District heating

Delivering affordable and sustainable energy

RESEARCH REPORT

APRIL 2017 Produced by Changeworks www.changeworks.org.uk

30 YEARS CHANGEWORKS

centre for sustainable energy

Supported by JRF JOSEPH ROWNTREE FOUNDATION

Report	District heating: Delivering affordable and sustainable energy – Report Joseph Rowntree Foundation (JRF)
Main contact	Katharine Knox Katharine.Knox@jrf.org.uk
Issued by	Ian Smith T: 0131 538 7949 E: ismith@changeworks.org.uk Changeworks Resources for Life Ltd Charity Registered in Scotland (SCO15144) Company Number (SC103904) VAT Registration Number (927106435)
Approved by	Liz Partington Deputy Chief Executive

CONTENTS

Acknowledgements

The research team would like to thank all the participants who took part in this research, including the social housing providers (SHPs), stakeholders and residents. Particular thanks go to those organisations who acted as case studies and provided much time to support our research. We would also like to thank all the members of the Project Advisory Group (PAG) who provided valuable input and guidance to the project. This included representatives of: Association for Decentralised Energy (ADE); CAG Consultants; Citizens Advice; Cofely; Heat and the City; Islington Council; Joseph Rowntree Housing Trust; National Housing Federation (NHF); Scottish Federation of Housing Associations (SFHA) and University of Leeds.

1. EXECUTIVE SUMMARY

Supporting energy and carbon reduction as part of efforts to mitigate climate change, whilst simultaneously tackling fuel poverty, continue to be strong drivers for change in the social housing sector. As such, the UK and Scottish Governments are promoting District, Community and Communal heating (DCCH) as an effective means of reducing carbon emissions and heating bills. This research examined how social housing providers (SHPs) develop, deliver and operate DCCH schemes and the extent to which these schemes are delivering different affordability and sustainability goals. Key points from the research are as follows:

- The most common aims of Social Housing Providers in delivering DCCH schemes are fuel bill savings and reducing CO2 emissions, but they also allow landlords to meet regulatory and policy objectives, as well as opening up the possibility of new business models.
- Given the monopoly status of heat network operators and the disproportionately high numbers of low income and vulnerable householders living in social housing it is a matter of social justice that DCCH schemes are designed and operated to deliver fuel bills which are lower than, or, at the very least, equal to, the best that can be achieved using individual heating solutions. SHPs must continually explore technical, financial and operational routes to lowering heat costs, providing customer protections and safeguarding residents where appropriate. Regulation of heat supply should be introduced and will address these issues.
- The complexity of DCCH design and construction processes, often involving multiple organisations, coupled with a lack of in-house expertise to properly scrutinise project progress among SHPs, can mean that the delivered system does not match the design intent and that systems perform sub-optimally. A lack of relevant expertise and skills is particularly evident among smaller SHPs.
- Although some SHPs, particularly in cities, have operated communal heating systems for many years, the more dynamic role of a low carbon heat and electricity supplier within a larger network is not a traditional one for landlords. It involves learning new skills or procuring the skills of others to manage heat (and electricity) generation, distribution, metering, billing and customer care. These are significant organisational challenges.
- Among our eight case studies, delivered heat was priced from 4.12 to 10 pence per unit, with standing charges varying from no charge to 84 pence per day. Thus some DCCH systems are able to offer unit heat prices at comparable rates to individual gas boilers and cheaper than Economy 7 electric storage heating. However, if standing charges are factored in, in some instances, the financial benefit of DCCH was reduced or lost completely, even when accounting for the costs of replacing individual heating systems over the longer lifespan of the DCCH system.
- The cost of generating heat is driven by multiple factors which vary across schemes. These include: the cost of finance, availability of grant and subsidy, choice of technology and heat source, the quality of design, build,

commissioning, maintenance and control systems provided to tenants. This complexity makes it very difficult to make definitive statements on the inherent capacity of DCCH to deliver low cost heat.

- Whether DCCH delivers low unit heat prices is also affected by charging policies, which may not relate directly to the costs of heat production, for example, prices may be deliberately capped to keep bills down or cross subsidised from sales of electricity. Some landlords surveyed in this study deliberately operated their DCCH schemes at a loss.
- While the circumstances affecting charging in schemes vary, when financial, technical and social aspects are successfully addressed, then a majority of landlords do report affordable warmth benefits from DCCH, particularly when replacing problematic heating systems, such as electric storage heating.
- The modelled sustainability credentials of DCCH are easier to demonstrate over alternatives. These suggest large CO_2 reductions are possible from shifting to heat networks served by low carbon heat sources. This is supported by the majority of landlords in our survey.
- Carbon dioxide reductions are reportedly experienced because the size of heat demand realisable via a heat network integrates well with larger scale technologies supplying low carbon heat such as Combined Heat and Power and biomass boilers. However, landlords reported that some of the sustainability benefit can be undone if residents don't know how to control their systems well or feel compelled to use electrical cooling because of issues with overheating. Managing distribution losses also appear key to the sustainability of schemes.
- Landlords identified multiple critical success factors for successful schemes at all stages of scheme development. These included: the need to engage and work with all stakeholders to get buy-in and support for the scheme at an early stage; the need for good in-house skills to oversee and scrutinise projects at all stages; delivering systems that are financed in such a way that residents do not pay high standing charges; ensuring realistic estimates of maintenance costs; operating systems at scale and careful management of resident control systems, accessible heat monitoring information for both residents and system operators and transparent billing.
- Many of the issues identified in this study have already been recognised and processes are underway at national government level and throughout the heat network industry to address them. For example, the Scottish Government's initial work to regulate heat supply will deliver standards and customer protections, the UK wide Heat Trust accreditation will provide some assurance about expected standards of service whilst their Heat Cost Calculator now allows householders to make fairer comparisons with alternative heating systems. The publication of CIBSE and ADE's Heat Network Code of Practice (CP1) will also support better project development and management of systems.
- The study has multiple recommendations for the social housing sector, for government and for the heat network industry covering all stages of the development, delivery and operation of DCCH.

- Key recommendations for SHPs include the need for better monitoring and analysis of DCCH system performance; ensuring that scheme costing takes account of the full costs of maintenance and operation as well as capital costs and that charging approaches are sensitive to affordability goals, taking a strategic approach to connect into wider networks where possible, to use larger scale technologies and to align with local authority planning and strategy.
- Key recommendations for government are to progress regulation of heat supply, promote technical standards, to support all SHPs but particularly smaller Housing Associations, to access lower cost finance and promoting the use of technical and financial guidance for initial feasibility and design of schemes.

1.1 Aims of DCCH

Landlords reported four general types of motivation for building and maintaining DCCH systems: a) to deliver resident benefits, particularly related to providing affordable warmth; b) to meet regulatory and policy targets, including meeting CO2 targets for new build; c) to provide opportunities for new business models through opening up new revenue streams, for example, from sales of heat to businesses; and d) to meet technical and strategic objectives, such as connecting into city-wide heat networks and regenerating neighbourhoods. The most commonly cited motivations were to provide lower cost heating and to deliver sustainability benefits and the majority of social housing providers responding to our survey felt that their most recent scheme was either very or quite effective in meeting these aims.

1.2 Design and delivery of DCCH

The final delivered performance of DCCH systems may be significantly lower than designed performance as a result of a host of issues. For example oversizing of systems is frequently encountered at design stage as a precautionary principle to counter contractual penalties for underheating. Also unforeseen issues can arise once construction begins which result in work around solutions which can impact scheme performance. Non achievement of design intent is exacerbated when multiple contractors are involved in the feasibility, design, build and operational phases of a scheme and communication between parties is poor. In addition, SHPs often do not have the relevant skills and expertise in-house to judge when things are going wrong. One means of countering this is to have one principle contractor to oversee the whole process and for a sufficiently skilled Clerk of Works or quantity surveyor to be employed to scrutinise the main contractor’s work at all stages.

1.3 Operating DCCH

Understanding the costs and performance of schemes in operation has proved extremely challenging in this study due to limitations in data availability and uncertainties over assumptions underlying the figures. Limited understandings of scheme performance also seem to apply more widely amongst landlords operating schemes; survey results indicate that a full understanding of scheme running costs was lacking in nearly 50% of SHP survey respondents. Robust monitoring systems that would diagnose system performance were also routinely lacking. Therefore a key recommendation is for landlords to conduct better monitoring and analysis of system performance. This will help them to better manage existing schemes and also to judge the success and appropriateness of DCCH solutions for other housing stock thereby ensuring that the benefits of DCCH solutions are more widely understood.

Landlords reported how the maintenance of DCCH can be problematic. For example, DCCH systems often use innovative or unfamiliar equipment, hence guidance is needed in writing maintenance specifications. Finding sufficiently skilled maintenance contractors can also be difficult. Case study landlords reported the importance of ensuring that charges were as transparent and clearly communicated to residents as possible. Setting up a clear, accountable billing and metering regime was therefore viewed as critical to building trust between tenants and landlords. Many different approaches were taken to billing. For example, landlords reported the pros and cons of a flat rate versus consumption charging approach whereby flat rate systems have more certain income but there is a lack of incentive to save fuel whereas consumption-based charging encourages residents to save heat, is fairer in that residents only pay for what they use but was considered unfair for those accommodated in energy inefficient property.

Achieving fairness and thermally safeguarding vulnerable residents was a key concern for all landlords. This affected various operational practices. For example, when moving from flat rate to consumption-based charging, landlords described how it was vital to ensure that vulnerable and low income households were protected from possible large increases in bills. This was achieved through a combination of improving controls, improving fabric standards in the home and providing energy advice. In another example, a landlord described how the advent of smart heat metering had allowed them to develop thermal safeguarding, because households who were significantly underheating or overheating their homes could be quickly identified through benchmarking, enabling an intervention to be triggered.

1.4 Affordability and fuel poverty

Achieving affordable warmth and addressing fuel poverty are the most common motivations for SHPs in installing DCCH. Concerns over the quality of the technical and financial data gathered from the case studies and the multiple complex factors driving the price of a unit of heat have made it extremely challenging to come to robust conclusions on whether DCCH can reliably deliver affordable warmth. However, taken together with survey findings and qualitative evidence from interviews with landlords and industry practitioners, our findings suggest that well designed, built, commissioned and operated DCCH schemes that are financed correctly can offer reduced fuel bills compared to alternative heating systems and therefore can help to address fuel poverty.

Our modelling work suggests that DCCH will offer clear financial benefits in various technical scenarios. These include when replacing old style electrical storage heating in tower blocks. Landlords reported other pathways for DCCH to offer low cost heat. For example it can be cost effective where it enables connection of low cost heating sources such as heat from energy from waste systems or where revenues from DCCH assets such as sales of heat to local businesses or sales of electricity to the grid can be used to offset the price of heat charged to residents. Scheme financing and the associated business model are also critical factors driving heat charges.

Three general approaches to calculation of heat charges were reported: a) capital cost and marginal cost recovery; b) marginal cost recovery only; and c) a policy driven approach where the heat price only indirectly relates to costs of supplying heat because a policy decision has been taken e.g. to cap the price of a unit of heat.

The choice of method and the final tariff depend on a number of factors, including perceptions of fairness to residents in charging and the overall funding and finance structures in place. Some reported that it was extremely difficult to offer a low unit heat price and/or standing charge if the capital cost of the scheme had to be repaid out of charges to residents. One landlord reported that this meant that development and operation of new DCCH in the social housing sector was unsuitable for profit making private sector companies, who would be compelled to set very high standing charges in order to recoup capital investment in the system.

DCCH also allows the SHP to become the energy supplier, thereby shielding sometimes vulnerable residents from the commercial practices of mainstream energy suppliers. However, landlords routinely subcontracted management of energy supply functions, such as metering and billing, to third parties. Contract permitting, in some arrangements, these third parties could impose their own charges on residents to meet the requirements of their business model. For example, in one case study the company responsible for billing had dramatically increased the standing charge in order to pay for its activities. This highlights the need for clear boundaries and caps in contracts to ensure residents are not charged unfairly high rates leading to increased risks of fuel poverty. Landlords also reported having to impose standing charges where heat sales were inadequate to make a scheme pay for its costs. Indeed 45% of landlords responding on this issue in our survey had some (four) or all (nine) of their schemes running at a loss; in these cases they often saw their role as providers of affordable warmth overriding the need to make the heating system pay for itself. Standing charges were invariably a contentious issue and were also often poorly understood by residents.

Levels of fuel poverty were modelled in each of the eight case studies, using both the English Low Income High Costs (LIHC) definition and the 10% definition[1] used in the rest of the UK for a typical low income household type: the single pensioner. Looking at the spread of incomes for this household type, we found that none of the schemes were expected to have any residents in fuel poverty under either the 10% or LIHC definitions.

1.5 Sustainability and DCCH

Reductions in projected emissions and anticipated improvements in residents' comfort were cited as the second and third most prevalent motivations for installing DCCH over another form of heating (after reducing resident fuel bills). Landlords felt

[1] Households are deemed to be in fuel poverty if they need to spend more than 10% of their income to maintain an adequate level of warmth

that DCCH offered particular benefits in this respect when using large scale low carbon heat sources, such as ground water heat pumps, waste heat, large biomass boiler systems and Combined Heat and Power (CHP).

To provide some insight on system performance in delivering carbon and financial benefits, the eight case study DCCH systems were modelled using SAP software. This indicated that DCCH is predicted to have lower CO_2 emissions than almost all other comparator systems, such as smart electric storage heaters, individual gas boilers or previously installed systems, such as coal-fired communal and electric storage heaters. In some cases, emissions reductions were very significant (up to 42%). However, SAP is a modelling tool and has a number of limitations. Most notably it assumes heat losses in DCCH systems of around 5%, whilst stakeholder feedback and our own analysis suggests that these are often higher, meaning the performance of DCCH may be overestimated in SAP. The project did not measure the actual CO_2 emissions of schemes.

Schemes need to provide sufficient, but not too much, warmth. Residents in three of the six case study schemes[2] felt that their dwelling or communal areas were sometimes too warm. However it was difficult to disentangle the degree to which this was the result of well insulated building fabric coupled with restrictions on ventilation and large amounts of solar gain, poor understanding of heating controls or a result of factors directly linked to the DCCH system, such as secondary heat gains from poorly insulated distribution pipework.

The possibility of building a system prone to overheating was thought to arise at different stages of project implementation. For example, at design phase, equipment can be oversized to head off contractual penalties from providing too little heat, whilst at the installation stage, insulation can be incorrectly specified and installed on connecting pipework. Behavioural responses to overheating such as introduction of portable electric air conditioning can reduce scheme sustainability. However, overall overheating as an issue was not commonly reported in the survey results. Underheating was cited even less commonly than overheating as a comfort issue.

1.6 Barriers and success factors

SHPs reported many barriers and success factors in developing and delivering successful DCCH schemes. Some of the primary barriers encountered include:

- The relatively small DCCH market in the UK resulting in less sectoral experience and fewer consultants and contractors to choose from
- High capital costs, lack of in-house skills or expertise, difficulty in engaging and convincing multiple stakeholders (such as residents, investors, board members);
- Poorly designed schemes leading to problems of oversizing, delays in development and higher than anticipated capital costs;
- Lack of coordination between key contractors through design, install, operation and ongoing maintenance phases;

[2] Residents were only consulted in 6 of the 8 case studies.

- Poor understanding of system efficiencies and data required to monitor and improve system performance; and
- Ineffective engagement with tenants including poor instruction on system controls and insufficient transparency regarding billing.

Identifying factors that have led to successful schemes is difficult due to the number of factors that influence outcomes. For example, it is difficult to determine that one type of technology or billing approach is more successful than others, as its success depends on so many other factors. However successful delivery of DCCH is more easily achieved when its full complexity and potential impacts are realised. This of course includes considering techno economic aspects but also social dimensions too. Some key success factors include:

- Recognising the need for effective stakeholder engagement and management across multiple groups, including heat users, to ensure engagement and support for the project;
- Taking a whole life cost approach so that operation and maintenance requirements are integral to system design and financing arrangements;
- Procuring sufficient expertise to be able to scrutinise all aspects of the development process from feasibility work, design, construction and commissioning; and
- Ensuring that metering and monitoring systems are put in place right across the network and that information flows, both technical and financial, are transparent, accountable and presented in engaging and comprehensible form.

1.7 Recommendations

Selected key recommendations for social landlords, government and the DCCH industry are provided here. The full set is available in the final report.

For landlords

- Ensure that the full range of benefits of DCCH are considered in the options appraisal e.g. related to resident benefits, affordability, sustainability, local economic benefits, possibilities for new business models and regeneration.
- Engage relevant stakeholders at the earliest stages, identify respective stakeholder agendas and continue to engage them throughout the project development and delivery.
- Engage with local authority planning to integrate DCCH with wider strategic objectives for the area. Seek to develop DCCH systems which can be future proofed and readily connected into wider networks and low cost, low carbon heat sources as these become available.
- Embed best practice in the design, delivery, construction and operational phases through, for example:
    - ensuring design engineers have appropriate professional accreditations for work of this type;
    - ensuring existing best practice guidance and standards are used, such as the CIBSE/ADE Heat Networks Code of Practice;

    - employing a single main contractor for design and build;
    - ensuring the principal contractor has a technical lead on site and a Clerk of Works or Quantity Surveyor is employed to oversee the installation and put in place a quality management system;
    - identify realistic operational and maintenance costs and build these in at the feasibility stage (a whole life costing approach).
- Seek maintenance contractors who have experience and knowledge of the systems and develop maintenance contracts that incentivise energy efficient maintenance.
- Set up detailed system monitoring systems that include collecting heat metering data from the heat generator, building level meters and/or dwelling level meters to robustly assess system performance in real time.
- Establish fair and transparent billing procedures based on dwelling level heat metering. Consider introduction of progressive ("social") tariffs for the most vulnerable residents in line with practice in the mainstream energy supply sector.
- Consider the needs of the tenant before, during and after installation. This extends from early consultation to promote buy-in to the scheme, to providing easy-to-understand advice, information and support to residents covering effective use of system controls, transparent billing systems and fair charging.
- Consider implementing thermal safeguarding processes. Monitor under-use of heat and overheating risks at the dwelling level and, with the necessary consents in place, support interventions if needed, e.g. with advice on keeping warm or avoiding waste. Smart metering of heat can facilitate analysis of data for safeguarding and support a near real time response if this is built in.

For government and industry

- Support SHPs, especially private HAs, to initiate DCCH projects and connect to wider networks. The work of the HNDU is much needed to provide the big strategic perspective needed by local authorities for heat network planning but this study finds that skills gaps amongst HAs are holding projects back.
- This can be addressed by creating and refining tools, support, guidance and training, and ensuring that these are accessible to SHPs and other stakeholders that need them.
- Improve the ability of the Standard Assessment Procedure (SAP) to model DCCH systems. Regional government retains SAP point targets for social housing. Fair comparison with alternative heating systems is therefore important for decision-making on asset management to promote energy efficiency.
- Review planning policy nationally and locally to promote DCCH and encourage DCCHs to expand where it is best suited.
- Generate and disseminate better evidence of the impacts of DCCH schemes to engage stakeholders and support project initiation and expansion where appropriate.
- Begin planning for wider regulation of heat supply and in the meantime promote technical and customer service standards already worked up in the Heat Trust and industry-led guidance and documentation.
- Develop standardised and robust methods of monitoring and reporting on heat production and consumption.

1.8 About the project

The research was carried out by research teams at Changeworks (Edinburgh) and the Centre for Sustainable Energy (Bristol). The research was carried out using the following methodology:

- Background research comprising a literature review and interviews with thirteen stakeholders, including representatives from the district heating industry, social housing sector and Government;
- SHP research (with housing associations and local authorities), comprising 24 interviews and an online survey with 62 organisations responding;
- Eight case studies of DCCH schemes, involving staff interviews, resident focus groups with 6 of the 8 case studies, technical and financial analysis;
- A national stakeholder workshop to refine research findings and recommendations.

2. INTRODUCTION

This research has explored the experiences of social housing providers or SHPs in developing and delivering district, communal and community heating schemes. The study focuses on understanding the extent to which these schemes deliver on their sustainability and affordability promise, with a view to informing policy and practice development. It was commissioned by the Joseph Rowntree Foundation (JRF) and delivered by Changeworks and the Centre for Sustainable Energy (CSE). The research involved a UK wide study of SHPs through a survey and interviews, as well as eight in-depth case studies of individual schemes. It was carried out over the course of 2016.

2.1 Definition of district heating

A district heating scheme 'comprises a network of insulated pipes used to deliver heat, in the form of hot water or steam, from the point of generation to an end user and provides a means to transport heat efficiently.'[3] It can also be known as a heat network. There are a wide variety of types of district heating schemes, varying for example in terms of fuel and technology type, buildings involved (commercial or domestic) and scale. In this respect, the set up and operation of schemes will vary depending on the type. For the purpose of this project and in order to be clear what scale of scheme is being referred to, the following definitions have been used:

- **Communal heating**: where one energy centre supplies heat to one building with multiple dwellings, typically a block of flats.
- **Community heating**: providing heating to multiple buildings in one locality. Typically community heating schemes would only have one energy centre, but it is possible for them to have more and to operate at neighbourhood scale, for example, within a housing estate.
- **City-wide heating**: providing heat to multiple buildings across a city. These schemes often include a range of buildings, both domestic and commercial. City-wide heating schemes typically have two or more stand-alone energy centres connected together, but may have only one energy centre.

This research looks at district, community and communal heating. When referred to collectively in this report, these schemes are termed **DCCH** (District, Communal and Community Heating) schemes.

2.2 Potential benefits of district heating

DCCH schemes currently provide only 2% of the UK's heating demand, yet there is potential for this to rise to 14%[4] by 2030 and 43% by 2050. Successfully installed and managed, DCCH can provide a range of benefits to the communities they serve, including alleviating fuel poverty, reducing CO_2 emissions and enhancing energy security. As a result, both UK and Scottish Governments are promoting the

---

[3] The Association of Decentralised Energy

[4] Pöyry Energy Consulting and Faber Maunsell (2009) The potential and costs of district heating networks

expansion and development of DCCH. The social housing sector is where most domestic DCCH schemes are currently found and, due to the economies of scale offered by social housing[5] , SHPs can play a major role driving and accelerating growth in DCCH.

2.3 Policy context

Both the UK and Scottish Governments are actively encouraging the uptake of DCCH schemes, with the Committee on Climate Change (CCC) recently reporting that DCCH will be a key technology on the route to decarbonising heat[6]. The UK Government's Heat Networks Delivery Unit (HNDU) fulfils a commitment from the Government's The future of heating: meeting the challenge to help develop more networks. HNDU provides support to local authorities developing DCCH schemes, in the form of guidance and funding. Similarly, the Scottish Government's Heat Policy Statement sets out its ambitions for district heating: namely the number of homes heated by district heating should increase fourfold by 2020 from 10,000 homes to 40,000; an annual total of 1.5 TWh of heat. The Scottish Government's District Heating Action Plan sets out a roadmap of how district heating is rolled out. Funding is available through the Scottish Government's district heating loan fund.

Schemes may also be eligible for the non-domestic Renewable Heat Incentive (RHI) for biomass or heat pump district heating schemes, and Feed-in Tariffs (FITs) for CHP units. The priority placed on developing new, and expanding existing, DCCH schemes has resulted in a number of recent industry developments. These include the CIBSE Code of Practice and the development of a voluntary consumer protection body, the Heat Trust. Owners of DCCH schemes are also subject to the Heat Network (Metering and Billing) Regulations 2014[7] which place certain regulations on how metering and billing must be carried out.

2.4 Research aims

The aims of the research were to:

- Understand how SHPs are managing the development and delivery of district and communal heating schemes;
- Assess the extent to which these schemes are delivering different affordability and sustainability goals;
- Explore in what context these schemes work most effectively and identify the critical success factors; and
- Identify recommendations for how policy and practice could be improved to address issues arising.

A full list of research questions to meet these aims is provided in Appendix A.

---

[5] including housing associations (HAs) and local authorities (LAs)
[6] Next Steps for UK heat policy. Committee on Climate Change October 2016. See: www.theccc.org.uk/wp-content/uploads/2016/10/Next-steps-for-UK-heat-policy-Committee-on-Climate-Change-October-2016.pdf
[7] DECC (2014) Heat Network (Metering and Billing) Regulations 2014 and amended (2015)

2.5 Research methods

A mix of qualitative and quantitative research methods were used:

- Evidence review
- Interviews with stakeholders (government, trades associations, consultants)
- Interviews with SHPs (local authority and housing associations)
- Survey of SHPs (62 responses)
- Eight case studies including technical and financial analysis
- Workshop with stakeholders and SHPs.

Evidence review

A brief review was conducted to provide a context and inform the research. This covered a range of topics including the primary goals of SHPs developing schemes and their experiences of delivering schemes in practice.

Stakeholder interviews

Interviews[8] were carried out with thirteen stakeholders including representatives from the district heating industry, social housing sector and Government. The intention of this stage of the research was to gain a range of perspectives on DCCH linked to the core brief that would inform the remainder of the research.

Interviews with Social Housing Providers

Telephone interviews were conducted with 24 SHPs to explore their goals and driver for developing DCCH schemes, including the extent to which sustainability/carbon reduction and affordability for residents were drivers and considered to be achieved within projects. SHPs were also asked for their experiences of installing and/or running projects, as well as their thoughts on key barriers and success factors.

Survey of SHPs

The aim of the survey was to gain a broad understanding of management challenges and successes amongst SHPs in the UK, including the barriers to uptake. The survey also provided a quantitative dimension to some of the qualitative findings. 62 responses were obtained. The SHP survey is in Appendix F.

Case studies

In-depth research was carried out with eight case study SHPs to enable exploration of different aspects of schemes in greater detail, focusing in particular on issues around scheme performance, affordability and sustainability. Each case study included staff interviews and the technical and financial analysis of schemes (data permitting). Local resident focus groups were conducted in six case studies.

Stakeholder workshop

A workshop was held in London with representation from SHPs, government and academia. The workshop aimed to discuss and refine research findings[9]. Full details of the methods are in the appendices.

---

[8] Stakeholders included: representatives from district heating, social housing sector and UK and Scottish Governments, and researchers in this field.

[9] Stakeholders at the workshop included a mix of representatives from district heating, social housing sector, consumer bodies, and UK and Scottish Governments, and researchers in this field.

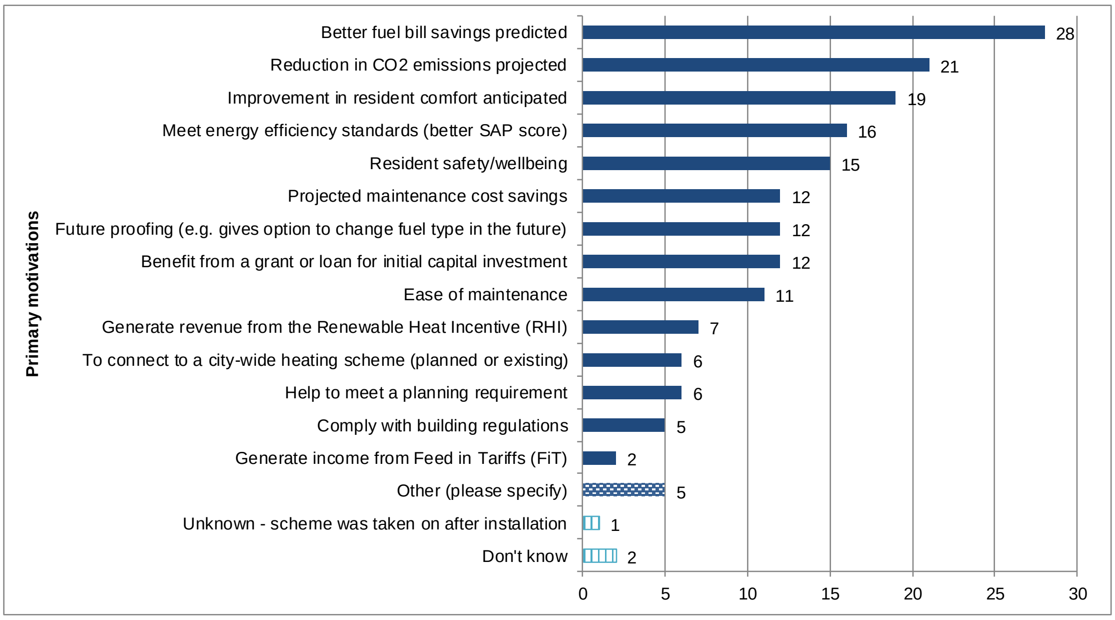
3. AIMS OF DISTRICT HEATING IN SOCIAL HOUSING

The drivers or aims of DCCH systems are the reasons to initiate a DCCH project. They influence decision-making at all levels: the roles of different parties, governance structures and specifications of contracts[10].

3.1 Aims and motivations

The prevalence of different motivations for DCCH systems amongst surveyed SHPs is shown in Figure 1.

Figure 1: Primary motivations for installing DCCH in most recent scheme over another form of heating



Base: 41 SHPs. Respondents could indicate as many motivations as desired

This suggests that landlords are primarily motivated by the potential for delivering fuel bill savings to their tenants and reducing carbon emissions. As discussed below, these objectives are not always achievable simultaneously (low carbon heat is not always cheap heat) and are more important to some organisations than others. Motivations can be grouped into four general types:

1. Delivering direct resident benefits related to fuel bill reduction and comfort improvement,
2. Meeting targets, standards and regulatory requirements, including those related to minimum energy efficiency standards and CO_2 reduction commitments,
3. Responding to financial opportunities and achieving a particular business model,
4. Technical and strategic opportunities including future proofing heat supplies and easing maintenance.

---

[10] The importance of identifying aims and drivers for DCCH systems and referring to them throughout the development process is set out in [draft DBEIS guidance for heat network development]

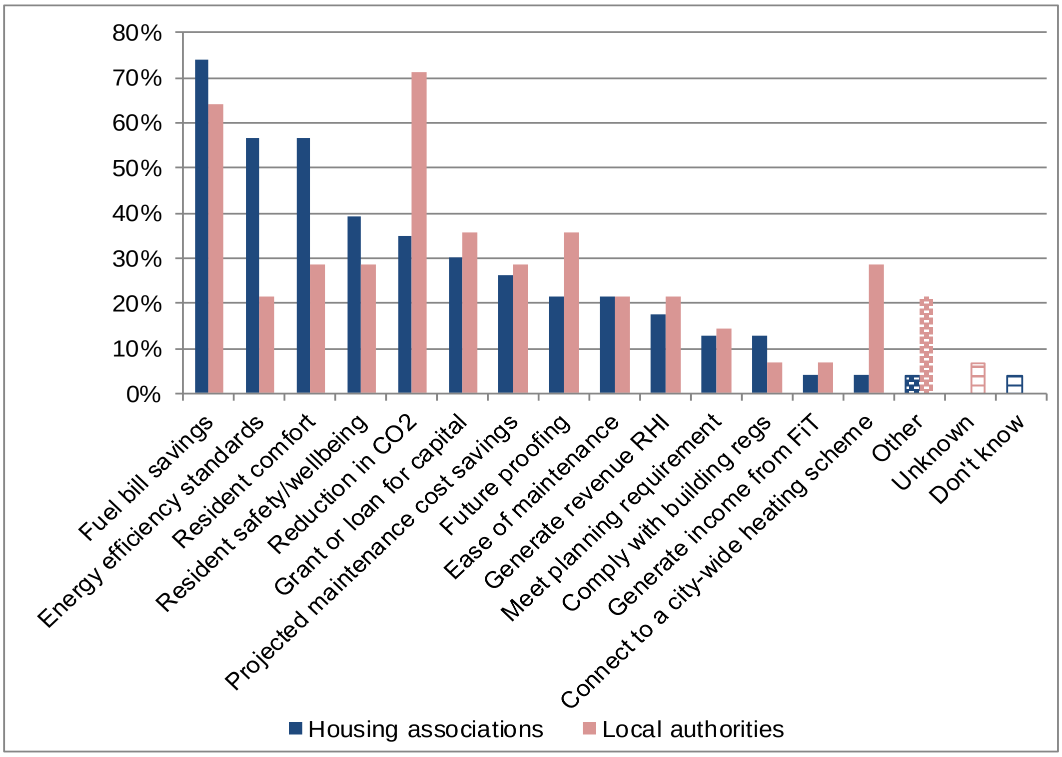
Figure 2 shows each motivation grouped by type with the count of SHPs reporting the motivation in brackets.

Figure 2: Types of motivation

Resident benefits	Targets, standards and regulation	Financial and business model	Technical and strategic
• Better fuel bill savings (28) • Comfort improvement (19) • Resident safety and wellbeing (15)	• Reduction in CO_2 emissions (21) • Meet efficiency standards (SAP) (16) • Meet planning requirements (6) • Comply with building regulations (5)	• Projected maintenance cost savings (12) • Benefit from grant or loan (12) • Generate revenue from RHI (7) • Generate income from feed in tariff (2)	• To connect to city wide scheme (6) • Ease of maintenance (11) • Future proofing (12)

This suggests that motivations related to 'resident benefits' are the most commonly held (three of the top five most commonly reported motivations are in this category). A group of aims related to 'achieving targets and planning obligations' are next most common (the remaining two of the top five are in this category). Then follow two groups of aims clustered around 'technical and strategic' and 'financial and business' model objectives. A comparison of the frequency of these different motivations split between LAs and HAs suggests a slightly different mix of priorities between landlord type (Figure 3).

Figure 3: Comparison of motivations for DCCH between HAs and LAs



Base: 23 HAs giving 97 responses; 14 LAs giving 62 responses.

The base for this comparison is small and so results should be treated cautiously; however, this distribution suggests the most common motivation for HAs is potential fuel bill savings for tenants (17 out of 23 reported this), whilst for LAs it is potential carbon savings (10 out of 14 reported this). In contrast, carbon reduction is the fifth most common motivation amongst HAs (only eight out of 23 HAs). HAs also appear to more commonly focus on tenant related benefits than LAs, for example, on resident comfort and energy efficiency standards. The opportunity to connect to a city-wide heating scheme is also more common amongst LAs than HAs reflecting the wider strategic role of LAs in encouraging development of DCCH schemes and sustainable energy supplies in their areas of jurisdiction (4 out of 14 LAs reported this versus 1 out of 23 HAs). Each group of aims is now considered in turn.

3.2 Direct resident benefits

Alleviation of fuel poverty, fuel bill reduction and comfort

The most common reason for installing DCCH over another form of heating was 'predicted resident fuel bill savings' (28 respondents). This fits with a key driver for SHPs' asset management decisions being the alleviation of fuel poverty: "*fuel poverty and affordable warmth are underlying everything we do".* (London LA). This suggests that a well-designed, commissioned and operated DCCH system was thought an effective means of reducing heating bills and delivering more affordable heat than alternative heating systems including individual gas boilers and electric storage heating. However, not all landlords felt that DCCH achieves affordable heat in practice. Reasons given included the significant distribution losses in large networks and, where residents are charged a flat rate for heat, the encouragement of wasteful behaviours (e.g. opening and closing windows to regulate internal temperature) leading to unnecessarily high energy bills for everyone connected to the network.

Safety and security

Landlords described a number of safety and security dimensions where DCCH appeared to offer benefits over individual heating alternatives. Provision of heated water into the living space via radiators and a Heat Interface Unit (HIU) rather than "burning gas in a metal box in the house" was thought to be an inherently safer heating solution. Communal or community heating was also widely reported as a more appropriate form of heating in sheltered housing where residents are often elderly or vulnerable and could struggle to manage and control individual heating systems. Some also mentioned that by becoming an energy supplier the landlord was removing often vulnerable tenants from exposure to the commercial practices of large mainstream energy suppliers, such as large price increases.

3.3 Targets, standards and regulation

Meeting carbon targets

SHPs described their wish to install low carbon and "green" heating solutions. For example this was to 'do their bit' in helping national government meet its carbon reduction targets or, particularly for LAs, to help meet authority-wide emission reduction targets. A key goal of SHPs is the provision of housing that tenants can affordably heat to comfortable temperatures via increasing its energy efficiency. Consequently, installation of technology to meet carbon reduction targets would not usually trump all other objectives, particularly those related to provision of affordable warmth. As one English Local Authority states, "*The Council does have carbon targets. Yes, part of it is the carbon targets for the Council, but overall I think the number one thing was making it more efficient".*

Meeting building regulations

An effective means of meeting building regulations[11] was thought to be via deploying DCCH schemes that use low carbon heat sources. However, despite this, not all landlords thought that DCCH schemes were always the best solution: "*Heat networks? We build a lot of homes, so the main driver is being compliant with building regulations really. We don't come at it from a point of view that we think it's the right thing to do necessarily. It's just, we're forced down the route, it's probably the only option."* (English HA).

Meeting energy efficiency targets

Whereas a target energy efficiency standard is no longer a requirement for social housing in England, SHPs in Scotland and Wales need to meet efficiency targets as a result of devolved government policy. In Scotland, minimum SAP ratings must be met to comply with the Energy Efficiency Standard for Social Housing (EESSH)[12]; the equivalent in Wales is the Welsh Housing Quality Standard (WHQS)[13]. As noted, energy efficiency standards for social housing no longer apply in England. It was not clear whether this was discouraging landlords from improving the energy efficiency of their housing stocks. In low rise dwellings, SHPs were able to meet some of these efficiency requirements by replacing storage heaters with individual gas and oil fired systems. However, in tower blocks, due to safety concerns with installing gas and technical issues with oil boilers, communal heating to replace individual storage heating was mentioned as the preferred solution.

Meeting planning rules

In some parts of the country local planning rules are important in driving installation of DCCH or in SHPs acquiring affordable housing via section 106 which has DCCH installed. Notable is the London Energy Plan (LEP) which requires new-build housing developments to have DCCH unless there are sound financial and technical reasons otherwise[14]: "*The London Plan, was a really, really heavy push towards communal heating and district heating."* (London HA). The Scottish Environmental Protection Agency (SEPA) has also created a planning framework using Strategic Development Plans and Local Development Plans to encourage heat networks e.g. by requiring connection of substantial and anchor loads to heat networks unless there are good reasons not to do so.

3.4 Financial opportunity and business model

Availability of grants and loans

Some SHPs stressed that they did not let the availability of particular types of grant funding drive decision-making; others were clear that it was a critical driver in the choice and management of particular heating assets. For example, availability of

---

[11] Part L of the building regulations for England and Wales require the building to achieve target CO_2 emissions rates.

[12] EESSH requires social housing flats to meet a minimum SAP level of 69 if they are heated by gas and 63 if heated electrically (using SAP 2012 methodology). www.energyefficientsocialhousing.org. This replaces the Scottish Housing Quality Standard (SHQS) which had to be met by May 2015

[13] The Welsh Housing Quality Standard: homes must meet a SAP score of 65 by 2020

[14] See London Plan's policy for heat networks as part of the GLA's response to Climate Change

favourable loans for renewable heat technology coupled with the income stream generated by Renewable Heat Incentive (RHI) payments was reportedly a powerful incentive to replace gas boilers with renewable heat alternatives. These are primarily biomass boilers which, when serving a DCCH scheme, are considered appropriate in contrast to individual biomass boiler systems which are thought totally inappropriate for social housing.[15]

Revenue raising opportunities

Becoming an energy supplier is an opportunity to create additional revenue streams. Exploring new sources of revenue was considered to be particularly interesting to SHPs at a time when LA budgets have been reduced by central government and where the Welfare Reform Act (2012) is also reducing rental income: *"It's a challenging time in terms of rent reductions and right to buy and development budgets being slashed. So it* [district heating] *might be something that's considered because it can still bring economic gain for the organisation."* (English HA)

Sources of potential revenue included the RHI[16], where a renewable heat source is used, or electricity sales from a CHP unit. However the low electricity prices currently available for sale of CHP electricity into the grid were thought to undermine the economic case for investing in DCCH using CHP as a heat source. Using this electricity in landlords' buildings was considered to be a much better financial option.

3.5 Technical and strategic issues

Suitability of property and problematic individual heating systems

Landlords described how particular properties lent themselves well to retrofit of DCCH and that this, in combination with other factors (such as the property having problematic incumbent heating in need of replacement and the availability of grants), had been a sufficient driver to prompt feasibility work for DCCH. However, retrofit was only considered feasible in a narrow range of circumstances, primarily because of safety issues and the capital expenditure required: "*It would be highly unlikely that we'd do a retrofit scheme. Because of capital costs, and it's very complex in the way that you have to set up the safety structure."* (English HA).

Retrofit of communal heating into tower blocks previously served by electric storage heaters, conversely, was cited as a good example of an appropriate situation for DCCH retrofit. Old style storage heating was considered to be expensive to run and difficult for tenants to control, often leading to discomfort, cold homes and a contributory factor in causing fuel poverty. An efficient alternative to storage heaters is individual gas fired boilers; however individual gas boilers are not allowed to be installed in buildings above five storeys and so a communal heating solution was reported by some as the obvious choice instead: "*So, say we have a block of flats*

---

[15] DECC's report on the responses of social housing landlords to the Renewable Heat Incentive describes the reasons for this.

[16] The levels of subsidy for units of heat available through the RHI are designed to cover the additional cost of a renewable heat source compared with a conventional fossil fuelled alternative. They are not designed to allow investors in renewable heat to make a return on their investment.

that's electric, all electric, high rise - we have looked at some sites in regards to providing district heating to them." (English SHP).

Future proofing and flexibility

DCCH schemes were described as offering some future proofing in that they are "agnostic" about where the heat comes from. As fuels change in cost and availability and heating technology also evolves, a DCCH scheme solution was thought inherently capable of adapting to these new opportunities, particularly to use waste heat in future: "*Renewable sources or waste sources from the underground or from other people's CHP that you know we can adapt the district heat network to that, which is another reason for promoting them."* (London LA).

Connecting up heat networks

A number of landlords described how the possibility of connecting their heat network to other heat networks had been considered. One landlord described how a network serving a local authority housing estate could be connected to the main city hospital. However connecting up heat networks opens new layers of complexity. SHPs mentioned how different ownership would pose challenges such as, in the example cited, the hospital not in local authority ownership. The distance between networks was also cited as a barrier which would rule out connection. The situation in London is different though. Landlords that owned or developed property in London described how planning rules set expectations that new development will connect to existing heat networks wherever possible. In one of our London case studies we were shown the pipework in place to enable connection to a new network should one arise. Another landlord operating in the London area described how a housing development had become connected to a pre-existing heat network for carbon saving reasons and for reasons of reduced capital expense: *"we connected two sites to a wider network in Lewisham. That was our decision to do that, we just thought that was the right thing to do from a carbon point of view and from a Capex point of view, it was a cheaper solution to dig under the road rather than build our own system, it seemed slightly folly when there was one next door."* (English HA).

Ease of maintenance

Some landlords reported how a further attraction of DCCH was a perceived reduction in maintenance requirements: a small number of centralised boilers is thought easier to maintain rather than hundreds or even thousands of individual systems. Individual gas fired boilers also need an annual inspection where access can often be problematic and this alone is a significant annual cost. However, others pointed out that whilst Heat Interface Units (HIUs) do not require a mandatory annual inspection like individual boilers, they are present in every home and also needed occasional maintenance. In addition, maintenance of DCCH was considered outside the core skillset of the contractors conventionally employed to maintain individual heating systems.

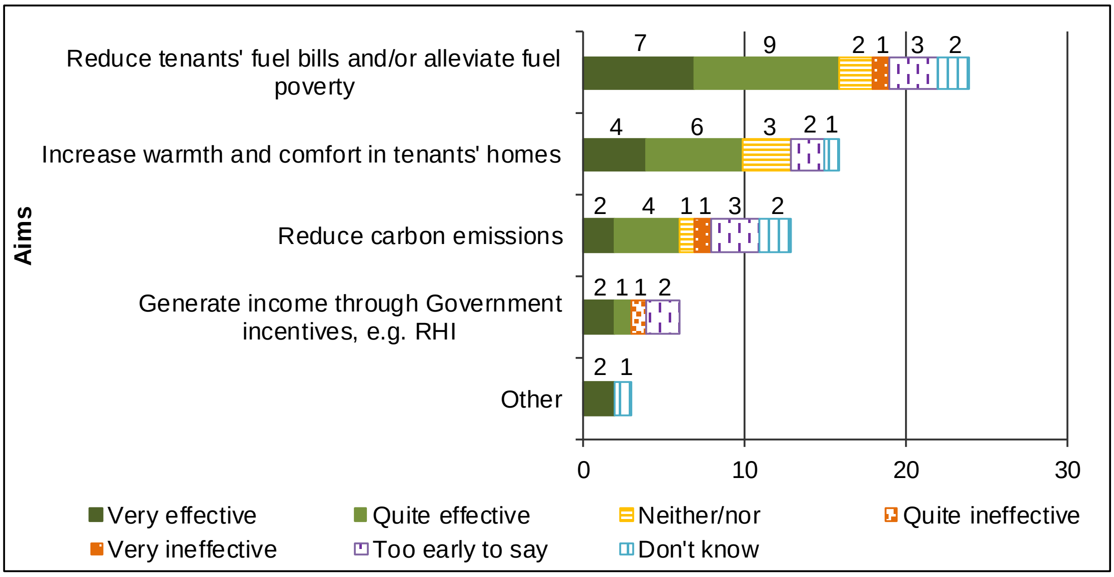
'Hobson's choice'

A number of landlords described how they effectively had no choice but to continue to maintain and renovate older DCCH schemes as these assets would be hugely expensive to remove and then replace with individual heating systems: "*We are* *maybe on Hobson's choice now in that this* [DH] *system exists across this vast estate, you can imagine actually taking it out and installing anything else would be a massive project. So what we've done is worked to renew, renovate and lower the carbon footprint of the existing installation."* (English LA).

Perceptions of scheme outcomes against aims

Our survey asked respondents how effective they thought their scheme had been in meeting its objectives. As shown in Figure 4 the majority of respondents felt that their most recent scheme was either very or quite effective in meeting the aims set out at the beginning of their project.

Figure 4: How effective schemes were at achieving aims



Base=32. Reduce tenants' fuel bills: 24, increase warmth and comfort: 16, Reduce carbon emissions: 13, Generate income through Government incentives: 6, Other: 3

The base for these figures is small and caution is advised in interpreting this data. However it appears that the majority of landlords that are able to make a judgement felt that DCCH is successful in meeting fuel poverty, comfort, carbon reduction and income generation objectives. For example, 16 of 19 landlords felt that their scheme had either been very or quite effective in reducing tenants' fuel bills. Ten of 13 landlords felt their scheme had been very or quite effective in delivering comfort improvements and six of the 8 landlords judging success on carbon reduction criteria felt their scheme was effective. The following sections of the report explore the extent to which these perceptions are borne out through the project in the data collection and more detailed case study analysis of performance of schemes.

3.6 Summary

The aims of DCCH schemes in social housing vary by the type of scheme: whether retrofit or new build; the organisational culture (some SHPs see themselves championing low carbon technology more than others) and organisational type, for example whether a HA or LA. However, all SHPs have a primary aim of providing heating systems which deliver affordable warmth for tenants and residents and most, but not all, saw DCCH as a means of achieving this. LAs in particular are also motivated by DCCH opportunities for carbon reduction, reflecting historic and continuing commitments to reduce emissions in both the LA's estate, and their strategic role in delivering national carbon emission reduction targets across their areas.

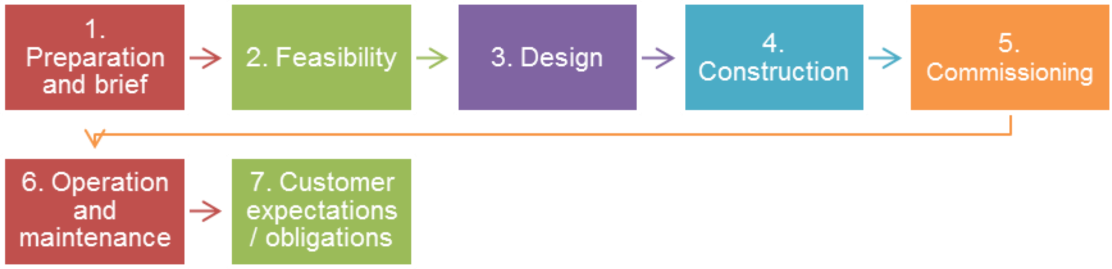
Important second order aims of DCCH systems include raising revenue for the SHP, future proofing heat supplies, reducing maintenance costs and compliance with a raft of planning and policy requirements and regulation. Outside of London, little evidence was found of HA schemes being connected into wider local plans and infrastructure planning, although the potential and desirability for this was often recognised and in Scotland is beginning to become enshrined in planning frameworks. Within London the spur for DCCH is often the requirements of the London Energy Plan thus highlighting the importance of planning rules and a conducive policy environment in encouraging the spread of DCCH.

The survey of SHPs suggests that most landlords feel that DCCH schemes are delivering key objectives. The challenges and issues encountered when developing, delivering and operating DCCH schemes, which may inhibit the delivery of these outcomes, are considered next.

4. DEVELOPING, DELIVERING AND OPERATING SCHEMES

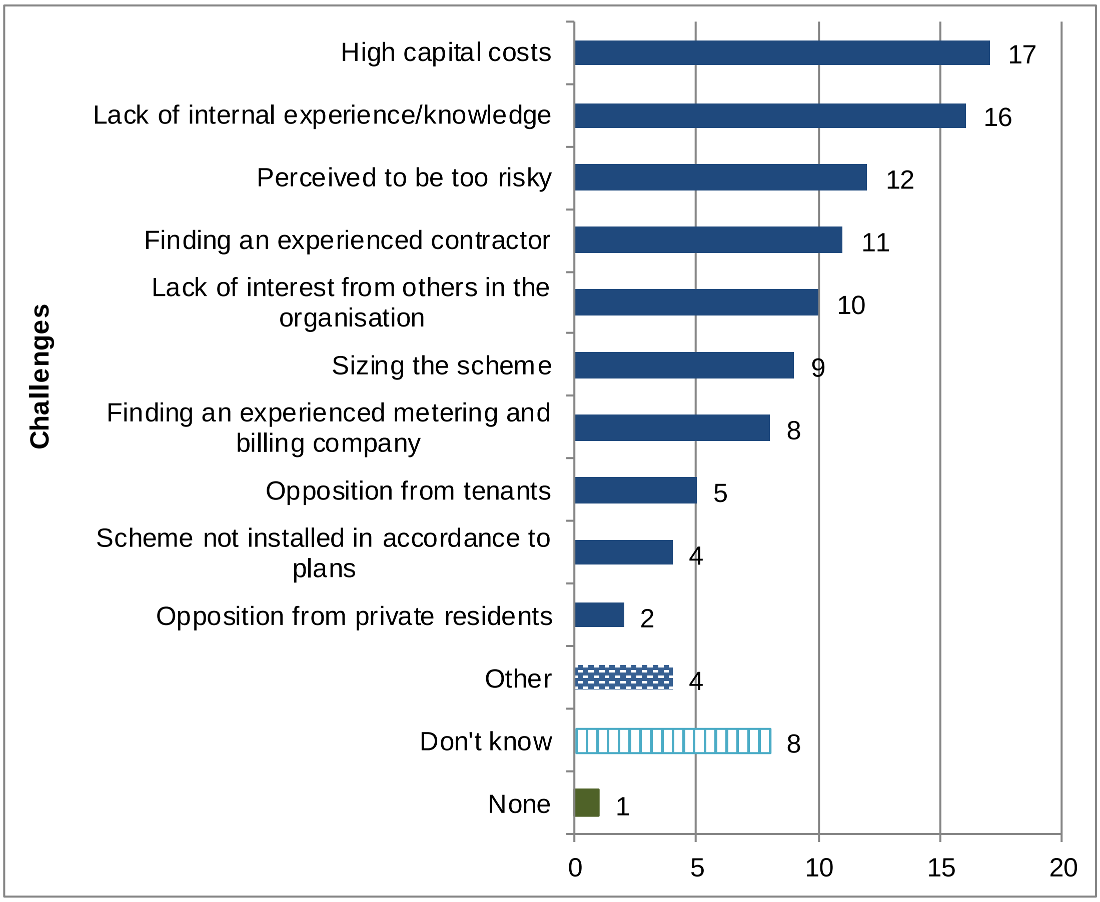
The realities of developing, building and operating DCCH schemes shape the extent to which affordable warmth and sustainability outcomes are achieved in practice. In this section we consider SHPs experiences in scheme delivery. Government and industry recognise a number of distinct stages in the development cycle of DCCH:

Figure 5: Stages in the development cycle of a DCCH



At each of these stages, landlords will encounter barriers, challenges and opportunities. Survey results in Figure 6 reveal which of these barriers are thought more common than others.

Figure 6 Identified challenges in feasibility, design, planning and installation phases



Base= 36

The most common challenges experienced by respondents in the initial stages are 'high capital costs' (17) and a 'lack of internal experience/knowledge' (16). Other common challenges were the perceived risk, finding an experienced contractor, lack of interest from others in the organisation and sizing the scheme. These barriers, challenges and opportunities are now considered at each stage of the development process.

4.1 Early decision-making and scoping

A number of factors leading to successful DCCH development were found in the early decision making phase. Most SHPs began by talking about the need to secure the very significant funding required.

Funding for the capital investment

SHPs frequently mentioned the high capital costs of DCCH systems as a significant issue. LAs contrasted this with reduced funding available to LAs as a result of central government spending cuts and the requirements of the Government's social housing rent review for both LAs and HAs to make a 1% cut in the rent charged to tenants each year for the next four years. HAs also mentioned the need for access to lower cost capital on a par with the loans available to LAs.

Survey respondents were asked how they had financed the capital investment of their most recent DCCH scheme. Most organisations had received some form of grant funding, with thirteen respondents relying entirely on grants from one (five respondents) or more sources (eight respondents). By contrast, only four organisations had solely relied on internal funding, whilst nine used a combination of internal and external grant funding. This mix was also reflected in the case study organisations, where a mix of grants and internal funding had been used.

In terms of funding sources, ECO and RHI were the most commonly accessed. The RHI, introduced relatively recently, has enabled more schemes to use renewable heat sources, typically biomass boilers or, less commonly, ground source heat pumps. Feedback from the case studies suggests that, without the RHI, it is unlikely that these heat sources would have been used, as the install or running costs of these fuels are expensive, making it difficult to achieve affordable warmth. Other sources of grant funding accessed included Government funding, for example, through Scottish Government programmes, HNDU and European funding.

Grant funding is a significant facilitator in the development of schemes. Sixteen survey respondents (of 26) said that their most recent scheme could not have gone ahead without access to grant funding (with a further ten commenting they did not know if it could). The impact of external financial support on scheme design appears to be quite significant with thirteen (out of 26), i.e. half of all respondents commenting that the funding source had some influence on the design of the scheme; with one commenting that their scheme had been *"very heavily"* influenced. The most common impact was reviewing alternative technologies to obtain funding, such as the RHI. In contrast one survey respondent stated that they were unable to install CHP (which would have reduced carbon emissions further) because their funder had already met their carbon targets (presumably under ECO): *"The utility which provided the funding dictated the design. This meant that, once their carbon savings were accounted for, they went no further. We would have preferred it to contain CHP and couldn't fund it ourselves."* (Scottish LA).

Borrowing money at commercial lending rates was thought to instantly make some projects impossible because recovery of the funds via the unit heat price or standing charge passed on to tenants would be too high. Therefore some felt that there was a particular need for HAs to be able to access loans on the same favourable terms as are available to LAs through sources such as the Public Works Loan Board.

Business models for attracting finance

A contrasting view was that rather than borrowing (at favourable rates), the key to driving development of district heating in the social housing sector was through changing the scheme economics so that schemes could be developed which offered commercial rates of return and would therefore attract investment finance: *"Fundamentally the economics need to change. The returns need to be commercial in some way, so either that is reducing risk so that people with lower risk capital can come in and accept the low returns or you need to increase the returns. That's the fundamental thing."* (DCCH stakeholder). This perspective is supported by one landlord who claimed that sometimes the efficiency savings from particular DCCH systems were so great that they could justify passing on repayment of the capital costs to tenants in the form of a standing charge.

Alternative financing models, such as using an Energy Services Company (ESCo) were also discussed. Some thought the ESCo model would potentially expose residents to very high standing charges, as the company naturally seeks to recoup its investment. The issue of recovery of the capital cost of the DCCH scheme via billing meant that some SHPs ruled out using a profit making ESCo to provide the capital investment and then run the scheme: "*The economics are pretty simple. You've got to boil down your running costs to just fuel and maintenance in order to give residents an economic heat charge. So, yeah, we didn't dare trust the private sector with the money."* (English LA). Not-for-profit ESCos do exist; if able to secure low interest finance it was thought possible to use an ESCo model incorporating capital cost recovery from tenants at affordable rates.

Organisational culture and strategic planning

Some SHPs described a lack of interest in DCCH, often sustained by a lack of understanding of the benefits of a DCCH system. Conservatism and risk aversion were also cited as key barriers at the early stages of decision-making. For example, SHPs described how financial managers were difficult to convince of the certainty of funding sources in a landscape of constantly shifting funding rules and changes to policy. An organisational culture that encouraged DCCH was linked to a number of factors, including senior support for DCCH solutions, which could in turn spread support throughout the organisation "from the top to the bottom", and having a highly motivated champion.

There also appear to be some broad cultural differences between HAs and LAs which influence the fit of DCCH solutions. For example, LA decision-making can be prey to five year political (election) cycles which was described as leading to short term thinking. The long timeframes associated with DCCH development do not align well with decision-making which is focussed on achieving deliverables in a short time frame. These differences in the culture of organisations suggest that proponents of DCCH systems need to ensure that the potential social, economic and environmental outcomes of DCCH are seen to align with organisational culture and broader strategic objectives if they are to succeed.

SHPs described how they were increasingly taking a strategic view of both the renovation of existing DH systems and the creation of new ones through considering local heat mapping, LA plans for DCCH schemes and the availability of local sources of waste heat: "*All of our social housing schemes form part of a wider strategy that was developed two or three years ago. We're fortunate enough to get funding to develop city-wide master planning."* (English LA).

Connecting DCCH outcomes with stakeholder priorities

Principle drivers of development of DCCH include fuel poverty alleviation, carbon reduction, income generation and compliance with planning. These drivers were reportedly owned and promoted to varying degrees by different stakeholders within the SHP and beyond.

Organisational buy-in is identified as an important success factor; therefore this suggests that early decision-making processes should create opportunities for stakeholders to make connections between DCCH outcomes and fulfilment of their own objectives[17]. This was reportedly an important dimension of the ability of organisation to mobilise stakeholders and to create the momentum for a DCCH project. This suggests that scheme developers need to be quite savvy in developing engagement strategies at early stages tailored to each stakeholder type.

Differing priorities between developers and tenants

SHPs described how the opinions of tenants towards the prospect of DCCH vary quite dramatically and may sometimes contrast with the attitudes of the developer. One LA commented that even when private tenants did not have to pay anything towards the cost of their system they still declined having it installed. The reason for this reticence is not always obvious. One SHP suggested that the UK does not have a "communal culture" and that householders like to have control of their own heating system.

The importance of the landlord being clear on the aims and objectives of retrofit DCCH scheme in order to create support for the scheme also became apparent in the case studies. Participants were generally unaware of the reasons behind their landlord's decision to install a DCCH scheme. In one instance, a participant who was a member of the residents group explained the aim was to reduce fuel poverty in line

---

[17] Ambrose, A., Eadson, W. and Pinder, P (2016) *The role of actor-networks in the early stage mobilisation of low carbon heat networks,* Energy Policy, 96, 144–152

with Government targets; however other participants had no knowledge of this. At another scheme, residents thought their landlord had installed the scheme for its environmental benefits, but there was also a lot of scepticism about their motivations including concerns that budget cuts had been a motivation to install the scheme.

There was also, reportedly, a widespread misunderstanding amongst tenants between paying for a unit of delivered heat and paying for a unit of gas, and the reasons why the unit price in a district heating network is likely to be higher than the unit price of gas: *"It's mainly because people don't like paying charges for things they can't see. The heat gets delivered, why am I paying this huge charge? They don't factor in the maintaining the network and the equipment behind it."* (English SHP).

Another SHP suggested that although tenants might initially be reticent towards a DCCH scheme, they tended to like it once it had been installed. Residents' expectations of what to anticipate from a heating system have also been difficult for some SHPs to manage. Some have found that tenants demand a very high level of heating and cannot understand why a system may not be providing it. Therefore engaging, educating and supporting tenants was seen by some SHPs as critical to the successful operation of a DCCH scheme.

Leaseholders and tenants

DCCH schemes operate across different tenures with a mix of leasehold and rented properties. In some housing estates in London up to 80% of the homes were reportedly leasehold. Leaseholders must generally consent to changes in their homes and this can pose barriers to retrofit or expansion of DCCH, especially where leaseholders pay for their heat under a different charging structure to tenants. One landlord described how leaseholders were expected to pay into a sinking fund to fund total system replacement whereas tenants did not. Under section 11 of the Landlord and Tenant Act (1985) and amended, 1988, landlords have responsibility for maintaining heating systems (including heat networks) and cannot charge *tenants* for maintenance and replacement of heating systems[18]. However charges to leaseholders can be made to leaseholders and this charge often rolled into service charges. The rationale for this is that it is not considered fair for tenants to pay for a fundamental component of their home. Tenants do not own the space they are living in and therefore do not pay to have it replaced, whereas, it is considered that leaseholders own their home (including the heating system) and should therefore pay for its replacement. Some leaseholders did not consider this to be fair.

Changing tenure in social housing

SHPs described how the Right to Buy scheme had dramatically changed the demographics of social housing with large numbers of homes now owned by leaseholders. One landlord thought that leaseholders were less likely to be at risk of fuel poverty and so the case for investment in a DCCH solution, where a primary objective was to target fuel poverty, was undermined. This situation also impacts

---

[18] Sections 11-16 of the Landlord and Tenant Act (1985) cover the charges that can be levied on leaseholders (www.legislation.gov.uk/ukpga/1985/70/section/11)

availability of grant funding for DCCH systems, for example through the Affordable Warmth strand of the Energy Company Obligation (ECO).

The need for a champion

In all organisations there is a tendency to procure technology that is known and understood[19]. Consequently, where DCCH is seen as unfamiliar and/or innovative landlords described how an important driver for a successful DCCH project was often a key individual within the organisation who would promote the technology, taking on the “nay-sayers” and staff with a more risk-averse perspective, including particularly the financial managers. DECC’s evaluation of the HNDU[20] and other studies exploring barriers to DCCH schemes[21] make the same observation. This suggests that champions need to be supported through provision of good guidance (for example on how to understand and engage different types of stakeholder in a DCCH scheme) and opportunities to witness good practice and to network with peers also seeking to develop heat networks.

4.2 Feasibility stage

Who does the feasibility work?

Landlords reported how feasibility work was undertaken in a number of ways:

- In-house. Where the SHP has sufficient resources, feasibility work was conducted in-house. This was reported to have considerable advantages in ensuring that known assumptions are used and that lessons from other projects are brought across.
- Design and build. Under this kind of contractual arrangement the whole project from feasibility to delivery (and sometimes also operation) was managed by a third party. Energy suppliers funding schemes through the Energy Company Obligation (ECO) reportedly often preferred to work in this way.
- External consultants. Where there is insufficient technical expertise to carry out feasibility in-house, external consultants are contracted to do the work.

In order to tackle issues with external consultants using opaque assumptions and not delivering the analysis needed, one HA had used their experience of constructing DCCH schemes to produce internal technical specifications. This meant that although external consultants carried out the feasibility studies, certain principles were adhered to and lessons they had learned in previous build processes were not lost.

In-house skills

Landlords described how the early planning and feasibility work is greatly eased where there is a core of relevant skillsets and expertise in-house. Case study 5

[19] For example, see DECC’s Rapid Evidence Assessment of decision-making on energy efficiency in the non-domestic sector (2012)
[20] See DECC’s evaluation of the work of the Heat Networks Delivery Unit
[21] DECC (2013) Research into Barriers to Deployment of District Networks

suggests that LAs with significant resources are usually better placed than HAs in this respect, particularly smaller ones.

Case study 5: Local Authority scheme in London – the importance of in-house knowledge and experience
Background and aims This large scale district heating network supplies over 800 dwellings across three social housing estates, two blocks of private flats, two leisure centres and four office buildings. The scheme came online in 2012 and currently operates a gas CHP engine at one energy centre. **Design and build** The local authority has a substantial Energy Service team with knowledge and experience of working with district heating, including a number of qualified engineers. Whilst they do not have experience designing schemes, their experience placed them in a strong position to procure suitable contractors and assess plans effectively. They were also able to co-ordinate teams from across the organisation, such as housing, legal and procurement to ensure joined up thinking. **Impact** Whilst they did experience some issues, including obtaining planning permission, once operational the scheme achieved its aims to deliver affordable heat. The Local Authority have been able to share their knowledge with other organisations and offer consultancy services to other councils. Following the success of the existing scheme there are plans to extend the network, which will including the development of a second energy centre and involve the use of waste heat. **Learning points** Undertaking a DCCH scheme requires internal knowledge and experience, particularly on a district scale. This can be achieved through the creation of new roles and the formation of a sub-team to oversee the project. Alternatively these roles can be outsourced to external consultants, but this too requires oversight to appoint an appropriate body.

Procuring and critiquing feasibility studies

Some SHPs reported that it was difficult to find the right contractor to do the work and took the approach of using a trusted consultant who they'd worked with on other projects before, whilst others went for someone they knew to have already successfully completed work on other district heating projects. In general, landlords reported a shortage of suitably qualified contractors and a sense of frustration at not having sufficient technical expertise in-house to adequately critique the options given to them by external consultants. Where SHPs could not use internal staff to review the consultant's work a third party Mechanical and Electrical (M and E) consultant was sometimes used. The services of these third parties were sometimes used right through the development process to act as the eyes and ears of the SHP, checking the specifications and quality of the work at all stages.

Considering the technical options at feasibility stage

A range of approaches to considering the technical options (heat source and distribution system) were given. For some landlords the experience of the tenants was the primary concern: reliability, affordability and controllability were all mentioned as key factors in both the decision to build a DCCH system and in making the decision about which heating fuel to use. Affordability was sometimes traded off against environmental benefits: "*It's the additional costs that's involved in acquiring that fuel, what will actually bump up the heat price and from an affordability perspective we can't justify that in terms of the impact to residents. So despite the sustainable side of things we have to look at it in terms of what the net impact is to cost and charges to end users."* (English HA).

For others, the amount of servicing that a system requires and the ease of access to carry out this maintenance were primary concerns. Indeed some SHPs mentioned that it was crucial to think about the cost of the system over its whole life cycle. They emphasised that although individual heating systems might appear cheaper in the short term, the cost of a DCCH system is more likely to stack up when considered over the whole lifetime of a system.

SHPs also described how catastrophic breakdown of equipment was insufficiently considered at feasibility stage. One landlord suggested that a better understanding of the repairs and maintenance needed for DCCH schemes was a "learning point" for the sector. Case study 3 exemplified these findings relating to adequately considering maintenance requirements at the feasibility stages.

Case study 3: Housing association scheme in North East England - factoring maintenance into scheme design
Background and aims A new build gas CHP scheme was commissioned in 2008 to supply a retirement village including 250 social and shared ownership homes and a series of non-domestic buildings. The scheme is managed by a landlord and metering, billing and Heat Interface Unit (HIU) maintenance is outsourced to a third party. The aim of the scheme was to achieve a system which was reliable, reduces risk of fuel poverty and decreases CO_2 emissions. **Operation and maintenance** When the scheme was initially handed over from the installer, all maintenance was handled by an internal maintenance team. However a lack of in-house experience with DCCH schemes resulted in some uncertainty around repairs. This along with a number of faults on the HIUs, which were latterly found to be not fully compatible with the boiler, resulted in the contract for Heat Interface Unit (HIU) maintenance being passed to a third party. The plant room maintenance is managed by another third party organisation. Since the scheme has been in operation there have been three different boiler maintenance organisations. A plant room maintenance contract had not been procured prior to the handover of the scheme and there was some initial uncertainty as to what criteria to

procure against. There is an on-going issue with the boilers cracking internally; the cause is still to be established, meaning the boilers need to be frequently repaired. In addition a lack of record keeping meant that it was unclear when the plant room was last serviced, this is now scheduled and recorded.

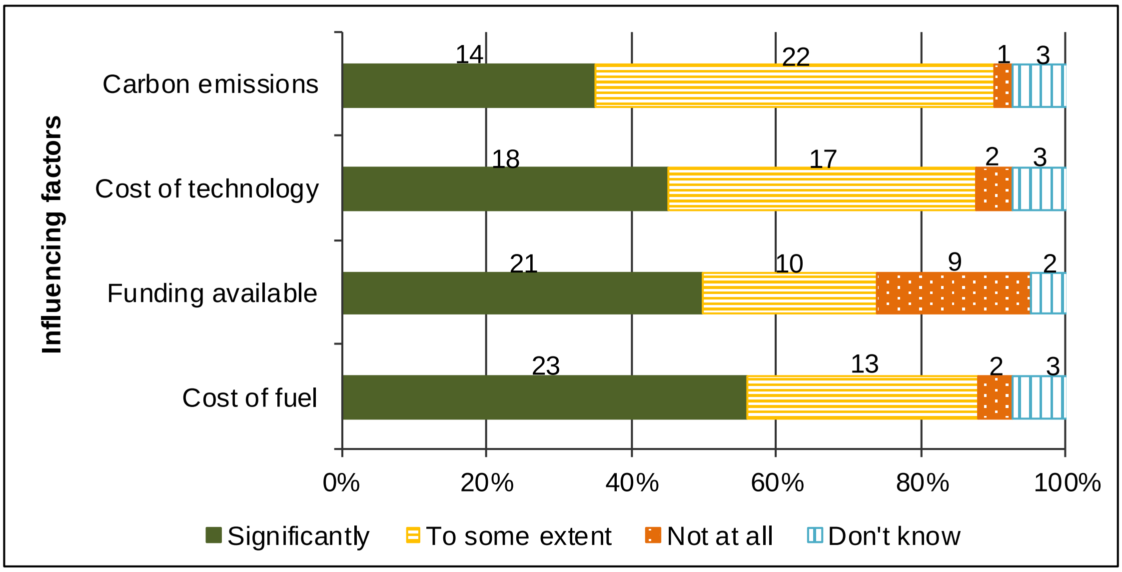
Learning points

Maintenance requirements should be included into the design brief including the development of a full maintenance plan.

One of the third party maintenance organisations now performs an annual maintenance check of all properties. Any issues arising during these checks are communicated to the landlord who uses their internal maintenance team to complete the work. The internal maintenance team have now built experience over common causes for faults on HIUs and can perform most repairs themselves without having to call on the third party.

SHPs described multiple other technical aspects which ruled out or made certain technologies or fuels potentially attractive. For example, biomass presented problems in terms of requiring enough space for storage of the fuel, and private wire systems[22] associated with optimising CHP economics, were considered too complex to consider further. The survey asked SHPs to what extent different factors influenced their choice of fuel and technology (Figure 7).

Figure 7: Factors influencing choice of fuel and technology type



Base= Cost of fuel 41, funding availability 42, cost of technology 40, carbon emissions 40.

Figure 7 suggests that the cost of fuel had the most significant influence on choice. However, all four areas of influence seemed to have a similar impact either ‘significantly’ or ‘to some extent’, suggesting that a range of factors are taken into

[22] Private wire is an independent electricity distribution system to serve buildings connected to the network or further afield.

consideration. 'Funding availability' seemed to be the most divisive influence with around half of respondents (21 of 42) finding it significantly influenced their decision and almost a quarter (9) stating that it had no influence at all. Carbon emissions significantly influenced the least number of respondents (14). However carbon emissions influenced the largest number of respondents "to some extent" (22) and only 1 respondent said that they were not influenced by it. This suggests that carbon emissions are often a second order consideration but one shared by many.

Investigating financial feasibility

Financial issues were seen by some SHPs as the main barrier to greater deployment of DCCH. Some mentioned the impossibility of generating sufficient capital to get a scheme off the ground. Others mentioned compromising on the design of the system as they did not have the funds to finance their preferred option: *"We all talk about drivers, important drivers, sustainability and fuel poverty, and, ultimately, if any project gets delivered it comes down to the cost and all the great aspirations will fall by the wayside. If the cost isn't right, it doesn't get delivered."* (Scottish LA).

For some landlords the existence of grant funding was pivotal in making a DCCH scheme feasible or was essential in enabling them to use a particular heat source. Other landlords stated that their schemes either were not reliant on grant funding, or would still have been feasible without it. It was also reported that the unsettled nature of grant funding has made it more difficult to determine financial feasibility, as there is a fear of funding being changed at short notice or withdrawn. Imposition of funding deadlines also presented a barrier. In the public sector, investment has to generate commercial rates of return, and for HAs this is also important. Well-designed charging structures were therefore important to a successful scheme.

Assessing heat demand

Knowledge of the level of local demand for heat is important for SHPs to assess the feasibility of DCCH schemes. Yet this data is difficult to obtain and must be available at the address level: *"One of the key things that's always been a problem with planning district energy is, nobody has access to the one bit of data that we all need, which is the actual energy consumption of a property...yes, we've got estimates and models to a lower super output area or a postcode but the data everybody needs is to individual unique property level."* (English LA).

Landlords further reported that estimates of heat demand are often wrong and lead to poorly specified systems, which can lead to problems. For instance, an oversized boiler will result in inefficient operation. Also, where the amount of heat used by tenants does not match the modelled demand, business plans are no longer valid. This might be due to a mild winter or higher rates of solar gain than anticipated or well insulated properties not requiring as much heat: *"In order for us to pay for the heat losses, we need everybody to be using an element of heat to contribute towards the cost of paying for the gas…all these tenants were saying that it was too hot and they didn't need their heating on, and it was a good thing from their point of view. But…we want it to cover its costs - so that was a concern to me."* (English HA).

SHPs also described how if pipework is not insulated to the correct level or insulation is poorly detailed then tenants might also benefit from the residual heat from pipework distributing heat across a floor ("laterals") and the pipework taking the heat to each floor vertically ("risers") such that the need to switch on their own heating was reduced.

Guaranteeing and creating sufficient heat demand

In order for a scheme to be feasible there must be a certain threshold of demand for the heat. However assuring sufficient heat demand in practice can be difficult. For example as highlighted above, persuading sufficient numbers of leaseholders to join the system (leaseholders are not obliged to connect to a retrofit DCCH system) could be difficult if they do not see any particular benefit and are concerned about standing charges and their ability to switch energy (for heat) supplier. It was also reported that there remains a culture of conservatism with respect to connection to DCCH schemes.

The London experience suggests that private housing developments and businesses will only generally connect because they are compelled to do so by planning rules. Therefore it was observed that DCCH scheme operators need to do a better job of selling the benefits of connection so they can be assured that they have enough demand for a viable scheme and so that there is greater incentive to build in capacity for future expansion. Connection of businesses and private housing to a network can also be an important source of revenue allowing subsidy of heat prices to social housing tenants. The design and delivery of communications around proposed DCCH schemes was therefore considered extremely important in securing requisite numbers.

Whether future expansion considered

Several HAs designed their systems so that scheme expansion in the future was possible. Indeed the planning guidance in London makes this a requirement of specification of heat generation plant and there are planning rules requiring landlords to connect into wider district heating networks *where feasible*[23]*.* For others the scheme had been specified tightly to meet the needs of a particular block of housing with no room for other connections. It seems a lack of capital is hampering this kind of master-planning of systems. District heating efficiency increases the bigger the scheme is: the most sensible approach would be to build a large DCCH scheme allowing connection of further dwellings as they are built. However, a lack of upfront capital creates a tendency for each block of housing to have its own small district heating system. It was also observed that outside of London systems are rarely close enough together to make linking up feasible.

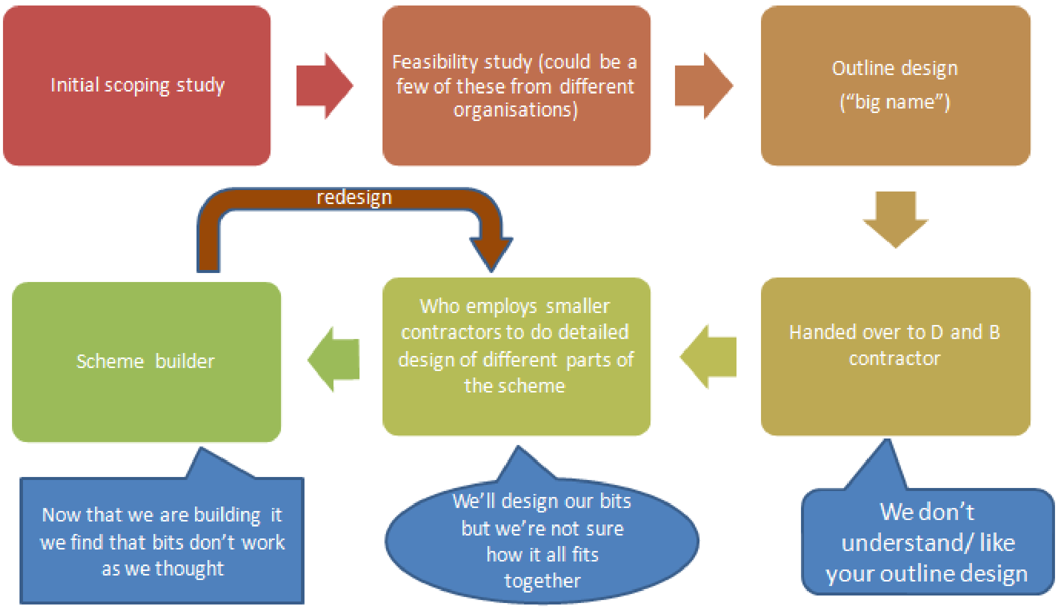
---

[23] It is recognised that it is not always feasible for a developer to connect to a pre-existing heat network in the policy documentation or planning guidance. For example the disruption and cost of laying pipe in densely built up areas can rule out connection in some cases. www.london.gov.uk/what-we-do/planning/london-plan/current-london-plan/london-plan-chapter-five-londons-response/poli-0

4.3 Designing and building the scheme

Landlords described the chain of stakeholders who would typically be involved in the design and build of a DCCH scheme. This is shown in Figure 8.

Figure 8: Organisations in the design and build phases for DCCH



Landlord experiences of each element of the design and build process are described in further detail below.

Procuring the outline design and the handover to the main contractor

SHPs described how once the feasibility work had been completed (itself often involving a number of organisations) and it had been identified that a scheme was feasible, the outline design could be procured. For city and community level heating networks, SHPs described how this work was often awarded to a "big name" engineering consultancy. The outline design would then be passed to the main contractor responsible for the build. SHPs reported that this stage could often become problematic as the main contractor could feel unable to implement the design based either on practical considerations or not being able to understand the design.

Challenges with multiple contractors

In some cases the main contractor had subcontracted various elements of the design process to a third party. This can particularly be the case for large new-build developments. Poor management, a lack of communication or weak contracting can lead to confusion amongst subcontractors as to how their part of the system integrates with other parts. Subsequently, this can result in incompatibilities between system components. This in turn can lead to unanticipated problems arising during the physical installation of the DCCH system which may make last minute changes necessary. Thus, having multiple contractors and subcontractors in the design and build process can lead to the original design intent being lost. A result of this is a deviation from the original intended design and therefore a potential cause of sub-optimal performance: "*Bits get lost along the way which ultimately leads to inefficiencies and it runs not how it was designed. So it's trying to find a way of holding whoever's operating it at the end back to how it was designed."* (English HA).

One reported solution was to use a single designer to design and then operate the system, so that they take on greater responsibility for designing a system that will work in practice, and as operator, they then understand the system design.

Design culture

Landlords described a number of broad features of the context in which design decisions for heat networks are taken. Some of these create designs that are sub-optimal for energy efficiency:

- There are greater contractual penalties for a designer in designing a system that delivers too little heat than a system that delivers too much. This can lead to over-sizing of plant.
- When designing systems originally, it is unlikely that much consideration would be given to the effects on heat demand from subsequent energy efficiency retrofit (e.g. improving insulation and better heat controls). Once retrofit has taken place, heating demand will drop and the plant can therefore be oversized.
- In general, it appears there is a culture amongst designers to put operation and maintenance costs as a secondary consideration after technical feasibility and capital costs. This approach contrasts with designs aiming to achieve a final price or costs for a unit of heat. Prioritising technical feasibility and bearing down too severely on capital costs may result in a system which, for example, is low carbon or cheaper to build but which is relatively expensive to fuel and operate.
- Having multiple contractors involved in the design and build process can result in a system that does not run optimally.

Procurement of contractors

Landlords described various arrangements for procurement of the design, build, operation, maintenance, metering and billing. Feasibility, design and build of DCCH schemes were competitively tendered, sometimes through procurement frameworks in an OJEU[24] compliant process. However, the paucity of organisations able to design and build DCCH schemes reportedly meant that sometimes, only a small number of bids would generally be received, sometimes just two. This was not thought to be conducive to healthy competition.

Once procured, landlords reported a mix of experience with the various organisations providing services into the district heating industry, some very positive and some very negative. Metering and billing was reportedly the area which was most problematic for tenants and it was thought very important to procure an organisation supplying robust and fairly priced services. The importance of being an 'intelligent client' or

[24] Official Journal of the European Union

employing an organisation that would help the landlord be an intelligent client was again highlighted.

Landlords could specify exactly what kind of equipment they wanted installed but reportedly would often follow the recommendations of the winning contractor. One landlord reported how the heat technology they wanted was specialist and being used for the first time and consequently they could not use a particular specification.

Design versus installation

SHPs reported that that the design process is often complicated and lengthy, integrating different elements of the network and using technologies which may be relatively new or innovative. Design also has to be flexible. SHPs reported that sometimes there was an ongoing requirement for changes to the design as elements are installed and are found not to be working correctly.

Landlords reported that delivered and designed heat efficiency can differ dramatically. For example one case study reported that, as a result of distribution losses, a delivered efficiency of 30% was achieved versus a designed efficiency of 50%[25]. Such large disparities can clearly throw a business plan and may necessitate fundamental changes to the system. This issue was thought to be in part due to the use of separate contractors to design and install the system: installers may not agree with the design or have experience of building it. This increases the likelihood of the installed components having different specifications to the design, which in turn causes inefficiencies and incompatibilities as the build progresses. The SHP in this case has changed their procurement process as a result of this experience so that they are no longer encouraged to procure two separate contractors for design and build respectively. SHPs also reported that the relationship and communication between the principal contractor and the subcontractors was critical to successful scheme delivery.

Expect the unexpected

A number of landlords reported that the design cannot anticipate all the unexpected problems that will arise; these only become apparent once the build is actually proceeding. Problems will need to be solved as they arise with possible impacts on the specification and layout of equipment. This may in turn have cost implications, therefore accurate costs are only possible once pipes start to be laid and the exact dimensions and positioning of the hardware comes to be known.

Landlords also reported that the location of buried services when digging trenches for pipework is a significant issue. Clearly, these unforeseen costs and technical challenges are more likely when installing DCCH schemes with buried pipework. A DCCH scheme with pipework above ground or as a network of pipes running around a block of housing in a communal heating system, was therefore thought more likely to be comparable in capital cost terms to a conventional individual gas fired heating solution where gas pipework must similarly be installed. This suggests that budgeting should always include a generous contingency fund to pay for such unforeseen

[25] However this wasn't backed up with data

costs. Case study 1 exemplifies the need for a contingency fund and the benefits of having the design and install of the scheme contracted to a single entity.

Case study 1: Arm's Length Management Organisation (ALMO) scheme in North East England - importance of design

Background and aims

In 2014 a Ground Source Heat Pump (GSHP) was installed to replace a coal fired boiler at a community scheme. The aim of the scheme was to reduce CO_2 emissions and provide affordable energy for 25 bungalows and a community centre. The scheme is owned by a local authority and managed by an ALMO.

Design and build

The heat load calculations undertaken as part of the feasibility assumed a system efficiency considerably higher than the resulting operating efficiency. The result of this is that the system would not have provided enough heat without a recalculation of the heat load by the design and build contractor, where other contributing factors were analysed. An added complexity is that two different contractors were used for the feasibility, design and build stage both of whom were relatively inexperienced. The installation contractor disagreed with the design and lacked technical leadership on site, which led to the scheme taking a year and a half longer to install than planned. The capacity of the electricity supply had also not been factored into the feasibility stage and was insufficient for the GSHP, which required the incoming power supply to be upgraded, at significant cost.

Impact

The impact of this has been reports from residents of insufficient heat which has resulted in a significant number of complaints, including some residents anecdotally reporting that neighbours had moved out as a result. This also had an impact on residents' perceived affordability of the scheme.

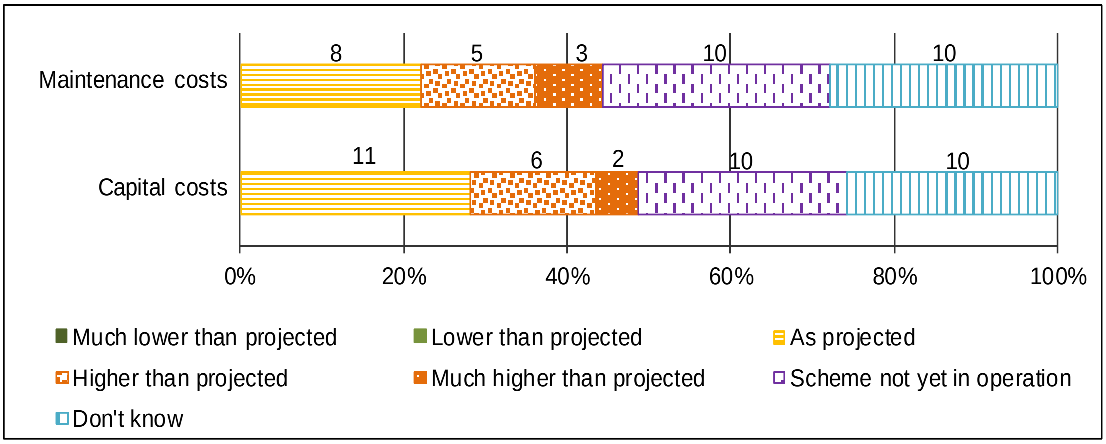
Learning points

This experience has resulted in the landlord amending the contractor's brief for future projects. A contingency fund has also been established for future heat network projects. They have amended the overall project process to enable improved continuity between the contractor at the feasibility stage and the contractor at the design and build stage. They plan to ensure that there is a clear technical lead on future projects and/or employ a clerk of works to oversee the project.

Actual costs compared to predicted

Survey respondents were asked about how the capital or maintenance costs of the scheme compared to those anticipated (Figure 9). Eleven of 39 respondents said that the actual capital costs matched projections, and 8 of 36 said the same of maintenance costs. No schemes were reported to have come in at less than projected for either maintenance or capital costs. Only a small number of respondents' schemes had capital (two) and/or maintenance costs (three) which were much higher than projected.

Figure 9: Projected vs actual CAPEX and OPEX costs



Base= capital costs: 39, maintenance costs: 36

However, experience from the case study schemes highlighted that accurate data on the operational and maintenance costs is often not being collected. This may reflect a wider trend in the sector, making it difficult for SHPs to determine how costs compare to those predicted. Feedback from the case study organisations also suggests that those in charge of running the schemes, or the maintenance aspects, are often not monitoring the financial aspects of schemes to understand whether it is cost effective. Instead the only financial calculations usually carried out are the review of heat tariffs.

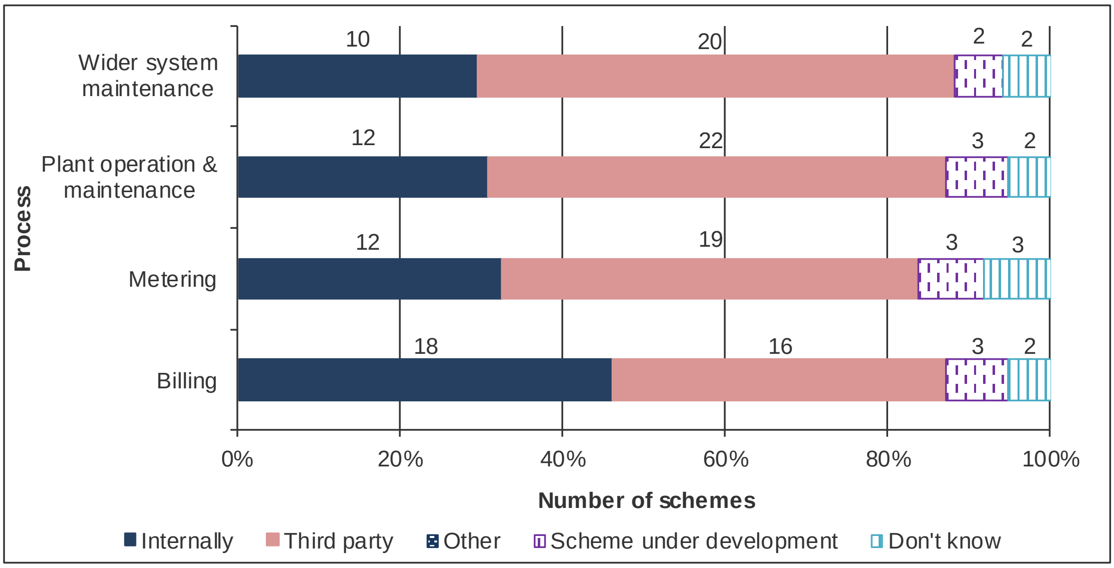
4.4 Operating the scheme

This section considers some of the reported issues found in operating a DCCH scheme and includes technical analysis of the performance of the case study schemes in practice.

Becoming an energy supplier

It is difficult for SHPs to assume the role of an energy supplier; for example, taking on metering and billing and customer care roles involves acquiring new skillsets out with the traditional role of a landlord. The majority of SHPs outsourced some (24 of 34) or all (8 of 34) of their operations to a third party organisation. Only two respondents stated that they themselves managed all of the operations. Approaches to management of different aspects of the operation of a heat network are shown in Figure 10. Billing was the service most commonly retained in-house (18 of 39 schemes), while system and plant maintenance and metering were outsourced about twice as often as retained internally. Six of the 34 SHPs were using a mix of management approaches across different schemes, e.g. billing was managed internally for some schemes and by a third-party for others, despite being owned by the same organisation.

Figure 10: Management of schemes



Base: Wider system maintenance= 31, Plant operation and maintenance= 34, Metering= 32 and Billing= 34

Some SHPs also felt there might be a reputational risk in being both the energy supplier and housing provider. It was thought that the commercial and more charitable roles sat uneasily together and could negatively affect tenants' perception of their SHP. To preserve trust between tenant and landlord it was therefore considered vital for tenants to feel they were being treated fairly and for landlords to be as clear and transparent as possible, for instance in how fuel bills and standing charges were calculated. A desire to be fair (and to be seen as being fair) also underpins landlords' wish to improve the efficiency of the heating system prior to moving tenants from flat rate charging to metered consumption-based charging. If residents are being made responsible for their own energy use then it was thought the duty of the landlord was to ensure residents are equipped with an efficient heating system. It was thought that this would become more important for all landlords with the introduction of the Heat Network Metering and Billing Regulations (2014)[26].

Management of billing

A variety of different methods for billing were reported including:

1. Landlord is responsible for billing. This reportedly worked well as it allowed a great deal of control over who is billed for what. Landlord billing is facilitated when the landlord owns the meters. One LA had developed a complex set of tariffs which were used to bring as much fairness to the process as possible.

[26]The Heat Network (Metering and Billing) Regulations 2014 place requirements on suppliers of distributed heat, cooling and hot water. These include notification to the National Measurement and Regulation Office (NMRO) of the existence of a network and a requirement to fit heat meters where appropriate to accurately measure, memorise and display the consumption of final customers. Government guidance at www.gov.uk/guidance/heat-networks

2. A specialist company is contracted to handle billing. However, outsourcing billing can add significant overheads to the cost of supply and one landlord commented that it would be cheaper to bring the service in-house.
3. Billing is conducted using prepayment metering. A number of landlords were attracted to this solution as it removes a large administrative burden. The advent of smart prepayment meters was also heralded as a big step forward, particularly for vulnerable households with mobility issues. Smart prepayment meters can be topped up remotely via phone call or website – the householder does not need to take a re-charge key to a designated pay point.

Landlords described the critical importance of ensuring that billing was seen as fair and transparent in order to maintain trust and good relations with tenants. This meant particular care was needed when appointing a third party to handle billing arrangements.

Choosing appropriate payment methods

Six out of the eight case study schemes were fitted with prepayment meters, meaning that the majority of participants were on a prepayment system. On the whole, participants seemed happy with this method of payment and some stated that they preferred prepayment to monthly bills as it helped them to manage their finances. At one scheme, residents were given the option to switch to a standing order payment method, which they appreciated as they felt this was a better way to budget "*because I get paid monthly I'm rich for a week and skint for three weeks*". However it appeared that this had not been widely advertised as an option and for most schemes it seemed that they were only given one option. In some cases participants said they would have preferred to be given a choice. Other focus group participants who were aware of heat with rent schemes indicated they might prefer this payment method versus prepayment consumption charging because it would help them to budget: *"…some months you might have to pay a little bit extra and it's finding that little bit extra. Whereas if you just know what you're paying".*

Prepayment services generally offered a large number of top-up options which residents appeared to welcome; however, several were unaware of some of the options available to them. In addition to this, participants at three schemes reported issues topping up where the money did not load onto the meter for up to 24 hours: in some cases a pin number could be entered into the meter by the resident in order to load the purchased credit manually. However the pin was reported to be 13 digits long which one participant struggled to enter. Prepayment participants at one scheme had concerns that it was more expensive than regular billing and at another scheme residents felt that the £5 emergency credit was used up more quickly than other money applied to the meter. Some residents banked regular payments on their prepayment meter to save up money for the winter to enable them to afford the extra costs over the heating season.

Smart metering and smart prepayment meters were identified as enabling much more accurate billing, useful to encourage less wasteful consumption of energy and to help tenants budget more effectively. It also enabled providers to offer a choice of payment methods to tenants, including to switch tenants with bad debt to prepayment meters, with the meter set up to recover the debt over time.

Prepayment using smart technologies was installed by some case study landlords and reportedly was largely successful. However residents were not making the best use of their smart monitoring systems. Functionality allowing residents to make comparisons of their energy consumption in previous weeks and months and to budget hot water and heating credit accordingly was often ignored as it was considered too complex. Those installing smart prepayment metering considered that their success could be improved if landlords spent some resource verbally inducting residents to understand the functionality to get the best out of them. Landlords were clear that the induction had to be face to face, and ideally, in the home to be effective. This was also the view of tenants: *"I think in the future, if you should have somebody that tells them what to do and I think some kind of workshop that you could go to if you were having problems understanding the system. A lot of people would have found it very useful to have had that explained to them onsite and in some depth."* (Focus Group, from Case study 7).

Challenges for residents using DCCH

Some residents were unaware of the tariff composition and pricing structure. However others knew the tariff breakdown and charges exactly. Participants that did not have a standing charge appreciated there not being one. Some SHPs had provided residents with an annual statement; most of those who received this stated they had read it[27]. Those who did not have an annual statement had a meter display instead. Of these residents, some did not know how to operate the display or what information it was able to provide. Others were met with more physical challenges reporting that they could not reach their meter to read the display, or that the display was not working.

In situations where the tariff had been increased or changed, most people reported receiving a letter prior to the change to notify them. However a couple of respondents were unaware of the introduction of a standing charge and the reasons for it being introduced. Others in the same scheme said that they received a letter but did not understand it and said that they would have appreciated a verbal explanation of the changes.

A strong preference for face-to-face explanation was reported: *"I don't have an engineering degree... I need someone to show me and explain it to me. I didn't even know we had a communal heating system".* Similarly SHPs said that they found delivery of advice was more successful where it was delivered face to face, there were regular meetings or events for residents to ask questions and when all staff had been trained on how to use the heating controls.

---

[27] Further it is not expected that the participants of the focus groups were particularly more engaged with their heating system that on average.

Where booklets or advice leaflets were provided they were generally reported to be too complicated and frequently went unread. However some participants did find their booklet useful: *"They gave us a booklet at the very beginning. It tells you how to use the heating system. It's all there. It's self-explanatory"*. Others stated that they did not have a chance to look at their booklet when they first moved in and used a social media page which had been set up for the building to share information and ask one another questions: *"For two years everyone has been answering each other's question about how the hell do I do that? Where is our local Pay Zone? Yeah, so we kind of assist each other…"*

In some cases (especially in sheltered housing), residents reported being told by the landlord not to touch the controls as they were deemed to be too complex, but were still provided with detailed monitoring data, which was largely ignored. Residents said they would like to see the following improvements to the delivery of advice: more information, a booklet that is easy to understand, more time spent on face-to-face visits with a demonstration to enable residents to practice using the controls, and the offer of a home visit prior to the onset of the heating season.

A general issue reported by landlords is that residents often do not understand how to control their heating and hot water systems. Programmable thermostats are routinely set up incorrectly, bi-passed by using system overrides or are used as on-off switches by turning the thermostat setting to maximum to start heating and then returning it to a low setting when the occupant wishes to turn off the heating. Whilst this is not an issue unique to DCCH systems it does become particularly important to DCCH operators shifting their tenants from flat rate to consumption charging. For example, tenants may be totally unfamiliar with scheduling heating times to match occupancy patterns as there is little impetus to do this if consumption is unmetered. A number of landlords described a sense of duty in ensuring that tenants could properly and efficiently control their heating if they were moved to consumption charging, particularly where the system is serving vulnerable households (e.g. the elderly in sheltered housing schemes).

Managing maintenance arrangements

A limited knowledge of good M&E (Mechanical and Electrical) contractors was identified as a barrier to organisations seeking to procure services. Landlords described how procuring maintenance contractors with the right specialist skills was also problematic. This had led one landlord to develop a medium term plan to bring the maintenance of the heat networks back in-house. The problem of maintenance contractors being insufficiently familiar with the equipment is also more likely to occur when the installer is not also responsible for maintenance. Often the maintenance role is handed to local firms who may have a long term relationship with the landlord but who struggle to do a good job without very detailed instructions and handover procedures from those installing and commissioning the system.

Some schemes, and in particular certain dwellings, had received significant on-going problems from the outset, which some participants attributed to either poor design or the installation not being completed to the design specifications. In addition residents felt as though the repair team did not have the skills or training to make repairs to the system. They also reported that the maintenance team were waiting for parts all the time which had led to long periods without heating and they would like to see their landlord store spare parts so that they are available when required.

Participants in one scheme experienced significant faults with their meters, which meant that engineers had to temporarily by-pass them for residents to receive heat. However participants reported that some people did not allow the engineers access to correct the fault, meaning that they were receiving free heat. Participants who did allow access felt this was unfair: *"…I was thinking, well, am I paying more because of you, because the meters are broken? You know. And it really annoyed me."*

Case study 4: Housing association scheme in Scotland - meter tampering

Background and aims

In 2006 the housing association retrofitted a gas community heating scheme in two, 23 storey high-rise blocks, replacing the old electric storage heaters. All 276 dwellings are on pre-payment meters, the administration and maintenance of which are outsourced to a third party organisation. The main aim of the scheme was to provide affordable heat to residents and reduce maintenance costs.

Design and build

Since the scheme was installed in 2006 there have been a number of issues surrounding the dwelling level meters. The design of the meters not being particularly tamper resistant, has left them vulnerable to tampering by residents, meaning that they receive free heat.

Operation and maintenance

In other cases the meters had been deliberately by-passed temporarily by engineers making out of hours repairs, to enable the resident access to free heat when parts were unavailable. However due to the lack of legislation surrounding enforcing access to make repairs for heat networks they were unable to return to reconnect the system. There was also a period where a dishonest engineer was found to have been actively by-passing the meters for some residents.

Impact

The meter design and legislation issues, together with the tariff not being increased since the system was installed, have led the scheme to run at a financial loss. However they did not see the loss to be a significant issue and had no plans to increase the tariff due to the importance of being able to provide affordable heat to residents.

Learning points

The landlord used meter data to identify those who were not using any heat and contacted them to establish whether they had self-disconnected and needed support, there was a fault with the meter or the meter had been tampered with. The landlord is taking steps to resolve these issues and was in the process of upgrading the old meters with a tamper resistant, smart heat meter.

Landlords reported further concerns with the maintenance of DCCH systems whereby if an individual heating system failed then only the relevant household would generate a complaint. If a DH system goes down, *“you have a whole estate complaining rather than just Mrs. Jones”.* The possibility of mass complaint made senior managers and politicians within LAs *“very nervous”*. Hence this possibility was cited as a barrier to DCCH. The perceived risk of DCCH system failure has reportedly been increased by the reputation for poor performance of older systems which were inadequately maintained and did suffer from breakdowns. SHPs described how these sorts of fears were often effectively allayed through visiting successful schemes operated by other SHPs.

Historically the primary objective of the maintenance contractor has been to make sure the system provides sufficient heat. It was thought that consideration of energy efficiency of the system has only become a priority more recently. One landlord described how they were incentivising maintenance for efficiency by incorporating efficiency targets into the maintenance contract. SHPs also noted that without specialist knowledge of DCCH it is difficult to write specifications for maintenance contracts. This is important because contractors without the specialist knowledge of the equipment would not know what needed to be looked at and would only work on what they were contractually obliged to.

A further management requirement for greater energy efficiency is greater monitoring and metering. Landlords reported installing new monitoring systems allowing remote access to real time data. This reportedly helped with heading off problems before they got worse.

The move from a flat rate to consumption based charging had prompted one landlord to investigate system losses in greater detail than before, particularly in older, less efficient systems. Following extensive deployment of heat meters across the whole system it was possible to accurately model system performance in different heating and hot water scenarios. This analysis allowed the landlord to design an optimal retrofit strategy which would greatly increase the efficiency of the system and thereby drastically reduce fuel bills for tenants. This would head off any issues with some, perhaps vulnerable tenants, paying greater fuel bills under a new consumption charging arrangement than under the flat rate system being replaced. This landlord’s experience is summarised in case study 6.

Case study 6: Local Authority Communal Heating Scheme : Using submetering to identify opportunities for efficiency measures

Background and aims

This local authority owned communal scheme supplies 72 sheltered housing, low-rise flats. There are also an office, communal living space and dining area on site. The gas communal heating system was retrofitted into the 1960s build in 2003.

Build and design

The scheme has had an on-going issue of significant heat distribution losses. This appears to be mainly in relation to the design of the hot water supply. Hot water for kitchen and bathroom taps is currently provided through hot water cylinders but for showers, water is heated at source using electric units. All of the residents either have a disability or are elderly and as such the controls are difficult to understand. The result is that hot water cylinders are left on constantly, becoming a source of significant standing heat loss.

Impact

The LA wish to address the system losses to bring down heating bills for the tenants, in order to create a heating system which is more controllable and capable of providing improved levels of comfort. The LA commissioned consultants to analyse the system performance in detail and to make recommendations. The consultants began by analysing data from the previously installed heat metering right across the heat network to establish at which points losses were being made and to determine the cycling and operation of the boilers.

Learning points

This systematic analysis of the distribution losses across the heat network using heat sub-metering revealed very significant opportunities to make savings (of increasing cost and complexity). The three options identified include controlling the time in which the hot water is heated, enabling the system to be shut down over summer when the heating is not required and introducing point of use heating for taps to reduce standing heat losses (or installing HIUs to enable hot water to be provided on demand through the communal system rather than being stored). The solution adopted was to provide HIUs, improve the network insulation levels, install new pumps and a single boiler better suited to summer running together with simpler domestic controls.

4.5 Scheme performance

This section provides an analysis of specific aspects of the technical data collected from the eight case studies. For each of the case studies contextual factors were collected, specifically relating to the heat generation plant, properties being heated, DCCH pipework routing and scheme area. In addition, all available meter readings were requested for at least a two year period from the scheme operator. It is also complemented by survey data where possible.

System overview

The eight case studies showed a mix of primary heat generators (Table 1); however the most prominent was gas CHP which was utilised in four of the eight. Six of the eight had been operational for five years or less with the two others being over ten years old. There was a wide range of outputs and scale of DCCH schemes from 137kW up to 3,500kW serving from 40 to 850 properties. With regards to distribution systems in the properties, seven out of the eight had radiators, with the one remaining having underfloor heating. Three of the DCCH schemes heated commercial buildings alongside residential, with the remaining five heating residential properties only.

Table 1: Technical details of the eight case studies

Case study	Heat source type	Scheme age	Nominal output (thermal)	Annual generation	No of connected residential properties	Commercial properties included
1	Ground source heat pump	2 years	137kW	202,700kWh	25	Yes
2	Gas boilers	2 years	3,500kW	1,400,000kWh	456	No
3	Gas CHP/gas boilers	5 years	Not provided	3,123,767kWh	242	Yes
4	Gas boilers	10 years	1,380kW	2,127,080kWh	276	No
5	Gas CHP/gas boilers	4 years	2,274kW	Not provided	850	Yes
6	Gas boilers	13 years	1,050kW	Not provided	72	Yes
7	Gas CHP/gas boilers	4 years	Not provided	Not provided	40	No
8	Ground source heat pump/gas CHP	2 years	2,400kW (plus 150kW CHP)	Not provided	505	Yes

System effectiveness

Limited metering data alongside incorrect and poorly-translated data did not allow for any clear indications of system performance in relation to overall efficiencies. For the eight case studies, only three had reliable and clear enough data to calculate heat losses. These indicate a very wide range of average percentage heat losses from 10% at one extreme to 53% and 59% respectively (Table 2). However, given uncertainties with the quality of the data and the differing assumptions underpinning provision of data items, we wish to stress that these figures should not be referenced to indicate typical heat network performance. Both of the higher values are considerably higher than the CIBSE heat loss benchmark figure of circa 10-15% across the whole network. Although some of the case studies were able to provide partial metering data it was not enough to calculate heat losses with any accuracy or confidence.

Table 2 System efficiency and effectiveness of case studies

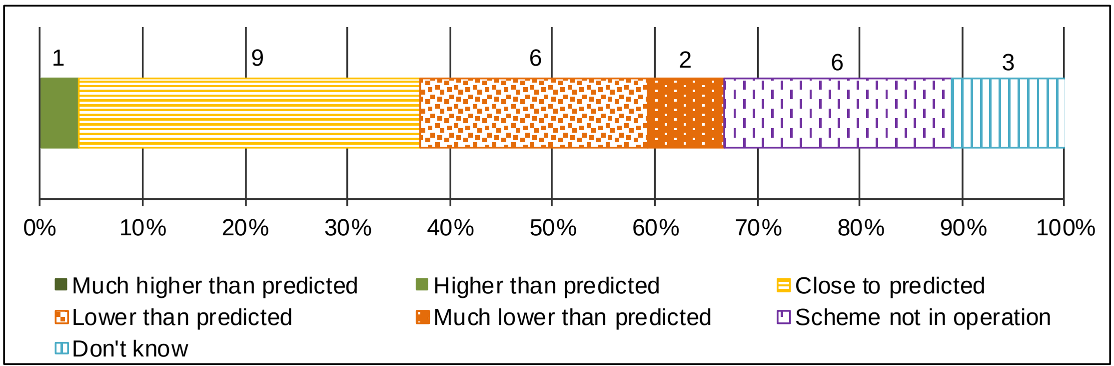
	Heat density	% Heat loss
Number of case studies for which data was available	Six	Three
Results (range)	5.54 MW/km^2 – 24.16 MW/km^2	10% - 59%

The reasons for the very high heat losses in two of the cases are not entirely clear. In one case, which was a reasonably recent installation, the landlord was aware that heat losses were high and that this was the result of installation problems such as poor pipe insulation. In the other case the landlord was also aware that heat losses were much higher than had been designed and highlighted that when the installer reviewed the designer's heat loss calculations, they were vastly underestimated.

Aside from the relative age of these two schemes, there appears to be no relationship with any other contextual factors. The heat generating technologies are different, one is a retrofit project, while the other is new build and one heats commercial property and the other does not. In addition the metering and billing strategies differ. It was intended to carry out a detailed system assessment and comparison between the eight schemes in order to assess efficiency alongside the contextual factors and effectiveness of the DCCH case studies. However this was not possible due to the lack of metering data.

It is interesting to note that of 21 SHP survey respondents whose schemes were in operation, nine reported that their most recent schemes to be operating close to the design-projected efficiency and one higher than predicted (Figure 11). In contrast, eight SHPs reported the efficiency to be less than that projected (including two who stated their schemes were running much lower than predicted). These results suggest mixed performances of schemes.

Figure 11 Operational efficiency of scheme compared to projected (survey respondents)



Base= 27

This is in a context of only 18 out of 30 SHP survey respondents whose schemes were in operation having carried out analysis of fuel billing data or meter readings, although nine further SHPs stated that they planned to carry this out. This suggests that not all SHPs are monitoring their schemes. This raises questions about what data SHPs are using to inform their perspectives of system performance. In other words, the majority of case studies were not able to provide sufficient data in order to assess their scheme performance and therefore it is questionable whether the survey respondents were basing their perspectives on robust, complete data.

One of the key factors when assessing the suitability of a DCCH scheme according to the BRE publication 'A technical guide to district heating' is the annual heat consumption per square km; known as heat-demand density. This is calculated by taking the total area of the DCCH scheme and the annual heat demand of all the buildings being serviced by the scheme. Of the eight case studies, enough data was available to calculate the heat density of six DCCH schemes, of which all six were above the recommended density of 3MW/km^2 according to BRE. The range however was quite considerable, with the six case studies lying between 5.54MW/km^2 and 24.16MW/km^2 (see Table 2 above). This suggests that heat density had been considered during the initial design stage of the case studies.

4.6 Summary

Our research has identified a number of practical barriers to development of DCCH in the social housing sector. Some barriers can be dealt with by the landlord themselves through changes of practice or better use of existing resources[28]. Others are inherent in a relatively new and loosely regulated DCCH industry and will need policy and regulatory intervention to reduce their impact.

High capital costs of DCCH schemes pose particular challenges in the current financial climate and the terms under which the capital finance is raised subsequently shape many of the fundamental decisions about how the scheme is designed and operated. For example, some SHPs find themselves developing schemes which prioritise funders' requirements rather than their own which may in turn influence efficiency and sustainability outcomes.

This study has found multiple business models in operation and it has been difficult to judge what works most effectively due to the numerous different types of schemes and difficulty in creating robust metrics against which to judge success. For example, a scheme running on renewable heat, such as biomass or a GSHP, may only be cost effective when the RHI can be obtained, but requires SHPs to source upfront funding. Similarly, LAs may be able to access lower cost finance than HAs, positively impacting their business case. Schemes which can generate revenue through sales of electricity or of heat to non-domestic customers, such as found in case study 8, can cross subsidise the price of heat charged to domestic tenants and residents

Prevailing design culture can also often lead to oversizing of schemes which may lead to inefficiencies which in turn impact DCCH scheme carbon reduction credentials. Operational and maintenance costs are often not considered early enough in the design or given sufficient priority resulting in systems not being optimised for efficient operation.

DCCH often required multiple contractors but common problems included:(a) limited in house knowledge and skills to inform procurement b) few contractors tendering for work, (c) poor quality services and (d) poor communications between main and subcontractors. The design process is a complicated and lengthy process which needs to be flexible as unforeseen problems will always arise once equipment begins

[28] CIBSE, GLA and the UKDEA have all recently produced clear guidance on navigating all stages of DCCH development. DBEIS is also producing very detailed project development guidance for heat networks.

to be put in. Poorly detailed installations or installs that deviate from the design specification can result in larger than anticipated heat losses which then have a big impact on business plans. An expert clerk of works able to review the quality of contractors work is invaluable here. Installs often lead to unexpected issues and costs, so a contingency fund is highly advisable.

Residents often do not understand how to use their heating system effectively. This can be a particular issue for landlords moving vulnerable tenants from a flat rate to consumption based charging system, and impacts the overall efficiency of the scheme. It was thought that schemes were insufficiently monitored to assess their operational efficiency, including overall heat losses. Procuring maintenance contractors with specialist skills was also reportedly sometimes problematic. Further, landlords needed to have sufficient knowledge to write the specification for maintenance contracts.

A lack of high quality data meant that robust assessment of the technical performance of the case study schemes was not possible within the scope and resources of this project. However this lack of data highlights a key finding. It suggests that SHPs are frequently either not collecting or being provided with technical data and that data available is not always analysed. This means schemes are not being effectively monitored or evaluated to assess performance or efficiency. This has major implications for SHPs and the sector as a whole as it makes it very hard to understand how well DCCH schemes are performing and therefore whether they are delivering intended impacts. A lack of understanding of the system operation will mitigate against its efficient operation. In turn, this threatens its financial performance with the potential to impact on heating costs passed onto residents.

Despite the challenges outlined in this section many SHPs were satisfied with their scheme and stated that they would consider installing DCCH again. Of the 22 survey respondents who said they had suitable stock for DCCH, 21 said they would consider installing DCCH again.

5. CARBON REDUCTION AND SUSTAINABILITY

A key research question was the extent to which DCCH schemes were meeting carbon and sustainability goals. In this section we review how successful DCCH has been in achieving these goals and objectives.

5.1 Sustainability at feasibility, design and build stages

As discussed above our findings suggest that a number of characteristics of the feasibility, design and build phases mitigate against sustainability goals being fully realised. These include the relatively high capital and running costs of some low carbon heat sources, endemic risk aversion to innovative technologies in a climate of constantly shifting policy priorities, a design culture which encourages over sizing of equipment and insufficient consideration of maintenance requirements resulting in poorly maintained systems which do not achieve their energy efficiency and low carbon potentials. Similarly, at the build stage, complex sub-contracting arrangements and poorly maintained lines of communication can result in misspecification of equipment and poor commissioning resulting in reduced system performance.

5.2 Modelled performance of schemes

This section presents results on how DCCH is theoretically estimated to perform across the eight case study schemes with regards to modelled CO_2 emissions, annual energy demand, SAP scores and fuel bills. One sample dwelling within each scheme was modelled. This was chosen to be representative of the most common dwelling type. More dwelling types would have provided more accurate results, however this was beyond the scope of the project.

The modelling was carried out based on the DCCH specification performance figures provided from the scheme. Where performance figures were unknown for the scheme, SAP default figures were applied instead. In general these defaults will tend to make conservative or worst assumptions about system performance[29].

Case studies have all been compared with the most likely comparator heating system i.e. the heating system deemed to be most likely to have been installed if DCCH had not been. In the three retrofit schemes, performance against the previous heating system was also assessed.

5.3 Retrofit System Analysis

Table 3 below shows the percent difference in SAP results post installation of DCCH when compared with the previous heating system. Results which show an improvement are shown in **bold** (improvements are defined as a reduction in energy use, fuel bills or CO_2 emissions and an increase in SAP score). Relative increases or decreases are shown as either (+) or (-). The most notable improvement is the

[29] Default values used in RdSAP modelling are available upon request.

significant reduction in CO_2 emissions expected (from 16-42%, equivalent to 0.5-2.2 tonnes per dwelling). This is due to the relatively low carbon intensity heat sources employed in the DCCH retrofits versus the previous heating systems (gas versus electric storage heaters; ground source heat pumps versus coal). An additional factor may be the way DCCH is treated in the SAP calculation assuming low distribution heat losses. However SAP suggests that annual energy usage (kWh) will increase (up to 29%, equivalent to 1,813kWh) or at best remain equal to the previous system. This may be due to SAP accounting for the energy losses in distribution with a DCCH system when compared to an individual heating system located at source, as discussed in the limitations section below (Section 5.5).

Results for estimated annual fuel costs and SAP scores are mixed and, apart from scheme 4 where fuel costs reduce by 9% (£82), DCCH has minimal impact on these figures. Therefore, the SAP model suggests that choosing to use DCCH is likely to have a negligible impact on reducing energy bills.

Table 3: Difference in SAP results post installation of DCCH compared to the previous system (retrofit only) (Bold = reflects improvements. + or – reflects relative changes)

Case study number	1	2	4
Current DCCH system	GSHP	Gas	Gas
Previous system	Coal fired communal system	Electric storage heaters	Electric storage heaters
Annual energy usage change (kWh) of DCCH versus previous	0%	+1,813 (+29%)	+440 (+6%)
Annual fuel costs of DCCH versus previous (£)	0%	+17 (+2%)	**-82 (-9%)**
SAP scores (1-100 rating) change versus previous	0%	-2 (-3%)	**+3 (+4%)**
CO_2 emissions of DCCH versus previous (tonnes)	**-2.2 (-42%)**	**-0.5 (-16%)**	**-1.3 (-33%)**

5.4 Comparator system analysis

Table 4 below compares the SAP results for the incumbent DCCH system versus a comparator heating system. Results which indicate the existing DCCH system remains better than the alternative individual heating system are shown in **bold** (better systems are defined as delivering less energy use, lower fuel bills or lower CO_2 emissions and higher SAP scores). In each case the most likely alternative heating system was chosen as the comparator system; gas boilers would be the most likely alternative aside from where not viable, such as in tower blocks.

Table 4: Comparison of SAP results between the incumbent DCCH system versus a modern alternative individual heating system (Bold = reflects improvements. + or – reflects relative changes)

Case study number	1	2	3	4	5	6	7	8
Current DCCH system	GSHP	Gas	Gas CHP plus gas boiler back up	Gas	Gas CHP	Gas	Gas boilers and gas CHP	GSHP + Gas CHP
Comparator system[30]	Gas Boilers	Smart storage heaters	Gas boilers	Smart storage heaters	Gas boilers	Gas boilers	Gas boilers	Smart storage heaters + gas boilers
Modelled annual energy usage change (kWh) of DCCH versus comparator	+983 (+8%)	+2,164 (+37%)	+1,071 (+15%)	+1,050 (+15%)	+430 (+4%)	+930 (+15%)	+240 (+5%)	+1,270 (+20%)
Modelled annual fuel costs of DCCH versus comparator (£)	+22 (+2%)	+96 (+13%)	**-10 (-1%)**	+9 (+1%)	**-12 (-2%)**	+134 (+20%)	+61 (16%)	**-63 (-9%)**
SAP scores (1-100 rating) change versus comparator	-1 (-1%)	-5 (-6%)	**+1 (1%)**	-2 (-3%)	**+5 (7%)**	-7 (-10%)	**+4 (5%)**	**+8 (11%)**
CO_2 emissions of DCCH versus comparator (tonnes)	**-0.13 (-4%)**	**-0.34 (-11%)**	**-0.89 (-41%)**	**-0.98 (-27%)**	**-0.1 (-4%)**	0 (0%)	**-0.2 (-14%)**	**-0.1 (-4%)**

[30] This was the heating system deemed to be the most likely/realistic alternative heating system that could have been installed instead of DCCH (i.e. smart storage heaters are suitable in tower blocks and gas boilers elsewhere).

The results are consistent with the retrofit system comparison, whereby incumbent DCCH solutions generally have lower CO_2 emissions than alternatives (from 0 - 41% lower). In cases 2, 4 and 8 this is because electricity, a carbon intensive fuel source is being compared with lower carbon fuel (gas burned at large centralised gas boiler plant or CHP engine). So even with a small amount of assumed distribution loss modelled by SAP for DCCH (5%) a gas fuelled DCCH system results in carbon emission reductions.

Further emissions reductions are calculated by SAP when gas CHP serving the DCCH system is compared with gas boilers only (case studies 3, 5 and 7). This is because the electricity produced is low carbon and SAP accounts for this when modelling overall CO_2 emissions from heat supplied by CHP. Emissions reductions using ground source heat pumps serving the DCCH network are also achieved versus individual heating solutions (case studies 1 and 8) reflecting ongoing decarbonisation of grid electricity and improvements in the coefficient of performance of heat pump systems over the last decade. Taken together these results indicate why heating solutions using DCCH served by low carbon heat sources can be an effective means of meeting part L of the building regulations[31].

The most notable negative impact of DCCH is that annual energy usage is expected to increase (from 4 - 37%) on most of the schemes. This is because SAP makes assumptions about the energy lost in distribution of the heat in a DCCH system. This will always be higher than in an individual heating system[32].

Results for annual fuel costs and SAP scores fluctuate; the most notable positive improvements are gained when the DCCH heat source is CHP. This may be due to SAP accounting for CHP maximising electrical and thermal efficiencies. The other results are mixed but whether there are incremental increases or decreases, DCCH has small impacts on fuel costs and SAP scores depending on the characteristics of the incumbent system and the comparator

When judging these results it should be noted that the incumbent DCCH systems in case studies 4 and 6 are more than a decade old (installed in 2005 and in 2003 to replace a 30 year old system respectively). Other case study systems were all installed since 2010. Older systems will have lower efficiencies as a result of their specification and as a consequence of the system performance degrading over the years of operation. These lower efficiencies will be reflected in lowered SAP scores if they are entered into the SAP model. Yet the comparison in this analysis is with a modern alternative with associated increased efficiency levels (modern storage heating and modern individual gas boilers respectively). Therefore we find that the BREDEM model underlying SAP calculates small reductions in SAP points for these cases.

[31] Part L of the building regulations requires that the annual CO_2 emissions calculated for a dwelling based on its specification (the Dwelling Emission Rate) do not exceed the Target Carbon Emissions Rate (TER) – a hypothetical benchmark tailored to the dwelling in question.
[32] Default values used in RdSAP modelling are available upon request.

Case studies 2 and 4 indicate that modern smart storage heaters generate slightly better SAP scores than modern gas fired DCCH systems - but worse CO_2 emissions because electricity as a heating fuel is carbon intensive. This illustrates the sometimes difficult balance that asset managers must strike when choosing heating fuels and systems.

Overall', in these case study examples, when modern DCCH systems with relatively high efficiency levels are compared with modern individual heating alternatives, the SAP model suggests small or negligible impacts on reducing expected energy bills. Consequently, these results indicate that DCCH is not a guaranteed way of achieving SAP targets for housing stocks over other alternatives e.g. individual gas fired boilers.

It is important to note that gas boilers and DCCH schemes vary in specification and hence there will always be variability in performance and results between different heating systems. For example, efficiencies of the existing DCCH boilers will vary as will the efficiency of the distribution pipework in transporting heat from boiler plant into people's living space.

5.5 SAP modelling and data limitations

During the SAP modelling exercise, it has become apparent that there are limitations to the SAP methodology and data available. This has hindered establishing robust results around how DCCH is likely to perform.

SAP is a modelling tool and as such parameters such as occupancy use, temperatures and other variable parameters are assumed or averaged. This means that there is some uncertainty regarding the robustness and accuracy of the results. For example, the modelled SAP results suggest that DCCH will significantly reduce CO_2 emissions. However, the results may be skewed given that SAP assumes a default heat loss of approximately 5% for distribution heat losses. Experience has shown that, in practice, distribution heat losses can be substantially higher. For example, two case studies for which this was measured showed much greater heat losses of 50 – 60%. However a third showed only 10% heat losses. SAP's treatment of DCCH is currently under review however these figures suggest that as currently formulated it has the potential to significantly underestimate distribution losses and therefore to overstate CO_2 emissions reductions for DCCH.

With regards to data limitations, only one dwelling for each case study has been modelled due to the scope of this project. However, there are many variable parameters that have a significant impact on CO_2 emissions and energy demand of a particular dwelling such as orientation, size etc. Therefore, more property types would need to be modelled to establish a representative sample and more accurate picture. In addition, typical figures for performance such as efficiencies or heat to power ratios have been assumed instead. These assumptions may not be entirely accurate.

5.6 Overheating

Overheating can not only severely impact resident comfort, it is also evidently wasteful. Where overheating is found in a system serving households vulnerable to temperature extremes it can have severe health implications, especially where combined with hot weather conditions, which are likely to be exacerbated by climate change. Overheating has been reported in DCCH systems in both winter and summer seasons due to poorly insulated pipework supplying hot water for domestic hot water systems. In this section we review evidence of possible overheating.

Causes of overheating

Overheating is sometimes perceived to be a common issue with DCCH. However it was only mentioned as an operational challenge by four out of 36 SHPs that completed the survey. Technical data was collected from the eight case study SHPs. Although there was some anecdotal evidence of overheating noted, from a technical perspective more detail on the installation would be required in the form of schematics as well as a visual inspection of the pipe routes, insulation levels, flow temperatures and controls. This was not possible from the data obtained. Interviews with landlords and stakeholders suggest that a tendency for DCCH systems to overheat dwellings can result from a number of factors:

- Equipment being oversized at early design stages. It was thought that greater contractual penalties result from a system delivering too little heat than too much;
- Incorrectly specified insulation on lateral pipework (taking heat across the floor of a building) and “risers” (the pipework taking heat up to each floor) or incorrectly installed insulation;
- Systems equipped with insensitive or inadequate control systems;
- Flat rate consumption charging encouraging wasteful behaviours. For example tenants heating living spaces and regulating heat by opening and closing windows.

Residents’ experiences of overheating

Focus group participants’ levels of comfort were very scheme specific. Most found their homes comfortable, but others experienced extremes. Research suggests variation in thermal comfort is specific to individuals[33] with air temperature only one dimension. Individual metabolic temperature, radiant temperature, humidity and air velocity are also important.

Some participants at three of the schemes explained that it can get too hot during the winter. This was mainly reported by residents living in flats, as opposed to low-rise buildings. At one scheme this was mainly the case in communal areas with some reporting that their flat can also overheat. In this case the communal areas ran from a separate heating system, which participants did not feel was necessary, especially as external doors were reported to be frequently left open.

---

[33] de Dear, Richard and Brager, G. S., 1998. Developing an adaptive model of thermal comfort and preference.

One resident reporting overheating said that their flat can overheat because of warmth from surrounding flats, explaining *"I can walk along my hall and my feet are sweating"*. However residents on upper and lower floors felt more comfortable. At another scheme the problem was more widespread affecting a number of flats and communal areas in the high-rise buildings; one resident reported *"you get homeless sleeping on the landings"*. Participants in this scheme felt the cause to be a lack of cladding on the pipes in communal areas; low-rise dwellings appeared to be unaffected. These schemes were all older buildings which had been retrofitted.

Two of the schemes that were described as comfortable at the dwelling level during winter were reported as having a tendency to overheat in summer. These were both installed into new-build properties in the last four years. Residents attributed these causes to wider issues associated with building location and design rather than heat from poorly insulated pipework. Reasons included very large solar gain from large south facing glazed areas and lack of sufficient ventilation, some of which was caused by not being able to open windows due to mosquitoes (at one scheme) or window restrictors.

Some participants had programmed the heating to come on twice a day. However many participants across the five schemes where overheating was reported, used the boost or advance function to turn the heating on and off as required, instead of setting the programmer. They reported that this was only necessary occasionally and for short periods of time; with many commenting that an hour is long enough. There were also some residents that either never or rarely use their system because the flat is already warm: *"three days every six months. That's it."* Residents attributed this to heat coming from neighbouring flats or communal areas and/or the amount of insulation.

Resident responses to overheating included installing portable fans and air conditioning systems, compounding the climate change impacts with further electrical energy expended to mitigate the effects of the overheated space. Fabric measures to make homes energy efficient (wall and roof insulation) also tackle overheating from solar radiation on the external surfaces of the building[34] and are therefore a welcome adaptation to climate change that particularly targets the needs of households that are vulnerable to temperature extremes such as the elderly[35]. Paradoxically, these same fabric measures perform well in retaining heat generated within the building during the summer months (such as from poorly insulated pipework) with potentially severe consequences for overheating[36]. In this respect, the careful detailing of insulation systems in social housing has a social justice dimension, both in providing

[34] Porritt, S.M., Shao, L., Cropper, P.C. and Goodier, C.I. (2010) 'Building orientation and occupancy patterns and their effect on interventions to reduce overheating in dwellings during heatwaves. Proceedings of Institute of Energy and Sustainable Development 1st Annual PhD Conference, Leicester, 21 May 2010.

[35] Climate change and social justice. an evidence review. www.jrf.org.uk/report/climate-change-and-social-justice-evidence-review

[36] This is discussed in detail in the CIBSE / ADE Heat Networks Code of Practice

affordable warmth in winter and avoiding overheating in summer where it would potentially have severe health impacts on vulnerable groups. [37] [38]

5.7 Underheating and insufficient heating

Participants at three case study schemes felt that they did not have sufficient heating and/or hot water. The extent of this varied across the schemes. This was particularly apparent at one of the GSHP schemes where participants felt that both heating and hot water were not sufficient[39] and a lack of understanding existed as to why the radiators were not hot to touch. There were reports that some residents had moved out of the estate because it was too cold and one said that they have to go to bed early to keep warm. One resident installed an electric shower to make sure that they have a reliable source of hot water as they didn't feel the current heating system provided this.

Participants in another scheme who had said that the temperature was satisfactory also stated that in-between having the heating on they used other items to keep warm: hot water bottles, microwavable bean bags, thermal layers, electric blankets. This appears largely to be an attitude of not wanting to spend more money on heating than necessary: *"Where I come from you're either hot or cold. You know, and if you're cold you put a cardigan on or two or three. You don't have heaters."* Whilst some explained that they would like to be able to keep the heating on for longer, there were no big objections to the costs.

Damp and condensation

At the GSHP scheme where residents had heat deemed to be insufficient, there were reports that damp and condensation had become a problem since the new system was installed. Participants described the impacts of this as chest infections and mould damage to clothes and décor. There was only one other report of damp and condensation at another scheme by a participant who stated they had mould in the bathroom. However they felt that this was a result of a lack of ventilation as opposed to a lack of heat.

5.8 Summary

Important aims of DCCH systems are achieving carbon reduction and sustainability objectives. SHPs have stated that drivers for this include meeting part L of the building regulations for new build served by DCCH, planning and funding rules such as those imposed by Local Authorities and the Homes and Communities Agency and Corporate Social Responsibility objectives.

---

[37] The 2003 heatwave is thought to have caused over 2000 excess deaths (Kovats, R.S., Johnson, H., Griffiths, C., 2006. Mortality in southern England during the 2003 heat wave by place of death, Health Statistics Quarterly, Spring 2006. National Statistics). Climate change will drive further heatwaves in the UK in the coming years. Evidence for the increasing requirement for cooling in summer months is abundant. For example between 1961 and 2006, the average number of Cooling Degree Days, a measure of how much energy is required for cooling, has increased throughout the UK and more than doubled in London (reported in Zero Carbon Hub's evidence review on Overheating, Ibid).

[38] Zero Carbon Hub's Overheating project provides an number of useful evidence reviews and guidance notes on overheating: http://www.zerocarbonhub.org/current-projects/tackling-overheating-buildings

[39] It should be noted that these residents were a mixed group and were not elderly residents.

SAP has been used to estimate how DCCH performs in terms of CO_2 emissions, annual energy demand, SAP scores and fuel costs in the eight case study schemes. SAP results indicate that DCCH can provide a significant reduction in CO_2 emissions particularly when compared to incumbent electric heating systems. However, it should be noted that SAP has the potential to significantly overstate CO_2 emissions reduction due to assuming much lower distribution heat losses than are usually achieved in practice.

Under SAP models, annual energy usage is expected to increase in most of the schemes. This may be due to SAP accounting for the energy losses in distribution with a DCCH system when compared to an individual heating system located at source. Results for SAP scores and fuel bills fluctuate but generally whether it is incrementally positive or negative, DCCH has a relatively minimal impact on either aspect.

The most improved SAP scores occurred when the DCCH system incorporated CHP. In fact the SAP model results suggest that DCCH's primary sustainability benefits lie in its suitability for connection of large scale low carbon heat sources rather than carbon benefits deriving out of energy efficiency of generating heat centrally and sending it around a network (energy consumption rises in DCCH systems versus the individual heating system comparators due to distribution losses).

The ability to take larger low carbon heat sources is facilitated when heat networks are connected together. When asked if district heating could help meet sustainability goals one stakeholder responded: *"I think in general it does. But it needs to be ideally part of a wider district heating network because small schemes using just gas boilers will have higher CO_2 emissions than individual gas boilers; but lower CO_2 emissions than electric heating. But if they are well designed and they have CHP or biomass boilers supplying them [as is possible in larger heat networks] there's definitely potentially quite a big CO_2 benefit."*

Our survey and focus group work also suggests that overheating remains an issue in poorly designed, commissioned and operated DCCH systems with negative impacts on the sustainability of DCCH schemes both from direct energy wastage and from further fossil energy expended to cool overheated spaces. This can be a particular issue in modern housing developments with high fabric standards where the heat can be more easily trapped in the building. Overheating has a social policy dimension as residents of social housing served by heat networks are more likely to be drawn from groups that can suffer severe health impacts from overheating including elderly and disabled groups. It is therefore vital that SHPs ensure that DCCH systems are designed to supply heat in a controlled way only to those areas that are calling for it.

6. DISTRICT HEATING AND AFFORDABLE WARMTH

The purpose of this section is to explore whether DCCH is delivering affordable warmth and fuel poverty goals. This is a complex research question because the final price of a unit of heat charged to a resident is driven by a very wide range of factors including:

- The capital costs of the DCCH system (costs of feasibility and design and build, costs of borrowing, extent of grant funding);

- The marginal cost of generating and supplying a unit of heat (cost of fuel, maintenance, metering, billing and back office systems);
- Revenues from government subsidy and cross subsidy from sales of heat to businesses and other organisations. Also the extent of use of self-generated electricity on site and electricity sales to the grid;
- Organisational policy (e.g. some fuel bills do not reflect costs but are set to ensure that tenants are not at risk of fuel poverty). Some SHPs charge tenants differently to leaseholders.

These factors can vary dramatically depending on the scheme and consequently it is very difficult to draw conclusions that can be generalised. Factors are explored further below.

6.1 Calculating tariffs

SHPs took a number of different approaches to calculating the cost that tenants should be charged for their heat. These could be broadly grouped into 3 types:

- Capital cost and marginal cost recovery
- Marginal cost recovery
- Heat price charged only indirectly related to costs of supplying heat.

Capital and marginal cost recovery

For some new builds some SHPs simply installed systems which were technically feasible and then once they were built worked backwards to set the price based on what the systems had cost to install plus the ongoing maintenance and fuel costs. Other landlords had used policy objectives as the starting point for determining the heat price. For example one LA was committed to having no tenants in fuel poverty and had therefore calculated the required heat price to achieve this and designed a system to meet that price: "*On the feasibility study they're using the heat price to the tenant as a starting line, and they use that and then work out what the…costs are going to be and then we see how we can get the funding, to see if the funding will actually match it".* (Scottish LA).

Other LA landlords described how they could not recover the infrastructure costs without setting an unreasonably high standing charge (or unit charge if the infrastructure cost was rolled into the unit charge). Some landlords also felt that as the owner of the buildings the LA should cover capital costs (including infrastructure cost of a DCCH system) and not seek to recover this cost from tenants. Note also that the provisions of the Landlord and Tenant Act (1955 and 1985) prohibit landlords from charging tenants for replacement of the heating system. Leaseholders are not exempt from this and should expect to see the detail of the charge in their contract with the landlord.

Marginal cost recovery

A number of landlords calculated heat prices based solely on various marginal costs including primarily fuel costs. In some cases these were pooled, i.e. the costs for a number of communal heating blocks were pooled together, to calculate the heat charge. This clearly benefited those who happened to be living in relatively inefficiently heated blocks and resulted in additional cost to those who were fortunate to be living in efficiently heated accommodation. This was widely considered the fairest solution as tenants have little control over the efficiency of the heating system of the housing they are offered. We heard how maintenance costs for DCCH systems were often poorly estimated when systems were being designed. This was particularly the case for innovative or renewable heat sources.

Some SHPs excluded maintenance costs from the bill. One case study explained that they sought to include in the heat charge the same components that a resident on gas central heating would pay i.e. fuel charges but not capital or maintenance costs, as costs of installing and maintaining technologies would be covered by the landlord. Thus, SHPs are not necessarily trying to recover all costs of running a DCCH scheme as it is seen as a service provision for residents. Another LA mentioned aiming to charge tenants no more than the unit price of gas, but was finding this impossible to do. The case study below highlights the multiple factors that can influence the costs passed to residents.

Case study 2: Local Authority scheme in Scotland – the multiple factors driving the fuel bill

Background and aims

A communal heating scheme was installed in July 2014 to deliver heat to 458 homes which were a mixture of low and high-rise, social and private properties. The local authority received funding to deliver the scheme via a fuel supplier as a result of the Energy Company Obligation (ECO).

Design and build

The fuel supplier, who had delivered a number of schemes nationally, completed the design. However, in the interests of investing in the local economy and increasing local jobs, the LA requested that local contractors be considered for the installation phase and the fuel supplier complied with this. Unfortunately the installer did not complete the installation to the design specifications, the local authority reported that this was a result of deliberate cost-cutting which led to the build falling far short of the CIBSE guideline recommendations. Limited skills and experience in working with heat networks also contributed to a less than satisfactory installation.

Impact

This resulted in a number of on-going faults at the dwelling level, some of which have required multiple visits to rectify, or resulted in replacement of equipment or pipework. This led to higher maintenance costs for the local authority. The most significant of these failings was that the pipework in high-rise communal areas had been insulated to the absolute minimum possible levels to meet the design specification. This resulted in system heat loss and residents in the high-rise properties using less heat. The LA has decided to undertake a pilot recommissioning programme, which if rolled out would see them revisit all properties to check for poor workmanship or components. There is an on-going dispute over who will pay for this remedial work.

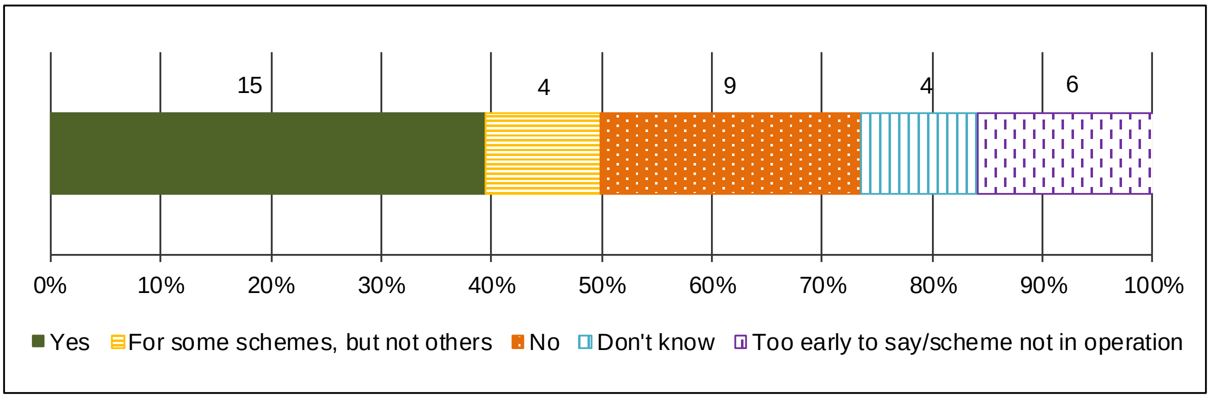
Residents pay based on consumption; the tariff for which has been increased twice in a period of two years, but does not include a standing charge. Problems with metering and system losses combined with the will to prevent further tariff increases or the introduction of a standing charge left the scheme running at a financial loss. Increasing the tariff is seen as counter to the desire to provide affordable heat and politically unacceptable.

Learning points
Great care is needed in selecting contractors. It is advisable to retain an advisory consultant throughout the design and build process able to judge the quality of contractors' work. Poor detailing and workmanship will cause a mix of problems down the line some of which will drive up the costs of a unit of heat. These considerations need to be factored in when considering what is a fair tariff to pass on to residents.

Indirect relationship between heat price and costs

Some SHPs have adjusted charges based on what was considered politically acceptable. For example councillors at a LA had capped the heat price and the landlord had to subsidise the heat payments with RHI revenue. This could sometimes result in schemes running at a loss. Survey respondents were asked whether the cost spent on fuel, operation and maintenance for their scheme(s) was fully recovered by the bills (Figure 12) i.e. were they running at a loss. Thirteen out of 28 respondents with schemes in operation (45%) had some (four) or all (nine) of their schemes running at a loss.

Figure 12: Whether the cost spent on fuel, operation and maintenance for scheme(s) was fully recovered by the bills



Base= 38

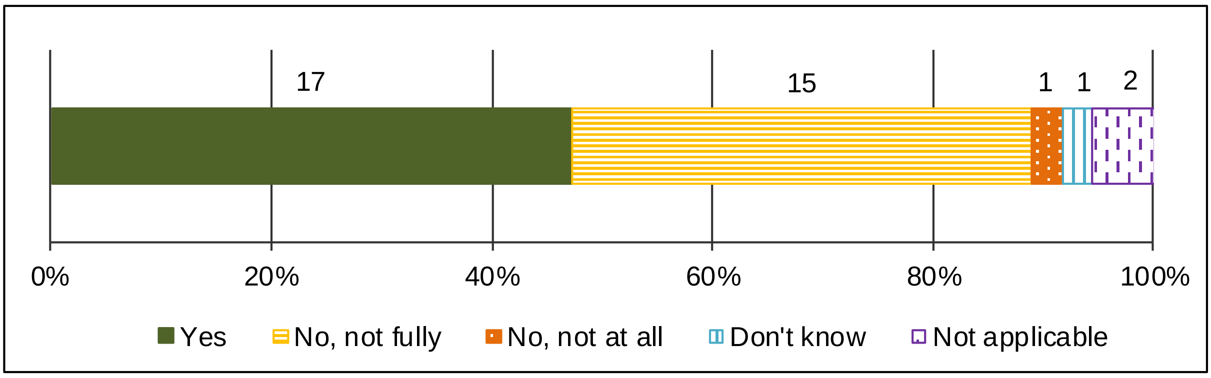
Respondents estimated the duration of these losses describing that this had been 'since inception' (two years ago), 'for three years' and 'for several years'. One respondent with a decommissioned scheme explained: *"Our scheme ran at a loss of £25,000 per year for the six years it was in operation, which does not include the costs of digging up and replacing distribution pipework or installation of new metering and payment system."*

Respondents' explanations for the cause of these losses included one reporting that they had taken the decision to actively run the scheme at a loss to begin with. Another had recently introduced a standing charge which residents were declining to

pay and another commented that they were going to install individual meters to help with the recovery of fuel bills, suggesting that arrears were the root cause.
It was thought that a lot of schemes were running at a loss because operational costs were higher than anticipated and because revenues from sales of heat were much lower than anticipated, particularly in metered and new-build schemes. This placed landlords in the uncomfortable position of having to raise heating charges, usually through the standing charge, to maintain a financially sustainable scheme. Some landlords were thought unwilling to do this as it would impact more vulnerable households and possibly cause underheating. Increases in standing charges are also reportedly often felt to further unfairly distribute the same cost on those that make less use of the heating system. For example, this treats those residents that go out to work during the day and therefore use less heating the same as those who stay at home. Other schemes were reported to be running at a loss due to fuel prices being higher than anticipated or poor efficiencies of schemes.

The existence of only an indirect relationship between heat price and costs in many schemes is at least partially because there is often insufficient metering and monitoring or analysis of scheme performance to build a coherent picture of scheme costs. Sixteen (out of 36) respondents said that they either did not have any understanding (1) or not a full understanding (15) of the running costs of their scheme (Figure 13).

Figure 13: Understanding of scheme running costs



Base= 36

6.2 Flat rate and consumption charging

A central dimension of the provision of affordable warmth is whether to charge for heat at a flat rate (i.e. heat is unmetered at the dwelling), or whether heat is metered into each home and tenants charged accordingly. Twenty of 38 respondents reported either all (12) or some (8) of their schemes on flat rate tariffs. Twenty-one had consumption based schemes in either all (9) or some (12) of their schemes. This lack of a predominant tariff structure has been noted in other research [40]. Flat rate methods had a greater number of respondents (seven) reporting the method as 'very successful' compared to those charging based on consumption (one). However there

[40] A survey by Changeworks found 62% of customers were on a fixed rate and 38% on a variable rate. A similar survey by Citizens Advice found 45% of tenants were charged on a variable rate system, 43% were charged according to the property size and 17% were billed based upon a flat rate for all.

were also a slightly larger number of respondents reporting heat with rent or flat rate as 'not very successful' (five) compared to consumption based charging (three).

One attitude reported by some landlords was that although consumption charging was in some ways fairer (i.e. people only pay for what they use), it was also less progressive. Older people (who need more heat, spend more time at home and may be retired and therefore on a lower income), will pay more for their heating under a consumption charging regime. One landlord described how it was their ambition to transfer everyone to consumption charging with dwelling level heat metering both for operational reasons and because it was considered fairer in some senses. However, in the process it was also thought vital to protect those who would be made vulnerable to large increases in their heating bill as a result. A programme of advice visits, improving the efficiency of the dwellings and thermal safeguarding through regular scrutiny of household heating bills was offered as the solution. The pros and cons of flat rate versus consumption charging are summarised in Table 5.

Table 5: Advantages and disadvantages of flat rate and variable charging systems

Charging system	Advantages	Disadvantages
Flat rate charge	• Income from the scheme is more certain • Ensures residents are not underheating/worried about bills • Does not penalise residents who are unfortunate to live in less efficient properties • Doesn't need individual meters (which can be expensive to install)	• No incentive to save fuel[41] • Unfair on residents who use less energy
Variable or consumption rate charge	• Encourages residents to save heat (a US study found lowered consumption of 15-30% when variable rate charging adopted) • More fair, as customers pay only for what they use	• Income from the scheme less easy to predict • Only possible if individual meters are installed • Might put vulnerable customers who need to use more heat at risk • Unfair on residents to happen to end up in inefficient properties

The effects of these different approaches to provision of affordable warmth are discussed further below.

Variable versus flat rate charging

Pros and cons of variable versus fixed rate tariffs vary for both residents and landlords, and there is currently considerable variation in the approach taken. SHPs were clear that the charging method could impact how efficiently the scheme ran and

[41] EST, "Slateford Green and Lasswade Road, Edinburgh: A case study on small scale communal heating"

many described how the system could be operated more efficiently if charging was based on actual heat consumption rather than using a flat rate. Flat rates were thought to encourage wasteful heating practices where tenants and residents controlled the temperature of their homes by opening and closing windows and were not careful with the use of heating. *"In communal heating systems in sheltered housing everybody assumes that they can have as much heat as they want because they've got a fixed charge. So that's one of the negatives we find is that people, I wouldn't say abuse it but they don't seem to grasp the realities of if they have their heat on full pelt and all the windows open, ultimately they are paying for it, albeit it will be delayed until next year's bills come in."* (English HA)

Focus group participants told a similar story. For example, one case study scheme had previously had a heat with rent tariff and had been switched to consumption based billing. Focus group participants said that this had prompted them to be "more economical" in order to reduce their consumption. Therefore although considered expensive, landlords reported that investment in heat metering systems was an important component of an efficient system as it allowed consumption based charging which in turn affected resident behaviour.

Winners and losers from flat rate and consumption charging

SHPs reported how moving to consumption charging had winners and losers. On one hand, flat rates were thought to benefit vulnerable households who were in the home for longer and older people who need higher temperatures to achieve comfort. However, overall, there was a penalty for the wasteful behaviour that resulted whereby energy costs distributed across all the residents of a block were higher than they otherwise might be.

Consequently, some landlords felt that investment in metering was a means of tackling fuel poverty by allowing reductions in the cost of production of heat for a building which could then translate as a lower unit cost charged to residents, rather than a potentially regressive measure that would encourage underheating amongst potentially fuel poor groups.

SHPs also described how they would support potential losers from a shift to consumption charging, for example by providing targeted energy advice and initiating programmes of works aimed at improving the efficeincy of the housing. This was reportedly out of a wish not to unfairly burden tenants with very high fuel bills as a result of the inefficient operation of the system. SHPs also mentioned how consumption based charging allows landlords to target thermal safeguarding and affordable warmth services to tenants. High users can be targeted for energy advice. Low users can likewise be given guidance on the dangers of underheating and be advised accordingly. Landlords reported that when switching tenants from flat rate to consumption charging it was vital to ensure that residents had a good understanding of their heating controls otherwise very high bills could inadvertently be incurred. Resident experience with heating controls is considered next.

Heating controls and affordable warmth

It is important to note that resident experiences with controls are not specific to DCCH technology. DCCH systems have similar controls to individual gas boilers. However they remain a key factor in residents' satisfaction and efficient use of the system. Most of the confusion with heating controls related to the operation of programmers, with a number of participants across schemes turning the heating on and off using thermostats instead of using the programmer. Participants at a scheme with underfloor heating found the controls (individual room thermostats and a programmer) to be overwhelming: *“Well, the new flats are just beyond me, really. You know, how the timers work, how the thermostats work.”* With regards to the hot water controls at one scheme, participants did not know how or whether they were able to turn their hot water off. At another scheme residents had back-up immersion heaters, which one participant had left on permanently (which is likely to be inefficient and lead to high bills).

Poorly understood controls also led to inappropriate and expensive methods of heating space. For example there was some use of plug-in heaters reported instead of using the central heating system. Reasons for this use included: wanting to heat the room up quickly, trying to save money by only heating one room, the flat overheating if the main heating system is on and use during periods of breakdown. Use of supplementary heating instead of the cheaper heat offered by the main DCCH system clearly impacts affordable warmth and fuel poverty goals.

Advice on controls

Most residents had received some form of advice around how to use their heating controls. This advice varied from a booklet to an in-depth advice visit by an internal or external energy advisor. However there were a couple of cases where residents reported receiving little or no information: *“when I was shown my house when I first moved in, they just said ‘under-floor heating’ Good luck, pretty much.”* Further to this, in some cases, inconsistencies in the content of advice caused confusion, reducing trust and confidence. Whilst advice was being delivered when the system was first installed or the residents first moved in, there was widespread uncertainty as to who to speak to in order to access heating control and billing advice. In some cases there were specific in-house services or external charity support available, that residents were not aware of. Providing a single point of contact to provide clarity on how tariffs are built up, including standing charges and heating system control is a particularly important learning point for social housing landlords learning how to be energy suppliers in the unregulated heat supply market where a disproportionate number of their heat customers are likely to be drawn from vulnerable groups. Case study 8 illustrates some of these difficulties in a new build context.

Case study 8: housing association scheme in London - management of multi-agency projects and the need for clear accountability for tenants
Background and aims This community-scale new build scheme was commissioned in 2014 and serves a number of buildings that contain both residential and non-residential floorspace. The site (including both the buildings and the heat network) was constructed by a private developer who still owns the freehold and is responsible for the day to day management of each of the buildings. The network currently serves 550 dwellings in total, and the housing association owns the leasehold on a number of these properties, The remainder of the dwellings are privately owned and there are plans to expand the site further over the next few years. The network also provides cooling to both the private residential and commercial properties, and it is managed by an energy company through a 25 year ESCO lease. It is supplied by a ground source

heat pump, a CHP unit, four gas boilers and a thermal store.

Design and build
This type of ownership model means that the housing association has little involvement in the design or in the day to day running of the heat network.

The design and management of the system has presented a number of challenges, particularly in terms of managing the phasing of construction. There was also a challenge in identifying suitably experienced consultants.

Impact
Despite these challenges the system is operating successfully in that residents reported receiving sufficient heat, and felt that because the properties rarely get cold, they only require the heating to be on occasionally. However they did feel uncertain about whom to approach to access advice and support in relation to the heating system.

Learning points
Due to the multi-partner nature of the project, the developer emphasised the importance of having clearly defined roles and responsibilities at all stages of the design, construction and operation of the system. The developer stated that in the future they would look to simplify their own procurement process by requiring the ESCO to manage the whole of the design and installation of the plant, including the appointment of their own specialist sub-contractors.

6.3 Actual and modelled fuel bills

In this section we explore questions of affordability and perceived affordability in our case studies. We also model fuel poverty rates in a typical dwelling for in each of the case study sites.

Size of heat charges in the case studies

Of the eight case studies, the heat tariff charged to residents varied between 4.12 p/kWh and 10 p/kWh (Table 6), with an average of 6.5 p/kWh. Three organisations use a standing charge and four do not; where these apply it is between 43p and 84p a day. Those schemes that have standing charges tend to charge lower kWh prices (i.e. under 5p); although there is one scheme with a low kWh price that does not apply a standing charge. However it is important to note that tariffs are set up in different ways and they are not always representative of the costs of the system; for example, heat tariffs may not look to recoup full costs.

Table 6: Heat charges for schemes

Case study number	Cost (p/kWh) for heat	Standing charge (p)	Billing approach
1	9.5	None	Prepayment
2	8	None	Prepayment
3	4.15	52[42]	Variable billing – range of options

[42] Includes an administration charge which covers water and electricity billing.

4	10	None	Prepayment
5	4.12[43]	None	Heat collected with rent but itemised separately (pooled and based on number of bedrooms rather than heat units consumed)
6	n/a	None	Heat with rent + variable
7	4.8	43	Prepayment
8	5.24	84	Variable billing

A modern individual gas fired boiler should be able to deliver a unit of heat for around 4-5 pence per kWh whilst an Economy 7 storage heater should achieve around 7-8 pence per kWh of heat delivered[44]. Therefore, the cheapest unit prices for heat (4.12, 4.15 and 4.8 p/kWh delivered via DCCH in three of our case studies (case studies 5, 3 and 7 respectively) are comparable in price to a modern individual gas fired boiler and cheaper than the electric storage heating solution. However standing charges must also be considered. All suppliers of natural gas and electricity for heating will have a standing charge for domestic customers of around 20 pence per day for electricity and 25 pence per day for gas[45]. Whilst one of these case studies has no standing charge and a unit rate of 4.12 pence per unit (case study 5), case studies 7 and 3 have standing charges of 43 and 52[46] pence per day respectively. When these standing charges are factored in it appears that only the DCCH scheme with no standing charge (case study 5) offers cheaper heat than a modern individual gas fired boiler solution. However all three case studies (3, 5 and 7) remain cheaper than storage heaters after accounting for standing charges.

The prices of gas and electricity and the cost of producing a unit of heat plus associated standing charges are constantly shifting as is the price charged to residents once cross subsidy and policy decisions are worked into the business models. This is also a small sample therefore it would be unwise to draw firm conclusions about the relative prices of heat from DCCH versus other heating solutions from this indicative analysis.

It is also important to note that standing charges to recover funds for heating system repair and replacement are unlawful for tenancies but allowed for leaseholds. However standing charges to pay for other overheads such as metering and billing are permissible. Further work is required to unpick prices of DCCH heat and the composition standing charges so as to allow fair comparison with alternatives.

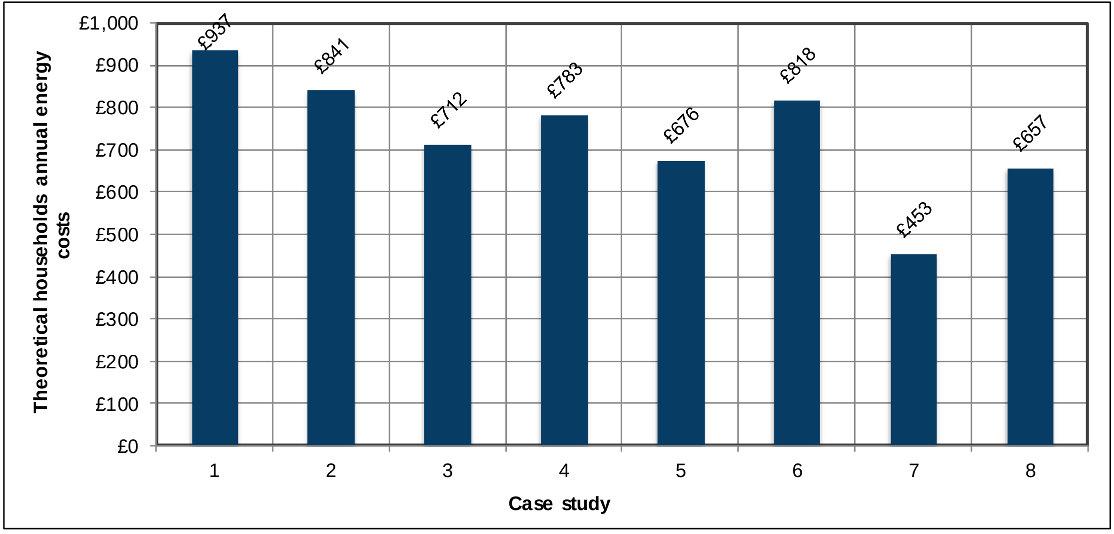
Modelled energy bills

Energy bills for the eight case study schemes were modelled using SAP. One typical dwelling type served by each scheme was chosen for each case study for this

[43] This figure is an average based on the last 3 years and represents the price the SHP would have to charge its residents to cover costs for a unit of heat delivered after cross subsidy from sales of electricity is factored in.
[44] Figures from October 2016 Sutherland Tables
[45] Ibid
[46] Includes an administration charge which covers water and electricity billing.

modelling exercise[47]. These figures apply to heating, hot water and fixed electrical items (including lighting), as well as an allowance for cooking, appliances and standing charge (assumed to be £120 / annum). These are shown in Figure 14. They vary from £453 in case study seven to £937 in case study one.

Figure 14: Modelled energy costs for a typical dwelling in each case study



It should be noted that these are based on modelled heat consumption and estimated prices from SAP. SAP estimates the heat price to be 5.22 p/kWh, which is slightly less than the average actual heat charge for these case studies; 4.73p/kWh where a standing charge is added and 8.03p/kWh where it is not. This means that actual fuel bills would likely be higher than estimated by SAP. The energy costs estimated for these dwellings were then compared to the estimated energy costs for (a) comparator systems (smart electric storage heaters for the tower blocks and gas boilers for the low-rise blocks) and (b) previous heating systems where retrofit (electric storage heaters or previous communal heating system fired by coal or gas).

In comparison to the comparator system, DCCH performed better in three cases and worse in five. In most cases these were marginal differences (e.g. under 2% difference), but in three cases fuel bills under DCCH were modelled to be 13%, 17% and 18% more expensive.

When comparing energy bills before and after the install, data was only available for three schemes. The other four were new-build and data was unavailable for another heat source. Of the three schemes where prices could be compared before and after, these varied, this showed prices to vary between DCCH being 2% more expensive to 9% cheaper compared to the previous system. These results do not provide strong evidence that DCCH will reduce residents' fuel bills in all cases. However it is

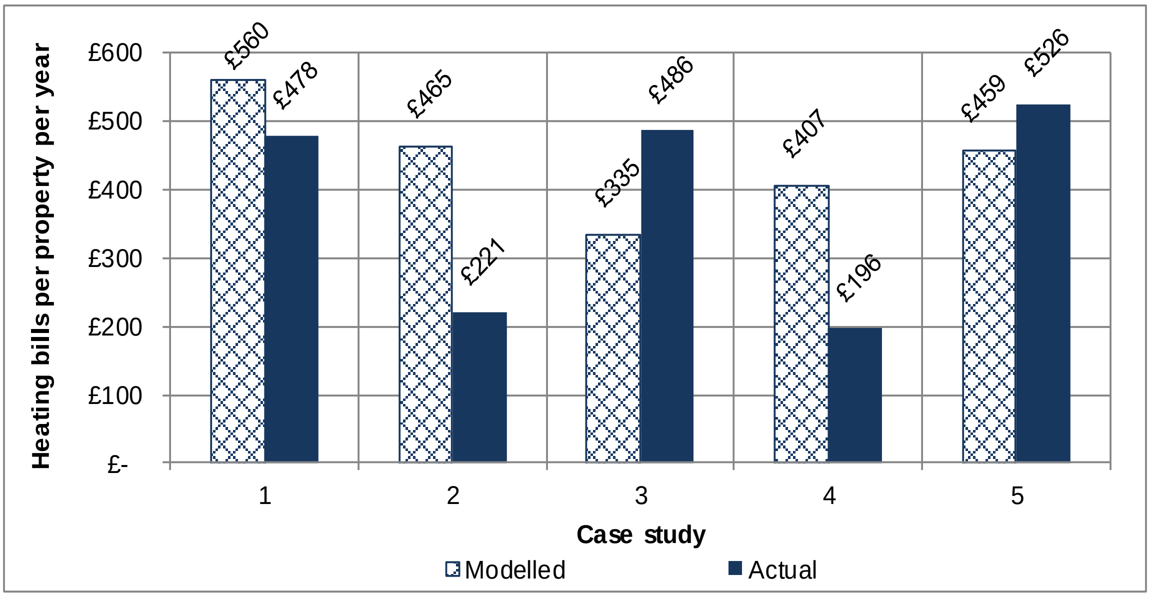
[47] Even within one housing block there can be a wide range of energy efficiency. For example, a flat in the middle of the block with flats above and below will have much lower heat loss than a flat located in the corner of the block with a northerly aspect. A larger sample of dwellings from each scheme would have allowed the range of modelled energy bills to be explored however this was beyond the scope of this project. Instead a dwelling with typical heat loss characteristics was modelled, neither extremely efficient nor inefficient.

important to note the limitations of SAP when modelling DCCH systems. For example, SAP will generate very conservative estimates of the impact of a scheme if default values are used[48].

Actual fuel bills

Actual fuel bills were requested from the eight case studies in order to compare with the modelled bills; however they were only obtained from five case studies. The actual billing data provided is purely indicative since it was either based on a small number of dwellings or averaged out across dwellings. In addition it does not always match the exact same type of dwelling used for the modelling. Further, as discussed, actual fuel bills may have little relationship to actual energy consumption in social housing: bills are determined by multiple unrelated factors including, for example, whether standing charges are included, unit rates that may be different to those assumed by SAP and even policy decisions to cap tariffs or standing charges at certain levels. This means the comparison between modelled and actual fuel bills is indicative only, and some variation would be expected. A comparison is presented in Figure 15.

Figure 15 Modelled and actual annual heating and hot water bills for sample dwellings



This shows a large variation between actual and modelled fuel bills, especially for some case studies. Actual average fuel bills are estimated to be between £196 and £526 a year, averaging at £381. Although the absolute values are difficult to interpret for the reasons outlined above, there is a trend with modelled energy bills higher than actual bills in three out of five cases. Notably case study 3 has a considerably higher actual figure compared to the modelled, this could be because the actual standing charge (£15.97/per month) is double than a standard figure used in the modelling

[48] Default values used in RdSAP modelling are available upon request.

stage (£7.67/month[49]). In other cases the modelled data is significantly higher than actual. This could be due to a number of reasons:

- Residents are underheating or, more likely, SAP over-estimates how much heating residents require[50].
- Distribution losses from poor detailing or incorrectly specified insulation in lateral and riser pipework provides some "free heat" to residents thereby reducing heat demand in homes. This was reportedly the situation in case study 2, a local authority high rise scheme in Scotland. However this effect is thought to be marginal in most of the case studies which had reasonably good levels of insulation in distribution pipework.

Residents' perceptions of affordability

Residents had mixed opinions on whether their heating was affordable or not. In some schemes the majority implied that it was affordable, especially compared to previous heating systems; *"we prefer this because it's cheaper; about half compared to electric."* However there were two schemes where some residents felt their heat was not affordable. This seemed to be largely centred around two causes, the first being the perception that heat was insufficient which made residents feel it was unaffordable: *"you're paying top whack but you're not getting anything* [heat]*"*. At the same scheme a participant reported that *"there was a collection in the village for one resident who couldn't afford to put money on her prepayment meter over winter."*

The second reason for bills being unaffordable was the introduction of a standing charge which had changed perceptions at one scheme: *"It's much more expensive.... my bill doubled as soon as that came in."* At another scheme, although residents did not feel the scheme was unaffordable, one resident commented on the standing charge being 'unfair'.

Residents at one of these schemes explained that the standing charge introduction had been communicated by letter a month in advance, which they felt was not enough warning. They also said that no reason was given for the introduction of the standing charge and the explanation of the new pricing structure was not communicated in an accessible way: *"And as I've shown, I'm not technically-minded. So there's all these kilowatts and blah-blah-blah."*

The need for clear billing and tariffs that were considered fair was clearly exemplified in case study 7.

---

[49] Sutherland tables October 2016

[50] SAP estimates a heating regime of 9 hours per weekday and 16 hours per weekend day, with living rooms heated to 21 degrees and the rest of the house to 18 degrees; these assumptions are only updated every few years.

Case study 7: Housing Association in south-east England - value of external consultants and the importance of transparent billing and tariffs

Background and aims

This is a gas CHP scheme installed (2012) in a new build comprising 40 social housing flats. The system provides heat directly via radiators with hot water via electric immersion heaters, powered by electricity from the CHP and solar photovoltaics. The main aim of the scheme was to be compliant with planning policy, but carbon emissions and fuel poverty were both important drivers.

Design and build

The landlord took the decision early that they wanted to have ownership of their own metering system so that operation of the metering and billing contract could be retendered if the incumbent did not perform as expected. This meant that the selected meters had to be able to work with a wide variety of back end billing systems.

Understanding how metering and billing works was considered the most challenging aspect of setting up the scheme. This was not thought a traditional role for landlords and requires learning a range of new skillsets and/or having sufficient knowledge in house to make sound choices when employing organisations that can take on these roles.

Impact

The scheme is considered successful in terms of delivering low consumption charges to tenants but this is primarily because of the high fabric standards rather than a relatively low cost of operating the heating system. Tenants were only paying for their units of heat consumption but partly because of very low consumption levels the system was operating at a large loss necessitating the introduction of a standing charge as recommended by the landlord's current third party metering and billing organisation. This caused a lot of issues amongst the tenants including self-disconnection from the heat network (and use of portable electric heating instead) in the erroneous belief that this would remove the requirement to pay the standing charge.

Learning points

The landlord initially experienced challenges setting up the metering and billing for the scheme but has since employed consultants to review the operation of the system. Outcomes of this will be used to develop a framework for use in future projects. This will ensure that contracts are better specified and other issues are headed off.

The landlord also highlighted the value of having a trusted consultant retained throughout the design, build and commissioning phases. This resulted in a relatively smooth process despite having to use a lot of new and comparatively untested technology in new configurations in the system.

Our focus groups also suggest the introduction of a standing charge had impacted residents' behaviour. Participants were asked if they had ever turned their heating off when they were cold to save money. One explained, *"not before the standing charge* *came in, no. But now I would consider it, if it was really cold and I had to have it on. I probably would be switching it on and off quite a lot, I think."* A number of people were unaware that despite the heating being off the standing charge would still be added to their bill.

Switching supplier

In a number of cases participants were not aware that their landlord was their fuel supplier. However once this was explained, in most cases, participants appeared content with the arrangement. A number of residents said that they trusted their landlord *"…I don't think they would, sort of, take advantage"* and felt that because they were buying in bulk they would be able to negotiate a better price.

On the whole participants felt comfortable about not being able to switch suppliers provided the prices do not significantly increase. A couple of residents commented that they enjoy not having another thing to shop around for: *"I don't even like going to do grocery shopping. I'm one of those. I hate shopping. For me, I'm quite happy"*. Others were less enthusiastic and just accepted the situation for what it was: *"Yeah, I wouldn't even think about moaning about it because there's no point. It's like it's kind of set in stone. There's nothing you can do, so you might as well just, you know, get on with it, really."*

However at the scheme where the amount of heat being provided was felt to be insufficient, participants felt dissatisfied about being unable to switch and said that this was not communicated to them before the system was installed. This is a finding supported by Which? in their report on consumer satisfaction with heat networks. This found widespread discontent over the inability to switch heat supplier once contracted as a leaseholder or tenant[51]. We now consider the extent to which the schemes safeguarded tenants and leaseholders from fuel poverty.

6.4 Fuel poverty

There are currently two different definitions of fuel poverty that apply in the UK:

1. **The '10%' definition.** In Scotland (and Wales and Northern Ireland), households are deemed to be in fuel poverty if they need to spend more than 10% of their income to maintain an adequate level of warmth.
2. **The 'Low Income High Costs' (LIHC) definition.** In England, households are specified as being in fuel poverty if they have required energy costs which are above the national average (median) and, were they to spend this amount, their 'after housing costs' incomes would fall below the 60% of the median national income.

As the eight case studies used in this analysis were located in both Scotland and England the fuel poverty status for both definitions were calculated for all case studies to ensure a level of comparability. The methodology for these fuel poverty calculations is outlined in the Appendix B.

[51] See Turning up the Heat. www.staticwhich.co.uk/documents/pdf/turning-up-the-heat-getting-a-fair-deal-for-district-heating-users---which-report-399546.pdf

Results using the 10% definition

For the 10% definition, *using an average income* for each household type found that no household types were found to be in fuel poverty for any of the case studies. Most of the case studies had single pensioner tenants and these households had the highest 'fuel poverty ratios' across all the case studies[52].

Table 7 shows the fuel poverty ratio for single pensioner households in a typical dwelling in each of the case studies (using the national average income for this household type). For case study seven, fuel costs only accounted for 3.3% of single pensioners' average income. The highest fuel poverty ratio was estimated to be 6.9%, for case study one.

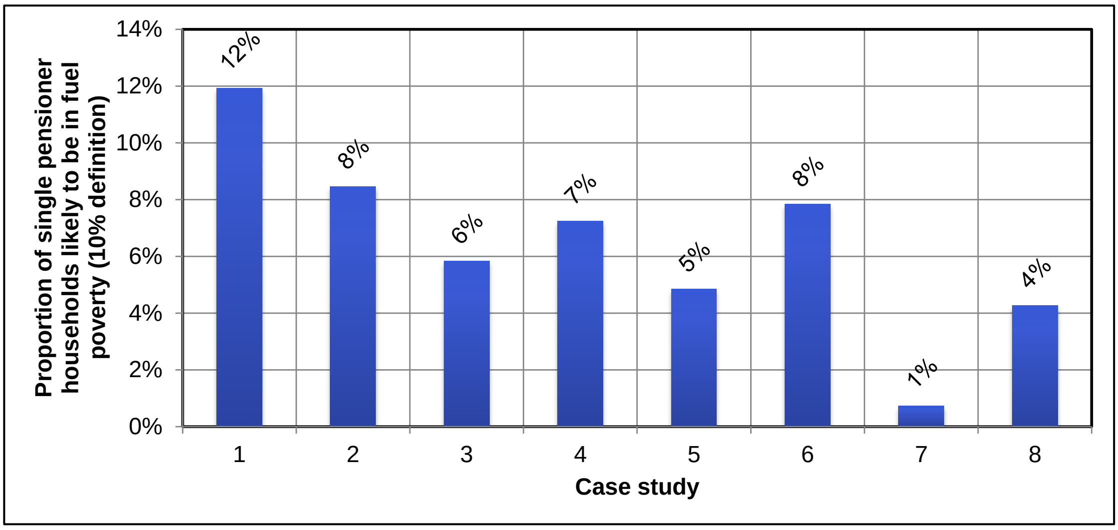
Table 7: The energy cost to income ratio for the 10% fuel poverty definition

Case study number	Average fuel poverty ratio (10% definition)
1	6.9%
2	6.2%
3	5.2%
4	5.7%
5	4.9%
6	6.0%
7	3.3%
8	4.8%

Further analysis looked at the likely net annual household income distributions for households (based on national data) i.e. *the range of income* for households of particular types. This was used to determine the proportion of each household type that were likely to be living in fuel poverty, that is the number of single pensioner households across the country for which the modelled energy costs were equal to or higher than 10% of this income. The results of this analysis are shown in Figure 16.

[52] the fuel poverty ratio is annual energy costs divided by net annual household income ie the higher the ratio the deeper the fuel poverty in that household.

Figure 16: Proportion of single pensioner households in the UK as whole who are likely to be living in fuel poverty in a typical dwelling for each case study using the 10% definition



Across all the case studies only a small proportion of single pensioner households (12% or lower) were found to be at risk of fuel poverty under the 10% definition. Case study seven, which had the lowest modelled energy costs, only had 1% of single pensioner households are likely to be in fuel poverty. In case study one, with the highest modelled fuel costs, around 1 in 8 single pensioner households (12%) could find themselves in fuel poverty under the 10% definition.

Results using the LIHC definition

For the LIHC definition of fuel poverty, as with the 10% definition analysis, no households in any of the case studies were found to be in fuel poverty using modelling and with the assumption of *an average level of income* for a single pensioner household. All households in each of the case studies had fuel costs below the fuel cost threshold (the national median energy bill). As Table 8 shows, the amount by which the modelled energy costs fell below this threshold for these households varied between £123 and £714. In effect, this is an illustration of how much fuel bills would need to increase for these households in order for them to be in fuel poverty.

Table 8: The difference between the modelled equivalised energy costs for single pensioner households in a typical dwelling for each case study and the fuel cost threshold for the LIHC definition[53]

	Typical Dwelling	
Case study number	**LIHC fuel poverty status**	**Difference between energy costs and threshold**
1	*not in FP*	-£123
2	*not in FP*	-£240
3	*not in FP*	-£398
4	*not in FP*	-£311
5	*not in FP*	-£442

[53] To be in fuel poverty under this definition households have to have fuel costs above the national median. In 2014 this was £1,266

6	*not in FP*	-£268
7	*not in FP*	-£714
8	*not in FP*	-£465

Fuel poverty conclusions

The low levels of fuel poverty found in the analysis reflect a wider national picture of low rates of fuel poverty among households living in dwellings which are communally heated. Of all households living in communally heated dwellings in England, 28% are living on incomes below the poverty line (60% of the national median income). This compares to 17% of households with individual central heating systems. However, only 5% of households in communally heated dwellings in England are fuel poor under the LIHC definition, compared to 10% of households with individual central heating systems[54], and 16% in households which have electricity storage heaters. This may be partially explained by the generally higher energy efficiency levels found in communally heated dwellings. Incidental heat gains from poorly insulated pipework would not affect this figure as it is based on modelled efficiencies. The average SAP score of communally heated dwellings was over 70 in 2014, compared to a SAP score of 62 for dwellings with individual central heating systems. See also the SAP analysis of the case studies found above.

However, as mentioned, there are also likely to be some shortcomings in the way that DCCH is handled in SAP and particularly in the official fuel poverty calculations. The use of a national median fuel cost threshold in the LIHC definition promotes fuel poverty in larger houses rather than smaller dwellings and DCCH is more likely to supply flats and apartments rather than houses. In addition, the fuel costs applied to annual energy consumption in the fuel poverty calculation (particularly for CHP systems), are notably lower than other fuel costs (e.g. mains gas). The use of these low fuel costs will serve to further reduce the chances of a dwelling having fuel costs above the fuel cost threshold. Furthermore, they may also be a poor reflection of the actual price being paid for energy by households living in these dwellings.

6.5 Summary

Alongside concerns over the quality of the data the complex multiple factors driving the cost of a unit of heat and hence its prices have made it extremely challenging to come to robust conclusions on whether DCCH can reliably deliver affordable warmth. This section clearly identifies a need for better understanding of costs, particularly the costs and maintenance of schemes. It appears that many SHPs are not recording costs, or doing so accurately, and therefore evaluating whether costs are as anticipated, or whether schemes are cost effective is difficult. Clearly there is a need for better information to inform the sector and build up a more accurate picture.

Where costs were known, the research highlighted that some schemes are running at a loss. In many cases this is due to operational costs being higher than anticipated, heat revenue being lower than expected or the systems operating inefficiently. Some SHPs passed costs on to residents whereas others did not.

[54] Bespoke analysis for this project conducted using the English Housing Survey 2014

A number of factors were reportedly driving down revenues and financial resources available to SHPs. These included rent reductions as a requirement of the rent review, ongoing cuts to local authority budgets and the right to buy stripping out rental income. In these circumstances HAs and LAs can be increasingly expected to look to DCCH schemes as possible assets to raise revenue through other means. These could include the sale of heat and electricity to new customers including non-domestic customers, maximising sources of possible subsidy such as available through the Renewable Heat Incentive, exploration of mechanisms to boost the overall efficiency of DCCH systems such as by connecting the system to other heat networks and connection to lower cost heat sources.

Calculating the heat tariff and billing method is pivotal to the business case as it will impact the revenue generated and therefore determine whether a scheme breaks even. The principles behind the tariff calculation differ between SHPs and are determined by the SHPs' objectives and drivers; for example, some have looked to essentially cap the fuel price to prevent fuel poverty, whereas others look to recoup all costs both marginal costs for a unit of delivered heat and capital costs for provision of the infrastructure.

Unfortunately little data was collected from case studies in terms of actual resident fuel bills: only five out of eight case study SHPs provided any fuel billing data and of those some were based on a small sample. In those cases where data was collected, it showed that residents were paying a lot less than the estimated costs generated by SAP. This could be due to underheating or due to limitations of SAP and the heating regime it assumes.

On the whole case study participants found their heating to be affordable, apart from in cases where a standing charge had been introduced and/or where heat provision was insufficient which had influenced participants' perceptions of affordability. Most participants had prepayment meters which were seen as a positive, due to supporting budgeting and the ease of topping up due to the number of top-up options available. However there were some issues with delays in meters topping-up and participants using the meter as a bank. Residents were generally comfortable having their landlord as their energy supplier, despite being unable to switch, with some stating that they do not want the task of shopping around and trusted their landlord to get a good price. However this could be a result of low awareness of communal heating.

Estimated fuel bills were used to model fuel poverty, since this is the methodology in which fuel poverty is measured. This shows that fuel poverty levels in all case studies were low under both the UK and Scottish fuel poverty definitions. Assuming an average level of income for a single pensioner household meant that no households in any of the case studies were estimated to be in fuel poverty under the 10% definition or the LIHC definitions.

This section indicates that more work needs to be done in terms of understanding the actual costs residents pay, and to compare this across a number of different schemes. Further analysis of heat charges would also be useful to understand the different charging regimes.

7. DISCUSSION AND CONCLUSIONS

What is DCCH trying to achieve?

The UK and Scottish Governments are promoting the uptake and expansion of DCCH primarily as a means of reducing CO_2 emissions, reducing consumer bills and alleviating fuel poverty. Other benefits, such as greater energy security resulting from DCCH systems being heat source agnostic, may also exist. This research found that SHPs are installing DCCH for similar reasons, with the provision of affordable warmth as a top driver. LAs are, or at least have been, driven to install DCCH to reduce CO_2 emissions and meet regulatory commitments (e.g. planning or building standards or energy efficiency standards). It was noted that the primary aims of schemes vary by the type of system (e.g. new-build or retrofit) and the organisation. Other motivations include reducing maintenance requirements, future proofing heat supplies or generating revenue. Little evidence was found of schemes being connected into wider local plans and infrastructure planning outside London.

Fuel poverty impacts

In terms of fuel poverty, this research found that none of the eight DCCH case studies were likely to have any residents in fuel poverty under either the English LIHC definition or the 10% definition (used in Scotland). However this may reflect the definition and calculation used to measure fuel poverty nationally which shows low levels of fuel poverty in dwellings heated by DCCH. This may be partially explained by the higher levels of energy efficiency in these dwellings. However the calculation relies on SAP modelling and this is known to have shortcomings in how DCCH is modelled; something that is being addressed in a recent consultation[55].

Data from this research would suggest that SAP over estimates the fuel bills in DCCH homes, as fuel bills obtained for the eight case studies were much lower than estimated in SAP. However, this may be more of a reflection on SAP than of DCCH since the bills from other heating systems were not measured. Therefore using the official definitions and measurements of fuel poverty, DCCH schemes are likely to have low levels of fuel poverty, especially in social housing, where energy efficiency levels tend to be high. But this is not inherent in the use of a DCCH solution. In the case studies, the analysis suggests that DCCH achieves marginal or no SAP score improvements over individual heating solutions such as gas boilers. It should be noted that the performance of DCCH schemes in SAP is important since SHPs may use it as a decision-making tool. This is particularly the case where they need to meet minimum energy efficiency levels for housing standards (e.g. Wales and Scotland) and design schemes that meet building regulations where designs must not exceed threshold CO_2 emissions rates.

Feedback from residents on affordability also provides useful insights. Focus groups conducted with residents in six schemes suggested generally that schemes were considered affordable, especially when compared to other systems. However in two cases it was not considered affordable; feedback was particularly negative where there was a high standing charge or perception was altered by heat being

---

[55] The consultation on SAP 2016 closed in January 2017. www.bre.co.uk/sap2016/page.jsp?id=3618

insufficient. Data on heat charges suggest these can vary a lot from scheme to scheme, which makes drawing conclusions on the affordability of DCCH systems more widely very difficult. Heat prices are influenced by many factors including the efficiency of schemes, how well they are managed and some factors which are unconnected with cost of heat generation such as policy decisions to place a price cap on heat costs to safeguard fuel poor residents.

Warmth, comfort and resident satisfaction

The ability of schemes to provide sufficient, but not too much, warmth is also important. Feedback on this tended to be quite positive, although again experiences from scheme to scheme varied and some residents complained of insufficient provision of heating. A more common concern was overheating; residents in three of the six case study schemes expressed that they felt that their dwelling or communal areas were too warm. In some cases this caused discomfort but the impact was largely that residents did not need to use their heating system, leading to bill savings. However, this is an important risk for SHPs to consider given the risks of increasing temperatures due to climate change and the vulnerability to temperature extremes of a disproportionate number of social housing residents, particularly the elderly.

Our research suggests that these problems are often the result of poor design, installation or breakdowns. However feedback from both residents and landlords highlights that many residents do not have a full understanding of how to effectively and efficiently use their heating, despite usually having been provided with advice. Whilst not unique to DCCH, this poses a risk to the success of schemes, particularly from residents' perspectives.

Other feedback from residents on living with DCCH was also relatively positive. Breakdowns were reasonably infrequent, although these and subsequent complaints could sometimes be handled better, with some residents experiencing significant problems. Further, the lack of ability to switch supplier was not raised as a major concern.

Carbon reduction impacts

The research aimed to identify whether carbon reduction was achieved in the eight case studies. Energy modelling using SAP has demonstrated that DCCH is predicted to have lower CO_2 emissions than almost all other comparator or previous heating systems, and in some cases very significantly so (up to 42%). However, SAP is a modelling tool and as highlighted above, has a number of limitations. Most notably it assumes heat losses of around 5% whilst stakeholder feedback and our own analysis show that these can be much higher, meaning the performance of DCCH may often be over estimated in SAP. It was out of the project's scope to measure the actual CO_2 emissions of schemes; however without sufficient metering and heat consumption data, it could not have been carried out.

Overall impacts of DCCH

Due to data limitations the research has found it difficult to draw firm conclusions on the fuel poverty and carbon reduction impacts of the eight case study schemes. Modelled data was not deemed to have the level of accuracy required (although a modelled analysis is a requirement of the fuel poverty analysis). Data on actual fuel bills and heat usage was requested from all case studies and only gathered from some, and even then much of it was partial and indicative. This highlights a potential sector wide problem that insufficient data is being collected or analysed in order to evaluate the impacts or efficiency of DCCH schemes. In this case the data was simply not sufficient to conclude on the impacts. Therefore a key finding is the need for more data to be collected on heat usage of schemes (including at a dwelling level), efficiency and cost effectiveness.

Clearly this is not something SHPs are universally incentivised, equipped or resourced to do and this needs to be made easier. This highlights a clear role for the Government, social housing sector and district heating industry. Understanding the impacts and effectiveness of schemes would greatly inform decision-makers and is likely to lead to better planning of schemes. Until more data is available, decision-makers will be reliant on tools like SAP, which is not currently well configured to compare DCCH-heated homes with alternatives. There is a potential role here for the Regulatory Delivery Office (RDO) that administers the Heat Network Regulations and therefore collects data. Wider Government and the district heating industry may be able to assist with this also.

However even if complete and accurate data had been available for all eight case studies it would have been difficult to draw wider conclusions as DCCH schemes vary so much in composition and type. Stakeholder feedback also suggests that the success of schemes has varied greatly from scheme to scheme so it is difficult to draw wide conclusions; however many SHPs believed that their schemes had delivered on their aims and stated that they would install DCCH again. Confidence in the DCCH sector needs to grow and this can only be achieved through greater monitoring and transparency of the real impacts of DCCH schemes.

Financing of DCCH schemes

A similar picture arises from analysing the financial aspects and cost effectiveness of schemes. Many SHPs stated that they had a poor understanding of the capital or operational costs of DCCH and little data was obtained from case studies. Whilst SHPs are not finding that this lack of data critically inhibits their management of schemes, it would surely be useful in order to evaluate current and inform future schemes. Although lack of financial information is an issue, 13 out of 28 respondents with schemes in operation (45%) had some (four) or all (nine) of their schemes running at a loss. This could be a concern especially given growing financial pressures on SHPs but some SHPs viewed DCCH as part of their service provision and did not appear to be overly concerned about this.

Barriers and success factors

Despite not being clear on the impacts of DCCH schemes, the research collected a large amount of data on SHPs' experiences of developing and delivering schemes. All schemes go through similar stages and this study has found a number of systematic issues related to the levels of skills and expertise in what remains a nascent district heating market.

Aspects of schemes tend to be interconnected; meaning the success of one aspect such as billing can impact other aspects. Much of this can be managed by, and is sometimes outsourced to, third parties but the success of this is reliant on good quality contractors, which are not always experienced in practice. Where SHPs manage aspects in-house they require sufficient expertise to do so; but anything they outsource still requires them to be able to correctly specify and assess tenders as well as to monitor and assess schemes as they are delivered to ensure compliance with contracted specifications are delivered. This can be a key challenge for SHPs without previous relevant experience. There is therefore a need to upskill those involved in developing and managing schemes, highlighting a need for training.

Key barriers to initiating or planning a DCCH project are the significant capital costs and many SHPs reported that their schemes would not have progressed without financial support for the capital investment such as Government grants or RHI. A lack of in-house skills or expertise is also a major barrier, and this persists as a problem throughout the development stages. Early work on developing a project can also involve engaging and working with multiple stakeholders including residents, leaseholders, investors or internal committees. Convincing these stakeholders of the benefits of DCCH is critical, yet is also hard to achieve given the difficulties encountered in this research.

Common issues experienced during the design and installation stages included: oversizing of schemes, poor quality contractors or lack of competition, poor communications between different contractors, poor main contractor leadership and unexpected costs. This can result in technical problems once schemes are operating, greater maintenance requirements or higher costs. It can also lead to higher heat losses and therefore inefficient schemes that will ultimately end up increasing costs for either the landlord or resident, or both. As noted, a number of landlord owned schemes were reported to be running at a loss as the landlord did not want to increase heat prices. There is a question as to whether these schemes are viable in the long term, especially given other financial pressures on SHPs.

It is also worth noting that some schemes have been installed for a number of years and given industry developments, there could be improvements in the quality of contractors and more competition. However the research focused mainly on SHPs' most recently installed schemes and therefore these problems continue to persist. Clearly there is a need for the sector to improve and also for SHPs to become better equipped at specifying and assessing work.

Feedback on the maintenance of schemes suggests this is often given insufficient attention and not planned in early enough in schemes. Yet organisations may lack the expertise or information to properly specify or cost in works to plan up front for this. An overall lesson is the need to plan and build in operation and maintenance at a much earlier stage. In addition there is a need to involve the various internal teams and external contractors who are involved, given that maintenance is linked both to scheme performance and efficiency, and residents' experience of schemes.

Another key challenge for schemes was engaging and educating residents, which was reported to be particularly challenging for new technologies such as GSHPs or when moving residents to a new billing or heating regime. Effective resident engagement was seen as critical to the success of schemes. SHPs were taking various approaches that included face-to-face advice (which was normally the preferred approach from residents), written information and social media, which was reported to be successful in enabling residents to support each other. Setting up a successful billing and metering regime was also viewed as important, and many different approaches were taken with no 'one size fits all' approach.

Despite these challenges it should however be noted that many SHPs were satisfied with the success of their scheme(s), with 21 out of 22 survey respondents stating they would consider installing DCCH again. This may partly be due to the fact that those SHPs will have been upskilled in the process and could utilise new skills and expertise in future schemes.

8. RECOMMENDATIONS

The following best practice recommendations are made to social landlords looking to develop DCCH schemes, and in some cases, those with existing schemes. These are based on the research findings and stakeholder input from a workshop held in November 2016.

8.1 Planning, early decision making and scoping

- **Identify aims of the project at an early stage with consideration of stakeholder and strategic objectives.** Carry out a structured analysis to understand stakeholders' needs and drivers (see DBEIS resources[56]). Create opportunities for stakeholders to make connections between the benefits of DCCH and their own objectives.
    - **Return to aims and drivers throughout the project** to keep stakeholders engaged and outcome-focused.
    - **Identify how the outcomes of the scheme can align with key aims** considering social, economic and environmental outcomes (such as affordable warmth and sustainability goals).

- **Engage stakeholders at an early stage and continue to liaise with them throughout the project whilst promoting scheme benefits.** This includes internal stakeholders (senior managers, board members, other departments), potential heat users (residents, leaseholders, commerce building owners) and potential subcontractors. This sustains political and organisational support, ensures that progress is transparent and timely, and that contractors are aware of their obligations. Review available support and guidance[57].

  Carry out an options appraisal to determine whether DCCH is likely to be the most effective option. This should include an assessment of the benefits, costs (capital, operation and maintenance) and risks. Judgements of the benefits of DCCH should factor in organisational appetite to become an energy supplier, development of new heat sources with potential to connect into the network and the possibility of future expansion. The latter may be particularly key to scheme viability.

- **Actively support the 'DCCH champion'** for example through: peer to peer learning forums; site visits to successful schemes; engagement tools to assist case-making; identifying key stakeholders at each stage of the development process, and creating tailored communications strategies[58].

---

[56] Draft guidance for heat network development
[57] For example through the Carbon Trust and the CIBSE Code of Practice.
[58] Some current examples exist such as The District Heating Vanguards Network run by Heat and the City

8.2 Design

- **Ensure the design engineer is CIBSE qualified and registered** and that the design is checked by someone who is CIBSE qualified to ensure that standards are being met.

- **Consider using one contractor for design and build, or ensure the main contractor takes responsibility for the management of the whole scheme,** with performance related contracts to ensure effective operation and minimise the risk of errors.

- **Include provision in the design tender to meet certain performance levels,** specifically relating to heat losses and operational efficiency of the main heating plant. This means that responsibility for efficiency lies with a contractor. It may be easier for the contractor to meet this if the contractor is responsible for design and build (see above recommendation). Also ensure that the designer produces a *detailed* efficiency estimate based on the proposed plant details and layout.

- If the scheme is designed by a third party and there are in-house designers, **make sure the in-house team is involved at an early stage.** If the scheme is designed by a third party but there *are not* in-house designers, there needs to be a **mechanism in place to maintain integrity throughout the design** (and installation) process. This could be achieved by getting an M&E consultant to provide oversight to ensure it is designed to standards.

- **Produce internal technical specifications.** These are useful for in-house design teams or for external consultants to follow to ensure that principles are adhered to. Lessons from previous schemes can be built in to inform future schemes.

8.3 Installation

- **Ensure the principal contractor has a technical lead on site.** This is likely to mean that any issues that arise will be dealt with swiftly and can help to prevent technical incompatibilities arising.

- **Employ a Clerk of Works or Quantity Surveyor to oversee the installation and put in place a quality management system.** This helps to ensure the work is carried out to specification and that, for example, hidden works such as underground pipes are installed to specification. The person overseeing the installation should have a good understanding of the range of work required for DCCH schemes and notify the contractor of any problems to support their resolution.

- **Ensure subcontractors are sufficiently qualified, experienced and briefed about the design.** Adherence to the CIBSE Code of Practice is important[59].

---

[59] The Association of Decentralised Energy (ADE) is currently creating a compliance scheme for the Code of Practice which should be live by the end of 2017.

- **Ensure effective communication with residents before and during and after installation**. Installing DCCH can be disruptive and therefore residents need to be informed about what is happening and how it affects them. It is recommended that the main contractor has a Resident Liaison Officer, a clear complaints process and an effective line of communication to the SHP to resolve any issues quickly.

- **Carry out a thorough handover process following the installation** including, wherever possible, testing elements of the system on site that may identify problems. Ensure that a comprehensive handover follows a thorough commissioning of the whole scheme.

- **Agree an extended defects liability period with the contractor/contractors as part of the original contract**. This provides a level of insurance for the SHP if any faults are noticed after a longer period of time.

8.4 Maintenance

- **Build in maintenance at the design stage and consider costs from the start** (see above), seeking input from the design and install contractors on the maintenance requirements. Ensure that the design and maintenance teams liaise to create and agree the plan and schedule (see below).

- **Set up a clear and concise maintenance schedule.** This means components will be replaced before they fail, preventing breakdowns and reducing costs. Several tools to facilitate this are available[60], e.g. a service engineer's programme that allows for real time tracking of plant and equipment degradation, service intervals and replacements.

- **Seek maintenance contractors who have experience and knowledge of the systems in use, or request they get manufacturer training.**

- **Develop maintenance contracts that incentivise energy efficient maintenance regimes.** Historically maintenance contracts reward contractors able to keep systems operational, serving heat for least cost to the contractor and the SHP. This sometimes results in outcomes which cause the system to be run inefficiently. Maintenance contracts can be designed to reward energy efficient delivery of heat to incentivise contractors differently.

- **Ensure clear demarcation between contractors to ensure clear roles and responsibilities.**

- **Link up efficiency monitoring with maintenance.** Set up a system to record and monitor efficiency data (i.e. using metering data) that informs the

[60] Such as SFG20

maintenance team. For example a drop in efficiency may indicate potential problems that need rectifying.

- **Maintenance should include frequent dosing checks**[61] to monitor the chemical make-up of the water. These should be scheduled in regularly to ensure they are carried out[62] (tools such as HEVASURE can assist with this).

- **Carry out performance checks regularly** (at least twice a year) to make sure that the system is running optimally under a range of conditions.

8.5 Monitoring systems

- **Review the scheme efficiency and performance after two years.** Evidence from the case studies suggests that two years is a sufficient period for any teething problems to have been resolved and for the scheme to be fully operational. This means any issues with design and install should have been identified and rectified. It is therefore an ideal point to review system efficiencies and identify whether the scheme has performed as designed, and whether efficiency levels specified in the design contract have been met . This data can help to refine the existing scheme and feed into the development of future schemes.

- **Continue to regularly monitor the scheme to identify performance and losses. Our findings suggest** that a major brake on the development of the sector is the absence of robust data on system performance (energy, financial, CO2) to allow informed decision making. So long as the costs and benefits of DCCH systems remain poorly understand there will always be justifiable reticence to invest in them. It would help if social housing landlords were provided with the software tools and guidance to facilitate this monitoring process.

- **Record data on the costs and revenue of the scheme** to monitor whether schemes are cost effective and to inform future schemes. In particular the costs of repairs and maintenance should be recorded in a transparent and accessible record.

- **Overheating needs to be better understood and mitigated**, especially in a context of increasing summer and winter temperatures as a result of climate change. SHPs should consider implementation of thermal safeguarding systems and better monitoring of temperatures in real time to assess risks and take remedial action[63].

[61] The addition of chemical additives to both the district network and distribution systems in the properties to main system effectiveness and efficiency.
[62] Tools such as HEVASURE can assist with this
[63] See Heatwave Plan for England at: www.gov.uk/government/publications/heatwave-plan-for-england

8.6 Cost effectiveness and finance

- **Have a contingency budget for installation to cover unforeseen costs**. Consider building in some contingency for maintenance costs.

- **Take a whole life costs approach to investment and system design.** This will generally, but always favour an 'invest to save' solution - invest more in the upfront costs to save over the longer term. For example, as mentioned above, invest in a well-designed scheme that is easier and therefore cheaper to maintain; this will save money in the long term.

- **Identify realistic operational and maintenance costs and build these in at the feasibility stage.** The research suggests this is often not done in sufficient depth or to account for unexpected events such as breakdowns.

- **Take into consideration other project costs which often go unnoticed** such as staff development time and costs, costs of engaging stakeholders, providing resident advice and upskilling staff.

- **Design a charging and billing system that is based on residents' needs** and fulfils the project's aims. For example if the scheme aims to provide affordable warmth, it is critical the tariff is affordable enough to prevent residents facing underheating or using plug-in heaters.

8.7 Resident engagement

Resident engagement is crucial for the success of a DCCH scheme, especially since the aim of many schemes is primarily to ensure a better heating system for tenants. Outcomes for customers must be guiding principles from the planning phase all the way through to ongoing operation. DCCH schemes are not common in the UK and even though the use of them for residents may not be that different to standard central heating systems, their installation represents a substantial change to someone's home. Supporting people to get the most out of the scheme is essential, especially for vulnerable residents.

- **Provide easy-to-understand advice and information to residents** covering:
    - how to effectively use the heating system, including how to avoid overheating as well as underheating;
    - how the billing system works, including a breakdown of charges such as standing charges and unit costs.

- **Train a variety of frontline staff in the heating system to ensure that they are able** to provide advice and answer questions from residents. Make sure that the advice staff and external contractors offer is consistent in order to avoid confusion and build confidence. Also consider how advice services can be linked up to wider internal or external advice services, for example, around energy use, benefits checks and budgeting.

- **Face-to-face advice is recommended as the most effective form of providing advice** and effective for demonstrating how to use the heating system.

Time should be built in to make sure residents trial the controls themselves whilst the advisor is present. It is particularly recommended for vulnerable residents who may need follow-up visits.

- **Other types of advice provision should be provided or encouraged to engage with different users and minimise costs** for example, advice sheets or instruction videos. DCCH schemes are inherently communal in their nature. Maximise opportunities for neighbours to support each other through social media or energy champion projects where residents advise each other.

- **Install user friendly and easily accessible heating controls and meter displays.** However bear in mind that what is 'user friendly' will depend on the type of residents (e.g. elderly people, young people). Consider the visual characteristics of the controls and dexterity of the users.

- **Set up an effective complaints handling process.** This should include a dedicated point of contact for complaints and queries. Ensure residents are aware of this. Complaints should be handled in a timely and consistent manner and communication maintained throughout the process.
    - It may be that a third party is the best first point of contact. In this case make sure there is a contractual arrangement for monitoring complaints and a protocol for the landlord to pass on complaints and explain the procedure to residents.
    - An independent dispute resolution service should also be adopted[64].

- **Throughout, consider how shared or private owners are engaged with alongside tenants**, for example, around billing and charging arrangements. It is particularly important to develop an engagement strategy for leaseholders, especially where there are high numbers of them.

- **Set up a policy for dealing with debt and disconnections.** Ensure effective liaison and communication between the landlord and third party, where this exists. SHPs could more proactively monitor the levels of debt amongst their residents. Additional support should be provided to vulnerable residents to avoid debt and disconnection.

- **Gather feedback from residents about the scheme** such as whether they find it affordable, easy to use, provides a comfortable level of heat and to get feedback on the payment systems. This will help to: identify any improvements that can be made, evaluate whether the scheme has achieved its intended impact and help inform future schemes. Feedback could be gathered through surveys or focus groups.

- **Consider implementing thermal safeguarding processes.** Monitor under use of heat and overheating risks at the dwelling level and, with the necessary

[64] Members of the Heat Trust use the Energy Ombudsman.

consents in place, Support interventions as necessary, e.g. with advice on keeping warm or avoiding waste. Smart metering of heat will facilitate analysis of data for safeguarding and also allows a near real time response if alarms and triggers are built into the analytics.

- **Wherever possible, consult tenants about the design and set up of the scheme.** This encourages buy-in and ensures that elements of the scheme (such as payment systems) are set up in a way that most suits residents.

- **Ensure residents of new-build schemes have sufficient information to make an informed decision before they sign up to the property.** This is an ideal opportunity to explain to residents the differences between gas boilers and DCCH schemes.

8.8 Recommendations for Government

- **Improve the accuracy of the SAP methodology.** A 2016 SAP consultation has recently completed to review its methodology. Notable issues and recommendations with regards to DCCH relate to:
    - Changing the assumption of 5% for distribution heat losses to a more accurate figure. Moreover, it would be even more beneficial to have the option to enter calculated heat losses for each scheme. Such an approach would put the onus on the design team to apply good design principles to reduce calculated heat losses and ensure CO_2 reductions are achieved in practice. It would also reduce residents' heat bills due to less wasted heat.
    - A more detailed analysis should be made with regards to how SAP assumes tenants heat their homes as it is very assumptive and may be outdated.

- **Review planning policy nationally and locally to promote DCCH and encourage DCCHs to expand where it is best suited.** Planning policy has not been a key focus of this research. However if the Government wants to increase the uptake and expansion of schemes, then planning policy is a key framework to do this. However as per this suite of recommendations, better evidence of the beneficial impacts of DCCH schemes is needed to engage stakeholders and support expansion.

- **Support SHPs, especially HAs, to connect to wider networks.** There is little evidence of this happening outside London but HAs are not always equipped to identify and pursue these opportunities irrespective.

- **Increase regulation so that owners of DCCH schemes have to monitor how well their schemes are performing** (potentially through an ongoing compliance scheme). A key challenge encountered in this research was the lack of available or accurate data on DCCH scheme performance, and this hampers confidence in the sector. The Heat Network (Billing and Metering) Regulations will increase metering throughout schemes. However Government should review how this data can be collected effectively and maximised to support understanding of scheme outcomes.

- **Consider introducing stipulations into funding to ensure DCCH owners carry out more monitoring**, including the finances of schemes.

- **Consider how decision-making regarding DCCH can be best facilitated.** Decision making for DCCH schemes can be difficult because a long-term, strategic view is needed on a reasonably large geographic area. This can be difficult given short term election cycles in LAs and small-level governance structures. National and local Government should proactively consider how the strategic view required can be obtained and decision-making thereby facilitated. There is a key role in this for city regions and local enterprise partnerships (LEPs).

- **Consider how HAs could access low cost finance, similar to what is available to LAs.**

- **Create and refine tools, support, guidance and training, and make sure these are accessible to SHPs and other stakeholders that need them.** This is a joint recommendation to the Government, district heating sector, social housing membership bodies and other key stakeholders. A key finding of this research is the lack of expertise, experience and skills required to develop projects both within SHPs and other stakeholders, such as LA planners. Many forms of support are already available and it is critical SHPs are made aware of these. However it is suggested further tools and guidance are required regarding:

    - Engaging with stakeholders, such as those that need to be connected to the scheme. Guidance should include how to identify the different needs and agendas of stakeholders, and how best to communicate with them
    - Writing the specification for maintenance contracts
    - Support with connecting to wider DCCH networks
    - Carrying out economic appraisals of schemes that can be used at an early stage of development to inform choice of business models
    - Indicative costs for developing and delivering a scheme particularly around maintenance and operational costs
    - Case studies
    - Tender procurement
    - Better means of estimating heat demand for feasibility studies

- **Promote technical standards (CIBSE Code of Practice)** for example as a funding stipulation.

- **Promote customer service standards** for example by stipulating recipients of Government funding must join the Heat Trust.

8.9 Recommendations for social housing membership bodies

- **Facilitate more peer-to-peer learning**: as outlined above it is essential for SHPs to learn from each other and share experiences. Other organisations have a role to play in facilitating this including through conferences, case studies, bringing together stakeholders and other forms of peer to peer learning[65].

- As listed as a joint recommendation under Section 8.9, **create and refine tools, support and guidance for SHPs.**

8.10 Recommendations for district heating sector

- **Invest in client support**: many SHPs are inexperienced at delivering DCCH schemes and need support to ensure effective delivery in a whole range of areas including design, installation, financing and resident support. It is in the interests of the wider industry that DCCH schemes are successfully installed so that the benefits can be realised and more schemes installed.

- **Ensure guidance on specifying feasibility and design work is fit-for-use and SHPs are aware of it.** Landlords need support to understand how to correctly specify and then check analysis robustly. Such support is available through the CIBSE Code of Practice 1 guidance.

- **Develop a compliance scheme to ensure CIBSE Code of Practice is adhered to.** The CIBSE Code of Practice is voluntary and SHPs need confidence that contractors involved at various stages of scheme development are technically qualified, experienced and carrying out works to industry standards[66].

- As listed as a joint recommendation under Section 8.9, **create and refine tools, support and guidance for SHPs.**

- **There is a need for standardised and robust methods of monitoring and reporting heat production and consumption**. There is a potential role here for the Regulatory Delivery Office (RDO) that administers the Heat Network Regulations and therefore collects data. Wider Government and the district heating industry may be able to assist with this also.

---

[65] This is already done in a number of ways such as The District Heating Vanguards Network and through sector bodies; however more learning and sharing is needed.

[66] The Association for Decentralised Energy (ADE) are in the process of establishing such as scheme as a mechanism to ensure that a Heat Network is designed, built, commissioned and operated to the minimum standards specified by the code. It is hoped that the scheme will be operational by the end of 2017.

8.11 Areas for further research

There are a number of areas in which further research is recommended:

- The business plans developed by social landlords. What level of detail do these go into? Are they adequate, effective and useful? What further support do landlords need?
- Understanding how tariffs are set i.e. what is and isn't included in variable and standing charges. In addition, how these vary across schemes in the UK. This could lead to the development of appropriate benchmarks.
- Understanding the levels of debt in schemes and whether this is a problem.
- Further monitoring and evaluation of the impacts and efficiency of schemes. This includes monitoring of the technical performance of schemes and typical heat losses and further assessment of the cost effectiveness of schemes.
- Greater understanding of the wider socio-economic and environmental impacts of DCCH schemes at local and regional levels.

This research report was produced by Changeworks in partnership with the Centre for Sustainable Energy. Research funded by the Joseph Rowntree Foundation.

Changeworks 36 Newhaven Road Edinburgh EH6 8AR
Visit www.changeworks.org.uk Call 0131 555 4010
Email consultancy@changeworks.org.uk

Follow us on

Changeworks ~ 30 years of inspiring change for people and the environment

This publication is available online at www.changeworks.org.uk