime for EES would support planning and delivery of more ambitious projects.
- There is a need for more differentiated understanding of what energy efficiency investments are affordable for different types and scales of commercial and community organisations. Financial support mechanisms for small businesses and local community organisations need to be reviewed.
- Procurement structures for contractors and materials for the diverse non-domestic sector are likely to need on-going development and review as energy efficiency programmes are established. Opportunities for joint procurement need to be identified to ensure reduced costs, delay and disruption. Establishing channels for sharing best practice in this new area of work will be important.

Domestic lessons

- Engaging households who are not in fuel poverty will need more detailed and accurate data, including access to smart meter data.
- Multi-year funding for long term, area-based, programmes is likely to support higher recognition, momentum and uptake of domestic energy efficiency measures by building a positive reputation in communities.
- Systematic information and education is needed at the point when households are adjusting to higher energy efficiency and/or new heating systems, to ensure that comfort is combined with energy savings.

In both sectors, pilot projects demonstrated the necessity for review of legal frameworks to enable timely energy efficiency improvements in multi-ownership and multi-purpose buildings. Where there is no legal requirement for multiple owners in the same building to negotiate and

agree on building renovation and energy efficiency upgrade, this will significantly hinder EES progress.

Skills and resources for delivery – lessons

Local authorities, delivery partners and Scottish Government are currently negotiating the distribution of responsibilities, skills, resources, contractual structures, and project timetables for the EES Programme. A clear understanding of roles and responsibilities will be key to identifying priorities for investment in capacity building. It will also enable local authorities to develop best value solutions in their areas of direct responsibility, combining in-house resources with outsourcing and contracting as appropriate. Regardless of the outcome of negotiations, more long-term dedicated local and central government staff resources will be needed for the large scale EES programme. This will provide the capacity and flexibility to innovate and adapt programmes to economic, organisational and cultural circumstances. Cooperation and coordination across local and national levels will be critical to success.

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1 Introduction

This report presents the final evaluation report of nine Scottish local authority-led energy efficiency pilots, which ran from September 2016 until December 2017, with a number of extensions until March 2018⁶. The projects were set up to inform the development of the Scottish Government's national energy efficiency programme 'Energy Efficient Scotland (EES)'⁷.

The EES programme aims to "support the improvement of the energy efficiency of homes, businesses and public buildings, as well as to work with local authorities to develop Local Heat and Energy Efficiency Strategies (LHEES)"⁸. The programme is in a phase of development set out within the Energy Efficient Scotland Routemap⁹. A draft plan was published for public consultation in July 2018, with an intention to launch the new programme in 2020¹⁰. EES will support the Scottish Government's ambitions to remove poor energy efficiency as a driver of fuel poverty and to meet the targets set out in the Climate Change Plan to reduce emissions in buildings by 23% and 59% for domestic and non-domestic buildings by 2032 respectively, on 2015 levels¹¹, and by 80% across all emissions by 2050.

The projects evaluated in this report are the first phase of pilots funded by the Scottish Government, aiming to inform the on-going development of EES and build local capacity for delivery of the programme. The pilots were designed to test innovative approaches to delivering energy efficiency and low carbon heat programmes, targeting both the domestic and non-domestic sectors in an area-based approach. A total of £9 million was allocated to the pilots from two existing funding streams: the Home Energy Efficiency Programme Area Based Scheme (HEEPS ABS)¹² and the Low Carbon Infrastructure Transition Programme (LCITP)¹³. Local authorities were also encouraged to find match funding to supplement their projects where possible, although this was not a requirement.

This first phase of pilots consist mainly of adaptations of existing local authority programmes and activities. Pilot bidders had only two months to design and write their funding bids. Therefore, these pilots represent a first attempt at testing the flexibility of established project processes to meet the needs of delivering EES in the future; bringing together domestic and

⁶ An interim evaluation report was published half way through the pilots in June 2017: Ruth Bush and others, *SEEP Phase 1 Pilots Interim Evaluation Report* (Edinburgh, UK, 2017) <<https://www.gov.scot/Topics/Business-Industry/Energy/Action/lowcarbon/LCITP/SEEP/Phase-1/InterimEvaluationReport>>.

⁷ The programme was called Scotland's Energy Efficiency Programme (SEEP) at the start of the pilots, but the name was later changed to Energy Efficient Scotland (EES). This report will use the current name and abbreviation EES throughout.

⁸ Scottish Government, 'Energy Efficient Scotland "Long Term Plan"', Webpage, 2018 <<https://beta.gov.scot/policies/energy-efficiency/energy-efficient-scotland/#long-term-plan>> [accessed 20 August 2018].

⁹ Scottish Government, *Energy Efficient Scotland: Routemap* (Glasgow, UK, 2018).

¹⁰ Scottish Government, 'Energy Efficient Scotland Consultation: Making Our Homes and Buildings Warmer, Greener and More Efficient', 2018.

¹¹ Scottish Government, 'The Scottish Government's Climate Change Plan, Third Report on Proposals and Policies 2018-2032 (RPP3)'.

¹² Scottish Government, *Home Energy Efficiency Programmes for Scotland: Delivery Report 2016-2017*.

¹³ Scottish Government, 'Low Carbon Infrastructure Transition Programme'.

non-domestic activities in an area-based way. The findings from this evaluation, and the challenges that are highlighted, represent versions of current experiences within already established programmes. Finding solutions to these challenges will be fundamental to ensuring the success of EES. Subsequent phases of pilot projects will need to push the boundaries of these project processes further to take on less familiar challenges, as well as testing solutions to existing challenges, building on the experiences in this first round of pilots.

The pilots evaluation, led by teams at the University of Edinburgh and Energy Saving Trust, aimed to measure the **technical and social impacts and benefits** of energy efficiency refurbishments, as well as to understand the organisation of **design and delivery** of the pilot projects. Lessons from analysis of this data aim to inform the development of EES, as well to inform the ongoing work of local project managers. In particular, it considers lessons and implications of the pilots for scaling up to meet the ambitions of the national programme.

The evaluation conclusions are based on both quantitative and qualitative data, collected in the form of technical monitoring data, social surveys and in-depth interviews with local authority project managers and their delivery partners. Local authority pilot managers were responsible for collecting the technical monitoring and social survey data, and this was made available to the evaluation team in June 2018.

The rest of this report is structured as follows:

Chapter 2 gives a summary of the nine pilots considered within the evaluation. Chapter 3 gives a brief introduction to the methodologies used for the social and organisational evaluation and the technical evaluation (full details of the methods used are covered in Appendix A). The analysis and results are presented in three parts: Chapter 4 presents evaluation of the non-domestic projects; Chapter 5 presents evaluation of the domestic projects; and Chapter 6 presents an evaluation of the skills and capacities of the partners involved in both non-domestic and domestic projects. Finally, chapter 7 discusses the impacts of the pilots. Lessons and implications are discussed at the end of each chapter. A final conclusion to the report is presented in chapter 8.

In addition, this was the first experience of participating in a detailed evaluation for many of the local authority pilot leads, and a number of challenges were experienced. Lessons for future evaluations are discussed in Appendix G.

2 Summary of the EES phase 1 pilots

The following table provides a brief overview of the nine pilot projects that participated in the evaluation. It details the types of domestic and non-domestic buildings that were included and the measures that were successfully installed.

Table 2: Summary of ESS phase 1 pilots by local authority.

Local authority	Domestic building types		Domestic measures installed	Non-domestic building types		Non-domestic measures installed
Aberdeen City Council	External wall insulation to 7 multi-storey blocks of flats already connected to a district heating network.		External solid wall insulation.	Community arts centre, ice-rink, council buildings		External solid wall insulation, connection to district heating network, installation of large-scale heat pump.
	#. planned 781	#. Completed 781		#. planned 7	#. Completed 4	
Aberdeenshire Council	Terrace houses, 1965-1975, 1 to 4 bedrooms.		External solid wall insulation.	Village hall, Church hall and local football club.		Underfloor heating, loft insulation.
	#. planned 100	#. Completed 100		#. planned 4	#. Completed 3	
City of Edinburgh Council	Pre-1919 tenements private homes.		Cavity extraction and refill, internal solid wall insulation.	Schools, community centres and offices.		Building energy management systems (BEMS), LEDs, draught proofing.
	#. planned 340	#. Completed 287		#. planned 8	#. Completed 15	
Fife Council	Flats, maisonettes and terrace houses.		External solid wall insulation, loft insulation and draught proofing.	Schools, community centres and business centre.		LEDs, biomass network extension and installation of a biomass boiler on additional heat network
	#. planned 44	#. Completed 52		#. planned 5	#. Completed 4	
Glasgow City Council	Project postponed/cancelled (See Appendix C.1 for details)		n/a	Community centre, schools		External solid wall insulation, connection to district heating network, installation of heat pump
	#. planned 106	#. Completed n/a		#. planned 16	#. Completed 3	
Midlothian Council	Terrace houses with no-fines construction		External solid wall insulation.	Town hall and sports pavilion.		Replacement of windows, loft insulation and upgrading of lighting
	#. planned 111	#. Completed 83		#. planned 2	#. Completed 2	

Local authority	Domestic building types		Domestic measures installed	Non-domestic building types		Non-domestic measures installed
Shetland Islands Council	Detached, semi-detached and terrace houses all connected to the Lerwick district heating network.		Top-up loft insulation, internal wall insulation, underfloor insulation, double glazing, and door replacement.	Offices, care homes, school, community centre, library and surveyors all connected to the Lerwick district heating network.		Heat exchanger maintenance, building energy management systems (BEMS), LEDs, TRVs and loft insulation.
	#. planned 30	#. Completed 30		#. planned 10	#. Completed 9	
South Lanarkshire Council and NHS Lanarkshire	Semi-detached and terrace houses all Swedish timber built between 1946 & 1958.		External solid wall insulation.	3 x NHS clinics, council offices.		Replacement of lighting with LEDs.
	#. planned 68	#. Completed 68		#. planned 4	#. Completed 4	
West Lothian Council	Bungalows and semi-detached properties, all are no-fines construction.		External solid wall insulation.	Community centre and church hall.		Flat roof insulation and external solid wall insulation.
	#. planned 43	#. Completed 43		#. planned 2	#. Completed 2	

3 Method overview

This section gives a brief overview of the method used to conduct the EES pilot evaluations. Full details of the data collection approach, timescales, sample size and approach to analysis are set out in Appendix A.

Overall approach

The pilot evaluation consisted of two parts: technical evaluation, and social and organisational evaluation. The technical evaluation, led by Energy Saving Trust (EST), aimed to monitor changes in energy consumption, temperature and humidity before and after energy efficiency changes. The social evaluation, led by the University of Edinburgh, explored the influence of programme design, delivery approaches, and the experiences and motivations of building occupants. The findings of these two parts have been brought together throughout this report to complement understanding of what influences reductions in energy demand, and how delivery could be scaled up and replicated across Scotland in a national programme.

3.1.1 Technical evaluation

The technical evaluation measured building energy consumption, temperature and humidity profiles. Local authorities were responsible for procuring and arranging the installation of monitoring equipment, which was used to examine the impact of energy efficiency installations on energy use and on changes in heating patterns. Monitoring was approached in different ways for domestic and non-domestic buildings as each have different considerations.

3.1.2 Social and organisational evaluation

The social and organisational evaluation was informed by quantitative and qualitative data. In the domestic sector, household surveys were used to understand householders' motivations for proceeding with energy efficiency upgrades, as well as the perceived impacts of these. In the non-domestic sector, surveys and interviews were used to understand the perspectives of building occupants and building decision makers in a selection of case studies. In addition, in-depth interviews with pilot managers explored approaches to design and delivery of the projects overall.

3.1.3 The role of local authority pilot leads in data collection

The local authority pilot leads (or their appointed delivery contractors) were responsible for coordinating both the technical and social survey data collection. This involved installing technical monitoring equipment in a sample of domestic and non-domestic buildings, as well as completing social surveys with building occupants. Collecting this type of detailed evaluation data was new to many of the local authorities and training was provided to support this process. Nevertheless, there were a number of challenges for data collection and lessons from this first phase of pilots are discussed in detail in Appendix G.

4 Organising and delivering energy saving retrofit in non-domestic buildings

The scale of change anticipated by the EES programme will require commercial and public organisations to invest in larger scale and hard-to-treat measures, which is likely to be facilitated by coordination across multiple organisations to achieve the best low carbon results. How close are we to achieving this at present, and what are we learning from the pilots about what needs to change in order to meet the ambition?

In general, delivery of energy efficiency programmes in the non-domestic sector was a less developed area of work for local authorities and their delivery partners. Projects also tended to be more complex, with multiple decision makers and complicated financial arrangements. Based on the first phase pilots, we suggest key lessons for meeting the ambitions of EES in the non-domestic sector are as follows:

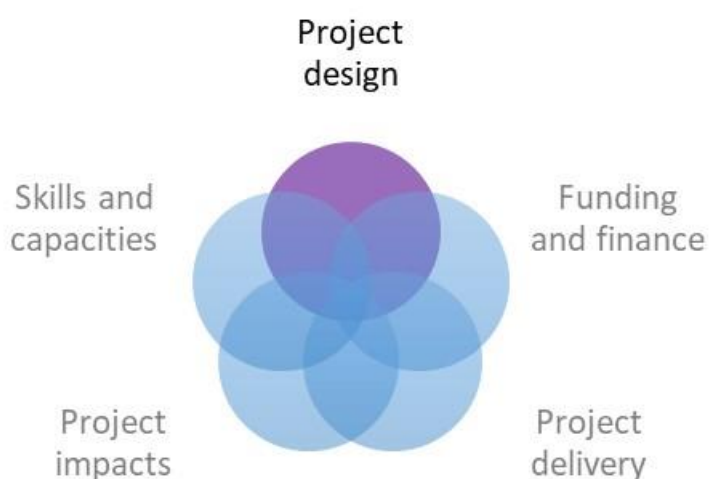
1. Planning for whole building and area-based retrofit needs **accurate data** on building stock, standards and retrofit options. There would be benefit in each local authority developing an electronic standard system, accessible across different departments, estates and services, although this would have significant financial implications.
2. Project management systems for area-based projects need to be developed to **coordinate work across national and local scales**.
3. Short term funding **restricts activities to certain project-types**, potentially leaving the more expensive works for the future. Long term complex programmes for energy saving retrofit of buildings would benefit from multi-year funding plans.

The rest of this chapter presents key aspects of the experiences in the EES pilot projects for the non-domestic sector: Planning and designing non-domestic energy efficiency programmes; the implications of funding and financing options; approaches to project delivery; and understanding the project impacts. Finally, lessons and implications from these experiences are discussed in more detail.

Additional detailed case studies of five non-domestic buildings included in the Phase 1 EES pilots are presented in Appendix C. These case studies explore delivery of measures to non-domestic buildings that were either not owned or occupied by the local authorities. This required liaising with and coordinating with relevant decision makers for the buildings and in many cases getting agreement to make a financial contribution. The case studies are informed by non-domestic social surveys of building decision makers and occupants, as well as a selection of in-depth interviews.

General lessons from the case studies are incorporated into the analysis below, along with findings based on interviews with project managers about all non-domestic buildings included in the pilots.

Designing non-domestic retrofit projects – what factors influence decisions?



This section considers the experiences of planning and designing the non-domestic elements of the pilots. It considers what factors influenced decisions and where pilot leads felt there was a need for new or different approaches.

4.1.1 Data to inform project design and planning

In the first round of EES pilots, there was a tight 6-week timeframe for funding applications, which led some local authorities to design projects and write bids with incomplete or estimated information on buildings. There were therefore some inaccuracies in estimating budgets and identifying required insulation measures for installation.

For example:

- Two pilots used Energy Performance Certificates (EPCs) as a source of information for specifying the required energy efficiency measures in the non-domestic buildings. However, the EPCs lacked accurate data (e.g. they were completed some time ago or were not sufficiently detailed) and this resulted in missed opportunities for installing some measures since budget had not been allocated for all of the necessary measures. In turn, this has impacts on the projected carbon emissions reductions and on the wider benefits such as improved comfort.
- Despite good examples of building logs detailing the current status of local authority and public buildings, and logging of upgrades and maintenance works as they happened, these were not universally available for use in writing project bids. Building information was sometimes held informally by on-site managers or key personnel in other departments and was not written down and/or was not up to date or compiled in a central database.
- Incomplete information limited the use of a whole-building approach to retrofit, for projects combining new renewable heating with upgrading the energy efficiency of the building envelope. In one project, this resulted in a connection to a renewable heat source being extended across a building with draughty, poorly fitting windows.

Local authority pilot leads were uncertain about the value of investing in such detailed assessments in advance of funding calls or a long-term national funding programme. One local authority called it a “loss leader” because it would involve significant staff resource without any guarantee that viable measures would be identified, or funding would become available.

4.1.2 Moving beyond smaller and simpler non-domestic projects

The short timescales available to develop and deliver the EES phase 1 pilots meant that non-domestic projects were primarily small, often in local authority-owned buildings, and focused on more straightforward changes. Coordinators chose small, simpler projects such as LED lighting or insulation because of short timescales for pilot funding that did not allow for development of more complex projects such as whole-building or area-wide retrofit, or low carbon heat supply. Local authority staff resources for development work beyond funded projects were limited. Bigger or more complicated non-domestic projects therefore tended to remain a low priority when writing project bids, despite aspirations to innovate:

“We just can't keep doing the same thing over and over [...] you know we're doing what we can with controls and BMS but yes we're getting to the end of what has been a really exciting period of constant investment and yes we definitely need to be a bit more innovative.” (Pilot coordinator)

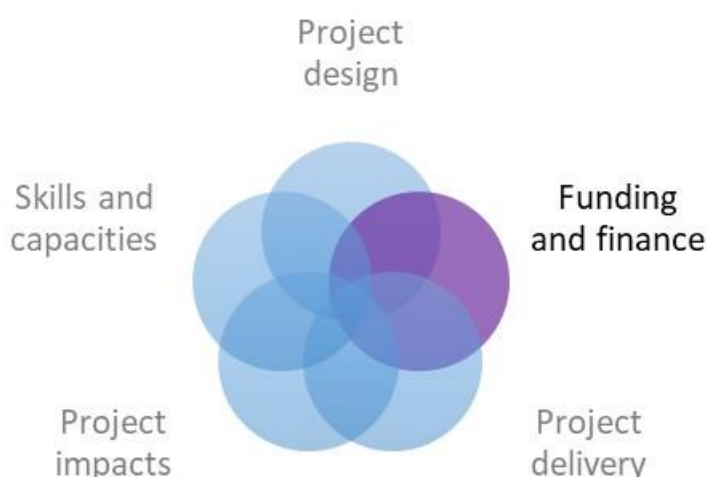
The lack of flexibility for re-profiling budgeted expenditures between financial years was also reported as a barrier to taking on larger or more complex projects because there were more chances for unexpected delays affecting the spend profile.

4.1.3 How local strategic planning and departmental structures affect project design

Several local authorities reported that designing area-based projects across the domestic and non-domestic sectors was challenging because existing departmental structures and existing strategies created a division of responsibility for work on the different sectors. Short timescales for the pilot funding bids meant too little time to build the necessary project teams in advance.

- In five of the pilots, bids were led by council teams responsible for domestic energy efficiency programmes. Three of these reported selecting non-domestic buildings based on geographical location in relation to domestic priorities, rather than basing decisions on the non-domestic strategic plan. One pilot lead commented that, in hindsight, this had led to missed opportunities to fund work on non-domestic buildings that were in greater need and could have delivered greater energy savings.
- In one case, setting up and managing an area-based pilot led to some disruption of existing programmes by drawing away staff resources and leading to bottle necks in project delivery across the wider local authority workload.

Funding and financing mechanisms



4.1.4 Funding criteria and affordability in the non-domestic sector

Grant funding for the phase 1 non-domestic parts of the pilots was allocated from the Low Carbon Infrastructure Transition Programme (LCITP)¹⁴. The criteria of this European Regional Development Funding allowed non-domestic energy efficiency retrofit and low carbon heat generation, amongst other potential project types. In addition, projects needed to demonstrate key qualities including “taking an innovative approach to cross sector collaboration to ensure successful project delivery”; “the potential to deliver significant reductions of greenhouse gas emissions (MtCO₂e) and/or energy consumption [...and] have a positive and significant social and economic impact on Scotland”¹⁵. In addition, a number of non-domestic organisations were offered energy efficiency audits and access to a zero-interest loan through Resource Efficient Scotland¹⁶. Match funding was not a requirement of the pilot bids, although where match funding could be provided this was considered favourably within the bidding process.

The pilots indicated a need for grant funding in some commercial and public service organisations if energy efficiency upgrades are going to take place. This section explores where there are gaps in funding provision or where alternative means of finance, such as loans, were considered ‘unaffordable’ for the organisation.

4.1.4.1 Funding of maintenance work

Remedial / maintenance work was not funded under the terms of EES pilot grants, but this was sometimes a necessary precursor to being able to install energy efficiency interventions. Insufficient budgets to cover maintenance costs led to measures not being installed in three projects and one project not going ahead at all.

¹⁴ <https://www.gov.scot/Topics/Business-Industry/Energy/Action/lowcarbon/LCITP>

¹⁵ <https://www.gov.scot/Topics/Business-Industry/Energy/Action/lowcarbon/LCITP/eligibility-criteria>

¹⁶ <https://www.resourceefficientscotland.com/funding>

4.1.4.2 *'Affordability' in the commercial sector*

Commercial organisations were not eligible for grants from EES pilot funding. In three pilots decision makers and project managers were concerned that organisations would not be able to contribute to the cost of measures, either through a loan, their own savings, or a payment plan, due to the low turn-over, limited income generation potential, or difficult local economic context.

There were also two pilots where building owners kept rents low to support community organisations or small business tenants, because they wanted them to be present in the area. The owners could not therefore recoup investment costs through rents and needed to find alternative ways to recoup these costs over time.

4.1.5 Loans

For buildings not owned by the public sector, a number of issues arose with organisations' financial capacity and willingness to take on a loan (even at zero percent interest). The following reasons were given for not taking on a loan:

- A lack of confidence that energy efficiency measures will deliver the expected savings.
- Financial insecurity – e.g. minimal or uncertain profit margins due to difficult local economic context; not-for-profit organisations with minimal financial reserves to take on the risk of loans
- Loans were for energy efficiency upgrades, but not repairs or maintenance. Where buildings required maintenance, the extra costs needed to be met by the organisation independently.
- Some organisations felt there was a lack of accessible information about loan options.

Alternatives to loans:

In two pilots, alternative financing arrangements were created to cover costs without loans or increased rents. For example, Aberdeen Heat and Power offered the Aberdeen Community Centre the option of incorporating the heat network connection charges into their standing charge for heat, if the arts centre could not access a zero percent loan (see Appendix C.2).

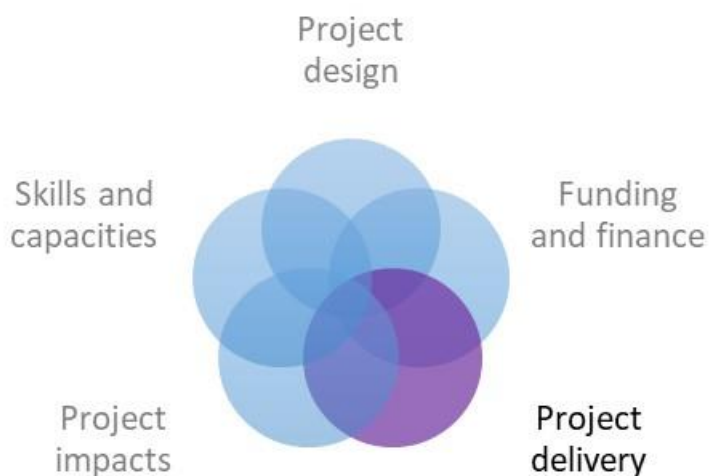
'Spend to save' revolving funds

A 'spend to save' mechanism was used for energy efficiency investments in several public sector-owned buildings. As energy savings are made, the budget that would have been spent on energy is redirected into the local authority or NHS revolving fund for future investments elsewhere in the building stock. EES grant funding was used to extend the 'spend to save' budget in NHS Lanarkshire (see Appendix C.4).

This mechanism needs an alternative way to recuperate the funding if the energy bills are paid by the building tenants. The Fife business centre solved this by adjusting their district heating network standing charge to recoup part of the investment costs, alongside a contribution from

the council's commercial maintenance fund (see Appendix C.5 for more details about this case study).

Project delivery



4.1.6 Energy efficiency decision making processes in the non-domestic sector

The Phase 1 pilots demonstrated the wide-ranging governance arrangements involving multiple stakeholders that influence how a decision is made to invest in an energy efficiency measure. These arrangements are not always clear, and at the beginning of the pilots there were several examples where it took several months to identify all of the parties that needed to be involved. In some cases, insufficient buy-in from key decision makers eventually prevented the projects from going ahead as planned.

Understanding and engaging with the decision-making processes for retrofitting non-domestic buildings will be critical to increasing uptake of energy efficiency in the sector. Particular decision making issues were as follows:

4.1.6.1 *Distributed financial responsibilities and risk*

In several cases, financial responsibilities and risks were distributed between building owners and occupants in complex ways, requiring multiple parties to agree on the decision to invest. Obtaining agreement caused delays in projects, or in some cases prevented them from going ahead.

For example, in two pilot projects non-domestic tenants had 'repair and maintenance' leases. Tenants were financially responsible for the energy efficiency measures, but not for other financial risks:

- In one case, the tenants accepted financial responsibility for the energy efficiency measures, but the owner was concerned that carrying out significant works might uncover critical structural issues or asbestos that would incur new costs for them. In this pilot the problem was solved by Scottish Government underwriting these financial

risks should they materialise, but this was a ‘one-off’ solution unavailable to future projects.

- In mixed-use tenement blocks, financial responsibilities were distributed unevenly between properties, according to the title deeds and lease agreements of each one. Getting agreement across all of the non-domestic property owners/tenants was time consuming and although an agreement to go ahead with the works was obtained at a factoring meeting, only two (out of eight) non-domestic owners were represented at the meeting. Since the project was managed by the housing association owner of many of the tenement properties, the risk of unpaid costs for works would have rested with them. In this case, the housing association deemed the risk too high and called off the project.

4.1.6.2 Local authority arms-length organisations

Local authority arms-length management organisations (ALMOs) will have an important role in some areas in enabling delivery of non-domestic energy efficiency projects, either as the owner of building stock, or as an energy supplier as in the case of Aberdeen Heat and Power district heating.

Two pilots involved local authority arms-length organisations:

- City Property in Glasgow City Council area was the owner of a property where tenants were planning energy efficiency upgrades (see appendix C.1C.2).
- Aberdeen Heat and Power, the district heating network manager, was looking to supply heat to buildings along a network extension (see Appendix C.2).

These organisations were important decision makers in both projects; there were however, differences in their relationships with the local authority departments responsible for the energy efficiency pilots. In Glasgow, City Property only became involved once the project had begun, and it took time to align the interests of all parties involved and to address all their concerns. The pilot project was a useful catalyst for developing this working relationship further. In Aberdeen, on the other hand, Aberdeen Heat and Power had a long history of working closely with the local authority energy department on similar projects, and there was already a well-established process and mutual understanding of objectives. This long standing working relationship between Aberdeen Heat and Power on energy efficiency meant that project design and delivery were quicker and smoother than when a new working relationship had to be established with City Property.

4.1.6.3 Decision making in the non-domestic sector (committees and boards)

In buildings not owned by the local authority, the pilots were often developed with the involvement of a key individual from the organisations in question with decision making powers. However, in several cases, the rest of the governing boards / building management

committees were not aware of the project, or what it would involve, until several months later. This led to project delays and in some cases cancellation.

4.1.7 Understanding the drivers for energy efficiency in the non-domestic sector

Understanding of the drivers for energy efficiency measures in the non-domestic sector is limited, but this is critical to successful engagement of non-domestic organisations in energy efficiency programmes. In the pilots, the motivations varied significantly by organisation-type and context.

- Complying with public bodies Climate Change duties (Public sector)
- One public sector actor felt that EES would play an important role in creating an appetite to take on these ambitious projects in the future:
- *“the best opportunity for us is these new targets coming in to say right here’s where we are, here’s where we need to be in ten/fifteen/twenty and thirty years’ time”* (pilot project manager)
- Reducing energy bills to enable more money for the organisation (SMEs and community organisations)
- Improving the comfort and quality of buildings for occupants and tenants.
- Reduced maintenance needs in the future (At a point of refurbishment or investment in the building)

However, the drivers for non-domestic decision makers to go ahead with the upgrades were not always clear. In case of the mixed-use tenement block in Glasgow, the project included essential maintenance works and was primarily concerned with benefits for the households. Engagement with the non-domestic property owners was done alongside the domestic owner-occupiers in the buildings. However, the case for investment presented in terms of comfort gains and energy bill savings was not received with the same enthusiasm by the non-domestic decision makers as by domestic owner occupiers. It should also be noted that no grants were available for the financial contributions from non-domestic building owners.

4.1.8 Engagement with non-domestic sector owners and tenants

Engaging with decision makers in non-domestic buildings about a project, particularly working beyond local authority-owned buildings, was a new and developing area of work for many of the pilot authorities. This engagement required a large proportion of staff time in the majority of the pilots.

4.1.8.1 Engaging with building ‘decision makers’

Project coordinators aimed to get buy-in from decision makers, and financial contributions where necessary. Several lessons were highlighted:

- Challenges were experienced where there were multiple building decision makers who needed to agree to go ahead with a project. For example, the Aberdeenshire pilot experienced problems with the project progressing without all of the governing

committee being fully informed and supportive. This blocked later works. Early engagement with all building decision makers is therefore critical to prevent unnecessary preparatory work if decision makers are unwilling to proceed.

- A clear common understanding of what the works entailed and how they might affect the building's use and aesthetics was essential. Two pilots held meetings with building decision makers and brought technical experts to answer questions about the installation process and to share experiences from past projects about the impacts of the measures.
- In the Fife business centre, it was planned for part of the costs of the works to be covered by tenants' heat network standing charge payments. It was therefore important to get a clear understanding with the tenants about the need for the works and the benefits to be provided, since they were paying, and the centre did not want to lose tenants. Engagement was focused on providing a solution to negative feedback prior to the project about the building being draughty and cold, with difficult to control electric storage heaters. In the end, due to the fear of not offering competitive business centre costs to tenants, the decision was taken to only marginally increase the heat standing charge in order to recoup the costs of maintenance and billing. The remaining investment costs, not covered by the EES grant, will be recouped via the council's commercial maintenance fund.

4.1.8.2 Engaging with building 'occupants' and tenants

Alongside building decision makers, several pilots noted the benefits of engaging with building occupants and tenants from an early stage. This helped to minimise disruption during the installation of measures and established a process for people to report issues, as well as ensuring that the building upgrades met the needs of building users. In the Fife business centre, council staff spent time with business centre tenants to talk about the planned works, hear any concerns, and also to highlight other ways that they could save energy, including what they could do in their own homes.

4.1.9 Procurement for non-domestic projects

Local authorities, other public sector organisations and housing associations must follow legislated procurement processes when they buy goods and services, with the aim of achieving value for money for the taxpayer, by balancing cost, quality and sustainability¹⁷. Local authorities can set up their own processes for ensuring compliance with procurement rules, or they can use wider procurement services such as Scotland Excel or the Scottish Procurement Alliance, which aim to offer better value through knowledge and relationships with the market for commonly procured goods and services.

¹⁷ <https://www.gov.scot/Publications/2016/03/8410/1>

Specific procurement frameworks have been set up for commonly procured energy efficiency measures to enable better prices through large volume buying and reducing the time taken to procure these services. In the pilots, these frameworks were commonly used for domestic retrofit projects and non-domestic public sector buildings. However, in several cases the existing frameworks used by the local authority were not suitable for the non-domestic buildings in their pilot and an alternative route to procurement had to be found. This either involved:

- An individual procurement exercise, which could take up to 6 months to complete.
 - o It was noted by one local authority that the staff time and expertise needed to go through the procurement process for a one-off, small project was high compared to the overall value of the works. The time taken also has implications for the budget since prices can change between the start of the project and the point where works are finally procured.
- Procurement of the works by project partners, using the partner's procurement framework or drawing down on existing contracts held by the partner. This had less of a drain on local authority staff resources and was seen as a way of getting through the procurement process more quickly.

4.1.10 Planning and listed building consents

Obtaining planning permissions for energy efficiency works on several of the non-domestic buildings was a barrier or delay. This takes up significant staff time and resource and can prevent a project from going ahead.

- In one non-domestic project that did not proceed, planning permission was unexpectedly refused for external wall insulation, although similar works had been done in a neighbouring building.
- Long delays occurred in another pilot building due to its listed status which required considerable staff time, including new technical specifications and appointment of contractors.

A key challenge going forward will be ensuring that energy efficiency upgrades comply with planning rules, and/or planning rules are adapted to streamline consent for energy efficiency retrofits.

Lessons and implications

This section considers the lessons and implications from the evaluation of the non-domestic elements of the pilots for scaling up and replicating programmes in the future. Some key questions are also highlighted for future pilots and evaluations to consider.

4.1.11 Planning and designing retrofit

- Many local authorities are not accustomed to delivering energy efficiency programmes to the non-domestic sector beyond their own building stock. It remains unclear from the experience in the Phase 1 pilots whether an area-based, joint approach to delivery

of energy efficiency measures across the domestic and non-domestic sectors is beneficial. However, current local authority departmental structures and strategic planning do not support this way of working. If this approach is used, then project management structures need to be developed to support strategic programmes.

- There is a significant lack of data to inform the development of non-domestic retrofit programmes beyond local authority or public sector owned buildings. Even where buildings were local authority-owned, there was still insufficient data at the necessary detail to accurately plan, prioritise, and budget for a retrofit project. As the details of EES become clearer, local authorities and public sector building managers will need to consider how they can develop sufficiently detailed databases of their own building stock, as well as privately owned building conditions, energy efficiency upgrade measures and EPC certificates.
- Preparatory work is needed to move beyond small-scale, incremental improvements to development of larger-scale or more difficult projects such as whole building retrofit or connection of buildings to heat networks and low carbon heat sources. This will require a bigger staff resource than is currently available in the local authority teams leading the pilots.
- If using a bounded project funding approach, longer-term (a minimum of 3-year funding of projects) and predictable funding criteria would enable local authorities to develop and implement strategies that align with the available funding and to take on larger programmes or more expensive and disruptive measures for hard-to-treat buildings.

4.1.12 Funding and financing

- Long-term clarity on available funding and financing mechanisms would enable strategic planning of energy efficiency upgrades and maintenance across sectors and different types of organisations. In the absence of grants or 'affordable' loans, alternative investment models need to be developed to spread the costs; this could include energy performance contracting¹⁸.
- There is a need for greater support for non-domestic organisations to carry out essential maintenance work alongside energy efficiency upgrades where affordability is an issue. There may be a need for loans or grants to cover these circumstances.

¹⁸ Energy performance contracting is where customers are provided with an energy service such as heating or lighting, rather than charged for the units of energy. This enables energy efficiency investments to be made, and the resulting energy savings used to recoup the investment costs over time.

- Flexibility in project funding timescales for detailed assessments of building-needs before measures are identified and budgets finalised would help project managers to set more accurate budgets and maximise energy savings by installing all suitable measures.
- Programmes need flexible delivery timescales to allow for the wide range of circumstances that can occur across the diversity of non-domestic buildings. Without this, larger scale projects involving large numbers of non-domestic buildings will not be deliverable.

4.1.13 Project delivery

- Identifying the governance arrangements of non-domestic buildings can be complicated and time consuming. Identifying the governance arrangements for non-local authority-owned buildings at the project conception and involving all the relevant decision makers before beginning the project can prevent project blocks and delays.
- There are opportunities for greater sharing between local authorities and delivery partners about non-domestic project delivery. In particular, it would be beneficial for public sector bodies to share best practice on 'Spend to save' funding models for tenant / landlord set ups; approaches to delivery measures in mixed-use buildings with multiple properties
- Mixed-use or multi-property buildings present a particular challenge to balance the potentially differing needs of the different properties (e.g. such as a tenement building with commercial units on the ground floor). There are opportunities to reduce the risks of coordinating such projects, for example, establishing processes for getting agreement that a project should go ahead, and for deciding who takes on the financial risk of the project if one or more parties fail to pay their share.
- Local authorities should consider how they can align the objectives of arms-length organisations with their agenda on energy efficiency, to enable cooperation and facilitate investment.
- Future projects: As projects get more diverse and larger scale, there may be a need for solutions to support procurement of energy efficiency goods and services in the non-domestic commercial and community sector. It could be beneficial for future projects to research and test approaches to cross-organisational procurement opportunities (such as suggested initially for the NHS Lanarkshire pilot, but which did not happen in practice).

4.1.14 Themes for future evaluations in the non-domestic sector:

- What is perceived as affordable by non-domestic organisations? And what are the attitudes to risk of different non-domestic organisations for taking out loans for energy savings?
- Under what circumstances are loans a realistic means of delivering energy efficiency improvements? In particular, where do loans with low or zero interest rates act as an incentive for an organisation to invest?
- As more pilots take place, and EES develops, it will be useful to understand better the drivers for non-domestic decision makers to invest in energy efficiency, including factors relevant to different types of organisations (SME, larger commercial businesses, not-for-profit organisations, public sector).
- Future evaluations might also consider how engagement with building occupants can influence people's perceptions of energy efficiency and lead to investments and behaviour changes at home.

5 Organising and delivering energy saving retrofit in domestic buildings

Local authorities and their delivery partners are experienced at organising and delivering energy efficiency programmes in domestic buildings. This was demonstrated in the pilots by the way that project managers were able to adapt existing programme design and delivery approaches to meet the needs of the area-based EES pilots. However, will existing processes be suitable as programmes focus on a wider range of domestic property types or move beyond grant funded programmes? Where are there gaps and areas in need of different approaches? This chapter highlights the strengths of current programme delivery approaches and considers where there is a need for further work and development to meet the needs of larger scaled delivery programmes in the future.

Summary of key findings

Below is a summary of the key lessons and implications of the evaluation for the domestic parts of the pilots. The rest of the chapter discusses these findings in more detail, with examples from the pilots.

5.1.1.1 *Project design*

- There should be a link between wider local authority strategies and the methods used for analysis of local data sets used by delivery partners. Analysis skills can be pooled, especially for local authorities lacking in-house resources.
- Developing more detailed databases about energy efficiency measures is beneficial for planning future energy efficiency programmes. Early engagement with households, including carrying out early technical surveys, is an area for further work.
- Current assessment methodologies for targeting domestic energy efficiency programmes are effective but are limited to certain house types and technologies. These methodologies will need to evolve as the priorities of EES broaden to ensure that recommendations are also in line with heat decarbonisation plans for the local area.

5.1.1.2 *Funding and finance*

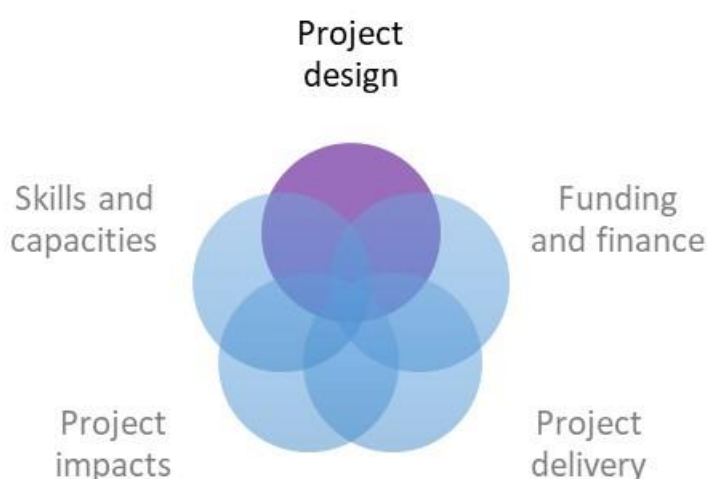
- The short funding timescales of current energy efficiency projects is an issue for delivering more complex projects, or long-term planning of future projects. Longer funding timescales, or greater project flexibility would help overcome some of these challenges.
- The significant costs of repair works necessary alongside installation of energy efficiency measures were, in two projects, a potential barrier to privately-owned households who had to cover these costs upfront, within a short timeframe, without access to financial support for this part of the works. As the pace of delivery of EES scales up, it would be beneficial to consider circumstances where financial support mechanisms might be helpful to cover the costs of significant remedial works.

- As programmes move beyond grant-funded measures into encouraging take up of loans or private householder investment, pilot project managers were concerned that the opportunities for achieving lower installation contractor costs through an area-based delivery approach may become more difficult, since it would be harder to guarantee household numbers to contractors and delivery could potentially be more dispersed over an area. The energy efficiency and low carbon heating measures would also likely become more diverse and tailored, which could prove challenging with the skill-sets of contractors predominantly used to delivering large-scale programmes of loft and wall insulation.

5.1.1.3 *Project delivery*

- The capacities of households, in particular with regard to installation disruption, should be considered when designing local programmes and setting national targets.
- Recognition of the energy efficiency programme is important for getting a high proportion of households to sign-up. National level public campaigns could be used to support programme recognition.
- Owner-occupiers seem content to use their own funds in conjunction with government grants and loans. An area in need of more development is how to encourage owner-occupiers to invest further in energy improvements which are not part of formal programme.
- Householders viewed the quality assurance work done by local authorities and delivery partners as a positive reason to get the work done. Consideration could be given of whether there a need to create a standardised process for quality assurance of works, along with accreditation for auditors.

Project Design



5.1.2 Benefits of established selection processes for HEEPS ABS

Terms and conditions of funding for the phase 1 pilots required local authorities to select their sample of households using the standard Home Energy Efficiency Scotland Area Based Scheme

(HEEPS ABS) criteria, aiming to target fuel poor areas beginning with those households in most need of assistance. These included:

- Scottish Index of Multiple Deprivation (SIMD)
- Council Tax Bands A to C
- Building type suitability for internal or external wall insulation

In addition, councils used data on fuel poverty, the energy efficiency of buildings (using SAP scores), tenure mix and fuel bills for the area. Wider council programmes, such as on-going retrofitting of social housing stock to comply with the Energy Efficiency Standards for Social Housing (EESH), also influenced the sample selection processes.

Local authority project managers' experience and familiarity with how to design and deliver HEEPS ABS programmes offered flexibility for designing the domestic element of the pilots. As a result, six out of the nine local authorities adapted their standard HEEPS ABS programme to fit wider objectives for the pilot.

Project managers noted the following benefits of using this established process for prioritising domestic projects:

- Pilots could be designed in the short timeframe.
- It allowed flexibility in combining the domestic and non-domestic elements of the pilots in an area-based approach.
- The pilot could be integrated into the council's existing energy efficiency housing strategy.

5.1.3 Challenges of Accurate Data

Residential sector data to inform programme design had been collected and refined over the previous years of running HEEPS ABS programmes. Three pilot lead officers commented that their data was most detailed for council-owned and ex-council-owned housing stock, including information about past works and energy efficiency measures that was unavailable for other domestic properties. However, there were still a number of unknowns and gaps in the available data such as type and age of existing energy efficiency measures. This created uncertainties for the local authority project delivery targets, budgets, and the contractors appointed to carry out the work.

5.1.4 Delivering more expensive retrofit measures

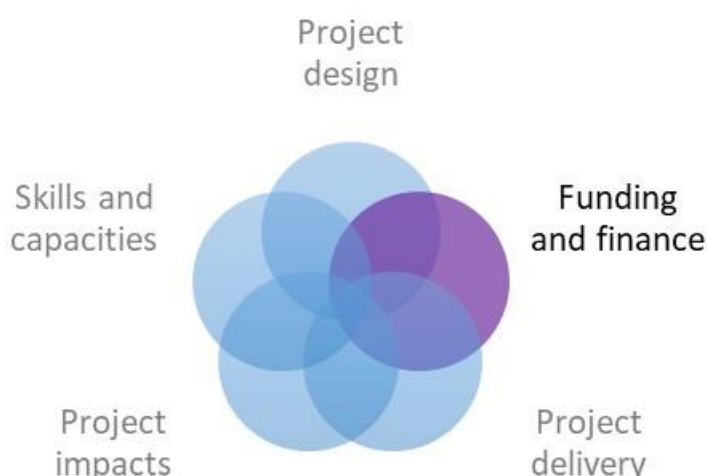
Some councils still have a large number of untreated domestic properties that are eligible for HEEPS ABS funding under the current criteria, and foresee a need, at current funding levels, for the HEEPS ABS programme to continue for 5 - 10 years. It was also noted by one local authority that there were many other property types that they were not currently tackling under HEEPS ABS, although their owners/occupants met many of the socio-economic funding criteria, because the property required more expensive retrofit work. Where possible it had blended different property types within a programme to enable the average cost per

household to stay within the funding limits. However, their main focus was on delivering the high numbers of lower cost measures that remained to be done.

5.1.5 Data analysis skills – role of external contracted partner and need for more internal resources

In four of the pilots, analysis of available housing and energy efficiency data sets was carried out by a third-sector external contractor, removing the requirement for in-house GIS skills and data quality checking of the local authority-held data sets. This also enabled local authorities to access the expertise and additional data sets developed by the commissioned external partner. One pilot also received support from the same partner in writing their wider pilot funding bid. However, it was noted by local authority officers that the lack of skills to carry out this type of spatial data analysis function in-house was sometimes limiting when they were trying to move beyond the standard HEEPS ABS model in designing their pilot project.

Funding and finance



5.1.6 Funding timescales

The HEEPS ABS funding for the domestic pilots needed to be spent within the 15-month project timetable (September 2016 – December 2017). Budgets were allocated by financial year (Year 1: September 2016 – March 2017; Year 2 April 2017 – December 2017) and in a change of practice from standard HEEPS ABS projects, the pilots were not permitted to accrue budget from Year 1 into Year 2. This change in budgeting policy generated a number of problems and flexibility was subsequently granted in several cases. Where delays had occurred, several projects were also given flexibility to complete works up until March 2018.

Local authority project managers made the following observations about the impacts of the funding timescales:

- Installation of works, including carrying out quality assurance checks and correcting any problems, had to be carried out within the short timescales of the funding. This meant

that works were sometimes rushed in order to complete them by the end of a funding period, creating a risk of poor-quality work.

- The short timescales for completion meant that bids for the work tended to come from a small number of larger installation contractors only, because they had the flexibility to mobilise sufficient staff. Although this was positive for local authority programme managers, in the sense that they worked regularly with the same contractors and got to know how to deal with them, it also had the effect of excluding local contractors.
- Work at the end of the financial year had an impact on the job security of installation contractors, because extra staff were taken on for short periods only. This also meant that opportunities to grow the experience and skills of installation were potentially undermined by unstable work circumstances.

5.1.7 Energy assessment methodology

Home energy assessments were carried out by all local authorities using RdSAP (Reduced data Standard Assessment Procedure) methodology creating an overall score for a property, taking into account existing measures and heating systems currently installed, and creating an overall score for a property. This score was used to define eligibility for funding.

The following issues were encountered in the pilots:

- In one pilot, a problem was experienced because the methodology assumed timber-framed homes would already be insulated, although there were several of these that were not. Insulation for timber-framed houses was not eligible without special permission from the Scottish Government.
- The RdSAP score is increased when a home is connected to district heating. This meant that households were ineligible for Warm Homes scheme grants¹⁹ to cover lower cost measures such as under-floor insulation, because their RdSAP score was too high.
- Due to the settings of RdSAP, recommendations for heating controls for district heating only allowed a combination of 2 measures from programmer, room thermostat, or thermostatic radiator valves. It was not possible to get all three with an oil system or a gas system. This change also had to be agreed explicitly with the Scottish Government during the course of the pilot project, causing extra administration and delay to the project.

5.1.8 Energy Company Obligation (ECO) funding

The Energy Company Obligation (ECO) is a UK government energy efficiency scheme where larger energy suppliers must fund installation of energy efficiency measures into British Households²⁰. Local authorities running HEEPS ABS schemes and EES pilots are encouraged to

¹⁹ Energy Saving Trust, 'HEEPS: Warmer Homes Scotland Scheme', 2018 <<http://www.energysavingtrust.org.uk/scotland/grants-loans/heeps/heeps-warmer-homes-scotland-scheme>> [accessed 17 September 2018].

²⁰ OFGEM, 'Support for Improving Your Home: How ECO Works', 2018 <<https://www.ofgem.gov.uk/environmental-programmes/eco/support-improving-your-home>> [accessed 17 September 2018].

access ECO funding to subsidise their area-based projects and maximise the works that can be delivered.

Predicting the amount of Energy Company Obligation (ECO) funding available for works at the start of projects was difficult for local authorities due to the approach used by energy supply companies to deliver their obligations through installation contractors. Energy Supply Companies would offer a certain level of ECO funding to an installation contractor for delivering a set number of measures. This approach was used because contractors were able to offer larger scale delivery of measures than those required by individual local authorities, hence reducing the administrative cost of dealing with multiple parties. Installation contractors would then include an offer of ECO funding when they tendered for the local authority project, thereby reducing the overall cost of the works. This system made it difficult for pilot managers to predict accurately the necessary level of owner contributions within the pilots since the ECO funding received by the contractor was not always passed directly onto the local authority. Project proposals that did not use a fixed owner-contribution had to wait until quotes were received from contractors in order to get an accurate idea about the costs to owners of proposed works.

5.1.9 Owner contributions and loans

Private home owners could be required to make an “owner contribution” towards the costs of those works which were more expensive than the maximum grant level. The maximum grant varied according to the location and house type and was between £6500 and £9000.

The EES pilots took different approaches to setting the level of owner contribution:

- Some set a flat rate for all HEEPS ABS projects. This allowed them to begin engagement with householders earlier, without having to wait for quotes from contractors to confirm the level of owner contribution.
- Some calculated the owner contribution for each household according to the costs of works.

One project did not require any owner contributions because the cost of the works was below the grant funding threshold.

5.1.10 Attitudes of owners to the required financial contributions

In some cases, it was reported to be easier to engage householders in a programme when there was an owner-contribution because completely free measures were sometimes viewed with suspicion by householders – it was “too good to be true”. However, in areas where the HEEPS ABS programme was already familiar to residents, due to past works in neighbouring streets, the owner contribution was also viewed as a barrier, because other households had in the past received the same measures free of charge.

5.1.11 Loans for energy efficiency

Owner-occupiers who needed to make a financial contribution had the option of taking out a zero-interest loan from Energy Saving Trust through the Home Energy Scotland Loan Scheme²¹ to cover the costs of the energy efficiency works.

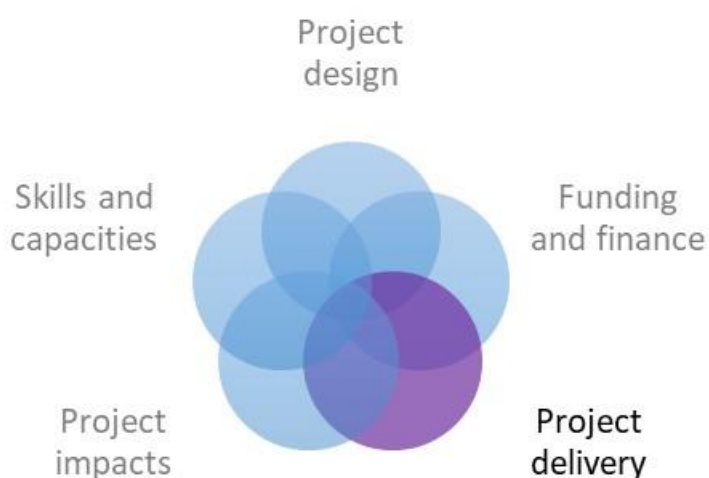
- Loans could cover only the costs of energy efficiency upgrades, and not additional costs for remedial works.
- The minimum loan was normally £500.
- The loans were arranged directly between the householder and Energy Saving Trust, and levels of uptake were not monitored by the local authorities. Pilot leads reported that they seemed to work well.
- In one case the householder was unable to access the loan until after the works had been completed. This meant that householders had to find the money from an alternative source in advance if they wanted to proceed.

In general, loans were thought to be working well for the purposes of owner contributions in the pilots.

5.1.12 Financing remedial works

Remedial works were needed in several pilots in order to ensure that the installation of energy efficiency measures such as external wall insulation would create an effective thermal envelope, particularly in certain building types (e.g. See example in Appendix C.1, where the costs of remedial works for owner occupiers was £3800 per household in a Glasgow tenement block) . In a few cases, contractors would arrange to carry out these works directly with the household. However, the costs of the remedial works were cited as a barrier to certain areas being selected for a HEEPS ABS programme, because the costs were significant and there was often not financial support available in the form of a grant or loan to help households to pay.

Project delivery



²¹ Energy Saving Trust, 'Home Energy Efficiency Programmes - Energy Efficiency Measures', 2018 <<http://www.energysavingtrust.org.uk/scotland/grants-loans/heeps>> [accessed 12 October 2018].

5.1.13 Procurement

There were well-established procurement processes for the domestic side of the pilots, because of on-going HEEPS ABS programmes. In four cases, the pilot domestic works could be included in existing HEEPS ABS works, and there was no need for an additional procurement exercise. This had a minimal effect on project managers' workload and meant that works could start earlier.

However, there were also examples of procurement processes causing delays to project delivery, with negative impacts on meeting funding timescales. In particular, the end of the Energy Saving Trust procurement framework (a means of procuring works from a list of pre-selected contractors without going through a time-consuming tendering process) during the course of the pilot projects meant that two of the projects had to begin using an alternative procurement framework and to get this approved in council committees. Project managers were also unfamiliar with the different framework and it took more time and work to complete the process.

It was noted by two of the pilots that contracts were often won by the same contractor. On the one hand, this was seen as positive: as mentioned previously, local authorities got to know the contractor and how to work with them. On the other hand, it indicated a lack of a competitive market for contractors. The new procurement frameworks were therefore an opportunity to bring in more players.

The structuring of EES pilots to integrate domestic and non-domestic projects had led to two pilots considering how to do a joint procurement exercise across both components of their project. This could reduce the overheads associated with procuring the works separately. However, neither project attempted this because different types of measures and different timescales were involved.

5.1.14 The role of installation contractors

This section discusses the approaches and practices used by the installation contractors and how they influenced the outcomes and benefits delivered by the pilots.

5.1.14.1 *Skills and capacities of installation contractors*

Local authorities and their delivery partners used the installation contractors as a source of experience and knowledge, particularly when delivering measures that pilot leads were not familiar with, such as internal wall insulation. Contractors were sometimes consulted about engaging with households and asked to attend public meetings to explain technical aspects of measures, such as the installation process and expected impacts and benefits.

Contractors could also identify other opportunities for additional energy efficiency measures not covered by HEEPS ABS grants during their standard technical survey (examples are double glazing or upgrading boilers). They could also agree with householders to carry out remedial works where necessary. These processes were conducted directly between the contractor and householder and were not monitored by the local authorities or covered by project funding.

5.1.14.2 Accreditation for installation contractors

The HEEPS ABS funding requires that installation contractors are “PAS 2030” certified²². However, in Shetland, this excluded many of the local contractors who were not accredited. In this case, the local authority had held an engagement event to raise awareness of this requirement and to encourage local contractors to register for the accreditation. The event had enabled new contractors to bid for works.

5.1.14.3 Contractors’ local knowledge and relationships

Installation contractors had existing local knowledge about target areas because they had already installed measures in other projects. For example, in one pilot the contractor had existing working relationships with housing association property owners on target streets. This meant that the contractor could achieve economies of scale by quickly gaining agreement of local decision makers to proceed with works in their properties alongside work in neighbouring homes. Another local authority had drawn on contractors’ local knowledge of housing types in their area to add details about existing installed measures and untreated homes to their database for future energy efficiency programmes.

5.1.14.4 Contractor influence on pricing

Contractor pricing for delivering the energy efficiency measures was influenced by the structure of the pilot project, local economic and environmental factors, and ECO pricing deals.

The way that a project was set up could create uncertainty for installation firms, who priced accordingly. In one local authority, firms quoted lower prices if projects involved a high proportion of social housing, because of certainty over the number of measures they would be installing and more predictable delivery timeframes. Firms also quoted lower prices for area-based delivery approaches, as opposed to individual referral schemes, because the number of measures could be predicted, materials bought in bulk, and works organised street by street. This made it simpler and quicker to do the works.

²² “PAS 2030:2012 is a Publicly Available Specification for the installation of energy efficiency measures in existing buildings, [available for purchase from the BSI](#). It also recommends best practice for managing the installation process and providing services to the customer before, during and after installation.” (BEIS, UK Government: <https://www.gov.uk/guidance/becoming-an-authorised-green-deal-organisation>, accessed 17/09/2018)

5.1.15 Recruitment and engagement with householders

5.1.15.1 Initial engagement

Letters: It was standard practice to send out an initial letter or postcard inviting owner-occupiers and private landlords to take part in the programme and providing some initial information. The landlord register was checked, and letters were sent both to registered landlords alongside the tenants. One delivery partner had also developed relationships with local letting agents and factors to help with engagement of private landlords. Information letters were also sent to tenants in social housing to ensure they could access energy advice services and information about the installation.

Other mediums: Pilots used posters in the stairwells of blocks of flats; as well as social media for larger projects. Local councillors for the area were also briefed about the programme so that they were able to respond to any queries from constituents.

Information event: For larger projects, pilots held open days and meetings on a weekend or evening for households to drop-in. These events were attended by representatives of the installation contractors, council teams involved in overseeing the works and sometimes local councillors. Home Energy Scotland or a council advice team would also attend these events.

5.1.15.2 Establishing a reputation for the programme

Prior knowledge among households of the HEEPS ABS programme was an advantage for recruiting new households successfully.

One pilot project used community contacts and trusted figures in the community to spread the word. Council officers reported that in previous HEEPS ABS programmes they were able to build up the reputation of the programme over time. As people saw their neighbours get the measures installed, allowing them to talk to others who had been through the process, they were more likely to sign up at a later date.

However, the short timeframe of the EES pilots meant that, in areas where the programme was new, there was insufficient time to build up recognition and pilots experienced low sign-up rates as a result. One pilot did not succeed with one of their original target areas; they changed focus to a different area where the programme was already well known and in demand, enabling them to spend the available funding in the timeframe of the pilot.

5.1.15.3 Signing-up householders

There were different approaches used in the pilots to get a commitment from householders to install measures under the programme:

- In three pilots, householders that expressed interest in taking part in the programme were contacted by a Home Energy Scotland advisor as their first point of contact. This approach offered the householder wider advice on energy saving and made

recommendations beyond the specific measures funded by the pilot. The advisors would also assess for eligibility for Warmer Homes Scotland²³ and refer them for a Citizen's Advice Bureau benefits check. Upon making a commitment to the programme, householders were then referred on to the contractor to arrange the installation works.

- Contractors also took direct responsibility for signing up households to the programme with a door-knocking campaign after the initial letter and information event. One pilot manager highlighted the experience and success that their contractor had with signing up households, particularly in blocks of flats. However, two other pilot leads felt that they got a higher sign-up rate when the local authority advisors lead on this work.

5.1.15.4 Support during delivery

The support that householders received before and during the installation process was thought to be an important part of maximising energy savings. Pilot managers used different approaches to support householders throughout the process:

- Three of the pilots identified households that needed additional support and set this up with Home Energy Scotland.
- One pilot had developed a pre-survey with householders to understand their needs and concerns. They liaised with a householder's family or friends support network where this was helpful.
- Three pilots had council-employed advisors supporting householders throughout the installation process. They were on-site during the installation works to answer questions and deal with issues. One of these pilots felt that this higher level of contact with the householder resulted in additional lower-cost measures, and more behaviour change, because householders felt more confident about making changes (unfortunately it was not possible to draw conclusions on this hypothesis with the social survey data since the sample sizes were too small).

5.1.15.5 Vulnerable households

It was beneficial, and often necessary, to provide tailored support to more vulnerable households during the installation process by offering extra home visits and providing contact details for advisors who could answer questions throughout the process. Internal wall insulation was a particularly disruptive measure, so energy assessors adjusted their recommendations to less intrusive measures according to the needs of the householders.

5.1.15.6 Factors that influenced sign-up to the programme

- Improved aesthetics of the home;
- Good value for money due to grant-funding;
- Adding value to the property;

²³ The Warmer Homes Scotland Programme is a national fuel poverty programme in Scotland. It aims to install "insulation, heating and micro-generation measures in homes of customers identified as living in or at risk of fuel poverty" Scottish Government, *Warmer Homes Scotland - First Annual Review* (Edinburgh, UK, 2016) <<https://beta.gov.scot/publications/warmer-homes-scotland-first-annual-review/>>.

- Being able to see the measures already installed in a similar home;
- Promoting energy bill savings;
- Creating warmer homes;
- Providing support throughout the installation process, including independent quality assurance.

5.1.15.7 *Current gaps*

- National awareness of the HEEPS ABS programme is currently low if the programme has not been run in a neighbouring area. Two project managers suggested it should be considered how national level public campaigns could be used to raise awareness of the programme.
- Local authorities and their delivery partners often have limited knowledge about the condition of privately-owned domestic properties and opportunities for energy efficiency improvements. It would be beneficial to invest more resources in developing this information through local surveys and engagement in advance of running a recruitment programme in order to inform appropriate programme design and achieve higher sign-up rates and energy savings.

5.1.16 *Quality assurance*

Ensuring that energy efficiency measures are installed to a high standard is critical to meeting the full energy saving potential.

A range of different actors were involved in quality assurance within the pilots:

- Clerks of works, employed by the local authority or delivery partner, were often onsite during installation.
- In two pilots, home energy assessors were also part of the quality assurance process.
- Installation contractors could deploy independent auditors to verify the quality and health and safety standards of their work.
- ECO inspectors can check that works were compliant with ECO requirements on behalf of energy suppliers.
- Contractors commented that there should be an accredited benchmark standard for carrying out quality assurance.

Implications and lessons

Project design

- The analysis skills of external delivery partners, which could be accessed by multiple local authorities, were clearly useful for those local authorities who lacked in-house resources. This set-up enabled skills to be pooled and common methods to be established for designing domestic programmes. These methods used purely data-based analyses with publicly available data sets such as the Home Energy Efficiency Database. One delivery partner had also developed their own fuel poverty database to inform their analysis. However, the delivery partners are detached from the wider

political and strategic thinking of the local authority, making it difficult for projects to deviate from established methods without significant consultation or a lack of scrutiny on the part of the local authority. As the scale of EES grows and the scope of work becomes wider, it will be important that there is a clear and accountable means of linking between local authority-owned local heat and energy efficiency strategies and the project prioritisation methods used by any outsourced delivery partner.

- There is a perceived lack of data about privately-owned domestic properties. Developing more detailed databases about energy efficiency measures as and when they are installed will be beneficial for planning future energy efficiency programmes. In addition, earlier engagement with households, including carrying out early technical surveys to inform programme design, costing and procurement, was an area highlighted for potential further work.

Funding and finance

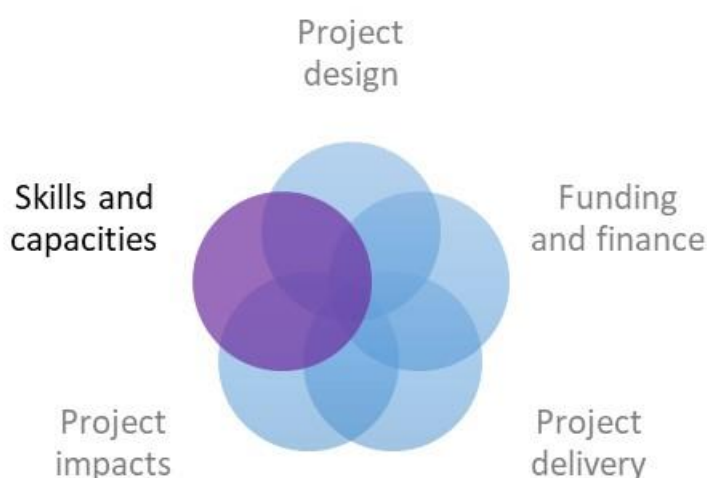
- The short funding timescales of the pilot energy efficiency programmes caused several project management problems. Longer funding timescales, or greater project flexibility would help to overcome some of these challenges.
- Although the standard assessment procedure (SAP) methodology provided a useful framework for making standardised retrofit recommendations, it caused problems for certain housing types and technologies. Methodologies need to be updated as issues arise and there is a need to ensure that recommendations are in line with local area heat decarbonisation plans.
- The costs of remedial works were a barrier for some households. Financial support mechanisms would be beneficial to help with the costs of remedial works. The circumstances and criteria for making financial support available need to be specified.

Project delivery

- As EES seeks to deliver less familiar or more disruptive measures, a programme of public engagement is needed, as well as new information networks to share experiences and best practice across local authorities, delivery partners and contractors about what has worked in supporting householders to proceed with retrofit.
- As the EES programme expands and evolves to meet the challenges of upgrading the whole building stock, procurement must be redesigned to support delivery needs. This will require regular reviews of the best procurement processes for retrofit programmes.

- As programmes move beyond grant-funded measures into encouraging private householder investment and take up of loans, the opportunities for achieving lower installation contractor costs through area-based delivery may decrease. Future pilots and evaluations should consider ways in which programmes can overcome resulting uncertainties and gain economies from bulk procurement of materials and installation.
- Installation contractors played an influential role in household engagement, and also sometimes encouraged households to install additional measures above those funded by the pilot. The general impression from the pilot projects' household surveys is that owner-occupiers are willing to use their own funds in conjunction with government grants and loans. What capacity is there to encourage home owners to invest further in energy improvements which are not part of a formal programme?
- It may be challenging to achieve the full technical energy efficiency potential in some cases because of the disruption caused to vulnerable householders. In several of the pilots, it was considered important to offer flexibility over recommended measures to allow for the differing capacities of households to manage the disruption. It was felt that this resulted in higher uptake rates of the simpler measures. The capacities of households should be considered when designing local programmes and setting national targets.
- Public recognition of the energy efficiency programme was important to ensuring that a high proportion of households signed up. This was limited by the short timeframes of the pilots, but as EES develops it will be important to increase programme recognition. National public campaigns could be used to support programme recognition and action by owners.
- Although householders viewed the quality assurance provided by local authorities and delivery partners as a positive reason to proceed with retrofit, there were inconsistencies in approaches to quality assurance. A standardised process for quality assurance of works is needed, alongside accreditation for independent auditors.

6 Skills and capacities for delivery across the domestic and non-domestic sectors



Scaling up energy efficiency upgrades in Scotland will require an efficient distribution of skills and resources between local authorities and their partners, and in some cases development of new skills and capacities. This section considers the current distribution of skills and resources in the pilots, delivering in both the domestic and non-domestic sectors, and discusses implications for scaling up EES in the future.

Project resourcing and skills - Outsourcing vs. in-house delivery

Allocation of resources to local authorities in the form of bounded project funding was seen as creating risks for effective management of core workloads alongside additional project tasks. For example, one local authority reported that their staff team already had a fully committed workload and additional work for the pilot meant delaying other core projects.

6.1.1 Outsourcing to contracted delivery partners

Local authority staff reductions over several years was cited as another key challenge which left no choice but to out-source delivery of the pilot projects. The short timescales also left insufficient time to recruit a fixed-term project officer. Two project teams were affected by the loss of staff members during the course of the pilots. This caused significant issues since there was no flexibility within the small teams to fill any knowledge gaps or deliver the tasks of the missing team member. In both cases, this led to a reduction in the pilots' delivered outcomes.

Delivery partners contracted by local authorities to take on project coordination roles were recognised as an important resource that “picked up the slack” when local authority staffing issues arose. Their involvement in multiple projects meant that they were able to pool knowledge and experience to inform their work on projects and they influenced the design and delivery of projects and their impacts. For example, they held specialist spatial data analysis

skills, and experience of public engagement and behaviour change campaigns on energy efficiency across multiple local authority areas and housing types.

The influence of, and opportunities offered by, delivery partners is an area that would benefit from further exploration in future evaluations.

6.1.2 Maintaining in-house capacity

Conversely, for some local authorities, maintaining in-house resource and skills was seen as important to achieving the best outcomes from energy efficiency programmes.

The presence of an in-house team to manage local authority-owned properties was common, and the skills and experience of this team were recognised as an important source of advice during pilot design. The fact that they were in-house also offered more flexibility to consider projects outside their usual remit.

On the domestic side of the pilots, three local authorities used in-house teams to deliver their domestic programmes. They had specifically chosen to develop skills in-house with training as Green Deal Advisors and from Home Energy Scotland. This approach enabled them to have more control over the programme delivery and adapt it to local circumstances. There was an emphasis on the importance of a consistent customer journey with one-to-one advice from a trusted and recognised source.

Despite the recognition of the value of this in-house capacity, in one of the local authorities, the in-house programme managers were on temporary contracts which were reliant on the HEEPS ABS project funding from Scottish Government. There was therefore a risk that the expertise and experience of these staff members could be lost to the local authority should the funding regime change.

What skills and capacities are needed to move beyond public sector building stock?

With local authorities taking on a strategic heat planning role through local heat and energy efficiency strategies (LHEES), it is important to consider and build upon the existing channels used for establishing cross-organisational working in the non-domestic sector and the factors for success. However, it should be recognised that areas of work such as working in the non-domestic sector outwith publicly-owned buildings on the scale implied by EES is a new area of work for all local delivery actors and this will require development of new skills, working relationships and resources to support these new activities.

6.1.3 The role of 'ad hoc' coordinators

Delivering retrofit programmes for non-domestic buildings beyond the public sector will require processes for identifying opportunities and coordinating the work. In the phase 1 pilots, there were few established processes or working relationships between the local authority and

non-domestic organisations for energy efficiency projects. For the limited number of pilots working with independently-owned non-domestic buildings, 'ad hoc' coordinators were critical.

For example, there were two pilots where external partners had proactively contacted the local authority on hearing about the EES funding opportunity. The local authority teams in charge of the pilot bids would not have known about the opportunity without this additional facilitator. In these projects, 'ad hoc' coordinators also played a role in project delivery, sharing expertise and liaising between building owners and tenants to ensure success. In another pilot, local politicians were influential in bringing a community organisation to the attention of the project team.

6.1.4 Cross-organisational cooperation within the public sector

For public sector buildings not owned by the local authority, cross-public sector cooperation was needed at the bid stage to enable a project to be included in the pilot. Cooperation was also recognised as important for enabling investment in larger low carbon energy infrastructures such as heat networks.

- In the phase 1 pilots, insufficient time to consult with potential partners in advance of project bids meant that pilots relied on existing, established relationships.
- However, these working relationships were often informal and were vulnerable to loss of a staff member.
- Availability of staff resources was recognised as a critical factor to effective cross-organisational working relationships. These were hampered because staff resources were already tied up with core organisational compliance, leaving little space for developing new ways of working.
- Differing investment timescales and priorities made it difficult for organisations to work together with the short funding timescales of the EES pilots.

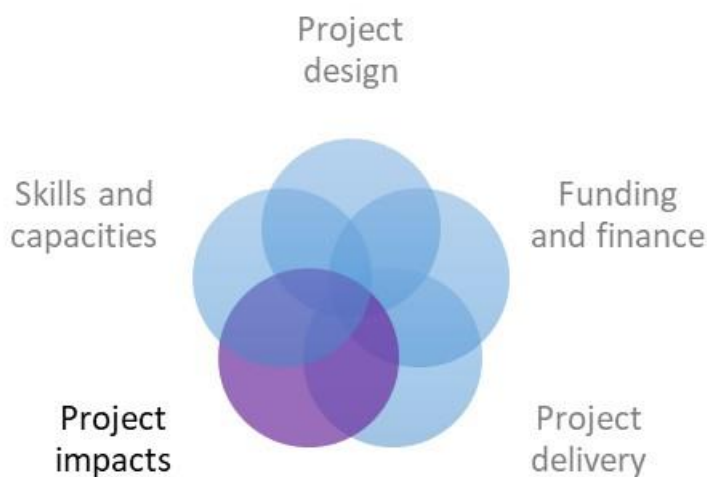
Implications and lessons

- Local authorities still need a clearer understanding of their future roles and responsibilities in the delivery of EES. This needs to be established in order to allow local authorities the time to develop appropriate staffing levels and skills development to take on larger and more complicated projects.
- A number of companies and charities regularly take on contracts to deliver energy efficiency projects for local authorities; it will be important to consider the skills and capacities held by these wider project delivery partners in future planning of capacity and skills development.
- There is a gap in skills and resource within local authorities to engage with non-domestic organisations beyond the public sector on energy efficiency (both in and out of the public sector). Scaling up programmes will require a move beyond ad hoc coordinators or individual social capital. This type of cross-organisational engagement

on energy is unprecedented and will require the establishment of new networks and processes to facilitate delivery of measures. How can this resource be developed?

- How can local authorities further develop cross-public sector working on energy efficiency, underpinned by the vision and ambition in local heat and energy efficiency strategies? Where possible, this could tap into existing networks such as Integrated Joint Boards between the NHS and local authorities that might offer an opportunity to support joined up approaches.

7 Understanding project impacts and perceptions



The non-domestic sector

7.1.1 Maximising carbon emissions reductions from non-domestic projects - Flexibility in timescales

The short project timescales resulted in projects running out of time to deliver some measures and this restricted the carbon emission reductions that were delivered in some of the pilot projects. A number of unexpected complications arose during the course of projects resulting in a reduction in scope or cancellation. For example:

- A lack of agreement between relevant decision makers meant that certain disruptive measures were not installed;
- Investment timescales of the non-domestic organisations did not fall within the timescales of the project (e.g. investments needed to be made sooner or later than the project funding allowed).

Although project managers were often aware that there were risks in attempting to deliver a particular project in such a short timeframe, they were inclined to commit to deliver the project in order to take advantage of grant funding and to maximise the benefits in their local authority area.

7.1.2 The importance of visual impacts of measures in the non-domestic sector

A notable aspect of feedback was that people valued the visual impacts of measures in both the domestic and non-domestic sectors. For example:

- Positive feedback was received on LED lighting retrofits in NHS Lanarkshire buildings,
- Visual improvements associated with external wall insulation on the Glasgow Community Centre were cited as a key driver for the project alongside savings on energy bills.

A concern for negative visual impacts from the measures was also a barrier in some pilots, where building occupants wanted to preserve charismatic or historical features of buildings.

For example, the red sandstone tenement block in Glasgow, and specialist building features in community buildings in Aberdeenshire.

7.1.3 What the non-domestic technical data indicated

In four non-domestic properties existing lighting was replaced by LED equivalents; all showed electricity savings ranging from 6% to 44%. The savings achieved depended on what was replaced; if florescent tubes or incandescent bulbs were being replaced then the saving would be larger than replacing existing CFL bulbs as they are more efficient, but not as efficient as LEDs. As LEDs are dependent on lighting requirements which do not vary year on year, the direct benefits from installing energy efficient lighting are typically very reliable, unlike measures that affect heating consumption which not only varies season by season but also depends on specific requirements.

In one non-domestic pilot, there were reductions in gas use in 3 out of 6 buildings and increased gas use in the other three. All indicated their heating patterns had changed, and all but 1 showed significantly changed gas consumption. These results indicated there was some review of the heating regime in the non-domestic buildings; this usually is good practice as heating needs change over time and energy efficiency measures should reduce the heating duration. Those buildings where gas consumption increased had new heat exchangers and a new building energy management system (BEMS) installed, which in themselves shouldn't increase gas consumption; this suggests that the heating duration or temperature was increased.

Non-domestic properties are difficult to analyse collectively as each has its own purpose, use and energy-use requirements. To make a full and conclusive study on non-domestic buildings requires long-term monitoring with details on usage throughout the period. Only then can actual impacts be attributed to energy efficiency interventions. Although this was a short study with limited data it does indicate promising positive impacts of the measures, but further data is needed.

7.1.4 Impact on EPC ratings of the non-domestic properties

EPC data for non-domestic properties was received from only one of the pilots, showing information from 11 buildings. However, much of this data was only for pre-installation EPCs and so a direct comparison was not able to be made about the impacts of the works on the EPC rating of the property.

Pre- and post-installation EPCs were received for 3 properties (see Figure 4); and from this data there was no suggested change in EPC rating. However, this was due to the methodology used to determine the EPC rating, rather than a lack of improvement in the energy performance of the building (as demonstrated by the technical monitoring data reported in section 7.1.3). For example, one of the properties which remained at an E rating had had a building energy

management (BEMs) system installed. The rdSAP methodology which calculates the EPC SAP score and EPC rating has no function to account for BEMs systems, therefore no change in the EPC was to be expected. Another property experienced no change and remained at a C rating because rdSAP cannot account for the installation of efficient water to water heat interface units (HIU) for district heating systems. Finally, the third property, which also remained at a C rating showed improvements in the energy consumption per square meter of the building from 435 kWh/m² to 428 kWh/m², most probably due to the combination of the loft top-up insulation and TRV's installed. However, the SAP score improved only by 1 due to the simplistic way rdSAP represents improved heating controls and assumes only a small impact, resulting in only a small change in SAP score.

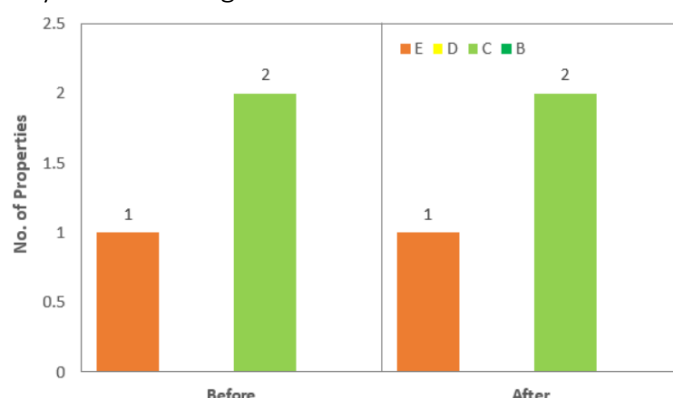


Figure 4: Comparison of complete pre- and post-installation EPC data received for non-domestic buildings in one of the pilots.

Of the remaining properties, there were several pre-installation EPCs that were calculated using an old methodology. In one case this resulted in a strange result where the post-installation EPC was worse than pre-installation; which is unlikely. These cases were removed from the comparison in Figure 4 since they could not provide a meaningful measure of improvement. Nevertheless, all EPC data received by the evaluation team is presented in Figure 5 for information.

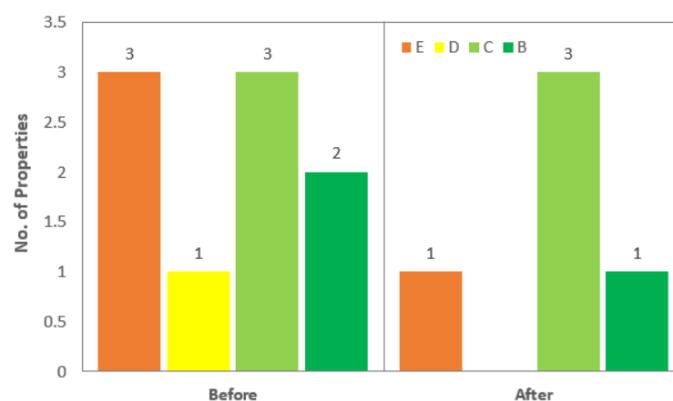


Figure 5: Full and partial EPC data received for non-domestic buildings.

It was only possible to do this analysis for one of the pilots, however, it highlights some of the challenges that may be experienced if using EPC assessments as a metric of building improvement. Given the lack of EPC data provided to the evaluation team by the majority of

the pilots, it would be useful for future evaluations to consider current local authority practice for conducting EPC assessments in the non-domestic sector and understand whether the experiences in the pilot discussed here are experienced more widely.

The full technical monitoring results by local authority area are included in Appendix B.

The domestic sector

This section provides a summary of the key findings of the domestic social surveys conducted before and after installation of the energy efficiency measures. For a detailed breakdown of the results by local authority area see Appendix E and as a complete cohort in Appendix F.

7.1.5 Household surveys

Prior to installation (Time 1; T1), 168 surveys with households were carried out across eight local authorities, and 109 post-installation (Time 2; T2). Of these, 86 were surveyed on both occasions, and provide the basis of this cohort analysis of pre- and post-installation experiences. Taken as a whole, the cohort provided a range of house types of varying ages, sizes, and tenures, and across households with diverse socio-economic and demographic characteristics.

The median gap between T1 and T2 surveys was 14 months, and between installation and T2 surveys, 6 months. The latter is a relatively short time-gap and does not cover a complete heating season. (See Appendix A.1 Table 4 for a summary of the survey numbers successfully collected at T1 and T2)

These survey numbers are lower than the target sample numbers. A discussion of the reasons for why the target numbers were not able to be achieved is presented in Appendix G, along with lessons for future evaluations.

7.1.6 Improved household temperatures

At T1, two-thirds said they had been cold during the previous winter for all, most or some of the time. Just under a half said that being cold was a problem for them. There has been a considerable improvement in respondents' assessments pre- and post-installation (Figure 6 and Table 3). For example, of the 22 respondents who said they were cold all or most of the time at T1, only 5 did so at T2, and these were commented in the survey data as being largely as a result of health issues.

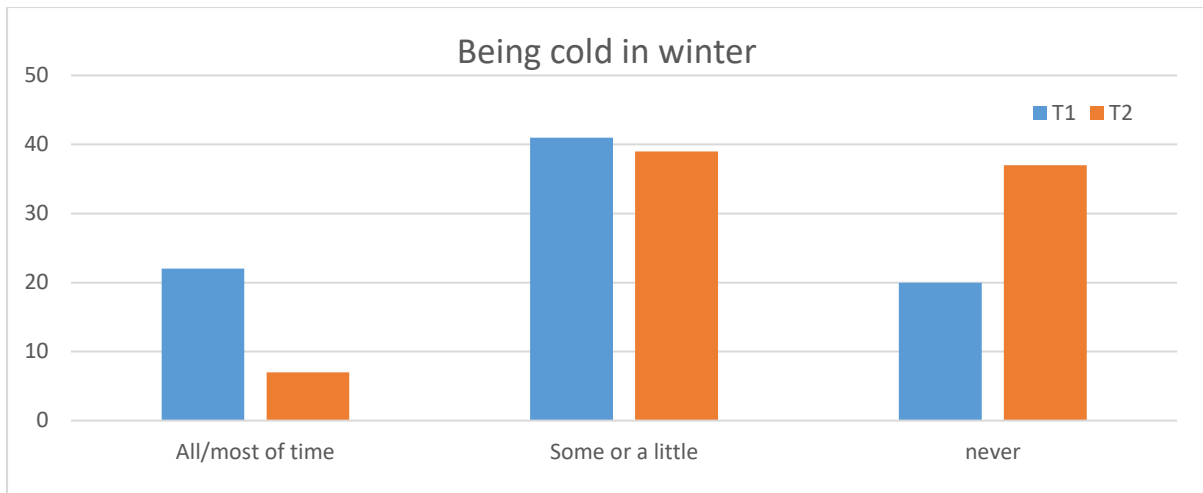


Figure 6: Being cold in winter graph.

Being cold in winter		T2			
		All/most of time	Some or a little	never	Total
T1	All/most of time	5	11	6	22
	Some or a little	2	23	16	41
	never	0	5	15	20
	Total	7	39	37	83

Table 3: Being cold in winter data.

Taking these figures as indicative of change, there has been considerable reduction in people's perceptions of being cold. This was echoed in the technical evaluation where it was found in several domestic dwellings that the average internal temperature had increased after the measures had been installed, with little change in gas consumption; suggesting that the heating system was able to achieve a higher average temperature in the dwelling based on the same gas usage (see section 7.1.12 for more details of the technical monitoring results).

7.1.7 Measures to keep warm

At T1, respondents were asked what they had done to try to keep warm at home in the previous winter. Practices ranged from relatively minor actions such as putting on a jumper, drawing curtains and closing internal doors regularly, through to more serious actions such as cutting down on food, deferring bills, leaving the house to save heating, and going to bed early. When interviewed at T1, few had adopted major measures to keep warm, and at T2, any need for these more serious actions had all but disappeared.

Housing conditions such as damp, mould and condensation were significantly improved between pre- and post-installation. This is to be expected as energy efficiency measures should reduce the heat loss rate and enable a building to retain its heat for longer, reducing the areas of cold air where moisture can condense and create damp mouldy conditions.

7.1.8 Paying for energy

Most of the households who completed the surveys seemed unlikely to be in fuel poverty: Calculating the median on the reported spend on energy (heating and hot water) at T1 and T2

showed a modest decrease in spending from 5% to 4% of net household income. This is well below the current official threshold figure indicating fuel poverty of 10% of net household income spent on fuel costs (according to the current definition of fuel poverty in Scotland, currently under review²⁴). These figures are illustrative rather than definitive, given that a complete annual heating cycle has not yet been achieved and are based on reported rather than actual spend. As mentioned above, virtually no-one had recourse to serious measures to pay for energy (such as cutting back on food, deferring bills, turning off heating). By T2 interviews, the small number who had taken such measures had dwindled to nothing.

7.1.9 Housing satisfaction levels

While levels of satisfaction and feelings of security (i.e. feeling at home, feeling safe, and not thinking of home as a place to get away from) had been high at T1, insulation measures had boosted these levels still further. For example, there was a significant shift from being 'quite satisfied' to 'very satisfied', and the handful of negative attitudes towards home had become positives. Everyone, without exception, reported feeling safe and secure at home at T2.

7.1.10 Expectations of the energy changes

At T1, three-quarters of respondents said that they were 'very keen' on proposed energy changes. By T2, virtually all reported that they were 'fairly' or 'very satisfied' with the energy changes, although a few judged that the changes had not had the desired effects of improved household temperatures.

What had people wanted from energy changes in the first place? Three features stood out, with 'reducing energy bills' top of the agenda, followed by greater home comfort, and greater control over energy. Post-installation assessments are influenced by the short time-period between the work carried out and T2 interviews. Less than half (around 40%) of those who had wanted reduced bills said they had made savings; there were marginally higher rates (around 50%) of reported improvements to home comfort and control over energy.

Interestingly in the technical evaluation there were not many dwellings that saved energy, however a number of them did show that their internal temperature increased after installation suggesting that comfort was taken negating the energy savings that would have been achieved. It should be noted though that the amount of data this was based on was limited and more data would be needed to confirm this (see section 7.1.12 and Appendix B for more details).

Despite the recency of installations in most cases, levels of disruption were not judged to be high. Complaints focused on detritus left in gardens or having to cope with work on internal wall insulation while living in the property.

²⁴ Scottish Government, *Fuel Poverty (Target, Definition and Strategy) (Scotland) Bill* (Edinburgh, UK, 2018) <[http://www.parliament.scot/Fuel Poverty \(Target Definition and Strategy\) \(Scotland\) Bill/SPBill375052018.pdf](http://www.parliament.scot/Fuel%20Poverty%20(Target%20Definition%20and%20Strategy)%20(Scotland)%20Bill/SPBill375052018.pdf)>.

Do people have a better understanding of how to save energy? Prior to installation, around 60% thought this would be the case, and at T2, about half of these judged this to be so, with the rest thinking it was too soon to tell.

7.1.11 Information and monitoring

At T1, most people (around 70%) had heard something about the work programmes, mainly from their local Council, whether by meeting officials at the door, letters or leaflets, or public meetings. About half said they had experience of previous energy efficiency improvements, as had their friends and relatives.

To what extent do people use their heating differently post-installation? The broad indication for the social and technical data is that life goes on as before the energy efficiency and heating system changes. There was a modest rise in the extent to which people reported using pre-set heating programmers, as well as adjusting radiator valves, but many suggested that they still relied on using some form of on-off switch. The technical evaluation corroborates this with only a handful of the monitored dwellings showing a significant change in gas consumption, which means that householders chose not to change their heating regime or received no advice on how and why they should change their heating regime²⁵. (See Appendix F.7 for more details of these survey results).

In terms of energy use post-installation, this had changed very little. Participants reported that monitoring of energy use is still done mainly by relying on energy bills, rather than using energy monitors or smart metering.

7.1.12 Reducing energy use

This section presents a summary of the findings on energy reduction in the domestic sector, based on both the social surveys and technical monitoring where complete data sets were available. Collecting complete data to inform this evaluation, particularly in the form of technical monitoring, was challenging. This is discussed in Appendix G in detail, including drawing lessons for future evaluations of energy efficiency projects.

To what extent have the energy changes led to reduced energy use? There were only a few instances where complete technical monitoring data was gathered for the domestic properties. Where these data were available (the key example is eight houses in South Lanarkshire where Swedish timber-clad houses were externally clad), it appears that residents were more likely to experience the effects of the energy efficiency measures as an increased

²⁵ It was a condition of HEEPS ABS funding to provide “support to [householders] to improve the use of energy in the home to maximise the benefits of the installation”. However, the form of this support was not explored within the social surveys. Current practice in post-installation advice and support would be a useful topic for consideration in future project evaluations, given the limited change in energy consumption resulting from the domestic measures.

household temperature, rather than reducing gas consumption. The corresponding social surveys indicated that there was also a considerable reduction in householders' perceptions of being too cold, suggesting this increase in temperature was experienced by residents as an improvement in home comfort. In only 1 of the 8 homes was there a statistically significant reduction in gas use over a 15-week period, although this was at a modest level (0.4%). The rest had no statistically significant change in gas consumption. On the other hand, there was strong evidence of greater heat retention in the houses, as measured by reduced standard deviations in gas consumption²⁶.

It should be noted that there were three households whose average temperature rose to around 22 degrees centigrade which is higher than the recommended higher temperature of 21 degrees for vulnerable people such as the elderly or the very young. Two of these households increased to that level from around 19 degrees, which is well within the recommended temperature range of 18-21 degrees centigrade. They also experienced an increase in energy consumption, suggesting that their energy consumption patterns changed after the installation of the measures, e.g. the thermostat was turned up, or the heating system was used for longer hours. This points to these three households actively taking comfort after installation of the measure. This may be an important and necessary improvement for households with members who require higher household temperatures for health reasons, but it does raise a question of whether householders are actively choosing to heat their home to this temperature for comfort or health reasons, or whether this is due to a lack of motivation or understanding about how to control the heating system.

Given that only one of the pilots was successful at collecting complete technical data to allow this level of analysis, in addition to the small sample size, it is not possible to draw wider conclusions from these results. However, other technical monitoring studies of similar HEEPS ABS programmes have been carried out, indicating similar findings with homes that were better able to retain heat and many residents feeling more comfortable. However, only a modest reduction in mean energy consumption was achieved in the monitored households²⁷. (See Appendix G for a discussion about how more complete data collection could have been achieved within the pilots).

7.1.13 Impact on EPC ratings of the domestic properties

There were 35 properties that had full EPC data for both pre and post installation, as summarised in Figure 7. These were from schemes in Fife and South Lanarkshire. Before any

²⁶ The data is not sufficiently detailed to draw a conclusion about why the households' gas consumption did not reduce. For example, did householders change their heating regime after the measures were installed? Given the relatively short monitoring period of 15-weeks before and after installation of the measures in this sample, it is also possible that occupants' short-term activities affected the gas consumption of the post-installation monitoring period, resulting in longer heating hours, increased hot water use or use of gas for cooking (e.g. the Christmas period could result in increased gas use with family and friends visiting).

²⁷ Energy Agency.

installations the average SAP score was 58 which equates to a mid-D rating; 74% of the properties were D rated with the remaining 26% having an E rating. Post-installation the average SAP score increased by 11 to 69 which equates to a C rating. 49% achieved a C rating, 51% had a D rating with none at an E. 49% of the properties changed to a C rating, with 23% changing to a D and 29% showing no change in rating; however, it should be noted that although the rating didn't change the SAP would have improved, although not enough to achieve a new rating.

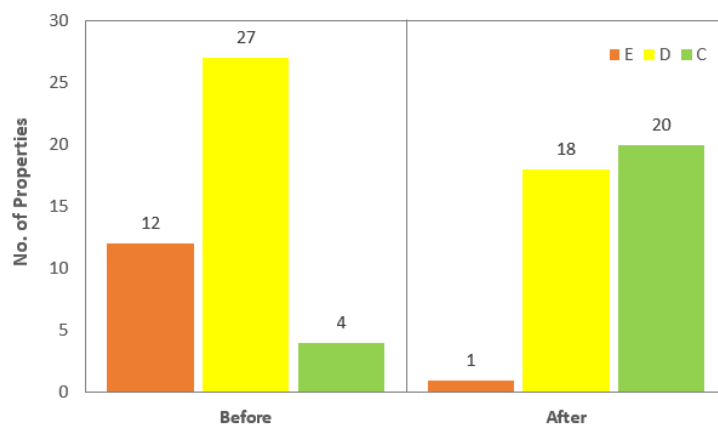


Figure 7: Count of domestic EPC ratings before and after installation.

The average improvement in SAP scores was 11, with a range of 4 to 23. This high range was due to the existing wide range of energy efficiency levels before the works began (i.e. a property that was already energy efficient would have less potential to achieve an improvement in SAP score than an inefficient property). The median of the range is 13.5, which suggests that more properties experienced smaller SAP score improvements, i.e. more of the properties were already somewhat energy efficient before any installations happened.

The full details of the technical monitoring results by local authority area can be found in Appendix B. Similarly, a full analysis of the social survey data is presented in Appendix E and Appendix F by local authority area and as a cohort, respectively.

8 Conclusions

The EES energy efficiency pilots have been a useful learning process, both to test out new ideas and project management approaches and to develop local capacities in line with national strategic priorities. In the context of short planning timescales, and uncertainty about the direction of EES, this first phase of pilots made a cautious start at pushing the boundaries of existing programmes to bring together domestic and non-domestic projects into an area-based approach. This evaluation, taking place alongside the project delivery, was a new experience for many of the local project managers and required some extra work to incorporate the needs of the evaluation data collection. However, reflections from these data have enabled an assessment of current best practices, challenges and lessons which can inform the work of both local project managers and national government. The on-going interaction with the evaluation team and other pilot local authorities also provided opportunities for cross-project comparisons and sharing of experiences. Going forward, it would be beneficial to embed this process of reflection, monitoring of progress, and cross-project interaction to ensure that successful delivery approaches are identified and replicated as quickly as possible.

In the domestic side of the phase 1 pilots, the evaluation highlighted how there were already well-established and flexible processes for delivering the existing programmes that could be adapted for the purpose of the EES pilots. This included processes for data analysis and programme design, procurement of relevant works, publicising the programme in target areas, support and engagement for householders with different needs, and forms of quality assurance. A consistent customer journey was important to householders, with project managers working to build trust and dialogue between energy advisors and householders to adapt recommendations that worked for householders' needs and lifestyles. Other influential factors included the importance of measures which improved the aesthetics of buildings and offered an improved sense of well-being and pride. Positive experiences of friends, family and neighbours from previous programmes were also important for creating trust and demand for a programme.

Building on and adapting these well-established practices will be the challenge for future programmes, as EES requires the delivery of less familiar or more disruptive measures in households, or encouragement of uptake without the assistance of grant funding. There was also a need to develop approaches to encouraging behaviour change and greater control of energy use in the home. Where technical monitoring data was successfully collected in the domestic sector it showed little change in the way that households used energy in the home, and much of the improvements in energy efficiency being taken in comfort gains.

In the non-domestic sector, the pilots tested solutions to a range of challenges, from using innovative energy efficiency measures in listed or hard-to-treat buildings in the public sector, to working beyond the public sector with community centres and small and medium sized enterprises. The evaluation explored the widely varying circumstances of non-domestic

buildings, particularly outside of the local authority, and the complexities of delivering programmes in short timescales to organisations with little previous experience of energy efficiency upgrades. Development work in advance of a project was important for understanding building use and ownership, as well as getting buy-in to a project from decision makers. This was time and resource intensive and there were several examples of projects that had potential but could not go ahead within the timescales of the pilot funding. Delivering beyond the public sector was a new area of work for many of the local project managers and there is still much to be understood about the motivations and concerns of non-domestic decision makers in relation to energy efficiency in different types of non-domestic buildings. There is also a need to consider where there might be a need for financial support mechanisms to overcome affordability issues in the non-domestic sector.

The pilots demonstrated the influence of local project management and the need for a detailed understanding of the local context in order to plan an appropriate project and to get buy-in from building decision makers. Local authorities and their delivery partners spent large proportions of project time unravelling and negotiating the complexities of building ownership, governance, local politics and relationships. A key restriction to both domestic and non-domestic innovations within the phase 1 pilots was a lack of staff resource and capacity for strategic planning and development work within local authority energy teams and their delivery partners. This suggests that growing long-term staff resources will be important to delivering more complicated or larger scale programmes in the future by enabling local relationships and strategic planning capacity to be built up.

There were a range of local actors involved in project delivery who were an important influence over building-owner experience and decision making, from community liaison officers, energy advisors to installation contractors and quality assurance assessors. The pilots demonstrated the importance of these actors being viewed as trustworthy and knowledgeable advisors and a source of support from the point of initial engagement until completion of the works and beyond. Coordination across the range of local actors that influence project success, including facilitating sharing of experience and best practice across the different actors and across local areas, could help to ensure a consistent customer journey and greater behaviour changes.

Finally, the evaluation highlighted areas of work where national coordination is needed to support efficient project delivery at the local level. It is clear, even from these initial pilots, that procurement approaches, particularly in the non-domestic sector, will need to be adapted and developed as different project management processes are developed moving away from grant funded measures to self-funded by households and organisations. Quality assurance is another critical area that was highlighted as needing further development to ensure consistent standards across the country. Data reporting and access to key data sets is another area that will need work across the country and can be supported by national level initiatives.

Overall, the pilots provided lessons and examples of good practice with talented and passionate staff working extremely hard to achieve successful outcomes. However, the short timescales and already stretched staff resources available to design and deliver programmes limited the extent to which the pilots ventured beyond existing programme boundaries to different types of domestic properties or beyond public sector-owned buildings in the non-domestic sector. As EES grows, investment will be needed at the local and national levels in data collection, strategic planning, and skills development across the range of key actors contributing to the successful delivery of programmes. This will need to be supported by additional long-term staff resources for local authorities and their delivery partners to provide flexibility in project management processes and enable innovation for the scaling up of programmes to meet the ambitions of EES.

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Appendix A. Detailed methodology

The pilot evaluation consisted of two parts: technical evaluation, and social and organisational evaluation. Figure 8 shows the division of project responsibilities, with Energy Saving Trust leading on the technical evaluation, and the University of Edinburgh leading on the social and organisational evaluation. These teams were appointed in October 2016 and November 2016 respectively; 2 – 3 months after the pilot projects got underway. The start date of the evaluation teams meant that the evaluation methodology was developed alongside the delivery of the pilots, and data collection was adapted to the available timescales.

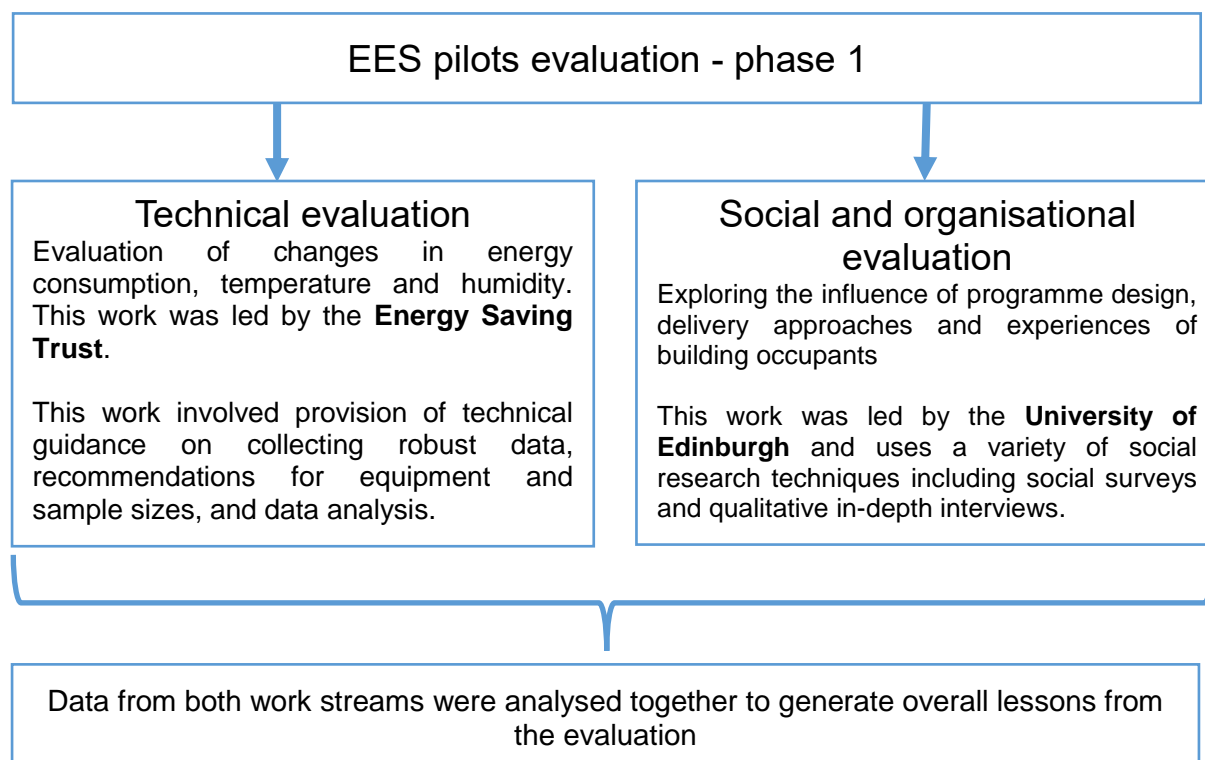


Figure 8: EES pilots evaluation - project responsibilities

The following sections detail the approach to data collection and analysis used by both of these parts of the evaluation.

A.1. Social and organisational evaluation methodology

The social and organisational evaluation was informed by quantitative and qualitative data. In the domestic sector, household surveys were used to understand householders' motivations for proceeding with energy efficiency upgrades, as well as the perceived impacts of these. In the non-domestic sector, surveys and interviews were used to understand the perspectives of building occupants and building decision makers in a selection of case studies. In addition, in-depth interviews with pilot managers explored approaches to design and delivery of the projects.

Domestic social surveys

Domestic sector data were collected through 2-stage surveys of a sample of households. This enabled householder experiences and perceptions to be detected before and after the

installation of the energy efficiency measures. The domestic survey contained questions about households' occupancy patterns and energy needs, perceptions of home comfort and control over energy-use, and expectations and concerns about energy efficiency changes.

Surveys were coordinated by the local project managers and were conducted either in person or by post (where the householder was asked to complete the survey on their own and post it back to the project team). In a small number of households, the survey was completed online.

The target sample of households was the same sample used for the technical evaluation to enable matching data analysis (the method for selecting and recruiting this sample of households is presented in Appendix A.2). The target sample size was not met in many of the pilots but the final collected survey numbers are detailed below in Table 4.

Table 4: Numbers of Time 1 and Time 2 domestic social surveys collected in each Phase 1 pilot

	Aberdeen	Aberdeenshire	Edinburgh	Fife	Glasgow	Midlothian	Shetland	South Lanarkshire	West Lothian
<i>Target Sample size</i>	76	14	33	11	n/a	52	14	26	8
<i>Time 1 social surveys collected</i>	41	14	29	5	n/a	24	9	26	7
<i>Time 2 social surveys collected</i>	16	7	19	3	n/a	18	9	21	4

As shown in Figure 9, the Time 1 (T1) survey would ideally have been conducted 1 – 3 months before measures were installed, and Time 2 (T2) approximately 6 - 9 months after measures were installed (ideally at the same time of year as the T1 survey). In practice, these timings and target samples were not always achieved due to the late start of the evaluation team (3 months after the start of the pilot projects), and delays in project delivery. However, there was a minimum of 2 – 3 months between measures being installed and completion of the T2 survey (see Appendix G for a discussion and lessons for future evaluation data collection).

The survey design was informed by existing academic literature and pre-tested household energy surveys, including studies of household energy habits, experiences of district heating, and public health surveys.

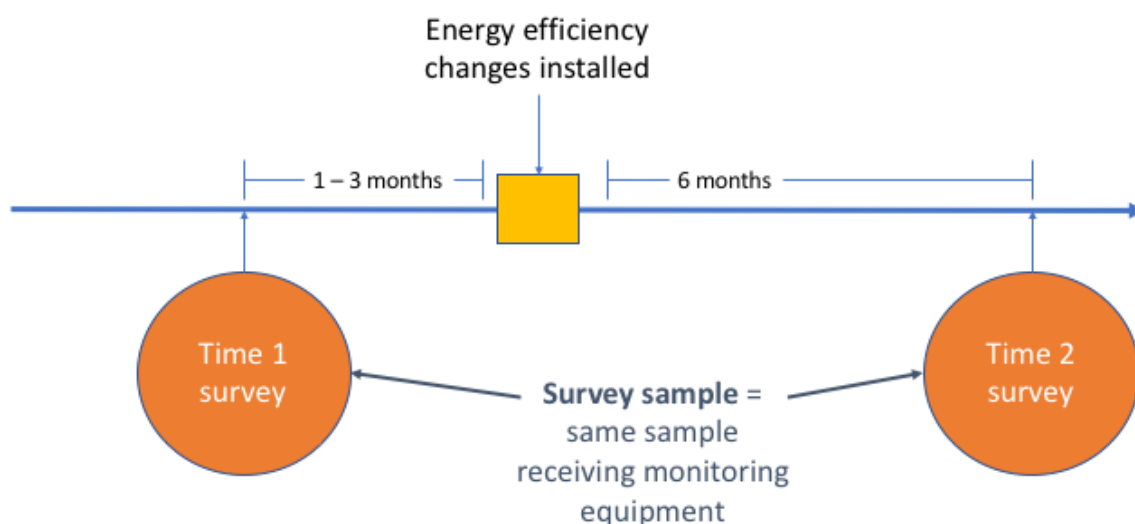


Figure 9: Ideal timescales for the domestic sector survey data collection

Non-domestic social surveys

Non-domestic sector data collection differed for each pilot, due to the range of buildings, variety of uses and energy efficiency changes in question. Additional social surveys were developed specifically for the purposes of the non-domestic evaluation. Similar to the domestic social surveys, they were designed as a **2-time survey** (T1 and T2) in order to detect changes in respondent perceptions before and after installation. However, tight timescales for developing the surveys meant it was not possible to conduct 2-time surveys in all cases, because works had already begun. A **single-time** version of the survey was developed to enable data collection in these circumstances.

Two different surveys were developed:

Different versions of the 2-time surveys and single-time surveys were developed for the decision makers and occupants of non-domestic buildings:

- 1) Decision maker survey – for people in the building responsible for one or more of the following: making energy bill payments; building and / or energy management; and allocating an organisation's financial contribution for the energy efficiency measures (where relevant). Decision makers included building owners, landlords, building managers, and organisation directors / governors.
- 2) Occupant survey – for people who use the building, and are therefore experiencing the installation process and impacts, but who are not responsible for any of the three Decision-Maker activities above. Occupants ranged from staff that worked in the building daily, to volunteers and visitors who might spend only a few hours a week in the building.

The **decision maker survey** covered: the building's energy use profile, comfort levels, engagement with occupants, the role of the local authority, knowledge about the energy efficiency measures being installed, motivations for installing the measures and their perceived impacts, the installation process.

The **occupant survey** covered: occupant's control over energy use in the building, perceptions of comfort, understanding of the energy efficiency measures being installed, perceptions about the impacts of the measures and the installation process.

Due to time and resource constraints in the evaluation team, the non-domestic buildings targeted for this detailed survey data collection needed to be fewer than the sample receiving technical monitoring. Non-domestic survey data was collected only for buildings that were either not directly owned or not occupied by the local authority, since this was a new area of work for many pilot managers and therefore offered more opportunities for learning.

Like the domestic surveys, data collection was coordinated by project managers, with support from the evaluation team. The surveys were viewed as a pilot since they were newly developed for the evaluation and untested. Project managers conducting the surveys were observed by the evaluation team in a selection of buildings and asked to comment on how well the questions functioned in practice. Small adjustments were made on the basis of these comments for the evaluation of the phase 2 pilots.

Data from the semi-structured interviews with pilot project managers were also added to the survey data on the non-domestic buildings to complement the analysis (see the next section).

Semi-structured interviews

Semi-structured interviews were used to understand the approaches to project management in the pilots and to discuss delays, challenges and successes. The in-depth interviews (each lasting between 1 – 1.5 hours) were conducted with the local authority officers leading the pilot project design and delivery. In some cases, external delivery partners were included in these interviews when they had been commissioned to take on all or part of this coordination role on behalf of the local authority. The interviews were conducted at two points in the pilot projects:

- 8-months into the pilot projects (March / April 2017)
- The end of the pilot projects (February / March 2018)

The initial round of interview data was used to identify areas for more detailed exploration in the final round of interviews. Results from this first analysis were published in the interim report²⁸. Group workshops with local authority officers were also used to inform the focus of the interviews and to refine analysis of data through the evaluation process.

The final interview schedule included questions about project delivery; project funding; engagement and recruitment of building owners and occupants; and reflections and lessons from the pilot.

Social and organisational evaluation data analysis

Thematic analysis²⁹ based on key topics shown in Figure 10 was used to structure analysis of the qualitative interview data: topics were project design; funding and finance; project

²⁸ Bush and others.

²⁹ Virginia Braun and Victoria Clarke, 'Using Thematic Analysis in Psychology', *Qualitative Research in Psychology*, 3.2 (2006), 77–101 <<https://doi.org/10.1191/1478088706qp063oa>>.

delivery; project impacts; and skills and capacities. Analysis was done separately for the domestic and non-domestic aspects of the pilots; mirroring the way the pilots were managed. The results sections of this report are structured according to this framework.

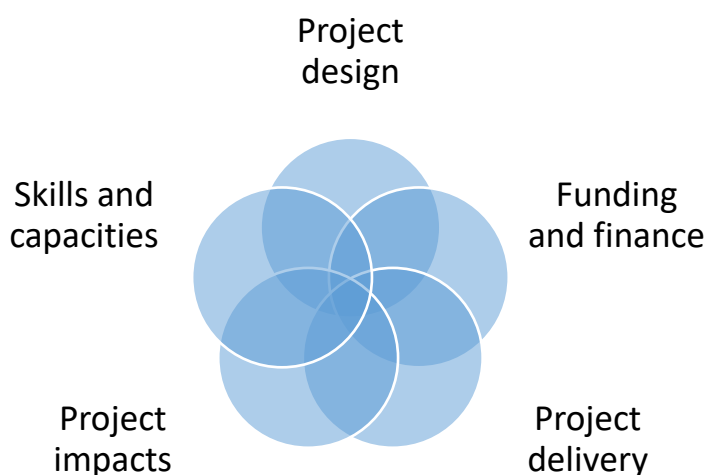


Figure 10: Framework of key topics used to structure the thematic analysis of the qualitative interview data in the social and organisational evaluation.

A.2. Technical evaluation: Data collection methodology

Aims

The technical evaluation measured building energy consumption, temperature and humidity profiles. Local authorities were responsible for procuring and arranging the installation of monitoring equipment, which was used to examine the impact of energy efficiency installations on energy use and on changes in heating patterns. Monitoring was approached in different ways for domestic and non-domestic buildings as each have different considerations as detailed below.

Profiling and sampling buildings

Domestic buildings fit a relatively narrow band of archetypes described by different physical and social characteristics; for example, a typical three-bedroom, semi-detached house typically has cavity walls with a party wall shared with the adjacent house, was built in the 1950-60s, with a pitched roof space and some roof insulation. A sample therefore was designed around the proportion of domestic archetypes in each project. During analysis the results could then be scaled up to larger geographic areas that were not part of the sample. Non-domestic buildings required a different sampling approach, because they cannot be as easily categorised; this category includes a wide range and scale of building types (such as offices, factories, industrial units, community halls, schools, NHS buildings etc.) which have varied occupancy and uses that affect heating patterns, giving each a unique energy profile.

Sample sizes and data collection

In order to provide robust evidence for the technical evaluation, the number of properties monitored needed to be sufficiently large to give confidence that results can be extrapolated to all buildings in the project. Domestic and non-domestic samples were approached in

different ways as explained above. The formula used to calculate the sample sizes for domestic properties can be seen in Figure 11.

$$SS = \frac{Z^2 * (p) * (1-p)}{c^2}$$

Where:

Z = Z value (e.g. 1.96 for 95% confidence level)
p = percentage picking a choice, expressed as decimal
(.5 used for sample size needed)
c = confidence interval, expressed as decimal
(e.g., .04 = ±4)

Figure 11: Sample size equation.

A 95% **confidence level** (Z) was used throughout; this refers to how certain we are of the result. The **confidence interval** (c) refers to the margin of error of the result. We opted for varying confidence intervals dependant on the total size of the project; those with under 50 buildings were at 20%, between 50 and 100 buildings at 15% and those over 100 buildings were at 10%. This means we will be 95% certain that the results (for instance, the energy savings) will fall within a 10% error margin if repeated again and again for projects that have over 100 buildings.

Local Authority	Proposed Total in Pilots		Proposed Target Sample Sizes		Data Received		Data Able to be Analysed	
	Domestic	Non-domestic	Domestic	Non-domestic	Domestic	Non-domestic	Domestic	Non-domestic
Aberdeen City	781	7	86	7	19	0	0	0
Aberdeenshire	100	4	30	4	7	3	0	0
Edinburgh	738	8	85	8	28	9	5	0
Fife	44	5	30	5	11	3	1	2
Glasgow	106	19	51	5	0	0	0	0
Midlothian	111	2	52	2	25	0	2	0
Shetlands	30	10	14	10	11	6	0	6
South Lanarkshire	68	2	26	4	26	2	12	0
Stirling	160	1	29	1	0	0	0	0
West Lothian	43	2	16	2	7	1	1	1

Table 5: Target sample sizes, data received and analysed.

Sample sizes were agreed to be ideal targets to aim for (see Table 5), but this was dependant on successful recruitment and practical implementation given the timeframes. Non-domestic building sample sizes were determined by reviewing each local authority's range of non-domestic buildings in the pilot. As non-domestic buildings are more varied in use and scale, the sample sizes recommended were in some cases all the buildings and in others the vast majority, where it was practical. Table 5 shows the initial proposed buildings in each local authority project, the targets that were calculated from those initial numbers, and the actual data received at the end of the project. The final column shows the total number of properties recruited who returned a complete set of data where a comparison analysis was completed.

Technical evaluation data were requested by the end of March 2018, although if there was a benefit in leaving the equipment in place for longer, a later date was agreed. It was recommended that this was planned well in advance as resource and time would be needed

to gain access to the buildings, collect the monitoring equipment, download the data and then send it.

Status	Domestic		Non-domestic	
	No. of Properties	Proportion	No. of Properties	Proportion
Analysed	20	14%	9	19%
Missing Data	43	31%	2	4%
Not Enough Data	55	40%	12	26%
Not Monitored	20	14%	24	51%
Total	138	100%	47	100%

Table 6: Data completeness.

No local authority was able to provide data to meet the target sample sizes (see Table 6) this means we were unable to scale up the results, which had to be treated individually and not as a representative sample of each pilot project. (See Appendix G for discussion of the challenges in data collection experienced during the evaluation and lessons for future evaluations).

Recruitment

The evaluation team helped local authorities, who were responsible for carrying out the recruitment, by providing guidance on collecting representative samples. It was recommended that random selection was practiced to ensure that those selected are representative of all pilot buildings.

Local authorities collected information on participants via the social surveys provided so that the evaluation team could compare the sample profile against all buildings and building occupants in the pilot and against the profile of the total Scottish population, to identify potential biases in representation.

As far as possible, the evaluation was designed to be straightforward for participants; the number of visits to each property was minimised, and easy-to-access surveys were provided. Information was provided on the purpose of the evaluation; what data were being collected; how data will be stored and for how long; who will have access to the data and how data will be used.

What was monitored?

Energy consumption was a focus for technical monitoring, and in most cases the primary heating system consumes most energy. Typically, samples were selected to include buildings with a range of heating system fuel types, including gas, electric storage heating, oil and district heating; this ensures the sample is representative of the wider housing stock. The primary heating system would help establish the amount of heating energy used before and after installation as well as determine if the heating pattern changed.

Electricity was also monitored as some projects installed energy efficiency measures that helped reduce electricity, rather than their heating fuel, consumption. Electricity monitoring also helps capture any energy consumption relating to secondary heating such as portable electric fan heaters or infrared heating in areas not covered by the primary heating system.

Electricity consumption helps identify when a building is occupied but heating is not in use and provides a complete picture of the total energy consumption within a building.

Temperature was measured internally in multiple rooms considered to be areas of primary use. This was typically the living room, main bedroom and hallway in domestic buildings; and the room where the thermostat was located and other main rooms (such as main halls, offices etc.) in non-domestic buildings. With temperature data, we were able to create a heating profile throughout the entire monitoring period; this helped establish a typical pre and post heating pattern allowing us to determine if the building's ability to retain heat has been improved, as well as other performance indicators such as the speed at which a building can reach the desired temperature.

Humidity was also measured to provide information about the internal environment of the building. If there are high levels of moisture along with low temperatures condensation can occur, which can have various health implications. Seeing how the humidity changes post installation will provide an understanding of the added benefits of the energy efficiency measures.

Monitoring duration

To ensure that monitoring took place during a period of time in which a building's main heating system was in full use before and after the installation, it was recommended that two heating seasons were included in the monitoring period. This meant that the winter of 2016/17 was the pre-installation heating period, and the winter of 2017/18 was the post-installation heating period. Although the heating season will vary across Scotland, especially in northern areas, heating degree day data was calculated to quantify this for each of the building's locations. This is the main reason for monitoring throughout the entire monitoring period as a heating season is not necessarily during the conventional winter months.

To make sure the before and after periods were comparable it was important to capture as much data as possible, ensuring both the pre and post monitoring periods were during the heating season. Both monitoring periods ideally had to be as long as possible but also have equal duration (e.g. 10 weeks before compared with 10 weeks after) so there was a representative sample before and after installation.

Monitoring frequency

To provide the required granularity of energy consumption and environmental data, hourly readings were recommended. Although 5-minute readings would have produced a higher resolution, enabling us to determine usage more precisely, the practical, financial and logistical considerations outweighed the need for such a high frequency of readings.

There were some exceptions to this, such as oil and LPG heating. The equipment available for hourly monitoring of these fuel types was limited so we accepted less frequent readings, with the recommendation that meter readings are provided as frequently as possible. For solid heating systems, such as coal and biomass, we recommended that these buildings were not included in the sample, as there is no cost-effective way to record energy consumption over an extended period of time.

Technical monitoring equipment

The recommended monitoring equipment for use by the local authorities was selected by Energy Saving Trust (EST) after considering several factors such as ease of installation, practicalities in data retrieval, cost, frequency of readings taken, the storage capabilities of equipment and the confidence we had in the equipment from past experience. After the review EST created a recommended equipment list for each fuel type and accessibility scenario (areas with/without internet access). A single option was recommended to make it easier for local authorities. In several instances other equipment was asked to be used, we reviewed those products' specifications and if the devices could provide data at the right frequency and over the whole monitoring period we were happy for those devices to be used.

The Gas Loop Energy Saver was used to monitor gas consumption in domestic buildings at an hourly frequency. This equipment was recommended as it was relatively inexpensive, can be installed by a competent DIYer and it connects to the internet where the data is automatically logged and uploaded. The Electricity Loop Energy Saver was made by the same company and had the same credentials with the added benefit of being able to buy both at a discounted rate. The manufacturer received the data being recorded as soon as they were set up, which was a useful check to see whether the devices were transmitting throughout the project.

Tinytags were recommended for recording both temperature and humidity data. They have a proven record of supplying data after long periods of time, they can be pre-setup and left in place without any other actions needed and they are robust enough to last over the monitoring period. Tinytags were used for recording both internal and external temperatures; it was recommended that there were 3 internal Tinytags and one external one. This was to ensure that all the various heat profiles within the majority of rooms were captured in domestic dwellings, although within non-domestic dwellings it was up to the discretion of the local authority as to how many internal Tinytags would represent the space.

As the Loop equipment required an active internet connection it required use of the properties' internet. In some cases, especially remote locations, there was no internal connection, so an alternative was to setup a cellular router using a sim card to connect to the mobile data network. However, power was another consideration, as the majority of cellular routers require a power socket and in remote areas mobile data signal may not be strong enough; all of which made monitoring in remote areas more problematic. For more details on the recommendations and guidance given to local authorities please see 'SEEP Pilot information for applicants'³⁰.

Parallel activity

The aim of the technical evaluation was to measure the change in energy demand and temperature during the evaluation period. This includes the impact of the main measures installed, but also the impact of a wide range of other changes during this time period. For example, this might include the planned provision of energy efficiency advice, or of other smaller measures. Any parallel activity which may impact energy demand or temperature was asked to be:

³⁰ Ruth Bush and James Wakelin, 'SEEP Pilots Information for Applicants', 2017 <<https://www.gov.scot/Topics/Business-Industry/Energy/SEEP/SEEPPhase2/Informationforapplicants>> [accessed 20 August 2018].

- Recorded where possible and reported to the evaluation team.
- Considered carefully, where it is in the control of the pilot project team. Does it need to take place during this time period? Are we comfortable with any implications this will have on the way in which we can interpret monitoring results at the end of the project?

Parallel activity is an important factor when analysing the data as it can have an unknown effect upon the results for a given property. For instance, energy efficient advice given after the measure was installed could increase the overall savings as the occupants could be practising energy efficient behaviours further reducing their energy consumption. Results from those properties that received parallel activity were still analysed, but needed to take the activity into account.

A.3. [Technical evaluation: Data analysis methodology](#)

The received data was analysed at a property-by-property level by collating all the energy and temperature data into a consistent dataset at weekly intervals. The data was reviewed to clean it of erroneous data and periods which were outside the heating season. It was then separated into the before and after installation periods.

The data was normalised to account for variations in external temperature using Heating Degree Day (HDD) analysis. Full details of the HDD analysis, including an explanation of what HDDs are, how we have used them and how to interpret the results is provided in succeeding sections. A number of statistical tests were then conducted on the dataset. An explanation of how to interpret the results of the statistical tests is also provided in the following sections Appendix A.

[Considerations when interpreting the technical results](#)

The following section will explain the technical metrics and calculations used to quantify the impact of the measures. However, it should be noted that although the analysis is as comprehensive as it can be given the limited data, it is not appropriate to draw conclusions about the impact of the pilot energy efficiency measures beyond this small sample. The results presented here should therefore only be seen as indicative of *potential* outcomes from the installation of such measures.

There are some properties which show counterintuitive results (such as no statistical change in heating patterns, temperature, a decrease in temperature variation but an increase in gas consumption when you'd expect a reduction in gas consumption). In these circumstances it should be noted that none of the data occurred over 2 consecutive years; if one period included the Christmas holidays then occupancy, hot water use and gas cooking may well have increased. If you pair this with the limited number of comparable weeks which the analysis was done on this effect would be magnified further. Extreme weather events will have an effect upon the data as well, although we normalise the data pre and post installation (meaning we apply a 20-year average heating requirement to all data so you eliminate the variation year on

year); extreme weather events such as the winter storms experienced in 2018 will have an effect on how occupants use their heating as well, such as longer heating hours and higher temperatures. Although we have normalised the data we cannot account for the effect the events had on the perceptions of how cold it actually is; if the occupants perceive it to be colder than it is actually is they could react by increasing their heating consumption.

What are heating degree days (HDD)?

To ensure that the comparison was like for like the heating degree days (HDD) methodology was used to make sure the periods before and after installation had similar heating requirements. Heating degree days is a way of calculating the amount of heating required for a particular house over a particular period of time; it uses the minimum and maximum external temperatures to work out how much more heating is needed to get the internal temperature up to the European standard internal base temperature of 15.5 degrees Celsius. The higher the HDD the more heating is required, typically HDD are much higher over the winter period as outside temperatures are much lower.

HDD can be used to work out the heating requirement for a particular time period, as seasonality will vary this throughout a year. It can also be used to 'normalise' heating data. To do so, the measured gas consumption is divided by the number of HDD over the monitoring period to calculate the kWh per HDD. This is then multiplied by the annual average HDD (averaged over a 20-year period) to give a 'normalised' annual heating consumption. This is often done to eliminate the seasonality within years, allowing you to see the impact of a particular measure that has been installed. It allows you to compare the data year on year excluding the varying heating seasons throughout the year.

How have we used heating degree days (HDD)?

In this evaluation HDD was used to find an equal number of weeks before and after installation that have similar HDD values. This was done to ensure we are comparing two periods with relatively similar heating requirements. HDD can be used over any period of time but we chose weekly as this reduces the variation day by day but also gives sufficient granularity to see trends. Longer term studies often use monthly HDD data for the same reasons but due to data limitations we could not do this.

We chose to use an equal number of weeks before and after to ensure we capture similar weekly schedules the occupiers had and to capture a series of heating behaviours. If we picked isolated days or non-consecutive days, we would be ignoring the fact that heating behaviour is influenced by the perception of the occupiers heating requirements over a longer period of time. For example, occupiers are more likely to change their heating behaviour if there are higher variations in temperatures day by day compared to a consistent external temperature, as they will notice the higher variations more.

Interpreting heating degree days (HDD)

Apart from using the HDD to ensure similar heating requirements before and after installation, HDD were also used to explore the highs and lows in both HDD and gas consumption before and after installation. Although a total series of weeks can have similar HDD, the way the high and low HDD are spread across those weeks may not be similar e.g. series of 3 weeks may have

a total of 100 HDD equally spread before the installation, whereas after you may have one particular week that has 80 HDD with the others only having 20 HDD each. This is an important aspect to consider, as it will affect the heating behaviour of occupants. These highs and lows are presented in the first table in each of the local authority sections.

In the second table in each of the local authority sections, one of the outputs is HDD per day. This is the difference in HDD before and after installation, divided by the number of weeks that are being compared (i.e. if it is 6 weeks before and after, then it will be divided by 6 weeks). This number can be used to sense check that the difference is not large enough to warrant a change in heating behaviour; a number around 1 HDD could be assumed to be small enough not to elicit a reaction from the occupant to change their normal heating behaviour and therefore indicates that those two periods are comparable.

What is a t-test?

A t-test or Students t-test is a statistical test that compares the difference between the averages of two samples of data. It also tells you how significant these differences are, i.e. it tells you whether this difference could have occurred by chance. The result is expressed as a probability. The most common way to interpret the result is using a 95% confidence level. This means that we can be 95% confident that these two samples are statistically different (meaning the two samples derive from the different samples of data); to achieve this the result will have to be lower than 0.05. You can also express it as having a 98% confidence level, where the result needs to be less than 0.02. Anything above these numbers means that the two samples are more likely to have occurred by chance and are statistically similar due to this.

Interpreting the t-test results

In terms of this evaluation the two samples of data are the gas consumption before the installation and the gas consumption after installation, as we want to know whether they are significantly different due to the measure installed. If they are it would indicate that there has been a change in the average gas consumption after the measure was installed, and they are statistically different. In this evaluation and in the second table in each of the local authority sections the results show either a 'Yes', to indicate a significant change or 'No' to indicate no significant change (see *Figure 12*).

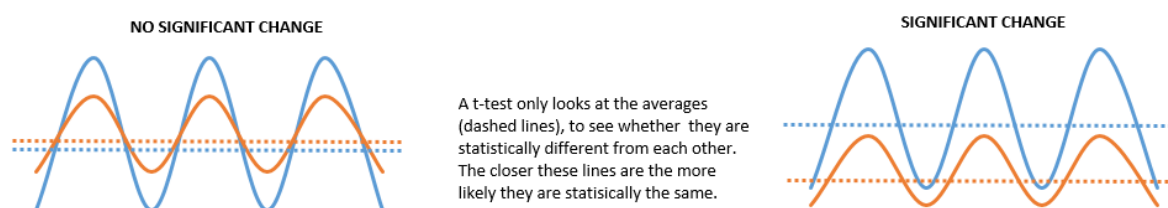


Figure 12: Interpreting t-test results.

However, this does not mean it solely supports or refutes any energy saving already calculated. If there is an energy saving but there is no significant change in gas consumption, it may mean that the highs and lows in the gas consumption have lessened, resulting in energy being saved, but the average consumption remains similar. This is because this test only looks at the averages and not the highs, lows or variations that occur; these will only affect this test if those variations change the average gas consumption before or after the installation significantly.

What is a correlation test?

A correlation test is another way to help indicate whether the gas consumption pattern before and after the installation is similar or has a strong correlation to each other. Heating degree days (HDD) have a linear relationship with gas consumption (i.e. with increasing heating degree days or increasing heating requirements we see an increase in gas consumption). Given the HDD requirements, we can model or forecast what gas consumption would be using the existing gas consumption data before the installation as a baseline; then comparing it with the actual gas consumption afterwards.

We do this to see whether the heating pattern is similar or different after the installation by making the HDD the same in both periods. The test results output a number called r-squared (R^2) which can be anything from 0 to 1; the closer the number is to 1, the stronger the correlation and the more similar the heating patterns are in both periods.

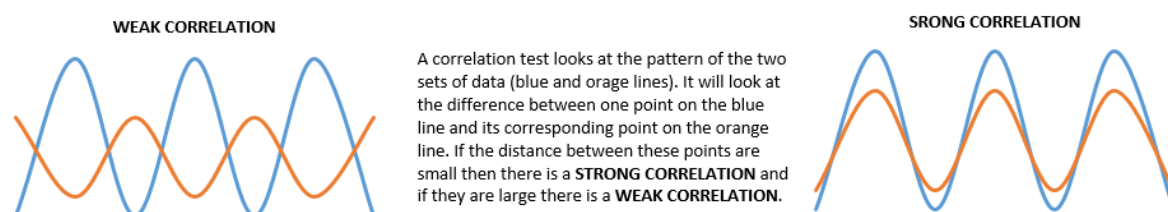


Figure 13: Interpreting correlation results.

Interpreting the correlation results

The correlation test will correlate strongly if the heat pattern is relatively the same, for instance if the peaks and troughs are in the same place over time. It will not correlate strongly if those peaks and troughs are in opposite positions and/or are much higher/lower than before. This test helps indicate a change in heating pattern, in contrast to the t-test which looks at the change in average gas consumption. As such, if the test shows there to be a weak correlation (i.e. an R^2 value closer to zero than to 1) this indicates that there is a difference between the consumption before and after installation, i.e. the installation has had a significant impact. When looking at the results from both tests you can start to build a picture of how the gas consumption has changed or not changed (see *Figure 13*).

How do we calculate a change in energy consumption?

To calculate a change in energy consumption we take an equal number of weeks before the installation and an equal number of weeks after installation and minus one from the other to get the energy change in kWh. We also calculate the percentage change to show the relative change. These results can be found in the second table within each local authority section.

Interpreting changes in energy consumption

A negative number would indicate a reduction in gas consumption after the installation whereas a positive one would indicate an increase. It is important to look at these kWh changes in conjunction with the percentage change, as some kWh changes may be quite small but in relation to all the total consumption be a large proportion.

These savings are only based on the total number of weeks in both tables, we did not scale these results up to a year as there are too few data points and it would over represent this period of time.

What is standard deviation?

This is a measure of how spread out the numbers are. To calculate the standard deviation, you square root the variance and then divide it by the number of samples. The variance is the distance the value is from the average of the entire sample.

For example, if we had 4 weeks' worth of internal temperature data before and after installation, our sample total would be 4. The variance would be the difference between 1 weeks' average internal temperature from the average internal temperature of the 4 weeks, resulting in variances for each of the 4 weeks. We then square root them individually, add them together and then divide it by the number of samples which would be 4; resulting in a standard deviation.

Interpreting standard deviation?

This methodology is applied to the internal temperature data as we use it to work out how spread out internal temperatures are before and after installation. If the spread has lessened it can indicate that the property is less reactive to outside temperatures and the property's heat loss rate has reduced. However, this output is reliant on the internal temperature data occurring during the heating season, whilst heating systems are in use and both before and after periods having similar heating requirements.

Appendix B. Technical evaluation: Results by local authority

B.1. Edinburgh

There were 5 domestic properties that were analysed, all of which had wall insulation (1 cavity wall extraction and refill, 4 internal solid wall insulation, 2 of which also had secondary glazing installed). At least 6 weeks' worth of data was available before and after the installations equating to a total of 12 weeks of data. The total heating degree day difference was small enough to ensure that the comparison was relatively similar before and after installation; this is important as a greater difference could presumably elicit a change in the way the building is heated.

When a paired T-test for equal means was performed to compare the 6 weeks before and after installation, it was found that there is not a statistically significant difference between the average gas consumption before and after. However, this does not mean that the highs and lows of gas consumption have not changed and been affected by the installation (see Table 7).

				High and Low Gas Consumption and Heating Degree Day Weeks							
				Before Installation				After Installation			
				Minimin		Maximun		Minimin		Maximun	
Property ID	Type	Measures Installed	Sample Size Weeks Before and After Measure	Gas Consumption (kWh)	HDD	Gas Consumption (kWh)	HDD	Gas Consumption (kWh)	HDD	Gas Consumption (kWh)	HDD
A	Domestic	Cavity Extraction & Refill	6	17	28	241	87	7	35	244	86
B	Domestic	Internal Wall Insulation	6	132	62	210	112	77	75	194	108
C	Domestic	Internal Wall Insulation	6	287	60	356	99	297	66	481	104
D	Domestic	Internal Wall Insulation, Secondary Glazing	9	3	67	416	107	186	67	297	105
E	Domestic	Internal Wall Insulation, Secondary Glazing	6	190	50	286	99	148	69	315	107

Table 7: High and low gas consumption and heating degree day weeks for Edinburgh properties.

The majority of the properties have shown a strong correlation; this means that the data before installation correlates strongly with data from after the installation, suggesting that those two sets of data are relatively the same (see Table 8). This indicates that there has not been a significant change in the gas consumption pattern for these properties. There are a couple of properties that show no or weak correlation and a moderate correlation suggesting that there has been a change in the gas consumption pattern after the installation. This is corroborated by the savings experienced by all properties but particularly these ones as they have the highest savings.

It is important to note that although all properties experienced savings of some degree. Those properties which showed no significant difference between the average gas consumption before and after, and strong correlations between the forecasted and the actual gas consumption indicate that the measure had no significant impact that was able to change the gas consumption pattern of the household; however, when the actual gas consumption before and after installation in this 12-week period was compared, in all cases we observed a reduction in the absolute gas consumption after the installation. Although the absolute savings are small, which is expected as the statistical tests performed showed insignificant change of the heating patterns, the respective percentage savings are relatively high suggesting that there are other factors impacting the data. These factors could be things like behavioural change, change in occupancy, or a reduction of internal temperature due to overheating etc. Without access to the corresponding temperature data we are unable to analyse the impact the measure had upon internal temperatures, which may well have shown the properties increased ability to retain heat and/or a reduction of internal temperature reducing gas consumption.

Property ID	Type	Measures Installed	Gas Analysis Results							
			Sample Size	Heating Degree Day Difference		T.Test	Correlation		Energy Consumption	
			Weeks Before and After Measure	Total (HDD)	Per Day (HDD/day)	95% Significance	R ₂	Description	Change (kWh)	Change (%)
A	Domestic	Cavity Extraction & Refill	6	20	0.48	No	0.768	Strong Correlation	-140	-19%
B	Domestic	Internal Wall Insulation	6	54	1.29	No	0.279	None or Very Weak Correlation	-180	-17%
C	Domestic	Internal Wall Insulation	6	5	0.12	No	0.581	Moderate Correlation	-252	-13%
D	Domestic	Internal Wall Insulation, Secondary Glazing	9	26	0.41	No	0.827	Strong Correlation	-62	-3%
E	Domestic	Internal Wall Insulation, Secondary Glazing	6	5	0.12	No	0.717	Strong Correlation	-153	-10%

Table 8: Gas analysis results for Edinburgh properties.

B.2. Fife

There were 2 non-domestic properties and 1 domestic property analysed; the 2 non-domestic replaced their lighting with LEDs and the domestic property had external solid wall insulation installed. The properties which had LEDs installed had 8 and 12 weeks' worth of data before and after installation, giving a total of 16 and 24 weeks' worth of data.

When a paired T-test for equal means was performed to compare the electricity data before and after installation for both properties, it was found that there was statistically significant difference in both cases. The electricity change achieved are quite substantial with property A seeing a reduction nearly 2900 kWh which is a reduction of 44% over an 8-week period; and property B saw a 4800 kWh reduction which is a reduction of 27% over a 12-week period (see Table 9).

			Electricity Analysis Results			
			Sample Size	T.Test	Energy Consumption	
Property ID	Type	Measures Installed	Weeks Before and After Measure	95% Significance	Change (kWh)	Change (%)
A	Non-domestic	LEDs	8	Yes	-2879	-44%
B	Non-domestic	LEDs	12	Yes	-4816	-27%

Table 9: Electricity analysis results for Fife.

Property C did not have any gas consumption data available to analyse, however there was enough internal temperature data to use as a proxy for the impact of the measure (Table 10). When a paired T-test for equal means was performed on property C to compare the 29 weeks before and after installation, it was found that there was a statistically significant difference in average internal temperatures. This indicates that there was a reduction in the average internal temperature after installation which can be seen in the temperatures in Table 10, where it reduced from 19.3°C to 18.0°C. The reduction in temperature to 18C suggests that the house wasn't able to retain the heat for very long and to compensate the temperature was set higher, whereas now the building can maintain temperature which perhaps prompted a reduction in the set temperature. The reduction in standard deviation supports this as it indicates that the houses reactiveness to colder external temperatures also reduced, albeit slightly. Whether this equated to a gas reduction as well is unclear as that data is not available; as a reduction in temperature may not necessarily mean a reduction in gas consumption as other factors may negate this such as increasing the overall heating area or having the heating on for longer.

			Internal Temperature Analysis Results					
			Sample Size	T.Test	Temperature			
Property ID	Type	Measures Installed	Weeks Before and After Measure	95% Significance	Before Installation (°C)	After Installation (°C)	Change (%)	Standard Deviation Change (%)
C	Domestic	External Wall Insulation	29	Yes	19.3	18.0	-7%	-0.38

Table 10: Internal temperature analysis results for Fife.

B.3. Midlothian

There were 2 domestic property analysed, both of which had external solid wall insulation installed. The properties both had 3 weeks' worth of data before and after installation, giving a total of 6 weeks' worth of data each. The highs and lows in gas consumption and heating degree days (HDD) show that property A has very low minimum gas consumption in both before and after periods (see Table 11Table 11), this could suggest these are weeks where heating was only use for hot water use and not space heating, if this is the case property A's data may not be suitable for comparison.

				High and Low Gas Consumption and Heating Degree Day Weeks							
				Before Installation				After Installation			
				Minimin		Maximun		Minimin		Maximun	
Property ID	Type	Measures Installed	Sample Size Weeks Before and After Measure	Gas Consumption (kWh)	HDD	Gas Consumption (kWh)	HDD	Gas Consumption (kWh)	HDD	Gas Consumption (kWh)	HDD
A	Domestic	External Wall Insulation	3	22	67	27	87	26	67	29	89
B	Domestic	External Wall Insulation	3	330	64	387	88	163	77	267	83

Table 11: High and low gas consumption and heating degree day weeks for Midlothian.

When a paired T-test for equal means was performed to compare the electricity data before and after installation for both properties, it was found that there was no statistically significant difference in both cases. A correlation test could not be applied due to the limited data available. There was an absolute change in gas consumption in property A of an negligible increase of 8 kWh or 10%, and a large reduction in property B of 385 kWh or 36% (see Table 12Table 12). Typical variations in daily life that happen week on week are usually smoothed out when you have a longer series of weeks, however, these daily changes will be exacerbated in the limited datasets used in this analysis; which are arguably not enough to derive any conclusions from so these results should be used with caution (e.g. a day where the house was not occupied or a day where heating was put on higher than usual would have a significant effect on the results).

Property ID	Type	Measures Installed	Gas Analysis Results							
			Sample Size	Heating Degree Day Difference		T.Test	Correlation		Energy Consumption	
			Weeks Before and After Measure	Total (HDD)	Per Day (HDD/day)	95% Significance	R ₂	Description	Change (kWh)	Change (%)
A	Domestic	External Wall Insulation	3	2	0.10	No	N/A	N/A	+8	+10%
B	Domestic	External Wall Insulation	3	10	0.48	No	N/A	N/A	-385	-36%

Table 12: Gas analysis results for Midlothian.

B.4. South Lanarkshire

There were 11 domestic properties that were analysed, all of which had external solid wall insulation. Property B only has internal temperature data available for analysis, so this will be used as a proxy for the impact of the measure. Sample sizes that were compared varied from 5 weeks up to 15 weeks' worth of data before and after the installations equating to a total range of 10 and 30 weeks.

The highs and lows in heating degree days (HDD) both before and after installation look relatively similar which is important as you do not want extreme high or low HDD to be very different when you are making a comparison; as these will often elicit a change in heating behaviour not related to the measure being installed, but to the extreme temperatures (see Table 13).

The total heating degree day difference was small enough to ensure that the comparison was relatively similar before and after installation; this is important as a greater difference could presumably elicit a change in the way the building is heated. When a paired T-test for equal means was performed on 10 properties only property E showed statistically significant results, with the other 9 showing no statistical change. Strong correlations were found in 6 of the 10 properties suggesting that the heating pattern did not change after the installations, but 4 properties did show there was a change in heating patterns. In terms of gas consumption change the majority saw an increase in consumption however, these increases are relatively small when looking at them proportionally so they were most likely influenced by other factors such as occupancy rates, lifestyle changes and increased hot water use and not related to the impact of the measure (see Table 14Table 14).

				High and Low Gas Consumption and Heating Degree Day Weeks							
				Before Installation				After Installation			
				Minimin		Maximun		Minimin		Maximun	
Property ID	Type	Measures Installed	Sample Size Weeks Before and After Measure	Gas Consumption (kWh)	HDD	Gas Consumption (kWh)	HDD	Gas Consumption (kWh)	HDD	Gas Consumption (kWh)	HDD
A	Domestic	External Solid Wall Insulation	8	75	16	265	46	76	10	289	44
B	Domestic	External Solid Wall Insulation		Not Applicable							
C	Domestic	External Solid Wall Insulation	4	227	10	354	21	248	12	316	21
D	Domestic	External Solid Wall Insulation	15	67	21	342	103	101	32	396	112
E	Domestic	External Solid Wall Insulation	15	78	5	359	58	91	7	342	48
G	Domestic	External Solid Wall Insulation	15	54	5	376	55	59	8	272	52
H	Domestic	External Solid Wall Insulation	4	265	17	608	31	458	15	633	22
I	Domestic	External Solid Wall Insulation	8	27	19	412	38	73	10	358	48
J	Domestic	External Solid Wall Insulation	10	130	6	205	16	119	9	288	20
K	Domestic	External Solid Wall Insulation	8	14	19	188	55	79	15	163	55
L	Domestic	External Solid Wall Insulation	5	227	23	371	54	230	13	398	51

Table 13: High and low gas consumption and heating degree day weeks for South Lanarkshire.

If we focus on those properties with high gas consumption change such as property K; there was no significant change in average gas consumption, no change in heating pattern from the correlation test, yet nonetheless there was an increase in gas consumption of 234 kWh or 34%. However, when pairing these results with those from the internal temperature analysis, it was found that there was a significant change in average internal temperature from 20.2°C to 22.7°C, a 12% increase; and an 85% reduction in standard deviation. This increase in average internal temperature is the likely cause of the increase in gas consumption, indicating the occupants took the savings they would have experienced in comfort. The impact of the measure can still be seen though in the standard deviation, as a large reduction of 85% suggests the properties ability to retain its heat has increased, keeping the heat in for longer, but any savings associated with this has likely been negated by the large increase in average internal temperature.

The internal temperature results show that temperatures in 3 properties (property E, H and K) increased. This suggests that they were previously under-heating their homes, but with the wall insulation their properties can now reach the set temperatures ranging from 21°C to 23°C. The other 8 properties saw no change or a decrease in internal temperatures, although the largest reduction was only 5% which is relatively small. Using the

standard deviation test it was found that in all but one property there was a reduction, indicating all those properties are able to retain their heat for longer and have become less reactive to external temperatures.

Property ID	Gas Analysis Results								Internal Temperature Analysis Results					
	Sample Size	Heating Degree Day Difference		T.Test	Correlation		Energy Consumption		Sample Size	T.Test	Temperature			Standard Deviation
	Weeks Before and After Measure	Total (HDD)	Per Day (HDD/day)	95% Significance	R ²	Description	Change (kWh)	Change (%)	Weeks Before and After Measure	95% Significance	Before Installation (°C)	After Installation (°C)	Change (%)	Change (%)
A	8	33	0.59	No	0.523	Moderate Correlation	+45	+3%	14	No	19.8	19.8	0%	-50%
B	No Data								4	No	20.4	20.6	1%	-73%
C	4	8	0.29	No	0.347	Weak or Low Correlation	+49	+4%	4	Yes	23.8	22.7	-5%	-23%
D	15	37	0.35	No	0.887	Strong Correlation	+522	+22%	16	No	19.0	18.9	0%	-57%
E	15	2	0.02	Yes	0.893	Strong Correlation	+3	+0.1%	15	Yes	20.3	21.1	+4%	-36%
G	15	7	0.07	No	0.741	Strong Correlation	-79	-4%	15	No	18.8	18.5	-2%	+27%
H	5	30	1.07	No	0.712	Strong Correlation	+61	+3%	5	Yes	19.0	21.7	+14%	-18%
I	8	14	0.25	No	0.279	None or Very Weak Correlation	+54	+4%	8	No	19.1	18.2	-5%	-8%
J	10	24	0.34	No	0.300	Weak or Low Correlation	+48	+3%	10	No	20.7	20.3	-2%	-37%
K	8	17	0.30	No	0.909	Strong Correlation	+234	+34%	8	Yes	20.2	22.7	+12%	-85%
L	5	5	0.14	No	0.957	Strong Correlation	+12	+1%	5	No	21.3	21.8	2%	-13%

Table 14: Gas analysis and internal temperature analysis results for South Lanarkshire.

B.5. West Lothian

There were 2 properties that were analysed, 1 domestic which had external solid wall insulation installed and a non-domestic property that had both flat roof insulation and external solid wall insulation installed. Sample sizes that were compared varied from 7 weeks and 6 weeks' worth of data before and after the installations equating to a total of 14 and 12 weeks. The highs and lows in heating degree days (HDD) both before and after installation look relatively similar for the maximum values but there is some difference between the minimum values. This may affect the results as the differences in the minimum values may elicit a change in heating behaviour (see Table 15Table 15).

				High and Low Gas Consumption and Heating Degree Day Weeks							
				Before Installation				After Installation			
				Minimin		Maximun		Minimin		Maximun	
Property ID	Type	Measures Installed	Sample Size Weeks Before and After Measure	Gas Consumption (kWh)	HDD	Gas Consumption (kWh)	HDD	Gas Consumption (kWh)	HDD	Gas Consumption (kWh)	HDD
A	Domestic	External Wall Insulation	7	35	12	249	64	52	42	134	63
B	Non-domestic	Flat Roof Insulation, External Wall Insulation	6	8369	38	14339	100	4874	27	12199	109

Table 15: High and low gas consumption and heating degree day weeks for West Lothian.

The total heating degree day difference was small enough to ensure that the comparison was relatively similar before and after installation; this is important as a greater difference could presumably elicit a change in the way the building is heated. When a paired T-test for equal means was performed on the 2 properties only property B showed a statistically significant result. However, it showed a strong correlation, indicating that there was a significant change in average gas consumption for but the heating pattern remained the same, which is not unusual for a non-domestic building which has a set heating programme. The absolute change in gas consumption shows a reduction of around 22,500 kWh over the 12-week period, or a 12% reduction. These results show a good indication that both the flat roof and wall insulation has reduced the heating requirements of the building and saved money off their energy bills (see Table 16Table 16).

Property A (a domestic property) show no significant change in its average gas consumption before and after installation, but a moderate correlation, suggesting there was a change in the property's heating pattern. The internal temperature analysis also showed a significant change in average temperatures, going from 19.5°C to 17.4°C, a reduction of 11%. A reduction of 78% in standard deviation was also observed in the internal temperatures. These results indicate that although the average gas consumption did not significantly change there was a change in heating patterns; the reduction in standard deviation corroborates this as a change in heating patterns would be indicate that the internal temperatures vary less. Interestingly, the average internal temperature reduced quite substantially. This suggests that the building was previously unable to retain heat for very long and to compensate the heating was turned up, but as gas consumption has remained the same, it could mean the heating is on for longer now for the comfort of the occupiers (see Table 16Table 16).

Gas Analysis Results									Internal Temperature Analysis Results					
Property ID	Sample Size	Heating Degree Day Difference		T.Test	Correlation		Energy Consumption		Sample Size	T.Test	Temperature			Standard Deviation
	Weeks Before and After Measure	Total (HDD)	Per Day (HDD/day)	95% Significance	R ₂	Description	Change (kWh)	Change (%)	Weeks Before and After Measure	95% Significance	Before Installation (°C)	After Installation (°C)	Change (%)	Change (%)
A	7	35	0.71	No	0.5422	Moderate Correlation	-651	-51%	6	Yes	19.5	17.4	-11%	-78%
B	6	17	0.40	Yes	0.7221	Strong Correlation	-22572	-12%	No Data					

Table 16: Gas analysis and internal temperature analysis results for West Lothian.

B.6. Shetland Islands

There were 6 non-domestic properties that were analysed with various measures installed. Property A and E each have two lines of results as installation of LEDs only affect electricity consumption and therefore are not applicable for the methodology used on heating data. Sample sizes that were compared varied ranging from 3 weeks to 51 weeks' worth of data before and after the installations equating to a total range of 6 and 102 weeks.

The highs and lows in heating degree days (HDD) both before and after installation look relatively similar which is important as you do not want extreme high or low HDD to be very different when you are making a comparison; as these will often elicit a change in heating behaviour not related to the measure being installed, but to the extreme temperatures (see Table 17Table 17).

				High and Low District Heating Consumption and Heating Degree Day Weeks							
				Before Installation				After Installation			
				Minimum		Maximum		Minimum		Maximum	
Property ID	Type	Measures Installed	Sample Size Weeks Before and After Measure	District Heating Consumption (kWh)	HDD	District Heating Consumption (kWh)	HDD	District Heating Consumption (kWh)	HDD	District Heating Consumption (kWh)	HDD
A	Non-domestic	LEDs		Not Applicable							
	Non-domestic	Loft Insulation	5	7542	69	9200	87	7201	67	7956	84
B	Non-domestic	Top Up Loft, TRVs	8	3561	56	5981	81	3932	63	5281	94
C	Non-domestic	Heat Exchangers	3	4430	61	4462	77	4821	79	4821	81
D	Non-domestic	Heat Exchangers	6	1938	61	1945	77	2083	79	2083	81
E	Non-domestic	LEDs		Not Applicable							
	Non-domestic	TRVs	28	4841	47	9901	86	3562	25	13597	112
F	Non-domestic	BEMS	13	1623	60	2899	102	2154	57	3430	98

Table 17: High and low district heating consumption and heating degree day weeks for Shetland Islands.

The total heating degree day difference was small enough to ensure that the comparison was relatively similar before and after installation; this is important as a greater difference could either elicit a change in the way the building is heated or consume more or less heating energy within the same time period to compensate. When a paired T-test for equal means was performed on the 6 properties' district heating consumption, only property A did not show a statistically significant result, indicating that the average district heating consumption did not change after installation of the loft insulation. However, it did show no/weak correlation suggesting that although the average gas consumption did not change, the heating pattern did resulting in a district heating reduction of around 6,600 kWh or 15% over a 10-week period. All the other heat related measures installed across the 6 properties showed both a significant T-test result and moderate to no correlation, indicating that in all cases both the average consumption and heating patterns changed after installation (see Table 18Table 18).

There were 4 properties where the energy consumption increased after installation (property C, D, E and F). Properties C and D had new heat exchangers installed which are designed to act as heating interface units (HIU) where they extract heat from the main district heating network into a property to be used within it; in this case more efficient water to water heat exchangers were installed to make this process more efficient. It is unclear why the energy consumption increased but it should be noted that for two properties there were only 3 and 6 weeks' worth of data available for comparison pre and post installation; arguably not representative of the changes in use over a year. Property C does have

corresponding internal temperature data which showed a significant change in internal temperatures from 19.1°C to 20.0°C and a large standard deviation reduction of 64%. This could explain the increase in district heating consumption for this property as their internal temperature increased by 5%, possibly negating the savings the heat exchanger was making by taking comfort. It is possible the same also occurred with property D (see Table 18).

Property F has a building energy management system installed or upgraded. Often when these systems are installed they are able to manage more aspects of a buildings energy demand and a review of how the property is being heated is often undertaken. The increase in district heating consumption of 8% could be due to the change in heating patterns shown in the weak correlation result, as heating a building for longer or at higher temperatures would do this; but without internal temperature data we cannot be sure of the cause (see Table 18Table 18).

Property ID	District Heating Analysis Results								Internal Temperature Analysis Results					
	Sample Size	Heating Degree Day Difference		T.Test	Correlation		Energy Consumption		Sample Size	T.Test	Temperature			Standard Deviation
	Weeks Before and After Measure	Total (HDD)	Per Day (HDD/day)	95% Significance	R ²	Description	Change (kWh)	Change (%)	Weeks Before and After Measure	95% Significance	Before Installation (°C)	After Installation (°C)	Change (%)	Change (%)
A	51	Not Applicable		Yes	Not Applicable		-36443	-16%	No Data					
	5	13	0.37	No	0.2543	None or Very Weak Correlation	-6635	-15%	No Data					
B	8	60	1.07	Yes	0.0011	None or Very Weak Correlation	-7759	-18%	No Data					
C	3	35	1.67	Yes	0.214	None or Very Weak Correlation	+1141	+9%	43.6	Yes	19.1	20.0	+5%	-64%
D	6	35	0.83	Yes	0	None or Very Weak Correlation	+426	+7%	No Data					
E	47	Not Applicable		No	Not Applicable		+5469	+6%	No Data					
	28	31	0.16	Yes	0.6118	Moderate Correlation	-59929	-25%	8	No	19.6	17.0	-13%	+154%
F	13	23	0.25	Yes	0.4743	Weak or Low Correlation	+3014	+8%	No Data					

Table 18: District heating consumption analysis, and internal temperature analysis results for Shetland Islands.

Both property A and E had LEDs installed, with property A showing a significant change in its average electricity consumption and a reduction in electricity consumption of around 36,000 kWh or 16% over a 51-week period. Property E showed no significant change in average electricity consumption and saw a small increase of around 5,500 kWh or 6% over a 47-week period (see Table 18). This could be due to increased use (possibly during winter months) but also could be due to increased power use in other non-lighting areas of the building. With existing data, it is unclear to the reason for this small increase.

Appendix C. Non-domestic case studies

Non-domestic data collection for the social evaluation focused on projects which were not owned by the local authority or involved a number of decision makers granting permission before a project could go ahead. This appendix presents five case studies detailing the context, challenges and successes experienced in these projects. The case studies are informed by non-domestic social surveys of building decision makers and occupants, as well as a selection of in-depth interviews. The appendix aims to shed light on the complexities and diversity of delivering energy efficiency projects in non-domestic buildings.

The case studies included in this appendix are as follows:

- C.1 Case study: Mixed use tenement building, Glasgow

- Case study: Community Arts Centre, Aberdeen
-

- Case study: Community Centre, Glasgow
- C.4 Case study: NHS health centres, South Lanarkshire
- C.5

- Case study: Business Centre, Fife

C.1. Case study: Mixed use tenement building, Glasgow

An important challenge for the successful delivery of EES going forward will be to develop successful approaches to delivering retrofits to tenement blocks with a mix of non-domestic and domestic occupants. These buildings are particularly challenging because of the often-differing priorities and circumstances of occupants.

This project did not go ahead during the timescales of the pilot. This case study is presented to explore the challenges and complexities that can arise with this type of project.



Figure 14: External cladding to a Glasgow tenement block similar to the works planned for this project.

Project summary

- Red sandstone, pre-1919 tenement building
- Ownership:
 - 13 commercial units including a solicitor's office, a take-away shop, a café, a vaping shop, and other shops. Only 8 were responsible financially for the works at the rear of the building (the remedial works and the external wall insulation). Non-domestic occupants were a mix of owners and tenants - some were on a full repairing and insuring lease and some were owner occupiers.
 - Domestic properties: 38 Privately owned, 68 housing association owned flats.
- Planned measures - included remedial work and energy efficiency measures:
 - Remedial works: Significant repairs to the rear screens at the back of the tenement which were letting in water
 - Energy Efficiency upgrades: External wall insulation to the rear and gable ends of the tenement blocks; Internal wall insulation to the front wall of the tenement.
- Delivery of the works was coordinated by the housing association

Data used in this case study:

- 1 x In-depth interview with the project leads from the housing association and Glasgow City Council. The interview was conducted by the evaluation team in November 2017, after the project had been cancelled.

Project context

- The housing association had delivered a similar project previously, retrofitting a tenement block with external and internal wall insulation. This project was delivered successfully, but there were problems getting payments from non-domestic shop owners for the work. The housing association had covered these costs in the previous project but were not in a position to do so again, having received much higher funding in the previous project
- The project was supported by a local architects' firm that had experience retrofitting energy efficiency measures in pre-1919 tenement blocks. This firm alerted the housing association to the possibility of accessing the EES pilot funding.
- The housing association approached Glasgow City Council, who were keen to include the project in their pilot bid because it offered learning opportunities about delivering energy efficiency projects to mixed-use tenements.
- This tenement building was selected by the housing association because it needed maintenance work. The EES pilot provided a good opportunity to fit energy efficiency measures at the same time as carrying out wider works.
- Although the housing association properties already met the Energy Efficiency Standards for Social Housing (EESH), they still received complaints from tenants about their homes being too cold. This was a driver for them to invest in energy efficiency upgrades.

Funding model for project

Non-domestic properties:

- Each shop was required to make an average contribution of £7000 (made by the owner or tenant, depending on individual lease conditions)
 - Offered zero-interest loans to cover these costs through Resource Efficient Scotland³¹.

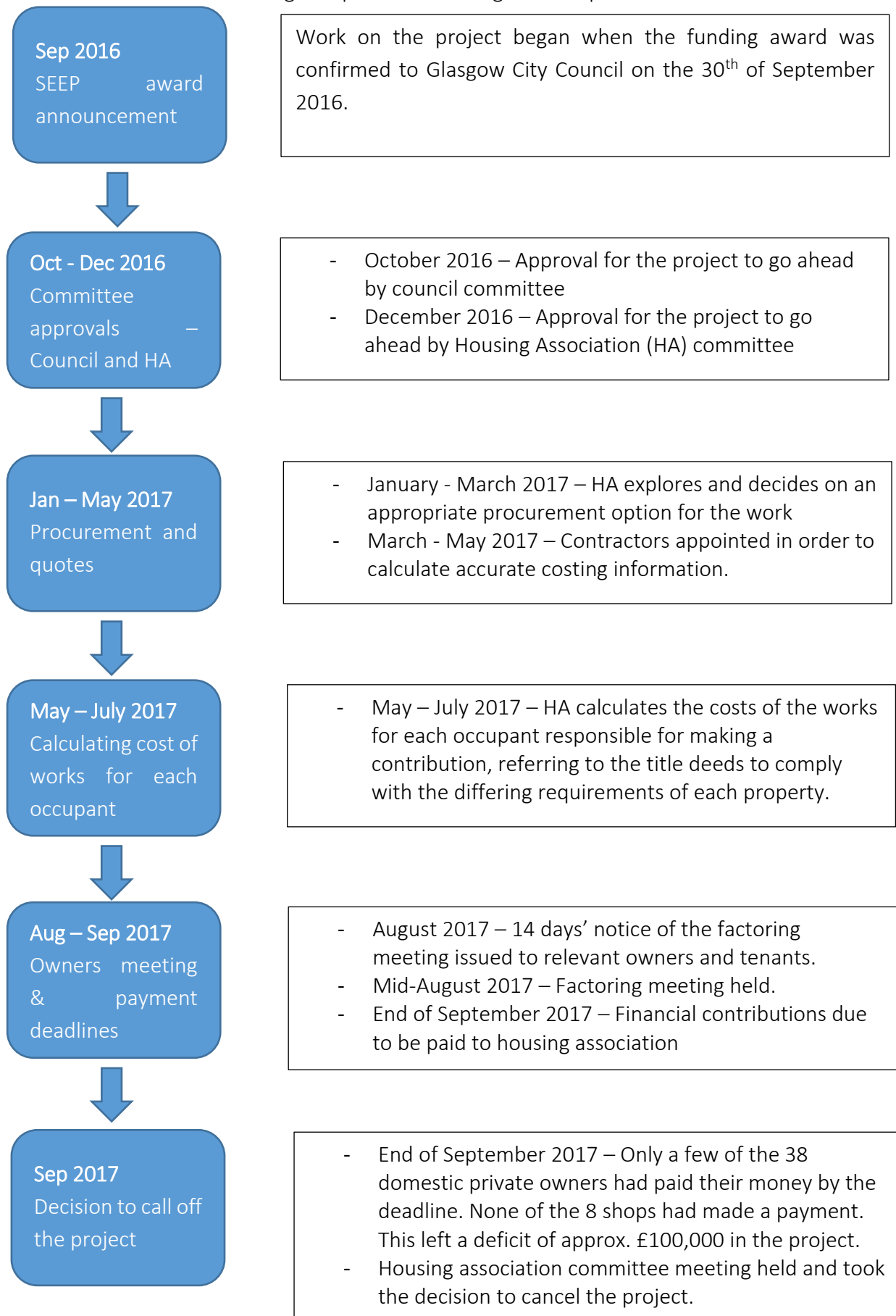
Domestic properties:

- ECO funding
- The housing association covered the costs of the housing association-owned properties (almost £500,000 from their planned maintenance budget).
- Private owned properties:
 - HEEPS ABS grant (£6,500 per owner property) covered 100% of the costs for insulation through HEEPS ABS;
 - Private sector housing grant from council to cover 50% of the costs of the remedial works
 - Remaining domestic privately-owned contribution was an average of £1900 per property towards the remedial works.

³¹ Resource Efficient Scotland, 'Resource Efficient Scotland SME Loan Fund', 2018 <<https://www.resourceefficientscotland.com/SMELoan>> [accessed 20 August 2018].

Project timeline

Project delivery was coordinated by the housing association. The project timeline is set out below to illustrate the challenges experienced throughout the process.



What worked well in the project?

- The previous experiences of the housing association and architects' firm meant the project managers were prepared for managing the complicated mix of title deeds, domestic and non-domestic owners and tenants.
 - Complying with the title deeds as closely as possible offered protection to the housing association so that if the works went ahead and somebody did not pay, they could go to court and show they had followed the required process.
 - The previous project also meant that tenants and owner occupiers had seen other tenement blocks get EWI and IWI installed, and they wanted it done on their block
- There was a positive response from domestic owner occupiers. Feedback suggested that people could appreciate the value of doing the project now when there was considerable grant funding support available and that they would have bought into the project had there been more time to get money together.
- Glasgow City Council added extra funding support to the project to cover 50% of the remedial works costs, significantly reducing the amount that owner occupiers needed to contribute on their own.

What was challenging about the project?

- The complexity of the title deeds meant that project administration to work out occupant contributions took a lot of time and reduced the time available for owner-occupiers to gather money together to make their payment.
 - o There were still unresolved aspects to payment responsibility e.g. One shop tenant who was on a repairing lease argued that the energy efficiency measures were not covered by their lease, and that their landlord should cover the costs. Another tenant was sub-letting the property, so it was unclear what their responsibility was for covering the costs of the works.
- As the Housing Association was a small organisation, there were limited staff resources available to coordinate the project made it hard to complete the project before the funding deadline.
- Owners had only one month to pay their money to the housing association. This short timeframe was required to ensure the funding could be spent within the stipulated timescales set by the Scottish Government.
 - o People recognised the benefits of the project, and the opportunity of grant funding... but they needed more time to get the money together.
- Many of the shops were marginal businesses and their financial contributions were not felt to be a realistic proposition, even with a zero-interest loan:
 - o *"I don't know that energy efficiency is at the top of most shop owners' priorities. I think it's business rates and just paying their lease and paying their bills."* (project manager)
- It was not clear what the drivers were for the shop tenants to make investments in energy efficiency:
 - o There was one concern expressed that the shops were being asked to pay for the benefit of the domestic occupants:
"[one non-domestic occupant] asked that at the meeting [...] 'What am I actually paying for here?' She said 'the government's putting a lot of funding into this for owners, what are they saving? What is the actual benefit to them? Is it two

hundred pounds a year? So you're asking me to pay six thousand pounds to benefit somebody up the stairs saving two hundred pounds a year on their heating bills?" (Housing association officer)

- Perceptions of risk:
 - o The housing association had previous experience of a similar project where they did not receive contributions from all owners. They had covered the costs themselves in this case but were not able to do this for this project due to the high number of private owners and reduction in available funding.
 - o The housing association had to consider the risk of taking people that did not pay to court, and the administrative and financial costs that this would involve.

Lessons and implications

Different 'intermediaries' played a critical role in enabling this project to progress:

- The architects' firm (who were aware of the latest funding opportunities),
- the housing association (who proposed and coordinated the works, researched the details of leases and liabilities of all the properties, and engaged with tenants);
- and the local council (who contributed 50% grant funding for the remedial works and accessed the EES funding for the EWI works).

Who would do this if there wasn't a majority of housing association properties in the tenement already?

The interdependence between building maintenance and energy efficiency was influential to this project going ahead:

- As a catalyst: The need for maintenance was a driver for the project going ahead in the first place
- As a barrier: It also increased the costs of the project, and meant it was harder for people to get the money together in the timescales.

Would it be beneficial to design programmes around tackling both maintenance requirements and energy efficiency upgrades?

Timescales:

- The complicated ownership structures meant that the project had a long preparation period before engagement with occupants could begin (worsened by lack of staff resources, and delay in project commencement at SG level);
- People eligible for making financial contributions needed more time to get money together; The project officers from the housing association and the council both felt that a more appropriate timescale to offer people for making their contributions would be: *"as a minimum six months"*.

Greater flexibility in project timescales would allow more time for coordinating works in the context of complicated governance arrangements and multiple owners making contributions.

C.2. Case study: Community Arts Centre, Aberdeen

This case study explores the drivers for a non-domestic building to connect to a district heating network, alongside the challenges of arranging suitable finance for small organisations to cover the connection costs associated with this. This was the first time that the Aberdeen Heat and Power network had connected a building that was paying its own connection fee.

Project summary

- The arts centre is a company and registered charity in Aberdeen which aims to provide facilities and opportunities for the community to learn and engage in the performing arts.
- It has a theatre, gallery, meeting room, café / bar, and conference room.
- Ownership:
 - The building is owned by local authority and leased to the arts centre on a long-term, repairs and maintenance lease.
- Works
 - Connection to Aberdeen Heat and Power district heating network, which was being extended to pass by the building (source of heat: gas-CHP).
 - Resource Efficient Scotland conducted an energy assessment of the arts centre to assess whether additional building energy efficiency measures were possible, and assess their eligibility for a zero-interest loan.
- Delivery of the works was coordinated by Aberdeen Heat and Power
 - Funding was then claimed back from Scottish Government through the local authority, since Aberdeen Heat and Power were not eligible to apply for the EES pilot funding.

Data used to inform the evaluation

- 2x In-depth interviews with lead local authority officer (April 2017 and March 2018) and 1 x interview with representative of Aberdeen Heat and Power (April 2017);
- No surveys were able to be conducted with the building manager or occupants due to delays in the project completion (see details below).

Project context

- Aberdeen Heat and Power is a not-for-profit, arms-length company of Aberdeen City Council, set up in 2002, which operates a district heating network connecting a number of local authority-owned buildings and social housing tower blocks in the city.
 - Aberdeen Heat and Power has an objective to extend the network to enable more efficient and affordable supply to more buildings in the city – in particular, supply to more social housing tower blocks with the objective of reducing fuel poverty.
- In total the pilot project aimed to connect 7 new non-domestic buildings to the network (4 of which were not the responsibility of the local authority).
- The Arts Centre was responsible for covering its own connection fee to the network.

Funding model for the project

- EES pilot funding was used to cover the district heating network expansion
- Building connection costs were covered by the arts centre.

- The arts centre took out a zero-interest loan from Resource Efficient Scotland in order to cover these costs.

Project timeline

- March 2016 - Submitted EES project bid with a set of buildings for connection identified.
- September 2016 – pilot project funding confirmed
- January – March 2017 – AHP did procurement for the required pipe work and heat exchangers ready to be able to commence the works.
- September 2016 - March 2017 – Collect detailed data on selected buildings, and engage with key decision makers. During this process, several buildings were ruled out, and additional buildings brought in.
- April 2017 – timings arranged with the council for digging up the roads to install the pipes, and make connections to a school over the summer holidays.
- May 2017 – December 2017 – Network extension takes place
 - October 2017 – confirmation that ACT was going to connect to the network, but the RES assessment and loan confirmation had not been completed.
 - December 2017 – ACT connected to the DH network, but heat connection not switched on, pending confirmation of financing arrangement with RES.

What worked well?

- Close and long-standing working relationship between Aberdeen City Council and Aberdeen Heat and Power meant that the certain elements of the project could go ahead without a high risk, enabling higher levels of uncertainty about who would and wouldn't connect from other quarters of the project.
 - AHP could go ahead and deliver the work independently and provide the necessary evidence to Aberdeen City Council in order to claim the funding. This did not draw substantially on the council's staff resources.
- Aberdeen Heat and Power had already started to engage with the decision makers in key buildings along the planned heat network route before the EES pilot funding bid was submitted. This enabled completion of the project in the required timeframes. If this had not happened, it was felt that the project timeframes would have been too short to deliver the pilot objectives.

What were the challenges?

- The arts centre needed a loan to be able to cover the connection costs to the district heating network. However, the staff member leading on the project within the Arts centre left half way through the project, leading to a delay in accessing the Resource Efficiency Scotland (RES) audit and confirming eligibility for a RES zero-interest loan.
 - High workloads within Aberdeen Heat and Power, RES and Aberdeen City Council also meant that this delay was not followed up.
- Due to the time-restrictions of the EES pilot funding, Aberdeen Heat and Power had to do the works to connect the building to the network before the financing could be confirmed. This exposed Aberdeen Heat and Power to a risk that the arts centre would not have suitable finance to cover the connection costs.
 - In order to manage the risk, Aberdeen Heat and Power set up an alternative payment programme that could be offered to the arts centre if the loan did not

come through (on a one-time basis for this project). The payment programme that would enable Aberdeen Heat and Power to recover the connection costs through their monthly standing charge to the arts centre. However, this payment programme included interest charges. The arts centre therefore preferred to access the RES loan if possible.

- At the time of writing (May 2018), the heat supply to the arts centre had not yet been switched on because the financial arrangements for the loan had not yet been confirmed.
- Some buildings originally identified in the project bid chose not to connect to the district heating network. The following were cited as reasons for not connecting:
 - Building owners did not want to make investments because they felt they may decide to sell the building in the near future. E.g. In one building, an economic down-turn in Aberdeen meant that building tenants were leaving.
 - One organisation was offered a low gas price for 3 years, undermining their business case for making investments in the network connection cost.
 - One building's gas-boiler broke down during the project and they had to replace it before the connection to the network could be made.
- The lower number of buildings connected to the network impacted on the project's overall carbon savings.

Lessons and implications

- Clear and simple access to low or zero interest finance was important in enabling the arts centre to decide to make the connection to the district heating network.
- A longer timeframe for the pilot (more than 18 months) would have potentially allowed for a higher number of additional connections to the district heating network. The project was dependent on the different contexts and decision making processes of each organisation the sought to connect, and offering greater flexibility in connection timeframes would have given some organisations sufficient time to get agreement from key decision makers.
- Despite the reduced number of buildings connected during the timeframes of the pilot, the project has also provided opportunities for other buildings to connect to the network in the future.

C.3. Case study: Community Centre, Glasgow

This case study explores the delivery of energy efficiency retrofit to an independent community centre with limited budget available for investment in their building (rented under a repair and maintenance lease). Financial responsibility for the risk of unexpected repair costs was a key issue which threatened to undermine the project (Figure 15 and Figure 16: Before and after the works had taken place in at the community centre).



Figure 15: Community centre in Glasgow before the works had taken place



Figure 16: Community centre in Glasgow after the works had taken place

Project summary

- The community centre is a registered charity which was established in 1979. 32 community and care organisations deliver services at the centre and 600 people attend on a weekly basis. It has a café where older people and disabled people meet; as well as a social area with pool tables and a function room.
- The community centre is located in a single storey building built in the 1980s with external walls of metal frame construction and a corrugated finish.
- Building ownership:
 - The building is owned by City Property, an arms-length company of Glasgow City Council.
 - The building has been leased to the community centre by City Properties for the past 15 years for a minimal annual rent on a full repair and maintenance lease.
- Installed measures:
 - External wall insulation

- SG agreed to the application for capital funding subject to an energy audit by Resource Efficient Scotland - done in June 2016 - with access to a loan to fund cost-effective recommendations from this audit. Recommended measures were costed at approximately £20,000 and they included:
 - Upgrading the lighting to LEDs
 - Replacing the heating controls
 - Improving the water efficiency
- Delivery of the works was coordinated by the local authority.

Data used in this case study

- 2 x In-depth interview with Glasgow City Council officers (March 2017 and March 2018)
- Two-time social survey with a community centre representative (January 2018 and May 2018)
- Surveys with building occupants were unable to be collected.

Project context

- An important driver for the project was saving money on energy bills. The building was expensive to run for the charity.
- Use of the community centre was not being used to its full capacity and this was putting financial strain on the charity.
- The building is surrounded by new and recently retrofitted housing stock which meant that aesthetic improvements were seen as an important outcome of the project in order to bring the building up to the standards of the surrounding area.
- Energy efficiency measures had not been installed in the building before this project, although the charity had previously received advice from a social enterprise, which helped them to save money by switching energy supplier. They also received a substantial refund from their previous utility provider, having been previously overcharged by them.
- An energy audit was carried out by Resource Efficient Scotland as part of the pilot project which made a number of recommendations to the charity alongside external wall insulation. Loan funding was awarded for these measures.

Funding model for the project

- Full grant funding was awarded for external wall insulation.
 - The charity felt grant funding was essential for the project to go ahead. The community centre is a self-funded organisation and does not generate sufficient income to pay for significant building investments.
- A zero-interest loan was made available to the charity to cover additional energy efficiency measures recommended by the Resource Efficient Scotland energy audit (although these had not been implemented at the time of writing).
- EES pilots enabling funding was used by Glasgow City Council to cover small unexpected additional costs in the project e.g. scaffolding costs.

What worked well in the project?

- Glasgow City Council's involvement in the project delivery was cited as an advantage by the charity as this enabled the charity to access council officers' experience from

other projects to help to manage the quantity surveyor, clerk of works, and ensure experienced site managers.

- The charity felt the aesthetics of the building had improved as a result of the works. Beyond the visual impacts of the works, the scope of the evaluation was too short to assess any wider impacts e.g. reduced energy bills, improved comfort. (Note: Measures were installed in March 2018, follow up survey was conducted May 2018)

What was challenging about the project?

- **Understanding building ownership and agreeing financial responsibilities:**
 - o At the time that Glasgow City Council wrote the funding bid for the project they did not know that the community centre did not own the building. City Property became the primary partner (Partner 1) for the works (instead of the community centre, who became Partner 2, and needed to authorise the works. Getting agreement from an extra partner caused delays due to a need for clarity over financial responsibilities.
 - o City Property were supportive of the project in principle. However, they expressed concern about the risk associated with any major works required to the building that might come to light during the course of the project, which they would have potentially been liable for, e.g. asbestos or structural issues. City property also had similar lease agreements and did not want to commit to taking on a risk in this case, which they couldn't offer to other lease holders.
 - o **Partnership agreement:** The local authority legal services needed to draw up a legal agreement with City Property before the Board could approve the works. Scottish Government also got involved in this process to assure City Property that they would not need to take on all of the risk of extra maintenance costs, should they arise.
 - o The quantity of staff time needed to make the project work (including LA legal department, Council Affordable Warmth team, City Property's staff time) was high compared to the capital budget of the project due to these complicated arrangements around payment responsibilities.
 - o The works were approved at the City Property board meeting in December 2017 (the final month of the pilot project) and a 3-month extension was given to the project to allow it to be completed.
- **Local reputational and political risks of the project not succeeding:** The project had the support of the local councillors and community members that wanted to see investment in the local community centre. This created reputational risks for the council when the project was delayed due to high levels of local interest in the project.
- **Unexpected complications and funding timescales:** A range of unexpected complications happened during the project. The building survey was not undertaken until after funding had been applied for and awarded. This threw up issues which had cost implications and also caused delays.
 - o A change in the work specifications to upgrade the fire safety specifications after the Grenfell Tower disaster. This involved removing the corrugated iron wall panels completely and carrying out additional investigations into the condition of a block work underneath.
 - o **Unexpected repairs:** Lead paint was discovered under the corrugated iron wall panels that needed to be removed.

- **Funding expenditure within financial years:** The original timescales set out in the project bid were not possible because of the unexpectedly complicated partnership agreements that needed to be drawn up. This meant that expenditures could not happen within the financial years that were originally agreed between Glasgow City Council and the Scottish Government. The project was given flexibility in this instance.
- **Using a zero-interest loan** to fund the additional energy efficiency recommendations was seen as risky for the charity because they did not have a financial reserve. They had not taken up this facility at the time of writing, although the option was still under consideration by the charity.
 - Approval for taking out the loan would need to come from the charity's board, in the context of uncertain rental incomes from community activities.
 - The charity manager was considering whether measures could be done in smaller packages to reduce the risk taken on by a larger loan.
 - Council officers felt that experience from installing the external wall insulation and demonstrating the resulting energy savings would help the charity to feel more comfortable taking on the risk of a loan with future upgrades. (This was not able to be assessed during the timeframe of this evaluation).
- **Gaps in energy efficiency measures** - There were still issues with the building that had not been recommended by the RES report because they were not cost effective within the terms of the loan - E.g. draughty doors and windows, that were recognised as energy inefficient and problematic by building occupants.

Lessons and implications

- **Developing a long-term process of engagement with large scale non-domestic landlords** to encourage uptake of future energy efficiency programmes could help to minimise issues around ownership and financial responsibility that cause delays.
- **Making the case for taking out a loan to pay for additional measures?** The experience of installing measures as part of the pilot provided an opportunity for the charity to see the impacts of making energy efficiency changes.
 - **Research question for future evaluations:** Can experience of energy efficiency measures supported by grant funding act as a catalyst for installation of further measures and reduce the perceived risk of taking out a loan?
- **Staff resources are needed to develop project ideas with building owners and occupants before the installation stage.**
 - The development time for the community centre project took up the majority of the pilot time. Is there a way that long-term development work could help to reduce this preparation time?
- **Coordination to align priorities across key partners and council departments is important**
 - As a result of the EES pilots, Glasgow City Council have set up a corporate delivery group to coordinate future energy efficiency projects and funding bids and create greater alignment with arms-length organisations such as City Property.

C.4. Case study: NHS health centres, South Lanarkshire

The South Lanarkshire EES pilot aimed to deliver measures to domestic, local authority and NHS-owned buildings situated within a small geographical area. The non-domestic part of this pilot aimed to test how cross-organisational working could support delivery of energy efficiency measures into this range of buildings. This included an aim to test whether joint procurement between the two organisations could reduce the financial costs of the measures overall. Unfortunately, this did not take place. This case study explores the experiences of the NHS Board working to deliver specific measures within the context of a EES pilot led by the local authority.

Project summary

- This project involved three NHS buildings located within the geographical area selected for the South Lanarkshire pilot. 68 domestic properties and the council's headquarters building were also retrofitted within the same geographical area.
 - Building 1: 4 storeys, 2,604m², stone construction, grade B listed building, no existing insulation installed at all.
 - Building 2: 2 storeys, 2,738m², timber-frame building – Approx. 15 years old, had some level of insulation already installed.
 - Building 3: 3 storeys, 2,604m², concrete clasp construction.
- **Building ownership:** buildings were all owned by NHS Lanarkshire
- **Building uses:** included occupational health, a residential care facility with 10 beds, and a GP surgery. However, the use of Building 2 changed significantly during the course of the pilot project from a 24-hour, residential care facility to a day-time office facility and Forensic Mental Health outpatient facility.
- **Installed measures:**
 - Building 1: LED lighting and motion sensors, Loft insulation was planned but could not go ahead due to lack of budget for roof repairs. Upgraded glazing was also planned but did not happen because of delays arising from listed building status.
 - Building 2: Internal insulation to pipes and valves, filling gaps in building fabric insulation, LED lighting and motion sensors, Upgrade of valves / mixers to improve the ability to zone the heating; Improvement to chiller controls / compressors
 - Building 3: Insulation, LED lighting and motion sensors
- Procurement and delivery of the works was coordinated by NHS Lanarkshire.

Data used in this case study

- 3 x In-depth interviews with NHS Head of Sustainability and Environmental manager (March 2017, November 2017, March 2018)
- Social surveys: 3 x Occupant surveys conducted after works had been completed (May 2018)

Project context

- NHS Lanarkshire covers the local authority areas of South Lanarkshire Council and North Lanarkshire Council.

- The design of this project was led by South Lanarkshire local authority, and the NHS were invited to identify buildings in need of energy efficiency upgrades within the identified area to include in the bid.
- NHS Lanarkshire and South Lanarkshire Council are part of a Sustainability Partnership which brings together key public sector players in the area to work together on sustainability issues, including the Strathclyde Partnership for Transport (SPT).

Funding model for project

75% EES grant funding

25% funding contribution from NHS Lanarkshire (Spend to Save scheme)

What worked well in the project?

- **Existing relationships to enable cross-organisational cooperation:** There were established working relationships between NHS Lanarkshire and South Lanarkshire Council, developed through participation in the Sustainability Partnership. This enabled development of the project bid quickly when the EES pilot funding was announced.
 - However, these working relationships were dependent on specific staff members, rather than formal organisational governance. When a key member of staff left from South Lanarkshire Council, these relationships had to be re-established.
 - Resource constraints on many of the members of the sustainability partnership have restricted the work that the group does together.
 - Opportunities for working together were sometimes missed and the NHS Lanarkshire sustainability team saw it as incumbent on them to monitor funding opportunities and make contact with the local authority when opportunities arose.
- **Detailed and up to date project register:** NHS Lanarkshire maintained a detailed and up-to-date project register which helped to them to identify buildings quickly when the funding opportunity arose. Buildings were coded from A- E according to their condition, their boiler efficiency and age. A 'wish list' of potential measures and upgrades is also maintained by the maintenance team and sustainability team.
- **Investment for the long-term benefit of the public sector:** Investment went ahead in Building 1 even though there were discussions about the sale of the building to another public sector organisation.
 - *"because it was still going to be a kind of public sector building we didn't feel if we'd have done some lighting you know the money would have been wasted kind of thing it's a listed building so it was never going to be demolished."* (NHS project manager)
- **Established processes for engagement with NHS building occupants:** The team have an established process for liaising with building occupants when work is going to take place through the operational service managers and practice managers in each of the buildings. Any concerns are raised through these key individuals and fed back to the project team.
- **Project delivery planned around existing commitments:** Expenditure of the EES funding could be planned for a quiet time of year for the delivery team (after the end of the financial year when internal budgets need to have been spent). This gave more

flexibility in the event of unexpected delays such as extended opening hours in the health centre due to a flu outbreak during January.

- **The grant funding will be recycled into the NHS Lanarkshire 'spend-to-save' fund.** Building up this fund allows them more flexibility to make expenditures at any time of the year (it is not tied to financial year budgets).

What was challenging about the project?

- **Funding criteria overriding strategic priorities of the NHS Board:** The area-based approach specified in the EES pilots funding criteria meant that the NHS buildings were selected based on location rather than their priority in NHS Lanarkshire building maintenance and upgrades strategy.
- **Joint procurement between the NHS and local authority:** The original pilot bid aimed to trial a joint procurement process between the NHS and local authority for LED lighting, as well as technical monitoring equipment for the pilot evaluation. However, this was not achieved. This was put down to a key staff member leaving the local authority just as the pilot began, and no replacement was made. This meant that the council's project delivery processes reverted back to standard practice, with no involvement of NHS officers in project meetings. There were also concerns about how this would be done within the procurement rules of both organisations.
 - o *"I did have a real concern that you know the price of the equipment went up because we're all buying it at the same time."* (NHS project manager)
- **Predicting project costs, timescales and maintenance requirements:** There were a number of unexpected budgeting issues that prevented work being completed in Building 1:
 - o The costs of the works set out in the bid for building 1 were significantly higher than estimated. The estimate for the project costs was based on a software programme which uses national data to estimate costs. However, Building 1 was a listed building, and some of the specified works to meet listed building requirements would have cost significantly more. This meant that not all of the works could be completed in the pilot.
 - o Due to the listed status of the building, it was difficult to align funding approval, planning approval and inviting tenders which are only valid for 6-8 weeks. This caused some delays to the project delivery timescales.
 - o The building required repairs to the roof, which had not been budgeted for in the NHS budgets for that financial year. This prevented the installation of the roof insulation planned as part of the EES pilot (although the works are now planned for this financial year, including the roof insulation).

Lessons and implications

- **Cross-organisational working** (e.g. across public sector institutions) could be beneficial for financial savings through joint procurement exercises, enabling strategic planning of energy, and energy infrastructure investments. In this case study, it enabled the NHS to access funding despite the short timeframe of the bidding process. However, establishing and maintaining cross-organisational working was undermined by the loss of a key staff member. The experience suggests that this requires long-term prioritisation and resourcing in both organisations to enable cross-organisational working and strategic planning to work effectively.

- It was suggested that the introduction of Joint Integrated Boards (JIBs), working across the NHS and local authorities to support joined-up patient care, could provide an opportunity to better establish joint working on estates management and upgrade, including investment in low carbon heating infrastructure such as heat networks where appropriate.
- **Established processes for building occupant engagement**, in particular understanding building occupants needs and having a process for reporting of concerns, enabled short project delivery timescales to be achieved without tensions.

C.5. Case study: Business Centre, Fife

This building is owned by Fife Council and is run on a commercial basis. Its tenants are small businesses who are responsible for paying their own energy bills. This case study has been selected to explore the financing and engagement approaches used to enable a project of this type to go ahead, where tenants are not responsible for making energy efficiency investments in the building but benefit from the energy savings.



Project summary

- The Business Centre rents spaces to small and medium sized enterprises
- It is a former maternity hospital, opened in 1937, closed in 1993. Opened as a Business Centre in 1996.
- Ownership:
 - The building is owned by the local authority and managed on a commercial basis.
- Works:
 - Extension of the biomass heating network within the Business Centre, using its existing biomass boiler;
 - Lighting improvements and LED lighting upgrades in a number of buildings;
- Delivery of the works was coordinated by Fife Resource Solutions – an arms-length company of the local authority.

Data used in this case study

- 2 x In-depth interviews with Fife Council officers (March 2017 and February 2018)
- Single social survey with onsite 'decision maker' and 2 x building 'occupants' (business tenants) (December 2018).

Project context

- Fife Council's commercial building stock is made up of a wide variety of building types that are rented to tenants on a commercial basis.

- A list of maintenance and improvements works needed in these buildings is maintained by the council.
- Fife council has an **'Energy Management Revolving Fund'**. This fund is a form of internal loan that the council allocated to council departments to invest in energy saving measures. The department repays the loan to the revolving fund using the energy savings from the investment, and the money can then be invested in another council energy efficiency project. Before this pilot, council-owned commercial buildings had never accessed the energy management revolving fund before because the tenants were responsible for their own energy bills and so the revolving fund repayment model was difficult to achieve.

Funding model for project

- Part-funded (17%) by Local authority Energy Management Revolving Fund, a form of internal loan from the local authority to the internal council department.
 - The internal loan will be repaid partly through a proportion of the tenant standing charge for use of the heating system. The council's commercial maintenance budget will also be used over time to cover the remainder of the costs.
- Part-funded (6%) by the Council's maintenance fund for the commercial buildings
- Part-funded (77%) by EES pilot grant

Project timeline

Biomass heating extension works:

- lead-in started: November 2016
- measures installed: August 2017
- formal handover: Oct 2017.

LED lighting works:

- lead-in started: March 2017
- measures installed: November 2017.

What worked well?

- The council had existing working groups in place that brought together different departments on non-domestic energy efficiency and district heating. This meant that when they were deciding on their EES pilot bid they could bring together people quickly.
- The EES funding catalysed use of the council's Energy Management Revolving Fund for the council's commercial property stock for the first time
 - *"property services hadn't worked with them before because we couldn't see a way to get a repayment in place [...This] grant was quite instrumental in taking that conversation forward and finding a solution to it and that's worked."* (Project manager)
- Skills were shared across council departments to enable the project to run smoothly, including approaches to engaging the business centre tenants about the energy project, and approaches to procurement and use of contractors.

What were the challenges?

- There was not sufficient or accurate information available for the local authority about the current state of their building stock, to inform the design and writing of their project bid.
 - o The EPC certificates available for the buildings were not recent or detailed enough to enable a 'whole-building' assessment of the retrofit needs.
 - o Detailed knowledge of the buildings was often held by building managers. However, loss of key staff members meant that a source of a lot of this information was lost
 - o Feedback from occupants suggested there was still a need for energy efficiency improvements in the building such as replacement of draughty doors and windows. Some potential benefits of the heating upgrade could be lost.
- Working with the private sector tenants required a longer lead-in time and more resource to get buy-in from all of the tenants before the work commenced.
- The original model the council had proposed to recoup the investment capital back to the Energy Management Revolving Fund had involved tenants paying a higher rent. Once this option was explored, however, it became clear that it would involve signing new rental agreements with the tenants, which was considered risky since it gave the tenants a chance to leave.
 - o The alternative approach of incorporating part of these costs into the heat network standing charge was used instead. However, this was also kept to a limited level in order to maintain competitive prices for commercial tenants in the centre.

Lessons and implications

- The pilot helped the council to try out an alternative way of using the Energy Management Revolving Fund with a commercial building.
- During the design of a project, more details are needed about the buildings in question than are provided in EPCs. Conducting the detailed surveys needed to accurately plan and budget for retrofit projects is resource intensive and may not always result in identifying viable projects.

Appendix D. Domestic social survey instruments

Table 19 summarises the questions asked to householders in the Time 1 and Time 2 social surveys.

TIME 1 SURVEY	TIME 2 SURVEY	
Q1 respondent's details & what LA is	Q1: ditto T1	
Q2 person responsible for paying bills	Q2 were energy changes installed?	
Q3 details of hsd members	Q3 psn responsible for paying bills	
Q4 type of property	Q4 who completed T1 survey?	
Q5 age of house (timed categories)	Q5 length of residence	
Q6 description of house & number of rooms	Q6 tenure	
Q7 length of residence	Q7 details of hsd members	
Q8 tenure	Q8 ditto Q9 T1 survey	
Q9 how many days in week house occupied	Q9 ditto Q10 T1 survey	
Q10 how many nights house occupied	Q10 ditto Q11 T1 survey	
Q11 whether in receipt of hsg or htg benefits	Q11 ditto Q14 T1 survey	
Q12 hsd income category	Q12 hsd income as Q12 on T1 survey	
Q13 how managing these days	Q13 how managing Q13 on T1 survey	
Q14 income gone up/same/down in past year	Q14 which items installed in energy programme	
Q15 use CH or electric heaters	Q15 as Q15 on T1 survey	
Q16 how frequently used by type	Q16 as Q16 on T1 survey	
Q17 how control CH	Q17 as Q17 on T1 survey	
Q18 understand controls on CH	Q18 as Q18 on T1 survey	
Q19 use other forms of htg	Q19 as Q19 on T1 survey	
Q20 how pay bills (eg DD etc)	Q20 as Q27 on T1 survey	
Q21 monitor energy consumption?	Q21 as Q20 on T1 survey	
Q22 in winter months, too cold/too warm	Q22 as Q21 on T1 survey	
Q22a is this a problem?	Q23 as Q31 on T1 survey	
Q23 in summer months, too cold/too warm	Q24 as Q32 on T1 survey	
Q23a is this a problem?	Q25 as Q33 on T1 survey	
Q24 ways of keeping warm last winter	Q26 in last htg season, too cold?	
Q25 if too hot, actions	Q26a in last htg season, too warm?	
Q26 house problems eg damp etc	Q26b is this a problem?	
Q27 how much spending on htg/HW, and bills frequency	Q27 as Q26 on T1 survey	
Q28 mechanisms to pay energy bills	Q28 as Q24 on T1 survey	
Q29 not invite visitors	Q29 as Q24 on T1 survey	
Q30 visitors declined to come	Q30 as Q25 on T1 survey	
Q31 satisfaction with house	Q31 as Q28 on T1 survey	
Q32 ontological security qns	Q32 as Q29 & 30 on T1 survey	
Q33 want to move house?	Q33 as Q30 on T1 survey	
Q34 heard about energy changes	Q34 health & well-being	
Q35 how heard of scheme	Q35 compare H & WB in past year	

Q36 who from?	Q36 rating H & WB in hsd	
Q37 previous energy efficiency measures	Q37 live in house when changes made?	
Q38 energy changes of friends & family	Q38 moving in after changes?	
Q39 how keen on energy changes?	Q39 aware of changes? Part of decision to move here?	
Q40 expectations of energy changes (10 items)	Q40 how feel about energy changes	
Q41 3 most important	Q41 chased up info on changes	
Q42 3 least important	Q42 how satisfied with changes	
END OF SURVEY: CAN WE COME BACK?	Q43 would recommend changes?	
	Q44 how financial costs covered?	
	Q45 financing of energy changes	
	Q46 were changes disruptive?	
	Q47 how much info and support?	
	Q48 how feel about installed changes?	
	Q49 done anything to get info on changes?	
	Q50 how satisfied with changes?	
	Q51 re pre-installation, how does temp compare?	
	Q52 heat home more, same or less?	
	Q53 paying more, same, or less?	
	Q54 recommend changes to others?	
	Q55 energy changes have made home (parallels Q40 on T1 survey)	
	Q56 3 most important reasons (as Q41 on T1 survey)	

Table 19: Survey questions in Time 1 survey and Time 2 survey.

Appendix E. Domestic social survey analysis by local authority area

E.1. Aberdeenshire

Seven properties were surveyed at Time 2. All had data at Time 1 survey pre-installation. These are one-storey harled houses in the Aberdeenshire village about 20 miles from Aberdeen. They are not connected to the gas grid and have storage heaters which are expensive to run. The median spend on energy as a percentage of income is around 8-10%. All but one house is owner-occupied, consisting of 2-person households, with respondents' average age of 66 years. Four residents are retired, the rest in FT or PT work. The median length of stay is around 40 years.

There are high levels of house satisfaction (5 out of 7) with high levels of ontological security in terms of feeling safe and at home. Virtually all would not move away. Feeling cold most of the time is the norm, and external cladding to improve insulation was welcomed. While 5 of the 7 were satisfied with the energy changes, there were complaints about the ways the work was carried out by the contractor, in particular the length of time it took, the sporadic nature of the work, and damage to property. Three of the five who responded to this question complained of disruption, even though all but one had been very keen on the energy changes to begin with, largely to improve comfort and warmth. After the work was carried out, residents were evenly divided between those who would recommend the work, and those who would not. Roughly one year had elapsed since the work was carried out, and 5 of the 7 said that they were paying much the same as before for their energy. Three of the 7 said their houses were warmer, 2 colder, and 2 about the same. What was important to those surveyed was, in the main, reduced fuel bills, and added comfort and warmth.

The Aberdeenshire experiences are useful in that the properties are off the gas grid, and dependent in all but one case on electric storage heaters (one household uses oil). The absolute and proportional spending on energy is high (roughly 10% of income), and it remains to be seen how effective external wall insulation is in improving retention of quite expensive heat from electricity.

E.2. Aberdeen city

Energy changes in these properties, all flats in multi-storeys in the north end of the city (AHP), consisted of external wall cladding and double glazing. Forty one properties were surveyed at T1 prior to energy improvements, but only 16 at T2. It is not clear why there was this drop-off in responses to the survey which was carried out by local agents. Furthermore, information assessing opinion on the impact of energy changes on energy affordability, quality of comfort, increased control etc (Q55 and Q56) is systematically missing even though it was collected at the T1 survey. It is not clear why this is so. It is regrettable as it has provided elsewhere a valuable set of summary statistics in terms of the effect of energy changes.

The headline item on the T2 survey is how many people (10 of the 16) said that their homes were 'too warm' some of the time post-installation. While they did not consider this a problem – opening the windows, taking off clothing, and turning down the heating were the main responses – it does suggest that properties are being over-heated, especially as the same people had not mentioned it (or to the same degree) as an issue at T1. There were few

complaints that properties were 'too cold' either at T1 or T2 (5 of the 16 said they had been cold some or a little of the time since installation).

Levels of satisfaction with home remained very high (only one person of the sixteen at T2 was 'dissatisfied'), and residents (who were tenants of the Council in all but one case) expressed very high levels of security, feeling safe and 'at home'. Only four wanted to move house, mainly families who wanted more rooms, or a dissatisfaction with the area itself.

Around half had found the work 'disruptive', 2 'not at all', and 6 neither disruptive or not. On the other hand, 9 of 15 were 'satisfied' with the outcome (mainly 'somewhat satisfied'), and only two people 'dissatisfied'. In terms of the pay-off of the energy changes, 6 had found their houses 'warmer', 4 'about the same', but 5 'colder', almost all concerning draughts. Their assessment regarding how they were now heating their homes had changed very little: 13 out of 16 said 'about the same'. Similarly, their energy bills were 'about the same' (11 out of 16). Would they recommend the work to friends and family? Five said they would, 7 'perhaps', and 3 that they would not.

Taking the responses together, and in the light of the T1 survey responses, there are high levels of satisfaction with energy systems in the multi-storey blocks. Improving external wall insulation, and installing double glazing, seem to have improved levels of heat retention in the properties (we do not have technical data on this aspect). However, the survey and anecdotal evidence is that a significant amount of heat is, quite literally, going out of the window. Arguably, there is a good case for better instruction and education as to how to use heating to best advantage in the light of people's domestic requirements.

E.3. South Lanarkshire

The houses surveyed are 26 terraced or semi-detached, built of Swedish Timber in 1948. Twenty householders are owner-occupiers, and the rest are renting, mainly from the local authority or public bodies. All are on Mains Gas, supplemented by gas, coal, electric fires. The houses have been had external wall insulation, a programme coordinated by the local authority, and carried out in mid to late 2017.

At the time of the first survey (T1, N=26) pre-installation, households were divided between those who were retired and those in full-time work. Most houses were owner-occupied (mainly tenants who had bought their houses), and households consisted mainly of older people (and of one or two-person households), with average occupancies of over 30 years. At T1, half of the 26 households surveyed said they were managing financially 'very or quite well', or 'getting by alright'. They were spending around 4% of annual income on heating and hot water, with a median sum of just over £700pa per household.

The houses had been identified by the council as especially draughty, given their timber construction, and around half of occupants confirmed that. Damp and condensation were not considered to be problems. There was widespread satisfaction with the housing at T1 few wishing to move, and high levels of 'ontological security' (feeling 'safe' and 'at home').

At Time 2 survey (carried out in April to June 2018, N=21), the population had changed very little, and in financial terms, most were 'getting by alright' or even 'quite well'. People's own

assessment of their incomes suggested that these had stayed the same or gone up. Only one household had an income of less than £10,000 pa. The broad proportional spend on heating as percentage of income remained broadly the same at a median of 5%. Most paid their energy bills by direct debit, and did not have problems paying these bills. If they were 'too cold', they put on a jumper, and/or closed internal doors to retain heat. Health levels were good (12) to fair (8) in a fairly elderly population, roughly similar to the previous year. Levels of house satisfaction were very high post-installation of external cladding. Almost no-one complained of being too cold, and more than at T1 thought they were at times too warm, reflecting higher levels of heating retention in the building.

There was overwhelming satisfaction with energy changes (18 of the 21 saying they were very or somewhat satisfied with these). Compared with pre-installation, all considered that the temperature in the house was 'a little warmer' (12), 'a lot warmer' (5) or 'about the same' (4). No-one thought it was colder. A majority (13) considered that they heated their house 'less than before', and 8 'about the same' (it is unclear what the basis for that judgement is: spending less? having the heating on for less time? or just a general feeling that they are heating the house less by adjusting the controls?). Around half think they are spending 'about the same' as pre-installation, the rest divided between spending 'a little more' or 'a little less'. In summary, residents think they are heating their homes a little less than before, spending about the same on heating, and that the houses are a little warmer.

The installation process itself was considered very successful. Only one person would not recommend it (largely because of disruption and problems with the contractor leaving rubbish in their garden), but the vast majority (15 out of the 21) would 'strongly' recommend it. Despite the fact that most residents continued to use their heating system much as before (those who set the programmer continued to do so; as did those who used the on/off switch to control temperature), almost everyone claimed that they 'knew everything' about the energy changes. They considered the changes to be of 'high quality', that the fact that the Council organised it made it happen. Interestingly, while at T1 residents' focus was on reducing fuel bills as well as improving internal comfort and warmth, post-installation the fact that the house 'looked nicer' and that the changes had potential to improve its market value rose in estimation.

One of the interesting features about the South Lanarkshire houses is that we have three key data points: the pre-installation T1 survey; the post-installation T2 survey; and technical data on 8 of the houses in terms of gas use and temperature changes. We can see from the summary below that there is not necessarily a close correspondence between T2 and technical results. Arguably, this may reflect the difference in time periods (variations in winter temperatures year on year), the smoothing out of bill payments using direct debit across the year which in the short-term masks what people are spending, but above all, because people may be improving their home comfort rather than reducing spending on heat. There is also the issue of what residents might mean about houses being 'too cold' in the first place. In the case of the South Lanarkshire houses, the general view at T1 was that the houses were 'draughty' which may or may not correspond to generally low ambient temperatures (the result of damp etc). All in all, we are dealing with quite complex social and technical data, and their interactive effects (changes in household circumstances such as retirement would be an obvious one where the house is used more intensively, and hence people are more sensitive to heat changes).

Comfort questions – detailed social survey results for South Lanarkshire

Q51: Compared with the time before the energy changes were installed, in general would you say that the temperature in your home is:

a lot colder/a little colder/about same/a little warmer/a lot warmer?

Q52: Compared with the time before the energy changes were installed, would you say that you now heat your home:

Less than before/about same/more than before?

Q53: Since you've had the energy changes installed, and comparing your energy bills to what you used to pay, do you think you have ended up paying:

A lot more/a little more/about same/a little less/a lot less?

Table 20: South Lanarkshire houses survey and technical results. (SD = standard deviation)

Homes with T1 & T2 survey and technical results	Q51 (temp comparison)	Q52 (now heat home...)	Q53 (energy bills)	Technical results
Household 1	'a little warmer'	'about same'	'paying a little more'	8 week comparison; No reduction in gas use; No diff in temp (19.8°C) SD 50% reduction; Comfort taken?
Household 2	'same as before'	'about same'	'about same'	8 week comparison; No reduction in gas use; Increase in temp from 20.2°C to 22.7°C; SD 85% reduction; bdg retains more heat; Comfort taken?
Household 3	'a little warmer'	'less than before'	'paying a little less'	4 week comparison; No reduction in gas use; Temp increase from 19°C to 21.7°C; SD 18% reduction; Under-heated before? Comfort taken?
Household 4	'about same'	'about same'	'about same'	8 week comparison; No reduction in gas use; No difference in temp (18.7°C); SD 8% reduction; Comfort taken?
Household 5	'a little warmer'	'less than before'	'paying a little less'	15 week comparison; A significant reduction in gas use of 0.4%; Temp rise from 20.3°C to 21.1°C; SD 36% reduction; Comfort taken?
Household 6	'a little warmer'	'about same'	'a little more'	15 week comparison; No reduction in gas use; No diff in temp (18.2°C); though bdg retains heat better; SD 57% reduction; Comfort taken?
Household 7	'a little warmer'	'less than before'	'a little less'	10 week comparison; No reduction in gas use; No diff in temp (20.5°C); SD 37% reduction; Comfort taken?

Homes with T1 & T2 survey and technical results	Q51 (temp comparison)	Q52 (now heat home...)	Q53 (energy bills)	Technical results
Household 8	'a lot warmer'	'less than before'	'a little more'	15 week comparison; No signif increase in gas use; A signif reduction in temp from 23.8°C to 22.7°C (-5%); Bdg retains more heat; Comfort taken?

E.4. Edinburgh

The 19 properties surveyed at Time 2 (April/May 2018) were all in East Edinburgh. All but one had been surveyed at Time 1 (Dec 2017 to Feb 2018) before work commenced shortly thereafter. Six of the properties were in one street which consisted of three-storey traditional 19th century tenements of 1 or 2 bedrooms, a living/dining room, a bathroom and kitchen. These properties had undergone internal wall insulation, and some double or secondary glazing (which was presumably paid for by owner-occupiers). The rest of the properties consisted of a selection of properties in east and north Edinburgh, a few traditional tenement flats, but mainly older Council properties, at least 50 years old. These had received external wall or cavity wall insulation. Five were owner-occupied, two were privately rented³², and the rest council properties.

Taking the flats that received internal wall insulation together, it was clear that the programme of work involved major disruption to internal walls, mainly made of lathe-and-plaster construction, all carried out while the residents lived there. Unsurprisingly, this was seen as very difficult to live with, and was not, in hindsight, recommended by anyone as a renovation process. Nevertheless, residents' assessments, even after a few months of such work being carried out, was mainly positive. All but one described their properties as 'warmer', that they were paying less for their heating, and four of the six would recommend the process, despite the disruption. There was almost complete satisfaction with the energy changes which resulted. There are perhaps lessons here for carrying out insulation in traditional Scottish tenement flats consisting of internal wall insulation (and glazing improvements). Decanting residents while this messy work is going on would seem sensible.

The remaining properties (also flats) had received cavity/external wall insulation. Assessments of disruption were, unsurprisingly, far lower (only two residents complained of disruption). The results were less positively received: five thought their houses warmer, the same number found no change, and 3 even thought they were colder (one resident complained throughout that the required wall vent created major draughts). Only three residents thought they were paying less for their heating, and the rest more (4) or about the same (3). Only 4 residents said they were satisfied with the energy changes, and the same number dissatisfied (the rest finding no difference). The same number (4) were happy to recommend the changes, but the rest would not (2), or were lukewarm (7).

In summary, we might conclude that external wall insulation seems to bring fewer immediate benefits to residents, and comparing people's expectations at T1 with the after-effects at T2

³² Three of the properties were described as privately rented which did not appear to meet the terms of the HEEPS agreement. Possibly they had been owner-occupied and subsequently let out by previous owners.

suggests that they have been disappointed, although this may change over time as the process beds down. On the other hand, internal wall insulation seems to have had a much quicker heat pay-off, but the price residents pay is much greater disruption when they have to live through the process. Intriguingly, however, technical data on five of the properties that received internal wall insulation indicates no significant cutting of gas consumption before-and-after (no house temperature data was available in the technical survey).

Nevertheless, in terms of people's own assessments, the pain of disruption has had some gain in terms of comfort and warmth. There is also a recognition among some residents that investing in house improvements has wider benefit. Said one long-term owner-occupier, 'Any changes that makes a home more efficient is a no-brainer'. A few mention the wider benefits of better insulation in terms of reducing carbon emissions and having environmentally friendly energy systems, which is an interesting angle alongside the assumption that residents are simply concerned with their personal benefit. This suggests that energy efficiency programmes are seen as contributing to improving housing stock and as delivering a public good. There is appreciation, as in the rest of Scotland, that the local authority and its agents have a key role to play in organising such work, and furthermore, that the work is carried out to a high standard as far as residents are able to judge.

As befits an urban population, there is much higher turnover in the properties surveyed: the average length of house tenure in the survey is four years. Nevertheless, there are high levels of house satisfaction throughout (almost everyone said that they were very or fairly satisfied), and comparable levels of feeling secure in their homes – almost all feeling 'safe' and 'at home', and house moves contemplated only because they are too small. What is also interesting is that calculating what proportion of people's incomes is spent on heating is relatively low – around 4%. Surveying people at two time-points gives us somewhat greater validity that this is what people spend on heating. Given that the houses surveyed are old and somewhat leaky in energy does provide a useful metric in terms of proportional costs in urban situations. The Edinburgh case-study does provide pointers as to the pros and cons of such improvement works.

E.5. Midlothian

This project is part of an ongoing programme of work by Midlothian Council to upgrade housing stock. In particular, it focuses on properties built in the late 1960s/early 1970s which require external wall insulation. Eighteen properties in a town about 10 miles from Edinburgh, in two adjacent streets, were surveyed at Time 2 (15 of these at Time 1). They consist of semi-detached, two-storey houses with traditionally harled walls of 50 years' duration built by Councils across much of Scotland at that time. Two of the properties had technical information on gas consumption pre- and post-installation.

Eleven were owner-occupied, and seven rented from the local authority. The population is geographically stable with a median length of stay of 22 years, and a median age of 61 years. On available data³³, 11 are in paid work (mainly part-time), and 4 are retired. The median spend on heating was around 5% of income (with a range from 3% to 12%).

³³ Not all 18 households answered all the questions, which accounts for the variable N.

The properties were surveyed within a month or two of the external work being done, and it is too soon to draw firm conclusions about its impact on improving heat retention. There is general consensus that the houses are too cold (half said that they are too cold some or most of the time). The population expressed high levels of satisfaction (virtually all were very or fairly satisfied with the house), and feelings of being 'safe', 'at home'. Around one-third would move house if they were able to, but mainly to downsize/upscale. Residents adopted conventional measures of keeping warm: putting on extra clothing, closing inner doors and drawing curtains. Health was good, despite an ageing population.

In terms of the work to clad the houses externally, disruption was judged minimal (only two people said it was significant, and largely concerned damage and detritus left in gardens). Most people were satisfied with the energy changes (11 out of 16 said they were very or somewhat satisfied). While it was generally too early to tell what the impact of heat retention had been, most people judged it to have been positive. Eleven (out of 15) that the house temperature was a lot or a little better; half thought they were heating their houses less than before; and 6 out of 14 that they were paying less for heating. Most people (9 out of 14 who answered the question) would recommend the energy changes to others. A clear majority of residents thought that the energy changes had made their energy bills more affordable (7/13); their homes more comfortable (9/14); gave them increased control over heating (7/13), and that it had changed when they used their heating (8/13). They also thought that it had given them a better understanding on how to save energy (8/14); and on what they actually spent on energy (7/14). The fact that the Council had organised the work was a positive feature (9/14), and that it appeared to have been carried out to a high standard (8/14). The most important features of the energy changes were: to reduce fuel bills (13), give added comfort and warmth (10), improved the external appearance of the house (8), and gave greater control over the house temperature (7). It remains to be seen whether in the longer term, say over a twelve-month period across heating seasons, significant effects are achieved in terms of energy consumption and added comfort.

E.6. Fife

Five houses were surveyed at Time 2 (of which three had T1 interviews). These properties, all in the same street, were maisonette flats built in the late 1960s/early 1970s. They were subject to a programme of external wall insulation. All but one (this had electric storage heaters) were on mains gas. Information on what people were spending on heating in context of their incomes was patchy, but was almost certainly less than 10%.

Three of the properties were owner-occupied, and two rented from the Council. Length of residence had a median of 7 years, but ranged from 3 to 53 years. Household composition was two persons on average; age median of respondent was 50, but ranging from 23 to 56.

All residents had complained of the cold at T1, and in particular the leaky nature of the houses. There was high satisfaction with the houses themselves, and high feelings of security.

The T1 interviews had been carried out in the second half of 2016, the work on external cladding in late 2017, and T2 interviews in mid-2018. This programme gives adequate coverage of before and after assessments, and sufficient time to assess impact of energy changes. The small sample was fairly evenly split on how disruptive the programme of work had been (3 said little or none, and 2 that it was very disruptive).

In terms of assessment of the impact, there was almost unanimous satisfaction with the results (4 were extremely satisfied, and 1 somewhat). Residents said they were a lot warmer than before wall insulation, that the house temperatures were higher, that they were paying less for their heating, with views on whether they were heating their houses more or less, fairly evenly split. Their main motive was to reduce heating bills, to provide more comfort and warmth, and provide greater control over heating. There was strong recommendation for the programme from all those surveyed. In the words of one resident: ‘after they put in external wall insulation, the flat could keep the heat, whereas before, it was losing heat really fast’. No technical data were available to assess people’s positive views of the energy changes.

E.7. Shetland³⁴

The houses selected for improvements were those which had high spending on energy from the DH system. They covered a broad spectrum, from low-rise and maisonette flats built in the inter-war period, through to semi-detached houses built from the 1960s. The houses are owner-occupied, with long-term residences (between 4 and 40 years, with a median of about 25), with the majority of residents retired, and at home most of the time. They are a mix of 1, 2 and 3 occupants. There were high levels of satisfaction with the houses at T1 as well as T2. The work was largely to improve the insulation of the houses (floors, walls, doors). The interviews were on average 15 months apart, with the T2 interviews carried out six months after the insulation improvements.

Residents thought these improvements had made a difference – for example, from saying their houses were cold ‘most of time’ at T1 to ‘a little of the time/never’ at T2, and that evidence of damp, mould and condensation had all but disappeared. Broadly speaking, improvements were evident but modest, reflecting the fact that satisfaction levels were high to begin with. The broad consensus was that they were heating their houses to ‘about the same’ level; but paying ‘a little less’ for heating in the main. At T1, the dominant impetus had been to reduce energy bills and improve home comfort and warmth, and residents thought this had been achieved.

They had found the availability of grants/loans an important stimulus to getting the work done, and the fact that ‘the Council’ had organised it. The work was done to a high quality with a minimum of disruption. The result was that residents ‘strongly recommended’ the energy changes. No-one was at all negative about how it had been done, or the outcomes.

It remains to be seen from the technical data whether residents are *actually* using less heating energy in practice, but there has undoubtedly been a significant improvement in perception both of use and of comfort. It would be interesting, in particular, to know whether these ‘outliers’ in energy use identified initially and selected for improvements now conform more or less to the DH norm.

E.8. West Lothian

This reports on four houses in a small cul-de-sac consisting of single storey houses built in early 1970s, which had external wall insulation carried out in mid-2017. The T2 interviews took place

³⁴ Nine houses had been identified at T1 and surveyed. At T2, data on 7 of these have been analysed where T1 and T2 data are available. One house at T1 had not been surveyed at T2, and vice versa, T2 at T1.

in Feb. 2018, and the T1 interviews just prior to the installation work. Two of the houses, occupied by elderly residents, are rented from the Council (for 16 and 18 years), and two are owner-occupied by younger residents (for 3 and 6 years). The pensioners' houses have a single bedroom (with a living/sitting room, kitchen and bathroom) and the owner-occupied houses have 3 bedrooms. All four residents are satisfied (2 very and 2 fairly satisfied) with their houses and have no desire to move house.

Being cold was not a major problem for any resident prior to installation.

Disruption was an issue for all four residents. Said one: *'Sometimes it felt that the work was never going to end'*; and another: *'there was a lot of mess left which we are still clearing up now. It was very disruptive while the work was going on'*. Another complained as follows: *'I had issues trying to speak to the contractor Everwarm³⁵. The site manager never seemed to be available to address my concerns. I eventually had to write direct to Everwarm and was able to get contact details and speak to a director of the company. I felt the communication and information was not good'*.

Nevertheless, the results of the external wall insulation were positive, and all four would recommend the process to other people. House satisfaction remained high: two very satisfied, and 2 fairly satisfied. People's own assessments of the effect were that: the temperature of the house had risen (3 out of 4); that they were heating their houses less (2) or about the same (2); and all four said they were paying about the same as before. The average spend on heating as a proportion of income is between 3% and 5%. Said one resident: *'I've noticed the difference since EWI [external wall insulation]. The house seems to hold the heat better, and it takes longer for walls to cool down'*.

³⁵ The same company had been criticised when they did external wall insulation in Aberdeenshire.

Appendix F. Domestic social survey cohort analysis

This appendix to the report focuses on those residents who completed questionnaires or were interviewed³⁶ before *and* after the programme of energy changes carried out in their houses. We identified 86 such households. To put this in context: while 168 interviews were achieved at Time 1 (T1), i.e. pre-installation; 109 were achieved at Time 2 (T2), i.e. post-installation. Not all of these T2 interviews had been interviewed or completed questionnaires at T1, however, and this process reduced the number to 86 usable questionnaires. The value of these data is that we have unique before-and-after responses, in contrast to simply analysing responses at T1 and T2, as cross-sectional surveys. The topics covered in the two surveys are detailed in Appendix D.

For purposes of across-the-board analysis, this cohort of 86 households is not intended to be 'representative' of households across Scotland, for Local Authorities have themselves selected projects for energy refurbishment, domestic and non-domestic, a process described elsewhere in the full report. The value of such work, however, is that it gives a variegated picture of different projects across Scotland, and as such, resembles a mosaic of domestic energy changes and practices across the country.

The specifics related to the eight Local Authorities: Shetland which had selected spending 'outliers' on their district heating network in Lerwick; Aberdeenshire, which externally insulated a sample of houses not on the gas grid in a village; Aberdeen city which externally clad and double glazed multi-storey flats which already had district heating; Fife, which did external cladding to some 50 year old maisonette flats; Edinburgh, which ran a mixed programme of energy refurbishment to traditional tenement flats (internal wall insulation), as well as to early council blocks; Midlothian, which did external insulation on 50-year old properties; West Lothian, which carried out external wall insulation to single storey semi-detached properties; and South Lanarkshire, which externally clad Swedish timber-clad housing. Each of these projects, and their impact on residents in question, is described in Appendix E.

F.1. The properties as a whole

The cohort analysed at T1 and T2 is spread across the Local Authorities as follows: in South Lanarkshire (21); Edinburgh (18); Aberdeen city (15); Midlothian (13); Aberdeenshire (7); Shetland (5); West Lothian (4), and Fife (3).

Taking these together, the cohort³⁷ had the following characteristics:

- A broad range of house³⁸ types: 26 semi-detached houses; 22 terraced houses; 15 multi-storey flats; 15 maisonettes; 8 traditional tenement flats.

³⁶ How these data were collected was the responsibility of Local Authorities, some of whom used interviewers, while others relied on respondents to complete the questionnaires. In both cases, the same research instrument was used, hereafter referred to as the 'questionnaire'.

³⁷ Where numbers do not add to 86, data are missing because respondents did not answer the question.

³⁸ Following standard Scottish practice, a 'house' refers to any residential abode, including flats.

- Age of houses: 9 built before 1919; 5 between 1919 and 1929; 20 between 1930 and 1949; 4 between 1950 and 1964; 43 between 1965 and 1975; and 5 between 1976 and 1991.
- Size of houses in terms of number of bedrooms: 1-bedroom (14); 2-bedrooms (29); 3-bedrooms (39); 4-bedrooms (4).
- House tenure: 52 owner-occupied; 31 publicly rented (from LA or Housing Association); and 3 privately rented³⁹.
- Household size: the mode is a two-person household (37), with 24 one-person households, and the same number of three-plus members.
- Employment (survey respondents): 31 retired; 27 in full-time paid work; 13 in part-time paid work; 6 unemployed; other (e.g. sick/disabled, looking after home/family, on maternity leave etc).
- Income bands (per annum): £10k or less: 14; £10-15k: 21; £15-20k: 16; £20-30k: 6; £30k or over: 17⁴⁰.
- Age of respondents: a median of 56 years, with a range from 23 to 85.
- In receipt of housing benefits: yes, 41; no, 45.

We have, then, a broad spectrum of housing, and of the socio-economic characteristics of residents. These were not, by any measure, affluent households. However, by their own lights, they considered themselves to be comfortably off: most said they were ‘getting by alright’ (46%), with almost the same proportion (42%) saying they were managing very or quite well, and only just over 1 in 10 that they were in financial difficulties. Six out of ten said that their income has stayed more or less the same over the previous 12 months, with one-fifth saying their income has gone up, and the same proportion that it had gone down. Furthermore, there was stability in people’s assessments of their financial positions at T1 and T2. Three-quarters of those saying they were doing very or quite well at T1 said the same at T2 (the remainder said they were getting by alright); and three-quarters of those ‘getting by alright’ at T1 said the same at T2. Four of the ten households in financial difficulties at T1 still said that at T2, but the rest had improved their financial assessments. Income stability too was the norm for more than three-quarters of households in the cohort. In most regards, the cohort is a good base to judge the impact of energy changes.

F.2. The programme of work

There was inevitable variation in the time which elapsed between T1 interviews, the work being carried out, and ensuing T2 interviews. The median gap between T1 and T2 interviews was 14 months (ranging from 2 to 23 months), and between the work being completed and T2 interviews, a median of 6 months, with a range from 1 to 17 months. Arguably, assessing the impact of the energy changes within a couple of months is too short, given that seasonal variations cannot be factored in. This should be taken into account in judging the impact of the work; the caveat may be that it is too soon to tell definitively.

³⁹ Strictly speaking, privately rented properties were ruled out of the programme, but this was how residents described them; presumably they had been let out by previous owner-occupying residents who have thus become ‘accidental’ landlords.

⁴⁰ The median annual income in Scotland in 2017 was £23,150. Most households in our cohort (around 62%) are below that figure.

F.3. Improved heating?

The purpose of the energy changes programme was to improve the condition of people's houses. At T1, we asked respondents to assess how cold they had been during the previous winter (October to March), as well as in the summer months (April to September). We also asked them to make a similar assessment about being too warm on both occasions. As many as two-thirds said they had been too cold all, most or some of the time during the previous winter. (About one-fifth said they were cold all or most of the time; 4 in 10 some of the time). A significant minority said they were never cold (24%) or only a little of the time (12%). On the other hand, nearly half at T1 (44%) said that being cold was actually a problem for them. As we might expect, far fewer (one in five) complained of being cold during the summer months.

Of the 22 households who complained that they had been cold all or most of the time during the previous winter, only 5 did so at T2. The remainder now said they were cold only a little or some of the time (11), or, indeed, never (5). More than half of those who had said at T1 that they had been cold a *little* or *some* of the time during the winter months were still saying that, but with a significant shift from 'some of the time' to a 'little of the time'. In like manner, focusing on those who had said at T1 that being cold had been a serious problem for them, there had been significant improvements: more than half of them now said at T2 that being cold was not a problem anymore. Those who continued to say that being cold in winter was a problem included people with health issues. Taking those figures as indicative of change, there has been considerable improvement in people's perception of cold.

What of those who claimed they had been too warm? About one-third had made the claim relating to the previous winter (mainly those who had district heating), but only half of those considered it to be a problem. In terms of being too warm during the summer months, at T1 this was a serious problem for only one in six. Had the energy changes made a difference? In terms of those who said at T1 they had *never* been too warm during winter, one-half now said that they were too warm *some* or a *little* of the time, and a handful (4 households) *most* of the time. On the other hand, those who had complained of being too warm in summer at T1, and that it was a problem for them, had ceased to do so at T2.

There has undoubtedly been a significant improvement in heating conditions for most people. There have clearly been improvements for those who felt cold all or most of the time, as well as those who were cold some or a little of the time. The apparently perverse effects should not surprise us, in that 'feeling cold' is a subjective condition, and related to health conditions as much as to actual home temperatures (for example, 5 who still felt cold all or most of the time, and 5 who had shifted from 'never being cold' to being cold 'some or a little of the time'). Bear in mind, too, the relatively short time-span for many households between the energy work being carried out, and the T2 survey, and the fact that many people had not yet experienced a second winter heating season.

The improvements in heating quality can also be gauged by other measures. At T1, we had asked people what they had done to try to keep warm at home in the previous winter. Practices ranged from relatively minor actions such as putting on a jumper, drawing curtains and closing internal doors regularly, through to more serious actions such as cutting down on food, deferring bills, leaving the house to save heating, and going to bed early. These latter actions

had been quite common in the Wyndford housing estate in Glasgow ⁴¹; a similar study conducted in the previous decade using a precursor to the assessment instruments used in the present study⁴².

When people were interviewed at T1 in this evaluation, very few said they had adopted major measures to keep warm. For example, only 2 said that they had gone elsewhere to keep warm, 3 wore outdoor clothing at home, and 4 had gone to bed early to keep warm. Far more common at T1 were: closing the curtains (39%), putting on a jumper (42%), or closing internal doors (67%). At T2, the numbers so doing had halved in terms of putting on a jumper, and drawing curtains, while a third fewer closed internal doors. Furthermore, housing conditions such as damp, mould, condensation and draughts reported by respondents at T1 had also materially improved. For example, one-fifth had mentioned draughts at T1, while more than half of this number said that it had disappeared at T2. Damp, mould and condensation, which in any case had presented a problem for less than 1 in 10 at T1, had all but disappeared at T2 for those people⁴³.

F.4. Paying for energy

The broad headline figure is that respondents are now paying, as a median, 5% of their incomes on heating and hot water (the range is from 2% to 20%). This compares with around 4% at T1. This is not a significant increase, and ought to be treated as ‘noise’. In any event, we should treat people’s assessments of their spending with some caution on the grounds that it is rarely arrived at by a rigorous comparison of before-and-after effects (it may be, in any case, too soon to tell what the financial pay-offs are). They are, however, broadly indicative of steady-state spending patterns. Most people (75%) pay energy bills monthly, except where it is included in heat-with-rent schemes. Virtually no-one has recourse to serious measures in order to pay heating bills. Only a handful (less than 10%) turn off (or down) heating in some rooms to save money. Only one or two people, even at T1, cut spending on food, leisure, borrowed money, or deferred other bills in order to fund their heating. By T2, virtually of this had gone. A mere handful at T1 said they had declined to invite family and friends, or that people did not visit them because of cold. Once more, these small numbers had dwindled further.

F.5. Satisfaction levels

‘Technical’ assessments of energy changes are properly bound up with what people’s housing means to them. There is a considerable literature in social sciences concerning the degrees of ‘ontological security’ attached to people’s homes. This refers to levels of satisfaction, feelings of security and safety, being ‘at home’, into which technical changes in heating for example, are inserted. To that end, we asked respondents at T1 and again at T2 for their assessments of their ontological security. At T1, levels of house satisfaction were already very high: Thirty percent were very satisfied with their house, and 54% quite satisfied, with only 1 in 7 at all dissatisfied. Furthermore, as many as 8 in 10 disagreed with the notion that their house was a

⁴¹ David McCrone and others, *Findings from a Survey of Wyndford Households and Experiences of New District Heating* (Heat and the City, University of Edinburgh, 2014).

⁴² Among Wyndford tenants (owner-occupiers in brackets), 44% (16%) had cut back on leisure, 27% (10%) had cut back on food, 34% (4%) borrowed money to pay fuel bills, 35% (10%) had gone elsewhere to keep warm, and 42% (32%) went to bed early.

⁴³ With the exception of condensation which remained an issue for about half of those reporting it at T1. Arguably, this might be explained by life-style practices related to cooking and bathing.

place to get away from. Nine out of ten considered their house a place of considerable safety (6 out of 10 saying it was 'very safe'); and 9 out of 10 said they felt at home there (two-thirds were 'very much' at home).

This means that there is very little room for improvement (known as a 'ceiling effect' in survey research). And so it proved at T2. Virtually everyone who was 'very satisfied' with their house at T1 were also very satisfied at T2. Indeed, there was a significant shift (40%) from the 'quite satisfied' at T1 to 'very satisfied' at T2. Of the small numbers who were dissatisfied at T1 (only 12 people), five were now 'satisfied', and even the uniquely 'most dissatisfied' person had shifted to having 'no opinion'. Incremental shifts had also occurred with regard to other features of ontological security: even fewer felt their house was a place to get away from; the handful of negatives on house as a safe place had become positives; and everyone, without exception, felt at home at T2. At T1, just under one-third expressed a wish to move house if they were able, and by T2, this had been halved, and those who still wanted to move house did so for extraneous reasons such as wishing to downsize or upsize (more bedrooms for growing families), or to be closer to family members.

F.6. Energy changes

It is a moot point as to whether these small improvements in satisfaction levels can be attributed directly to energy changes, and the number who are 'dissatisfied' is too small to partition out an 'energy changes' effect. As regards satisfaction levels relating to energy changes themselves; at T1, two-thirds of respondents said they were 'very keen' on energy changes, and virtually all the rest 'quite keen'. In the T2 survey we asked: 'how satisfied are you with the energy changes?', relating responses to how keen they had been at T1. Of those who were keen (very or quite) at T1, fully three-quarters were 'satisfied' at T2. The rest were mainly neutral, and a few (10%) were dissatisfied, either because the changes had not had the desired effects, or levels of disruption on installation were sufficiently recent to remain in people's memory. There is also the issue that expectations had been raised. Thus, we find that the 'very keen' at T1 tended to have slightly lower levels of satisfaction at T2 (71%), compared with those who were 'quite keen' in the first place (81%). Given, however, the small numbers in question, we should avoid hard conclusions.

What had people wanted from the changes in the first place? Three features stood out. First of all, reducing energy bills was top of the agenda. When asked which were the features they wanted in order of importance, these were: reduced bills (mentioned by 87%), greater home comfort (67%), and thirdly, greater control over energy (43%). To what extent had these been met post-installation, bearing in mind the foreshortened timescale between the work carried out and interviews at T2? First of all, only 19 of the 49 who thought energy bills would be more affordable think that has turned out to be the case, with the rest suspending judgement. On the other hand, more than half of those expecting to have a more comfortable home have found this to be so (the rest wait to be convinced). Similarly, about half who were looking for greater control over their heating system say this has been the case at T2, with most of the rest suspending judgement, given the short timescale since the work was carried out.

It was a measure of how keen most people were to have better heating that at T1 they did not think that disruption during installation was a problem. Seven out of ten, for example, did not think it would be especially unwelcome, given the pay-off. There turned out to be complaints

about disruption levels (notably those who had internal wall insulation carried out), as well as a perceived failure by installers to clear away detritus from gardens once work was complete. Most of those who expected there to be disruption found that there was, but most had factored this into their assessments of improved heating. On the basis of experience of other projects (such as Wyndford in Glasgow) we have found that disruption effects lose their force as time goes by.

Do people have a better understanding of how to save energy? At T1, about 60% thought they would be able to save energy, and of these, about half at T2 thought this had turned out to be so, with the rest roughly split between those who said it had not, and those who thought that it was too soon to tell. A similar split related to spending on energy, with about half at T2 saying this had turned out to be the case.

It is interesting that as many as two-thirds of people at T1 thought that energy changes would have a positive effect on climate change, arguably not an explicit feature of the energy programme, but clearly one which frames people's expectations today. It is, of course, even harder to tell what this impact has been at T2, but there is modest evidence that at this point about half thought this had been achieved, with the rest neutral. The inference is that in today's socio-political context, issues of climate change have risen up the agenda even where not explicitly part of government programmes. They provide an important hook to attach to assessing the impact of energy change programmes.

F.7. Information and monitoring

What assessment can we make about how well-informed people were about the work programmes and their impact? At T1, most people (71%) had heard a little about forthcoming work, and mainly from their local Council (72%), relying on officials at the door, local meetings or letters/newsletters. Almost half (45%) said that they had had previous energy changes, and roughly the same number that friends and relatives also had energy changes, without respondents relying very much on advice from such people.

To what extent have people changed their patterns of energy use since the installations? Do they, for example, have a better understanding of how their heating system works? Do they use it differently? The broad conclusion is that by and large life goes on as before, that people are somewhat passive recipients of energy changes. To take some examples: at T1, most people (80%) said that they used the central heating controls all or most of the time. Furthermore, two-thirds said they used the programmer all or most of the time, while around two-thirds used the on-off switch to control heating (some, obviously, used both). There was less use of individual radiator valves to control heat (around 60%).

So to what extent have energy changes altered these patterns of behaviour? Not greatly, it seems. Arguably, using the programmer is a more efficient way of controlling heating than simply using the on-off switch to the boiler. There was a modest rise in the numbers (26%) using the programmer at T2 compared with T1, notably among those who previously had used the on-off switch, but that still left a substantial number relying on the latter. There was also a concomitant rise in people using radiator valves to control room temperatures (an increase of 12 in a sample of 31).

Are heating controls easier to understand post-installation? The proportion saying that they are easier has risen barely at all (from 74% to 76%), but very few have been converted in their use (a mere 5 out of 48) which just about balances out those who had moved in the other direction and were not using them at T2.

To what extent have energy changes encouraged people to monitor more directly what they spend? A minority (43%) at T1 said they did such monitoring, mainly by means of their energy bills rather than energy monitors or smart metering (in a ratio of 2:1). At T2, this had barely changed, and most (60%) did not monitor use at all, and where they did do so, relying once more mainly on energy bills.

In terms of information and monitoring of energy use, the patterns of use seem passive, relying perhaps on previous practices, rather than taking into account new procedures and heating regimes. It was a condition of HEEPS ABS funding to provide “*support to [householders] to improve the use of energy in the home to maximise the benefits of the installation*”. Despite this, the social survey results suggest that there is still scope for greater consumer education at the point of change when people are adjusting to new systems, and are arguably more receptive to using heating controls more efficiently. The form of the existing post-installation support provided within the pilots was not explored within the social surveys, although interviews with project managers suggested that householder advice provision was mainly focused on pre-installation visits at the point of sign-up to the programme. Only one local authority explicitly mentioned a post-installation visit as part of their advice service. The others only mentioned visits from contractors, gas engineers and to conduct post-EPC assessments. Current practice in post-installation advice and support would be a useful topic for consideration in future project evaluations, given the limited behaviour change and reduction in energy consumption from the domestic measures suggested by the evaluation data available here.

Appendix G. Lessons for future evaluations

The Phase 1 pilots were the first local energy efficiency projects in Scotland to receive such detailed evaluation involving both technical and social evaluation. There were several challenges that were experienced during the set up and data collection process. This chapter will discuss these challenges and any lessons learned which can feed into the evaluation of future pilot phases or wider rollout of evaluation within EES.

G.1. Resource planning for an evaluation

Collection of the evaluation data, particularly for the domestic projects, was time and resource intensive. One of the key lessons for Phase 1 was that early engagement with the project managers is crucial to ensure there are shared expectations of what will be involved in the evaluation. In this first phase of pilots, the evaluation team began work on the project after the pilots had begun, meaning that early engagement was not possible.

In the absence of the evaluation team, project managers with previous experience of evaluating their energy efficiency programmes had used a smaller sample size of 10% of the domestic properties in their programme to conduct monitoring, and had not collected such an extensive range of data. Therefore, they had not planned for such a high proportion of buildings to be monitored, the cost of the equipment or the extent of the monitoring (heating fuel, electricity and 4 temperature/humidity sensors) that needed to take place.

Lesson?

Clear communication of the survey and monitoring requirements are crucial at the very beginning of the bidding process so that project managers can plan adequate staff resource, budgets and processes into their bids.

G.2. Coordinating evaluation timescales with delivery timescales

It was challenging to match the timescales of the evaluation with the delivery timescales of the projects during Phase 1. In particular, the ideal evaluation data would be collected during the heating season, and if possible during the same calendar month, before and after the installation of the energy efficiency measures.

During the phase 1 pilots, recruitment of domestic households for the evaluation was not always possible during the first heating season of the project; either because the project delivery timescales did not fit with this, or because recruitment took more time than project coordinators had anticipated. This meant that the first heating season was sometimes missed.

In other cases, projects had to delay their installation dates to allow sufficient technical monitoring time before any changes took place. It was therefore not possible to do a 'before and after' scenario for all of the pilots. Instead, it was agreed to continue with the technical monitoring with less data. The evaluation analysis focuses primarily on the social data collected from a single social survey and semi-structured interviews in these cases.

Issues with timescale coordination were particularly due to the late start of the evaluation project team and the lack of detail known about the evaluation when the projects were being planned. However, the short timescales of the pilot projects meant that technical monitoring

was particularly difficult to coordinate with heating seasons before and after the installation of measures.

Lesson?

Complete evaluation data collection is key to being able to make meaningful conclusions. Flexibility in funding timescales could support this, by enabling project managers to implement projects and deal with any unexpected delays, alongside the demands of evaluation data collection.

Advance planning of evaluation timescales at the point of initial programme design to include the timings for recruiting the evaluation sample and installing monitoring equipment would also enable better quality evaluation data without hindering project delivery.

G.3. Recruitment of an evaluation sample:

Local authorities approached recruitment of participants for the evaluation monitoring and surveys in different ways. Lessons from project managers' experiences of recruiting an evaluation sample during the pilots were discussed during a workshop after the first set of surveys and monitors had been installed. A one-page summary of 'advice for domestic survey collection and monitoring' was produced⁴⁴.

Recommendations included:

- *It was important to communicate to householders and non-domestic building-owners from the outset about social surveys and technical monitoring that they may be asked to participate in. Information should be included in all points of communication including initial letters, public meetings and technical assessments. This ensures that the evaluation is viewed as a fundamental part of the project rather than an inconvenient extra.*
- *Conducting social surveys in person, at the point of installing monitoring equipment, resulted in a high success rate for meeting the target sample numbers. The quality of the survey data collected was also improved by doing the survey in person.*
- *Designing a smooth customer journey with clear information about the organisations involved in the evaluation and timescales for activities, contact details for dealing with any issues, and where possible using the same person to conduct the Time 1 and Time 2 survey.*
- *Some of the pilots chose to use incentives to encourage householders to take part in the evaluation (e.g. enter into a prize draw, or payment of vouchers for taking part). This was not considered essential.*

Lesson?

Careful planning of recruitment into the evaluation sample, as well as information provision, is required to meet sample target numbers and ensure good quality data is collected.

⁴⁴ <https://www.gov.scot/Topics/Business-Industry/Energy/Action/lowcarbon/LCITP/SEEP/Phase-1/InterimEvaluationReport>

G.4. Social surveys

This section considers the approaches used for collecting the social survey data. In general, social survey data collection was done successfully in many of the pilots. However, there were the following areas for consideration in future evaluations around survey skills needed for quality and consistency of data collection, and concerns of householders about personal survey questions.

Survey skills and data quality

The skills of the survey collection team (coordinated by the local authority leads or appointed delivery partners) were critical to achieving good quality and complete data sets in the domestic social surveys. In particular, helping the householder to feel comfortable answering the questions, accurately recording the responses to questions and noting down relevant extra information during conversations with householders.

Training for surveyors was organised during the course of the pilots to try to encourage common practices across the pilots. However, this was not attended by all surveyors due to travel time or other work commitments.

The domestic social surveys included a small number of personal questions in relation to householders' health and financial situation. In the majority of the pilots these questions were answered without any issue, however, there were a small number of comments from householders that they didn't feel comfortable answering the questions.

Lesson?

The skills of surveyors are important for ensuring accurate and consistent data collection across the pilot projects. Questions of a personal nature need to be asked with sensitivity by surveyors. It is also important to explain how the data will be analysed and used once it is collected.

G.5. Technical monitoring equipment

This section discusses the range of challenges experienced around the procurement and use of technical monitoring equipment, including procurement, IT requirements, concerns of building occupants, and supply chain availability.

Procurement of monitoring equipment

Local authorities did not know when they applied for the EES pilot funding that technical monitoring would be required, nor that they would have a role in procuring the equipment. In some instances, procuring monitoring equipment became difficult for local authorities at short notice. Their internal procurement thresholds meant that they would need to gather additional quotes and go through a longer procurement process due to the large cost of buying the monitoring equipment. This led to delays which meant monitoring kit could not be installed on time, pushing back the delivery timescales of the whole project which had an impact on recruitment and ultimately the final analysis.

Each local authority has different procurement processes which can take varying amounts of time and administration to get through. There also different procurement processes

depending on the amount of money you want to spend, called procurement thresholds. These thresholds vary between organisations but usually the more money you need to spend the more resource intensive a procurement process becomes, taking more time and information before they can be signed off.

During Phase 1 each local authority was responsible for procuring monitoring equipment for their sample. As each local authority had to go through their procurement processes with various policies, some experienced delays due to the high cost. During the workshop it was noted that if a central procurement process was in place so that as part of the pilot the monitoring equipment was centrally procured, then it would avoid these potential delays. This would also help reduce administrative costs across each local authority as the pilot's project management team will take responsibility for this, it would not have to be duplicated in each local authority and It will also mitigate the risk for delays to the project timeline which happened in Phase 1.

Lesson?

- Ensure the project allows enough time for the local authorities to get through their procurement processes and make the local authorities themselves aware that they need to anticipate the internal requirements of their procurement processes in their project plans.
- Explore the possibility of a procuring monitoring equipment centrally so each local authority does not need to procure individually.

Information Technology (IT) to support monitoring equipment

Some of the monitoring equipment recommended requires accompanying software so that you can configure and extract the data stored, such as the TinyTag temperature and humidity monitors. One local authority experienced a delay to installing the monitoring equipment when their internal IT department needed to verify the software and equipment to be purchased, as their IT systems have a strict digital security policy. However, due to a recent staff strike this verification was not prioritised due to a backlog of work, which led to delays in setting up the monitoring equipment and sending it out for installation. Although a strike is an unforeseen circumstance, for future evaluation projects the evaluation team could encourage local authorities to liaise with internal IT departments early. This would give them enough time to verify access to the software and the equipment to their IT systems potentially avoiding delays.

Lesson?

Evaluators should provide clear guidance when devices need software to be installed and cables used to download the monitoring data. This will reduce the risk of delays caused by the IT approval processes if there are strict IT policies in place within local authorities.

Concerns of building occupants about monitoring

There were some concerns raised by building occupiers around the capabilities of the monitoring equipment that was being installed. In some domestic buildings occupiers were concerned that the meter reading devices would monitor their internet usage, as they needed

to be connected to their WIFI so they could transmit data periodically. In one non-domestic building the building manager was not happy with the devices being installed, possibly due to the disruption caused during installation. This issue arose when a second site visit to the building was required to replace monitoring equipment which was not transmitting data (either due to a fault with the device or due to poor WIFI connection); at this stage, the building manager requested all monitoring equipment be taken out, and did not want to take part in any further monitoring.

Lesson?

These two situations highlight the importance of early engagement with building occupants and information provision so that stakeholders understand what the devices are doing, how they operate and to what extent we need their involvement. This level of engagement can come in multiple forms so that all demographics can be effectively engaged; such as public meetings, emails, letters, videos and face to face conversations by trained individuals such as installers and site visitors. A series of FAQs could be put together for different audiences such as the participants, installers and/or site visitors to aid this.

Supply chain availability of technical monitoring equipment

There are currently only limited 'off-the-shelf' meter point energy monitoring devices available and over the last few years the support for these devices seems to be declining. This suggests that the current mass rollout of smart meters and the setup of the data sharing framework is having an effect upon the energy monitoring market. When smart meters are in the majority of properties and data sharing is available then monitoring projects will most likely use this infrastructure as it will be less invasive for the occupier, potentially less expensive (depending on the costs of accessing the data) and potentially easier compared to procuring monitoring devices and contracting an installer to install and remove them. However, during this project we were unable to monitor households with smart meters as the infrastructure isn't in place to access the data being collected and the monitors used were incompatible with smart meters.

There are several bespoke radio and cloud based monitoring options however a large scale monitoring project spread over several geographic areas will make these systems impractical due to their higher cost and involved setup

Lesson?

- Availability of low-cost monitoring equipment could be an issue for future technical monitoring project.
- If smart meters are going to be used as an alternative source of data, it is important that it is possible to access smart meter data easily, although in the interim period traditional monitoring equipment will need to be used.

Technical monitoring data retrieval

Towards the end of the monitoring period an initial deadline of March 2018 was set for all the data to be sent to the evaluation team. It was the local authority's responsibility to collate and send over this data which would have involved gaining access to properties and downloading

the data from the devices. However due to the delays mentioned in G.2 it was agreed that some of the local authorities would leave the monitoring devices collecting data for longer to capture potentially more useable data.

There were several local authorities that were unable to provide the data by the deadline due to resourcing issues and some were unable to gain access to the properties to collect the devices which delayed the data analysis timelines.

Data was also sent to the evaluation team in parts so although we received some data, the datasets for a particular property still could not be analysed as a full set of data was required. A full dataset consisted of heating energy consumption, internal temperature data, external temperature data and electricity consumption; although at a bare minimum only the heating energy consumption was needed but this reduced the insights that could be derived from the analysis significantly.

When the evaluation team started to receive data from the local authorities a lot of time was spent cleaning, formatting and sorting through numerous files as each set was slightly different as well as chasing missing bits of data and information. This caused unnecessary delays to processing and analysing the data.

In some cases, it was apparent that the time it would take to retrieve the data and download the data was a lot longer than the local authorities anticipated, but as the project was ending at financial year end, resourcing for the project was exacerbated further.

Lesson?

- *Support the creation of a data retrieval plan factoring in accessing properties to collect devices, resourcing and downloading the data.*
- *The evaluation team could provide a data template so that all the data is put into a template by the local authorities, so once received no formatting, cleaning or chasing missing data is needed, speeding up the process.*
- *Avoid both holiday seasons and financial year end when setting the end of the monitoring period so they do not coincide.*

Technical data quality, resolution and completeness

Technical data quality, resolution and completeness were significant issues experienced in the evaluation of the phase 1 pilots. This section discusses some of the reasons for these issues and lessons for future evaluations.

Technical data completeness

All properties that had complete datasets were initially assessed for their suitability to be analysed. They were checked to ensure the data occurred during the heating season and there was enough data before and after installation to provide a pre- and post- installation period; which accounted for 15% of all the properties we expected data for. Unfortunately, 32% of properties did not have enough data to do this therefore were not analysed. In some cases, the installation period was over a year and was still ongoing due to a large scale retrofit project, this meant no analysis could be done as there was no pre or post installation data, as the

monitoring data occurred during the long installation period. This highlighted a lack of understanding of how a monitoring evaluation project is structured and in this instance shouldn't have been part of this monitoring project as it was too short to encompass the entire retrofit project.

Lesson?

Provide 1 to 1 meetings to take local authorities through the evaluation process and structure of the technical evaluation so they can see how it relates to their specific projects and whether they are suitable to take part in it.

Technical data resolution

Some of the data came from building energy management systems (BEMS), which is a system that among other things monitors and controls energy consumption in non-domestic buildings. Some of the data received was from these systems and in all but one instance the data was supplied on a monthly basis. Monthly resolution did not provide the detail needed for the short monitoring duration that was provided, resulting in incomparable data.

Lesson?

Ensure during the planning period that the resolution of the data BEMS are able to provide will be enough to output robust analysis from; if not alternative monitoring devices may be needed or a longer monitoring period arranged.

Change of building use

In some non-domestic properties there was a significant change in usage where the building service hours were increased as well as the staff that worked in them. This meant that the energy consumption was higher than expected after installation; the approximate occupancy change was provided but it did not sufficiently normalise the data. To do this the exact dates and number of staff using the building was required to isolate the impact the measure has on the energy consumption rather than the increased usage.

Lesson?

In instances where non-domestic buildings have a significant change of use and hours, gathering details of the dates when these changes occurred and the increase in staffing is key, as this will make the data comparable.