NATIONAL HOUSING FEDERATION
london

Lifetime costs of installing renewable energy technologies

A guide for housing associations

business for neighbourhoods

helping householders, businesses and communities
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Summary

This guide was commissioned by the Development Group of the National Housing Federation's London region. It provides information to housing associations about the lifetime costs and implications of installing low and zero carbon (LZC) technologies.

Housing association development teams are facing increasingly challenging design targets set by government and funding bodies for incorporating LZC technologies in new developments. The guide looks beyond hitting these targets and focuses on the long term costs and implications of incorporating these technologies for all concerned. It does not make specific recommendations over dealing with these costs but instead passes on lessons learned from best practice case studies.

Housing associations have a tremendous track record of ensuring residents are provided with good quality, affordable homes. This guide assesses ways in which housing associations can make this achievable while incorporating LZC technologies, but it also addresses the barriers and challenges which may arise as a result of designing homes to meet LZC technology targets. Using research and real examples, it addresses the following areas:

- Specification and procurement
- Commissioning, handover and post-occupancy evaluation
- Considerations for housing managers
- Considerations for residents
- Specific costs and considerations for a range of LZC technologies.

LZC technologies should only ever be considered after a development has been designed to be as energy efficient as possible.

Challenges

The study has found a number of challenges which housing associations face when incorporating LZC technologies into new developments. Many of these involve the increased capital and operational costs of developments which incorporate LZC technologies. There are also key management issues that must be addressed to ensure LZC technologies are successfully incorporated into new developments.

The following challenges are addressed within the guide:

- Determining total lifetime costs of LZC technologies, from capital and installation, through to ongoing management
- Recovering costs within the constraints of rent caps and the fuel poverty agenda
- Bridging the gap between designed performance and real in-use performance through commissioning, education of residents and staff, and post-occupancy evaluation and feedback
- Developing ongoing maintenance strategies for new technologies
- Metering and billing for heat and electricity
- Developing the knowledge of housing associations and residents to maximise the benefits of LZC technologies for all.

Lessons

'Fit and forget' LZC technologies do not exist for housing associations. The key lesson of this guide is that LZC technologies require ongoing management and changes to behaviour if they are to succeed in reducing carbon dioxide, fuel bills and management & maintenance costs.

Housing association staff and residents must understand the technologies in order to benefit from them, so ongoing monitoring, education and advice is crucial.

In many cases, the reduced fuel bills predicted as a result of LZC technology installation can be eroded by increased burdens on management teams, servicing, maintenance, and replacement costs. These costs must be identified at an early stage as they have the potential to influence the overall feasibility of a project. The challenges of paying for new billing systems in order to charge residents for heat and electricity must also not be underestimated. The conflict between rent caps and increasingly challenging LZC technology targets means that housing associations are in the difficult position of having to achieve more with restricted resources.

Despite these significant challenges, housing associations are successfully delivering cutting-edge, comfortable and affordable homes by building energy efficient homes with well specified and installed LZC technologies that residents understand.

The introduction of feed-in-tariffs (FiTs) and the renewable heat incentive (RHI) will help to make technologies more economically viable. When combined with the rapid development of knowledge and professional skills within housing associations and their design and construction partners, residents will increasingly stand to benefit from well designed and specified homes.

Conclusions

The following list summarises the key messages and conclusions from this guide:

- The primary focus of any project before LZC technologies are considered must be energy efficiency
- Housing associations are increasingly taking on a new role as energy providers. In order to do this, significant knowledge development is needed to provide quality services to residents
- Design teams must consider the full lifetime costs of LZC technologies before specifying them
- It is wrong to automatically assume that LZC technologies will always reduce running costs for residents and housing associations
- Good design, specification and installation are essential, but this will be wasted if residents and housing association staff do not understand how to use the technology. Simple controls are vital
- The ongoing maintenance, servicing and replacement costs of some installations may be so high that they cannot be recovered through currently allowed net rent levels.
- The costs of billing and metering for heat and electricity from communal heating systems must be reduced in order to provide competitive charges equivalent to those of homes with individual gas boilers
- Greater cooperation and understanding between contractors, development teams, wider housing association management and residents is needed to ensure that the overall goals of carbon dioxide reductions and affordable running costs are achieved.

The full guide is available on www.housing.org.uk/london.

1 Introduction

1.1 Going beyond design

This guide goes beyond simply designing systems to meet targets. It covers some of the unique challenges that housing associations face in managing low and zero carbon (LZC) technologies throughout their lifetimes and will focus on ways to consider and optimise the real impacts LZC technologies have on the lives of residents.
The guide is not intended to cover every practical consideration for all LZC technologies, but highlights the processes that housing associations should go through to ensure an integrated approach to incorporating LZC technologies is taken, considering resident needs, housing management requirements, income streams and costs.

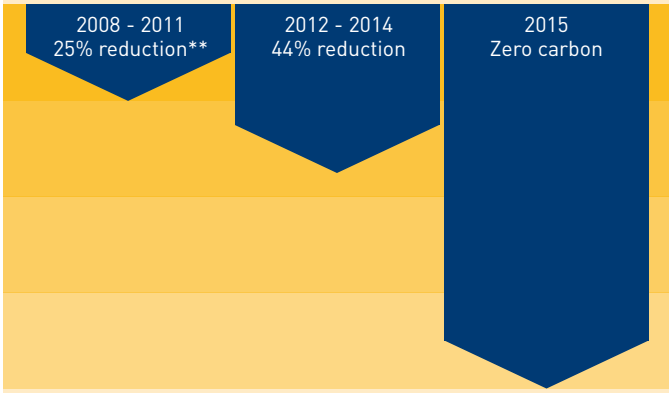
Housing association design teams have led the way in incorporating LZC technologies in new developments over the past five years. Increasingly challenging targets are being set by funding bodies and planning authorities which require significant carbon dioxide reductions and on-site energy generation from LZC technologies. Good design and installation is crucial in achieving these targets and is addressed in the National Housing Federation's publication, 'Renewable Technologies: A guide for housing associations'[1].

1.2 Covering all needs

Good design and installation of LZC technologies should always be combined with a primary focus on reducing carbon dioxide emissions and fuel bills through energy efficiency.

This is a large step towards achieving real savings, but energy use can vary by over 250% between homes with identical energy specifications and standards of installation[2]. The interaction between residents and LZC technologies will have dramatic impacts on the savings they achieve and should be a focus not only of design teams, but of all resident-facing staff throughout the lifetime of the technology.

Homes and Communities Agency Code for Sustainable Homes CO_2 emissions requirements*



- 2008 – 2011: Level 3 (25% emissions reduction*)
- 2012 – 2014: Level 4 (44% emissions reduction)
- 2015: Level 6 (Zero carbon)

*Provisional only. Currently under consultation by the Homes and Communities Agency.
**Improvement on regulated emissions compared to 2006 Building Regulations Part L requirements.

Housing associations must consider all costs from the initial stages of a project through to its ongoing management. It is a myth that all LZC technology installations will result in cost-savings for housing associations and residents, but early consideration will allow for better management of these costs. Capital costs, design and installation, ancillary equipment, metering and billing systems, maintenance, fuel procurement and replacement requirements must all be considered. Doing this early in the design stage will increase the chances of them being dealt with cost-effectively and transparently accounted for in rents, service charges and fuel charges.

Figure 1-1 gives an example of some of the interdependencies between design teams, residents and the wider housing association

[1] Available to download from: http://tiny.cc/q9qdf
[2] Demonstrated through energy monitoring at Angela Carter Close, a Metropolitan Housing Partnership low energy housing development. See page 34 for more details.

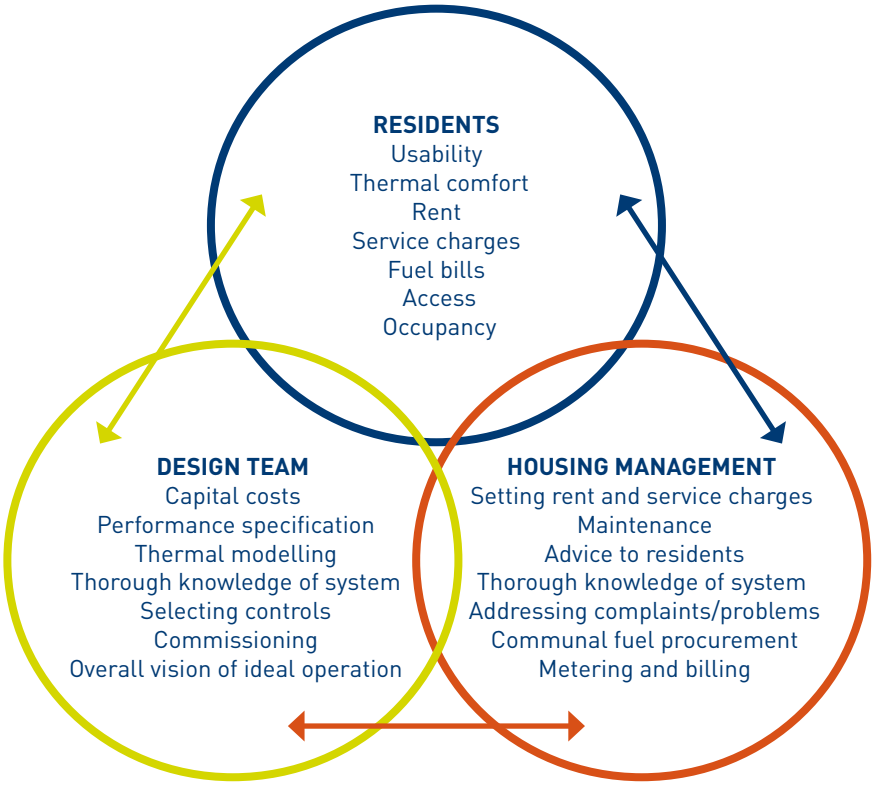


Figure 1-1 Interdependencies in LZC technology projects

management teams that should be considered in all projects and are addressed throughout this guide.

This guide begins by outlining the wide range of issues and implications in relation to LZC technologies. These include the following specific areas:

- Specification and procurement
- Commissioning, handover and post-occupancy evaluation
- Issues for housing association managers
- Issues for residents.

It will then provide guidance specific to the following technologies:

- Solar photovoltaics
- Solar thermal
- Ground source heat pumps (GSHP)
- Air source heat pumps (ASHP)
- Wind turbines
- Mechanical ventilation with heat recovery (MVHR)
- Communal heating systems and private wires
- Gas-fired combined heat and power (CHP)
- Biomass heating systems.

The guide is intended primarily for new build developments, but many of the principles can easily be applied to existing stock refurbishment projects. The primary goal should be the same: to provide an excellent service to residents, delivering carbon dioxide and energy savings in the most cost-efficient way possible.

Wherever possible, the guidance is based on real figures and experiences of housing associations who have already been through the challenging process of managing LZC technologies in new developments. Specific examples are given at the end of the document as case studies.

2 Specification and procurement

2.1 Introduction

The specification and procurement of LZC technologies will have significant effects on all areas of a project. Intelligent specification and procurement of technologies should cover all of the following areas:

- Design and build costs
- Resident satisfaction
- Fuel bills and procurement
- Commissioning
- Maintenance and servicing
- Upgrades and replacement
- Metering and billing.

Extra or hidden costs, or compromises on quality of equipment and installation, are far less likely to occur if the housing association has made their priorities absolutely clear and outlined the standards that they apply to the procurement and installation of each LZC technology and its auxiliary equipment.

The level of housing association involvement in the specification and procurement of technologies for new homes varies due to factors such as organisational awareness and contract type. For schemes acquired under Section 106 agreements, the housing association typically has little involvement in specifying equipment. This can lead to a disconnection between the needs of the housing association and its residents, and the aims of the developer. The same may apply to design and build contracts unless the housing association takes an active role in specification. Clearly defining the needs of the housing association and its residents in these situations is crucial to ensuring the housing association can deliver a quality service after handover.

A case study of supply chain development for LZC technologies by the Create Consortium can be found on page 32.

2.2 Design and build costs

By specifying LZC technologies early in the project as part of a broader building or site-wide energy strategy, the technologies can be fully integrated into the design and reduce expensive revisions of designs or poor specification of technologies due to 'designing out' options.

Being clear on exactly what the design requirements and priorities for the scheme are will reduce unexpected costs and time delays later in the project. These requirements should be detailed enough to ensure that all contractors are following the same specifications in their bids. This will encourage greater transparency of costs, and allow development teams to compare similar bids more accurately. Some examples of factors often overlooked at the specification stage include:

- Heat meters
- Billing systems
- Controls
- Monitoring equipment
- Space for cylinders and expansion vessels
- Fuel storage space and access for biomass fuel deliveries.

The more specific the requirements of the housing association at the outset, the less chance there will be of unexpected increases in overall project costs due to LZC technologies and their ancillary requirements.

2.3 Resident satisfaction

Providing a comfortable living environment with affordable energy costs should be the first consideration when specifying and procuring LZC technologies.

Specification of good quality equipment will help to achieve this goal by providing higher efficiencies, greater outputs, fewer defects and potentially lower maintenance requirements.

The specification of control systems should be a priority as this is the main

interface between the resident and the technology. Poor functionality or lack of understanding due to unnecessary complexity may lead to higher fuel bills and reduced thermal comfort which will severely reduce overall satisfaction.

A good understanding of the products available will enable the design team to select the most appropriate technologies for the building and its residents. Clear information should also be passed on to the residents to ensure they receive the maximum benefits of any technology installed.

2.4 Fuel bills and procurement

Full life costs should be considered. Capital cost is critical, but should not obscure the impact on running costs to residents in the form of fuel bills, maintenance and service charges.

Increased fuel costs can be caused by poorly specified technologies, such as MVHR in a home with high air permeability, or using inefficient ASHPs where a high efficiency gas boiler could have been installed instead.

When specifying biomass systems, early consideration of fuel supply chains should be a priority. Availability, quality, and cost of fuel should be considered as part of the initial feasibility assessment as these three factors will have significant impacts on the system performance and running costs (see page 30 for further details).

2.5 Commissioning

Commissioning requirements should be identified as part of the overall specification. This should clarify the time requirements, whether seasonal commissioning will be included as part of the main contract, roles and responsibilities, whether provision of specialised equipment for commissioning will be included as part of the contractor's contract and aspects such as access to the technology and requirements for monitoring and metering.

The complexity of the technology will often determine the level of commissioning necessary. Simple systems with which the housing association is familiar may be commissioned before handover is complete, whereas more complex systems, such as MVHR systems, may require seasonal commissioning to be carried out post-handover.

Metering and monitoring can be used to verify that the technology is functioning as designed, identify and rectify inefficiencies in the operation of the system and, for communal heating systems, play a key role in the accurate billing of residents for heat. Monitoring can also provide valuable information to residents and provide data for future decision making. Meters and monitoring equipment should be specified early in the design process to ensure it is adequately budgeted for and included in the mechanical and electrical design.

2.6 Maintenance and servicing

Good specification and procurement can have several positive impacts on the maintenance and servicing requirements for LZC technologies. Warranty requirements should be specified for each technology to be procured, minimising the need for unplanned maintenance due to defective equipment.

Asset management and maintenance teams should be directly involved in the decision making processes behind specification and procurement to ensure maintenance requirements can be dealt with effectively.

A consistent policy for procurement of equipment will standardise the range of manufacturers and products used across stock. This can reduce the maintenance burden of providing additional training to in-house maintenance staff and subcontracting to external maintenance companies.

Different products will have different service intervals. More frequent servicing may increase the ongoing costs to the housing association and result in greater disruption to residents. This should therefore be a key consideration when specifying any technologies.

The ability of both present and future residents to carry out basic maintenance tasks, such as cleaning filters in MVHR systems, should also be

a key consideration when specifying technologies. The technology should always suit the likely resident profile.

2.7 Upgrades and replacements

Considering the costs and practicalities of upgrading or replacing technologies or components is a crucial part of the specification and procurement stage. It should be confirmed that a supply chain is in place for parts and components of LZC technologies for the lifetime of the equipment. Particular care should be taken when specifying any technologies requiring manufacturer-specific replacement parts.

The costs involved need to be estimated at an early stage in order that they can effectively be accounted for in depreciation or sinking funds (see page 21). Transparent breakdowns of costs for equipment and installation by the contractor will make accuracy more achievable and prevent any shortfalls or over-collection of funds or charges.

High initial capital costs will not always translate to high replacement costs. Some technologies, such as GSHPs, have relatively low replacement costs compared to their initial capital and installation costs. In this case, a significant part of the initial cost is due to equipment and installation which will not require replacement, such as ground loops.

2.8 Metering and billing

Metering and billing systems, particularly for communal heating and private wire networks, should be clarified in the specification.

2.8.1 Heat

Accurate metering and billing will require a range of equipment including dwelling interface units, heat meters, remote metering transmitters, central energy meters in the plant room and prepayment card top-up equipment. The heat meter specification can strongly influence the options for subcontracting of billing and metering, so the ongoing costs of these services should be considered as part of the meter procurement.

2.8.2 Electricity

Metering and billing for electricity is often necessary where renewable or low carbon electricity is generated on-site. Where electricity is to be exported to the grid, or where FiTs are sought, suitable generation and export meters should be specified.

Private wire networks, where the landlord owns all electricity distribution equipment between the main wires supplying the site and each home's individual electricity meter, enable landlords to sell electricity generated on site to residents. The cost of installing and operating private wire networks is often significantly more than when distribution network operators (DNOs) install and own the meters and wires (see page 30 for further information).

2.9 Energy Service Contracts

For larger projects, turnkey solutions can be provided by energy service companies (ESCos). These can be external specialist companies, or a sub-company of the housing association. A typical ESCo will be responsible for the following:

- Design
- Procurement
- Installation
- Commissioning
- Metering
- Billing
- Maintenance.

Discussions with potential ESCos should occur very early in the design process to confirm the impact on capital and operational costs. The scale of the project will have a significant impact on the feasibility of an energy service contract, with ESCo operational costs often meaning that only solutions for larger projects will be competitive.

Even where an ESCo is appointed to oversee the specification and procurement of LZC technologies, close participation of the housing association is crucial. It is essential to ensure the residents and the organisation receive value for money both in the procurement of the energy service contract and its implementation thereafter.

Checklist of considerations for specification and procurement

	Key considerations	Consultees
Sustainability targets	• Are there requirements for LZC technology energy on the scheme? • Are there energy efficiency targets? • Will the targets be met using the proposed technologies and energy strategy? • Can the targets be exceeded within the project budget?	• Local authority • Funding bodies • Internal strategies • Energy specialists/engineers • Development management
Maintenance and servicing	• What is the frequency? • What are the access requirements? • Can it be carried out in-house? • What are the costs of external maintenance contracts? • Is there a reliable supply chain for parts and replacements? • Can it be added to an existing maintenance contract? • What is the anticipated lifetime and replacement costs of the LZC technology?	• Asset management • Maintenance teams • Specialised maintenance contractors
Warranty	• What is included/excluded? • What is the length of cover? • Is an optional extended warranty desirable? • Can anything invalidate the warranty?	• Manufacturers • Framework/preferred suppliers
Resident satisfaction	• What are the estimated running costs (fuel costs and standing charges, net rent, service charges)? • Is the system simple to use and control? • Will the system provide adequate thermal comfort? • What will be the visual impact of the technologies? • Is noise attenuation required? • Are there any specialist needs within the likely resident profile? • Will access for maintenance disrupt residents and require housing managers to book appointments?	• Residents • Housing managers • Any resident-facing staff
In-use performance	• Is independent data available on the performance of the product? • Have similar products already been installed in other schemes? • Are there recommended industry standards/accreditations for the technology?	• Other development assets and housing management teams • Residents • Microgeneration Certification Scheme (MCS)[3] • Renewable Energy Assurance Limited (REAL)[4] • Combined Heat and Power Quality Assurance scheme (CHPQA)[5]
Fuel costs	• Is gas available at the site? • What is the best value fuel for the development? • Is there a reliable local source of wood fuel for biomass boilers?	• Utility companies • Distribution Network Operators • Local wood fuel suppliers • The Biomass Energy Centre[6] • The National Energy Foundation's Log Pile website[7]
Commissioning	• Is the system being 'designed for commissioning'? • Is specialist monitoring equipment required? • How much time is required to fully commission the system? • Is seasonal commissioning required? • Will post-occupation evaluation be carried out?	• Commissioning managers • Contractors • Manufacturers • Housing management
Billing and metering	• Is individual billing and metering required? • Will this be carried out in-house or subcontracted? • What equipment is required? • What are the additional costs of this equipment? • What are the standing charges for metering and billing? • Can the meters installed be used by organisations other than the one who supplied them?	• Housing management • Asset management • Mechanical and electrical engineers/ designers

Table 2-1: Specification and procurement checklist

[3] www.microgenerationcertification.org
[4] www.realassurance.org.uk
[5] www.chpqa.com
[6] www.biomassenergycentre.org.uk
[7] www.nef.org.uk/logpile/

3 Commissioning, handover and post-occupancy evaluation

3.1 Introduction

The commissioning and handover of LZC technologies bridges the gap between the design and installation of systems, and the in-use performance of those systems. Commissioning ensures that the system has been installed as the design team intended. Handover procedures ensure all relevant information is conveyed and understood by those who will be interacting with the systems, including maintenance teams, housing officers and residents.

Well managed processes significantly increase the chances that LZC technology will perform as expected, and can save valuable time and resources troubleshooting at a later date. Post-occupancy evaluation (POE) goes further than traditional handover procedures and involves dynamic measures to monitor and optimise the performance of systems when in use.

A case study of The Hyde Group's work on commissioning CHP and communal heating systems can be found on page 44.

3.2 Commissioning strategies

3.2.1 Commissioning issues

Commissioning should be integral to the project and not be an afterthought in the overall project planning phase. This can result in inadequate time and resource being allocated. The project timetable should include clear allocation for commissioning and this should not be eroded by other delays in the project. A project team member should be appointed early in the design stage to take overall responsibility for commissioning.

3.2.2 Aims of commissioning

The overall aims of any commissioning programme should be clear to the design team and include the following points:

- The system is safe and compliant with all statutory requirements
- All equipment is as specified in the design.
- Installation has been carried out to the required standard
- Operational performance is as designed and equipment is adjusted to optimise performance
- Controls are properly calibrated
- The system does not conflict with other building services (eg heating and cooling)
- Faults are identified and rectified
- Adequate records of all commissioning activities are kept.

These requirements apply to all systems installed regardless of their complexity.

3.2.3 Planning for commissioning

From the initial design stages, commissioning should be a priority of the design team. Responsibility should be allocated for the commissioning programme, considering all issues outlined on this page. It is important that one point of contact remains for the entire commissioning programme to ensure an integrated programme, covering all LZC technologies and their interdependencies with other building services. Any works or testing being carried out on building services should be coordinated through the overall commissioning manager to ensure that good records are kept of any alterations to, or impacts on, the LZC technologies.

3.2.4 Commissioning stages

The following stages must be considered when planning the commissioning of LZC technologies:

- **Designing systems for commissioning:** this will include basic requirements, such as access to all areas of the LZC technology to be commissioned through to technical requirements such as meters and feedback displays which will monitor fuel consumption and outputs.

- **Appointing specialist commissioning managers:** will be necessary for complex systems. A specialist commissioning manager should be appointed at the design stage and asked to provide input into the overall design of the system as well as final performance testing and commissioning.

- **Programming of commissioning:** must be undertaken by the member of the design team with overall responsibility for commissioning. This programme should be flexible, but uncompromising on the overall time allocated to the commissioning of each LZC technology. Inspections during installation, upon project completion and, where necessary, following occupation of the homes. Coordination of commissioning of different systems is crucial to avoid time delays and potential conflicts between systems; for example, commissioning of a heating system before a mechanical ventilation system has been switched on.

- **Pre-handover commissioning:** should take place only when all construction which may impact on the performance of the technology has been completed. Adequate time must be allowed to test the system in full, and make any adjustments necessary to ensure that the system performs as designed.

- **Post-handover seasonal commissioning:** particularly important for more complex systems and any technologies with which the housing association is unfamiliar. Commissioning over a minimum of 12 months allows the performance of LZC technologies to be assessed under a wide range of conditions. POE is discussed in more depth on page 16.

- **Re-commissioning:** crucial if any changes are made to the LZC technology or any other parts of the building that may affect its performance. The commissioning manager should be responsible for identifying if and when re-commissioning is necessary.

3.3 Handover

Pre-handover is by far the best time to obtain all relevant LZC technology information as the housing association still has easy access to everyone who designed, procured, installed and commissioned the system. All practical and technical information on how best to use and maintain the system can be gained at this stage. Issues covered must include the following:

- Key contacts and information sources
- Documentation
- Maintenance and servicing requirements and schedules
- Use of controls
- Troubleshooting guides and procedures
- Ensure a guide is produced for tenants
- Training for housing managers on advising residents about the LZC technology.

3.3.1 Capture of information

The housing association should ensure that adequate systems are in place to capture the information outlined in Table 3-1.

Key contacts	Who should the housing association contact if a problem or question relating to the LZC technologies cannot be answered in-house? Is there a telephone helpline for residents? Will the contacts change after the defects or warranty period has expired?
Installation details	To cover: Main contractor Installer Manufacturer and product details Commissioning programme Installation and commissioning dates As built drawings detailing the design
Defects and warranties	What is the period covered? Are there any notable exclusions of cover?
Documentation	Have all relevant Operation and Maintenance manuals been handed over? Have commissioning and re-commissioning records been provided? Have non-technical user guides been provided for residents and non-technical staff? Can information be provided in alternative formats (eg large type, Braille, other languages)?
Training and demonstration	Has any training for housing association staff and residents been provided? Can maintenance training be provided for housing association maintenance teams?
Maintenance and servicing	What are the planned maintenance and servicing requirements for the system? When is the first planned maintenance/service visit due? Who is responsible for planned maintenance and servicing? Who should be contacted for unplanned maintenance?

Table 3-1: Key handover questions and information

A template handover summary sheet has been provided in the Appendix on page 48.

3.3.2 Technology days

Development managers, housing officers, asset managers and maintenance teams should all be involved in the handover process to ensure continuity of information. Where new systems that the housing association has not previously used are being installed, 'Technology days' should be considered, where both technical and non-technical staff can visit the homes with the installers and other design team members to learn more about the technology. In some cases it may be appropriate for residents to attend these events as well. These should be interactive opportunities to ask questions and trial control systems under the supervision of experts.

3.3.3 Documentation

The level of documentation provided at handover will depend upon the complexity of the technology. As a minimum, statutory operation and maintenance manuals should be provided, along with manufacturers' guides for the technology. Where any controls or other interface with the technology is provided, simple, jargon-free instructions should be provided to each resident and displayed in a convenient location. An example of simple control instructions developed by Metropolitan Housing Partnership is provided in Figure 6-2 on page 27. In addition, to raise awareness of LZC technologies, each technology should be summarised in a Home User Guide which may include a simple list of 'Do's and Don'ts' to ensure the smooth running of the technology.

3.4 Post-occupancy evaluation

POE should form part of the commissioning and handover programme for LZC technologies. By assessing the performance of technologies over a 12-24 month period, their performance in dynamic conditions can be determined. The impact of resident occupancy profiles, general behaviour and interaction with controls can all be assessed, and fine tuning or troubleshooting may then enhance the performance of the technology. Feedback on the technology should also be sought from residents. In addition, the performance of the technology under a wider range of external conditions, such as summer and winter temperatures, different levels of humidity, and varying degrees of solar radiation, can all be assessed. Wherever possible, feedback should be given to the residents as well as the design team and those responsible for any re-commissioning or fine-tuning.

The POE strategy should be developed to suit each individual technology and development type. A range of techniques can be employed to assess the systems, some examples of which are given below:

- Using dataloggers to monitor real-time fuel consumption and energy outputs
- Using meter readings to determine fuel consumption and energy outputs
- Analysing fuel bill data
- Using dataloggers to monitor environmental conditions (eg internal and external temperature, humidity and carbon dioxide levels)
- Spot checks (such as hood tests for mechanical ventilation flow rates)
- Interviews with residents covering understanding of controls, thermal comfort levels, noise levels, general perceptions and overall satisfaction.

As well as allowing for identification and rectification of any problems or inefficiencies with an LZC technology, POE allows housing associations to develop a knowledge base to aid future decision making on new projects and provide more detailed feedback and advice to tenants.

Designing systems for housing association residents is a unique challenge. It is widely accepted that housing association residents spend longer in their homes than private sector residents[8]. These unique occupancy rates are often neglected in the design of systems, with design teams opting for more standard occupancy rates to predict fuel costs, maintenance and servicing intervals, and overall lifetimes of LZC technologies. A case study of Metropolitan Housing Partnership's work on POE can be found on page 34. This work demonstrates just how significant occupancy rates can be in overall running costs for LZC technologies.

[8] Capital Gains: Making High Density Housing Work in London, National Housing Federation, 2002.

4 Low and zero carbon technologies and housing association management

4.1 Introduction

The use of LZC technologies will have ongoing management implications for housing associations. Depending on the technology, these will range from minimal maintenance and servicing requirements to ongoing metering and billing services.

Housing associations must undertake an analysis of the lifetime costs of the different LZC technology options at the very early design stages to ensure choices do not result in higher ongoing costs imposed on themselves and residents. In some instances, the demands of sustainable energy targets may mean that schemes are financially unfeasible within the constraints of rent and service charge setting that housing associations are subject to, so it is critical to establish this as early as possible.

This section will discuss the implications for housing associations. The direct impacts on residents are addressed in greater depth on page 25, however these sections are strongly linked.

4.2 Billing and metering

4.2.1 Context

A key challenge is where housing associations must charge residents for heat and power generated by LZC technologies. Catalyst Housing Group have provided a case study of their work on billing and metering for heat which can be found on page 40.

LZC technologies servicing individual households generally have meters owned and maintained by the DNO. A utility company chosen by the householder undertakes the billing. The only requirement of the housing association may be to ensure that meters are compatible with suppliers' requirements for FiTs and the RHI.

For communal systems, however, metering and billing need to be brought in-house or outsourced. It is widely recognised that it is more equitable to charge households for actual consumption rather than a fixed rate and that this provides an incentive to reduce usage. This therefore places an additional burden on the housing association of metering consumption as well as an additional billing process. The cost of this process can result in standing charges for heat to residents in excess of charges for an individual gas system even before any additional capital costs of the communal system are applied.

4.2.2 Heat metering

To undertake heat metering, specialist equipment will be required as well as management procedures for undertaking the tariff setting, billing, financial analysis and provision of debt risk to calculate the unit rates and standing charges. These place an additional burden on the housing association and, unless the LZC technology provides significant efficiency savings or is of a sufficient scale, can result in an increase in the cost of heat for residents in comparison to individual systems.

4.2.3 Equipment

The design team should consider procurement and specification of the following equipment in order to successfully meter and bill for heat:

- **Dwelling interface units** – approximately the size of a small combi-boiler, these units allow residents full control of the heat entering their home and provide a break between the domestic system and the heat mains.
- **Heat meters for dwellings** – either measure flow rate to attribute consumption as a proportion of total heat cost, or measure actual heat entering the dwelling in kilowatt hours.

- **Remote transmitting system** – often easier to manage than manual readings, individual meters are linked into a remote transmitting system which will transmit energy consumption data to the organisation responsible for billing residents.
- **Prepayment card top up facilities** – often located in a local shop, these allow for prepayment customers to top up cards with credit. Service level agreements should be established to ensure that those responsible provide an agreed level of accessibility in order to allow residents to top up cards at convenient times.
- **Fuel consumption and heat generation meters for central plant** – this will allow for the calculation of heat losses, heat charges and identify any inefficiencies within the plant room.

Ownership of all equipment and maintenance contracts must be established. This will generally be the housing association or a sub-contractor who is carrying out the billing and metering on its behalf.

4.2.4 Management

The management procedures for metering and billing will vary depending on the overall structure of the scheme.

The key issues to consider for metering and billing management systems are outlined in Table 4-1. These are the same for electricity metering. Issues surrounding standing charges and heat tariff setting are outlined in the next section.

Heat tariffs: Used to charge residents for the heat to their property, but not for any heating in communal areas. This would typically be included in a separate service charge. The tariff set will be driven by the efficiency of the plant, the distribution losses, and the tariff for the fuel used to generate the heat. System inefficiencies and purchase price can result in higher heat tariffs compared to individual gas boilers.

Standing charges: In addition to unit heat charges, standing charges are used to cover all other aspects of the metering and billing system.

The following list is not exhaustive, but provides examples of items typically included in standing charges:

- Maintenance and depreciation of metering equipment
- Prepayment systems
- Communications (eg data phone lines, postage for billing, telephone charges)
- Staff time relating to metering and billing (eg tariff setting, data management, accounting)
- Direct Debit fees
- Credit control
- Change of occupant fees
- Bad debt allowance.

Standing charges should not include any depreciation, maintenance or management costs for the plant itself or any distribution systems.

Whilst there are no regulatory requirements on the level of heat charges there is consensus amongst housing associations and billing companies that charges should not exceed those from individual gas systems. Heat charges and standing charges therefore need to be considered, and their viability assessed, early in the development of the project to ensure that a communal system can be provided without increasing costs to residents or the housing association.

Ownership of the metering equipments	Should the meters be owned by an external metering and billing company or the housing association? If an ESCo has been appointed, will they take ownership of the metering equipment?
Compatibility of meters and billing software	If a metering and billing company has installed meters, can they be used by other organisations if it is decided to switch companies or bring the service in-house? What would be the cost of reconfiguring software or meters to work with alternative systems?
Maintenance of metering equipment	Who will be responsible for maintenance of the metering system? How will losses be recovered if the metering system fails? Is there a service level agreement in place for unplanned maintenance response times? Are the meters accessible without accessing the home?
Replacements	What is the typical life expectancy of the metering equipment? What is the cost of replacement meters? Who will be responsible for replacing the meters?
Billing procedure	Who will send bills to residents? Are adequate reporting systems in place to set fair heat tariffs (ie heat consumed vs. fuel used)? If an external company is responsible for billing, should housing association branding be used on the bills? Who do residents contact with queries about their bills? How often are standing charges and heat tariffs reviewed, and how are changes communicated to residents? What payment options are available to residents? (Please note: if prepayment cards are to be used, they should be charged at the same rate as all other payment methods.)
Bad debt	Who is responsible for chasing bad debt? Have repercussions for non-payment of heat bills been outlined in the tenancy agreements/ leases? Has sufficient allowance to cover bad debt been included in the standing charge?

Table 4-1: Considerations for managing metering and billing systems

4.2.5 Electricity metering

In order to supply LZC technology-generated electricity to multiple dwellings, housing associations must either own or have use of the wires. A private wire network is where the housing association owns all the electricity wires and individual meters between the main electricity cable to the site/building and each home.

The costs of installing private wire systems will depend on the scale of the development, but will generally be higher than paying the DNO to install their own wires and meters. One housing association has recently estimated the extra-over costs of installing a private wire system to be in the region of £2,000 per home for a medium sized installation (c. 800 homes).

Arrangements to sell electricity over the DNO wires can be set up but are complex and can be costly. This should therefore be discussed with the DNO and Ofgem early in the process.

Electricity demand over and above that generated on-site is bought and sold on from electricity suppliers. The rates charged to residents must not exceed the rate charged by the external supplier to the housing association. It is a common requirement for housing associations to protect residents by fixing their electricity tariffs at or below an aggregate of the cheapest tariffs available from the 'Big 6' suppliers.

Consumer rights should be considered before installing a private wire network. Although the '28

[9] This rule made it compulsory for suppliers to allow customers to switch suppliers within 28 days' notice being given.

Day Rule' no longer applies to supply contracts[9], a recent ruling in the European Court of Justice called into question the legality of private wire systems as they were deemed to remove competition from the supply of electricity to any properties subject to a private wire network.

Before installing a private wire network, it is essential therefore to liaise with Ofgem and the local DNO to establish an approved system that provides a legal, fair and equitable tariff to residents. If this cannot be established cost-effectively, another option used by some housing associations is to secure an export tariff for any electricity generated on site, to sell electricity back to the Grid or to pay the DNO a 'Use of System' charge to distribute electricity over their wires.

4.3 Maintenance, servicing and replacement strategies

As discussed on page 10, maintenance, servicing and replacement requirements should be addressed during the specification and procurement of LZC technologies.

Establishing an effective maintenance and servicing strategy for LZC technologies within housing association stock requires forward planning to address the following issues:

- The strategy should cover all equipment, including auxiliary kit
- The responsibilities of residents, the housing association and sub-contractors should be made clear within relevant contracts
- Differences between tenant and leaseholder responsibilities should be clear
- Methods of recovering the costs of maintenance and servicing should be confirmed in resident contracts.

In addition, depreciation or sinking funds for equipment should be accounted for in net rent and service charges to allow for replacement.

4.3.1 Responsibilities for maintenance

Responsibilities for maintaining LZC technologies should be attributed to relevant parties by the housing association. The three main parties involved will be the resident, the housing association maintenance team and maintenance subcontractors. Table 4-2 outlines some of the key considerations for allocation of maintenance responsibilities.

Residents
• Simple tasks may be carried out, such as filter cleaning. • Tasks must be subject to a full risk assessment, and only allocated to residents if suitable. • Tasks required should be demonstrated to the resident, outlined in the home user guide and confirmed in tenancy agreements or leases. • Consider repercussions if tasks are not completed. • Leaseholders will generally be responsible for all maintenance tasks for technologies located within the curtilage of their home.
Maintenance teams
• Tasks carried out by housing association maintenance teams will depend on available skills and resources. • Extra training on commonly used technologies may reduce the need for subcontracting of some tasks. • Often the first contact in the event of unplanned maintenance.
Subcontractors
• The responsibilities and level of service required by subcontractors should be clearly identified. • Often a requirement for complex systems such as CHP and biomass boilers.

Table 4-2: Responsibilities for maintenance

4.3.2 Maintenance, replacement and billing costs

Costs for maintenance, servicing and depreciation of LZC technologies should all be recoverable from net rent or service charges. Although energy efficient design and LZC technologies can decrease expenditure on fuel, an increasingly common experience of housing associations is that the supplementary costs for metering, billing, maintenance, servicing and replacements result in an overall increase in expenditure.

The allocation of these costs should be reviewed at the development appraisal stage and, while Table 4-3 provides some general allocation guidelines, exact allocations will be specific to the project, tenancy and lease type, so should always be reviewed by legal experts. It is essential that the impact of LZC technologies on residents' expenditure is accurately predicted to avoid unexpected and unwelcome increases to rent or service charges following initial occupation of a property.

It should be noted that underestimation of maintenance, servicing and depreciation costs at the design stage can potentially lead to the housing association subsidising the ongoing costs of a system, as rent caps will prevent indefinite increases to cover these costs. More flexibility is available with leaseholders, but in a competitive market excessive service charges must clearly be avoided.

Income from resident fuel bill savings resulting from LZC technology installations cannot generally be recovered by housing associations. However, the recent introduction of the Clean Energy Cashback scheme (see page 23) will enable the owners of electricity and heat generating LZC technologies to receive set tariffs for all energy generated, and additionally for energy exported to the Grid.

		Tenants	Leaseholders
Maintenance, servicing and depreciation	Individual systems	Net rent	Owned and maintained by resident[10]
	Communal systems	Net rent[11]	Service charge
Metering and billing	Energy used in communal areas	Service charge	Service charge
	Personal energy use from communal systems	Heating and electricity charges	
	Metering and billing costs (including maintenance and depreciation of meters)	Standing charge on heat/electricity bill	

Table 4-3: Cost recovery routes

[10] For any technologies located in communal areas, such as solar collectors on a communal roof, the housing association may choose to retain responsibility for maintenance and servicing and charge leaseholders for this service.
[11] Secure tenancies and transfers taking place before 15 January 1989 may still be charged for maintenance, servicing and depreciation of communal heating systems through service charges.

5 Funding opportunities

5.1 Introduction

Funding for LZC technologies is available from a number of sources. This section will highlight some of the main funding streams, although the list of support available is constantly changing. Visit the Energy Saving Trust's website (www.energysavingtrust.org.uk) for an up-to-date list of available funding.

5.2 Funding streams

Table 5-1 summarises some of the main funding streams for new-build LZC technology projects. Project teams should always contact local authorities and energy suppliers in order to make a thorough assessment of current funding programmes.

Funding stream	Notes
Low Carbon Buildings Programme (LCBP) Phase 2[12]	A Department of Energy and Climate Change (DECC) scheme offering up to 50% of the capital costs (up to £200,000) for heat generating technologies up to 300kW. From 24 May 2010, funding for all heat generating technologies under the LCBP has been withdrawn. A total of £3 million savings was taken from the programme in order to contribute to DECC's £85 million departmental spending cuts in 2010/11.
Clean Energy Cashback Scheme	This scheme includes the feed-in-tariff which began operation in April 2010, and will also cover the renewable heat incentive which will come into operation in April 2011. Owners of renewable technologies will receive a fixed price per unit of energy generated as well as an additional tariff for any electricity exported to the Grid. Details of the FiT are outlined on page 24. Final arrangements for the RHI have yet to be confirmed.
Renewable Obligation Certificates (ROCs)[13]	Energy suppliers pay renewable electricity generators for ROCs. For installations after 1 April 2010, any systems under 50kW will not qualify for ROCs. Those between 50kW and 5MW have a choice of either receiving ROCs or FiTs. Any technologies over 5MW will only qualify for ROCs. Unlike FiTs, ROCs are subject to market mechanisms and therefore do not offer a guaranteed rate of return.
Bio-energy Capital Grants[14]	The Bio-energy Capital Grant scheme is funded by DECC and provides up to £500,000 funding for biomass heating and biomass CHP projects. The funding is competitive and only available for applications at certain points during the year.

Table 5-1: Funding for LZC technologies

[12] www.lowcarbonbuildingsphase2.org.uk
[13] www.ofgem.gov.uk/Sustainability/Environment/RenewablObl/Pages/RenewablObl.aspx
[14] www.bioenergycapitalgrants.org.uk

5.3 The Feed-in-Tariff

Introduced in April 2010, the FiT provides an income for owners of qualifying installations of electricity generating LZC technologies. A full breakdown of the tariffs available and eligibility criteria for the FiT is available from the Energy Saving Trust website[15].

For any new installations (under 50kW), a Microgeneration Certification Scheme (MCS) certified product and installer must be used in order to qualify for the FiT.

The FiT will be linked to the retail price index. The tariff for which an installation is eligible will depend on the size of the installation and the year when it was installed. Tariffs up to 31 March 2012 for a range of technologies are outlined in Table 5-2. For subsequent years, tariffs will be reduced on a yearly basis. Once a tariff has been awarded it will remain at that fixed rate throughout the life of the installation. For any installations completed before 15 July 2009, a reduced tariff will be available if the installation was registered with Ofgem for ROCs before 31 March 2010.

The FiT provides housing associations with a potential means to recover their investment in renewable electricity technologies if a mechanism is put in place to ensure that the FiT is recoverable by them and not the occupier of property. The resident will stand to benefit from reduced energy bills, while the housing association is given a fixed tariff for all electricity generated, regardless of whether or not it is used on site. An additional tariff is paid for any electricity exported to the Grid.

5.4 Renewable Heat Incentive

The RHI will provide incentives for heat generating LZC technologies in a similar way that the FiT provides incentive for electricity generating technologies. Exact details and rates are not currently available as the public consultation finished 26 April 2010 and details are currently being finalised. It is due to be introduced from April 2011.

5.5 Pay As You Save

At present there is no way for housing associations to secure income from fuel bill savings resulting from energy efficiency measures or LZC technologies. The 'Pay As You Save' model of green loans for energy saving measures in affordable housing is currently being trialled by Gentoo Group Ltd. This trial is exploring ways to share the financial benefits of energy saving measures between the householder and the housing association in order to simultaneously combat fuel poverty and sustainably finance the installation.

	Scale	Tariff (p/kWh)	Tariff lifetime (years)
Micro CHP	≤2kW	10.0	10
Wind	≤1.5 kW	34.5	20
Wind	>1.5 - 15 kW	26.7	20
Solar electricity (PV)	≤4 kW (retro fit)	41.3	25
Solar electricity (PV)	≤4 kW (new build)	36.1	25
Hydroelectricity	≤15 kW	19.9	20

Table 5-2: A selection of tariffs available for installations between 15 July 2009 and 31 March 2012

[15] http://www.energysavingtrust.org.uk/Generate-your-own-energy/Sell-your-own-energy/Feed-in-Tariff-Clean-Energy-Cashback-scheme#eligible

6 Tenant and leaseholder considerations

6.1 Introduction

The impacts of LZC technologies on residents should be the primary concern from the design stage through to the day-to-day management of a scheme.

The cooperation of residents and their interaction with LZC technologies will have major impacts on the overall success of installations in reducing carbon dioxide emissions and tackling fuel poverty.

Some technologies will require significant changes in the behaviour of residents in order to be successful, whilst others will be relatively unobtrusive to the resident and may even go unnoticed. Regardless of the relative complexity or simplicity of any LZC technologies, the following impacts on residents should always be considered by housing associations throughout the management of a scheme:

- Costs and charges
- Quality of life
- Maximising benefits from technologies through controls and advice
- Troubleshooting and help
- Maintenance.

6.2 Costs and charges

The major costs incurred by residents due to LZC technologies are likely to be for metering and billing, fuel, depreciation and replacement, and maintenance. It should be stressed that the additional capital and ongoing management costs of LZC technologies may lead to future fuel bill savings being eroded. Table 6-1 outlines some of the key considerations relating to costs to residents.

Fuel Costs
• Personal fuel costs should be paid by the resident directly to the energy supplier (not as part of a service charge or net rent). • Heating and power for communal areas should be included in service charges. • Advice on suitable tariffs should be provided (eg off-peak tariffs may not be suitable for heat pumps).
Depreciation and replacement costs
• Should be calculated during the development appraisal stage. • For most tenants, this will be included in net rent. • For leaseholders, communal system replacement costs should be included in service charges, or as a one-off charge. • All costs must be transparent and clear within leases and tenancy agreements.
Maintenance
• Included in net rent for most tenants. • For communal plant and distribution, this should be included in a service charge for leaseholders.
Metering and billing
• Substantial additional cost for residents. • Included in the standing charge on energy bills. • To recover all costs associated with metering and billing, including depreciation of equipment. • Do not include costs for central plant or distribution.

Table 6-1: Costs and charges for residents

6.3 Quality of life

LZC technologies in new developments can affect the quality of life of current and future residents in a number of ways. Noise, visual impacts such as the flicker effect from wind turbines, aesthetics, thermal comfort, economic security and awareness of sustainability issues are all potential considerations.

Specific issues for each technology are covered on page 28.

6.4 Maximising the benefits of technologies

6.4.1 Making design aims clear

If residents do not understand the reasons for including specific technologies in their homes, they may not appreciate how to realise the benefits. Design aims should be communicated to all residents through home user guides in suitable formats, resident-facing staff and open days to avoid any misunderstanding.

6.4.2 Controls

If the end-user does not understand how to interact with the technology, the anticipated benefits will not be realised, even where technologies have been well designed, installed and commissioned, Specification of simple control systems with clear instructions will help to ensure residents use the technology efficiently. Feedbacks from the technology, such as generation and temperature information, will give residents an accurate idea of whether the technology is performing correctly. The forthcoming introduction of smart meters will be a significant step towards empowering residents with accurate knowledge of their energy consumption.

Another key to ensuring residents understand the controls on LZC technologies is to ensure all resident-facing staff are adequately trained, or can access information in order to provide advice to residents on how to use their technology. For complex systems, a helpline run by either the housing association or the manufacturer of the technology may also be appropriate.

Figure 6-2 shows an example of a simple and easy to understand leaflet developed by Metropolitan Housing Partnership to enable residents to gain the most from their heating controls.

6.4.3 Tariffs

The most appropriate fuel tariff should be outlined to residents when they occupy the property. Close liaison between the housing association and the resident will also be required to ensure any eligible technology receives the FiT and, from April 2011, the RHI. For tenants, the housing association should make clear who will receive any generation or export tariffs. For leaseholders, advice can be given on how to sign the technology up to the appropriate scheme with their energy supplier.

6.5 Troubleshooting and help

Some technologies may require specific advice to be given to residents in order to avoid unnecessarily poor performance or high fuel costs. Examples of this include explaining the role of emergency electric immersion heater back-ups in solar thermal or heat pump storage cylinders, and instructing residents not to block ducts for mechanical ventilation systems.

If unusually high fuel costs are reported, the housing managers should cross check any advice given by the manufacturers and installers during handover, or use the relevant contacts given by the design team during handover to address the problems (see page 14).

Contacts should be given to residents when they occupy the property so they know who to ask if they experience any problems with the LZC technologies in their properties.

6.6 The need for good maintenance

Poor maintenance of LZC technologies will inevitably lead to deterioration in their efficiency or total failure. This may lead to higher fuel bills, poor thermal comfort or even health problems.

To avoid this situation, roles and responsibilities for maintenance should be made clear in tenancy agreements and leases. The housing association may choose to allocate simple tasks to residents,

such as cleaning filters on ventilation systems, but should only do this where it is safe to do so and the resident is absolutely clear on the requirements.

More complex maintenance tasks and safety checks may require access to homes. This should be avoided where possible in order to reduce disruption to residents and simplify arrangements for maintenance teams. Specification of equipment with fewer or less frequent maintenance requirements will help to avoid any disruption. Residents must always be told from the start of potential disruptions due to maintenance.

For leaseholders, maintenance of individual LZC technology systems will normally be their own responsibility. In some cases, the leaseholder may not have access to the entire system (such as a solar thermal collector on a communal roof). The lease should therefore clarify responsibilities for maintenance. In this example, replacing glycol may be possible from within the property (and therefore a task for the leaseholder) whereas annual checks on the collectors may be covered by the housing association maintenance team and included as part of a service charge. In all cases, the housing association should provide advice on the requirements and arrangements for maintaining LZC technologies to leaseholders upon occupation of the property.

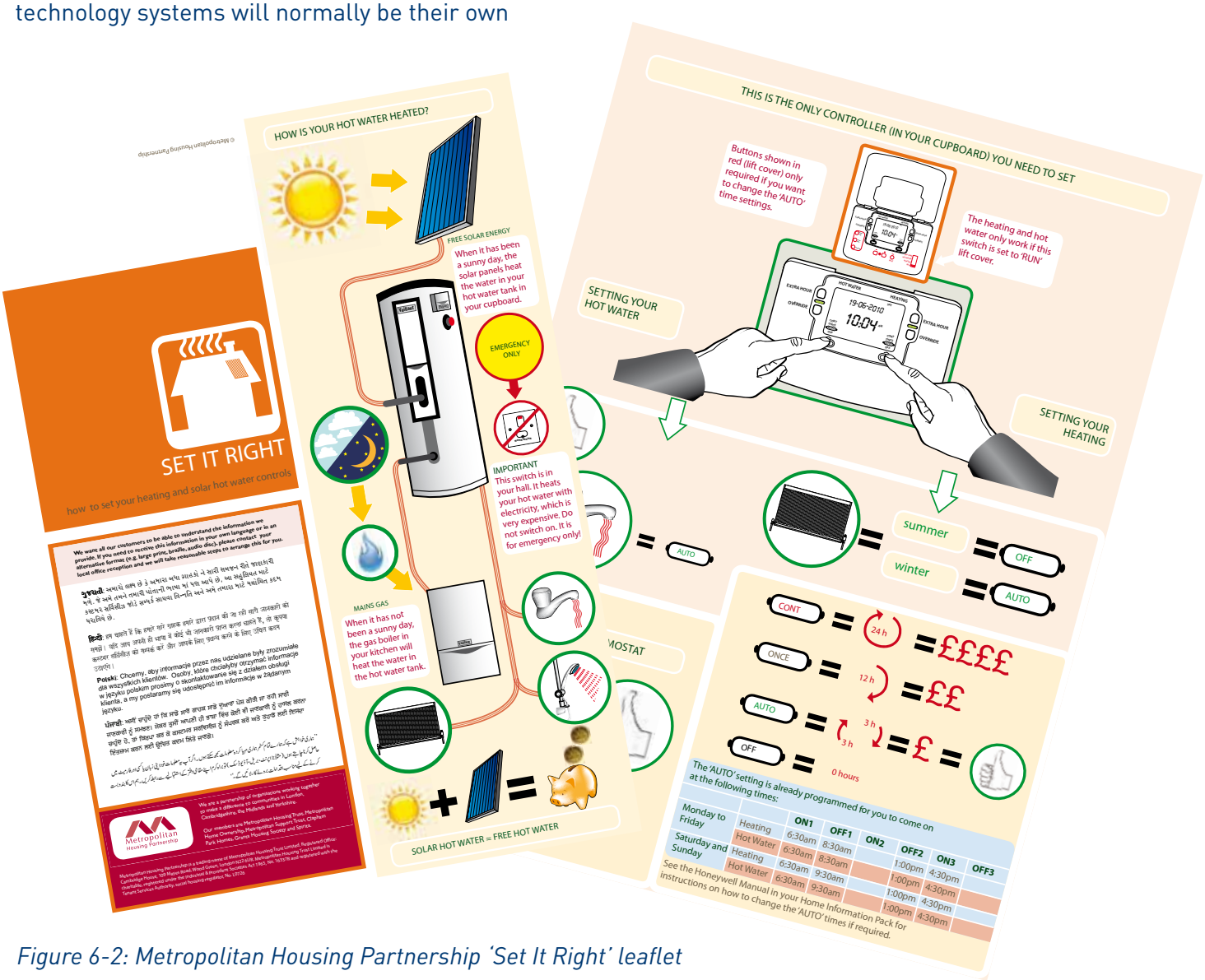


Figure 6-2: Metropolitan Housing Partnership 'Set It Right' leaflet

7 Technologies

7.1 Introduction

This section is intended to highlight some of the technology-specific issues that should be addressed when designing, installing and managing LZC technologies. It does not represent a comprehensive design and management guide, but instead highlights some of the findings of housing associations who have already installed the technologies. It should be read in conjunction with the National Housing Federation's publication 'Renewable Technology: A guide for housing associations'[16] which provides guidance on specific design criteria and considerations for each technology.

Costs will vary dramatically between projects and manufacturers, so these are intended as a rough guide only.

7.2 Summary of individual technologies

	Resident considerations	Procurement and management	Income streams	Example costs
Solar thermal	• Visible commitment to sustainability • Low maintenance requirements • Will only be successful if controls are understood and boilers and immersion heaters do not override the solar thermal collectors • Display units confirming output of solar thermal collectors are preferable • Space for cylinders and expansion vessels will reduce storage space within the home	• Ensure supplier and installers are MCS certified in order to qualify for RHI • System must be compatible with the boiler or other heating system planned for the home • Auxiliary equipment may include: cylinder, expansion vessel, pumps, collector fluid, pipes and insulation, roof fixings and A-frames • Contracts should confirm who will receive RHI • Metering and billing may be necessary for communal systems • Advice on registering for RHI should be given to residents • Access arrangements should be confirmed for leaseholders with systems on communal roofs	**Resident** Fuel bill savings: • £20 - £60/system/yr (displacing gas) • £50 - £100/system/yr (displacing electricity) **Owner Of System** Renewable Heat Incentive	**Capital** Collector: • £150 - £225/m² (flat plate) • £300 - £400/m² (evacuated tube) Cylinder: £500 - £1,000 Auxiliary equipment (pipes and insulation, pumps, controls, collector fluid, roof fixings): £800 - £1,000/system Installation: £1,200 - £1,800/system **Maintenance** • Change solar fluids (5 years): £150 - £250/system • Annual collector inspection (optional): £0 - £50/system
Solar photovoltaics	• Visible commitment to sustainability • Very low maintenance requirements • Unlikely to experience tangible benefits if the system serves communal areas (although service charges for communal electricity may be reduced) • Display units confirming output of system are preferable • Controls not required	• Ensure supplier and installers are MCS certified in order to qualify for FiTs • Include installation and all auxiliary equipment: inverters, cables, isolators, meters, fixings, A-frames • Contracts should confirm who will receive FiTs and export tariffs • Advice on registering for FiTs should be given to residents	**Resident** £70-£95/kWp/yr **Owner Of System** Feed-in-tariff: £0.36/kWh (for new-build ≤10kWp) Export tariff: £0.03/kWh	**Capital** • PV module: £2,500 - £3,500/kWp • Inverter: £400 - £1,000/kWp • Auxiliary equipment (cables, isolators, meters, roof fixings etc.): £500 - £1,000/kWp • Installation: £200 - £700/kWp **Maintenance** • Electrical inspection (5 years): £50 - £100/system • Inverter replacement (15 years): £900 – £1,300/system • Annual panel inspection (optional): £0 - £50/system

[16] www.housing.org.uk/default.aspx?tabid=400&mid=1061&ctl=Details&ArticleID=2051

	Resident considerations	Procurement and management	Income streams	Example costs
Ground source heat pumps	• Low maintenance requirements • Long-lag under floor heating systems may be unfamiliar and require behavioural change (such as greater understanding of and interaction with time and temperature controls) • Controls should be simple and avoid over-use of immersion back-up • Off-peak electricity tariffs may not be appropriate • Noise impacts should be considered when locating the heat pump	• Ensure supplier and installers are MCS certified in order to qualify for RHI • Ground works are a one-off cost and should be carefully scheduled into the construction timetable to avoid disruption • Checks should be made to ensure ground surveys are included in the drilling price or accounted for elsewhere • Auxiliary equipment may include: ground loops, manifolds, cylinder, expansion vessel, ground loop fluid, pipes and insulation • Contracts should confirm who will receive RHI • Metering and billing may be necessary for communal systems • Advice on registering for RHI should be given to residents	**Resident** Fuel bill savings: • Negligible (displacing gas) • £300 - £900/system/yr (displacing electricity) **Owner of system** Renewable Heat Incentive	**Capital** • Heat pump: £2,800 - £7,000/system • Cylinder: £500 - £1,600 • Auxiliary equipment (ground loops, manifolds, expansion vessel, ground loop fluid, pipes): £1,000 - £2,000/system • Installation (including boreholes): £2,000 - £6,000/system **Maintenance** Minimal **Running Costs** Electricity tariff
Air source heat pumps	• Some access to the property will be needed for pressure checks • Long-lag under floor heating systems may be unfamiliar and require behavioural change (such as greater understanding of and interaction with time and temperature controls) • Controls should be simple and avoid over-use of immersion back-up • Off-peak electricity tariffs may not be appropriate • Visual and noise impacts should be considered	• Ensure supplier and installers are MCS certified in order to qualify for RHI • Auxiliary equipment may include: cylinder, expansion vessel, pipes and insulation, ductwork for exhaust air systems • Contracts should confirm who will receive RHI • Metering and billing may be necessary for communal systems • Advice on registering for RHI should be given to residents	**Resident** Fuel bill savings: • May result in an increase when displacing gas • £250 - £600/system/yr (displacing electricity) **Owner of system** Renewable Heat Incentive	**Capital** • Fan unit, heat pump and cylinder (5kW): £2,500 - £4,000 • Cylinder: £0 - £700/system • Ductwork for exhaust air heat pumps (2-3 bed house): £1,000 – £1,500 installed • Installation: £700 - £1,000/system **Maintenance** • Pressure check (annual): £60-70/system • Filter cleaning for exhaust air heat pumps (Quarterly): £0 - £100 **Running Costs** Electricity tariff

Table 7-1: Individual technologies summary

7.3 Community heating and private wire networks

Communal systems and private wires

	Resident considerations	Procurement and management	Income streams	Example costs
Heat networks and private wires	• No access to homes needed for maintenance • Dwelling interface units give residents total control over heat consumption • Standing charges for metering and billing can result in high energy bills • Electricity supplied must be competitively priced alongside the 'Big 6' suppliers' tariffs • Reduced flexibility of residents to choose energy suppliers	• The following costs must be clearly itemised for calculation of net rent, service charges and standing charges for energy bills: dwelling internals, billing and metering equipment, communal distribution system, plant room equipment • Compatibility of metering equipment should be considered • Contracts for metering and billing must be established early • Maintenance, depreciation and sinking funds for plant and distribution will be significant so must be accurately reflected in rent and service charges • Metering and billing is often subcontracted • Bad debt and payment collection systems should be clear to all from the outset • Implications of non-payment should be made clear to all residents • Management burden may be significantly reduced with the appointment of an ESCo, although this is not always cost-effective	See Table 4-3 for a breakdown of income streams for communal systems An example standing charge for metering and billing heat for a 2-bedroom flat is £120/yr	Example heat network costs (including dwelling interface units, not including dwelling internals): £9,000/home – low density £5,000/home – medium density Example private wire network costs (including meters): £1,500 - £3,000 extra-over DNO price
Biomass heating	• No maintenance requirements within homes • Dwelling interface units and controls should be simple to use and fully explained to residents • Sound insulation must prevent disruption from boiler and auger operation	• Ensure supplier and installers are appropriately certified in order to qualify for RHI • Auxiliary equipment may include: fuel store, auger, control units, supplementary boilers, calorifiers and buffer tanks, communal heating system, metering and billing system, dwelling interface units • Metering and billing systems must be established • Registration for RHI • Procurement systems for biomass fuel must be reliable • Specialist maintenance contracts will be required • Where possible, deliveries should be coordinated to reduce transport emissions and costs	Bio-energy Capital Grants: Up to £500,000 of capital cost See page 22 for a breakdown of other income streams (metering and billing, maintenance, etc) Owner of system Renewable Heat Incentive	**Capital** • Boiler: £200/kW • Fuel transfer system (auger): Example costs: £4,000 for 60kW system, £13,000 for 500kW system • Fuel store: Project specific • Installation: Example costs for biomass boiler only: £6,500 for 60kW system, £14,000 for 500kW system **Maintenance** Maintenance contract for biomass boiler only: 2% capital cost/yr **Running Costs** Biomass fuel costs: • £0.04/kWh wood pellets • £0.025/kWh wood chips • Delivery costs for fuel dependent on frequency and distance

	Resident considerations	Procurement and management	Income streams	Example costs
Gas-fired CHP	• No maintenance requirements within homes • Dwelling interface units and controls should be simple to use and fully explained to residents • Sound insulation or location of engine must prevent disruption to tenants • Private wire systems should only be used where electricity can be supplied at a competitive price	• Installation and operation should follow Combined Heat and Power Quality Assurance (CHPQA) guidelines and standards • Auxiliary equipment may include: supplementary boilers, calorifiers and buffer tanks, control units, communal heating system, metering and billing system, dwelling interface units, private wire system • The system should be sized on the base heating load to ensure long operating hours • Metering and billing systems must be established for electricity (if sold to residents) and heat • Private wire systems will require detailed electricity tariff setting and procurement of any 'top up' electricity requirements • Specialist maintenance contracts will be required	See page 22 for a breakdown of income streams (metering and billing, maintenance, etc) Refer to page 20 regarding the sale of electricity to residents	**Capital** Engine: £700-900/kWth up to 100kW, costs decrease thereafter Installation: Very dependent on the scheme and manufacturer Lowest cost for small systems will start at £5,000 **Maintenance** For CHP only: 3-4% of capital cost/yr **Running Costs** Gas tariff

Table 7-2: Communal technologies summary

8 Case studies

8.1 Developing supply chains for LZC technologies

The Create Consortium

Summary
The Create Consortium consists of five London-based housing associations: Gallions Housing Association; Hexagon Housing Association; Islington and Shoreditch Housing Association; Newlon Housing Trust and Wandle Housing Association. The consortium has a development programme across London with almost all new schemes using LZC technologies.

The consortium has to date been sourcing technologies on an individual project basis, with the choice of product mainly being decided by the main contractors. This has resulted in an extensive range of technologies, products and manufacturers being installed on schemes.

As planning and funding requirements are continuously driving the need to incorporate technologies in schemes, the consortium decided to undertake a formal procedure to analyse the market with the aim of establishing an approved list of suppliers and installers and, where possible, a reduction in capital and lifetime costs.

Aims
The Create members saw a growing array of low and zero carbon technology product types, sizes and designs being installed in new developments. This raised concerns about the challenges of operating, maintaining and servicing such a wide range of technologies. Housing managers need to be able to explain systems to residents, servicing and repair contractors may need specialist training and additional contracts may be required with specialist service engineers.

Many of the technologies installed have been specified by building contractors with different priorities to housing associations. Products with low supply costs and simple installation may not provide the lowest lifetime costs or best resident comfort and usability. For development managers the array of options can be daunting and knowing which sources of information to trust is challenging.

Create therefore decided to undertake a formal tender process to develop an approved list of suppliers and installers that had been quality assessed and the full costs of supply, installation and maintenance ascertained. This list could then be used by contractors on their schemes.

The process

CEN was employed to undertake a technical analysis of the LZC technology market and its applicability to the Create build programme in order to support the tendering process.

An analysis of the operational energy and carbon performance of different products was carried out. Likely site characteristics and design constraints were identified and considered alongside the current and future energy and carbon dioxide targets that schemes will be subject to.

This process resulted in the identification of the following:

- Individual (and combinations of) technologies which could be used to achieve the different planning and Code for Sustainable Homes requirements
- Technologies suitable for different scheme designs, sizes, and densities
- Indicative capital costs, maintenance costs, fuel costs, ease of use and resident satisfaction with the product.

The procurement volume for each technology type was predicted based on build volume and scheme type, technology suitability and planning and Code for Sustainable Homes requirements.

Suppliers and installers were then asked to outline their services and prices in response to a tender process. A range of quality criteria were evaluated to ascertain the responses in relation to value for money, experience, flexibility, deliverability, added value, partnering and price.

Benefits

The tender process has helped the Create consortium move towards having an approved list of suppliers and contractors in which they can be confident of the organisational, operational and financial performance.

The qualitative and price analysis identified both the companies and products that will be cost effective throughout a scheme's life, taking into consideration the level of service and experience the companies can provide to Create.

A wide range of information is now available to Create members' design teams, including:

- Capital costs
- Installation requirements and costs
- Lead and installation times
- Maintenance
- Design considerations
- Auxiliary equipment requirements
- Fuel requirements
- Warranties
- Ease of use for residents.

The reduced list of products and suppliers means that the Consortium can have confidence in the technologies installed in their schemes and share their experience of the products, although new equipment can always be added to the list as technology progresses.

The list of products and suppliers give development managers confidence in the products that are being specified for their schemes. It enables them to verify the prices being given for technologies against the tender return prices.

8.2 Post-Occupancy Evaluation at Angela Carter Close, Brixton

Metropolitan Housing Partnership

According to Matthew Bush, Sustainability Manager at Metropolitan Housing Partnership, 'Set It Right aims to give residents a better understanding of the heating and power technologies in their homes and therefore far greater control of their energy consumption. This is key to ensuring our customers benefit from the investment and our excellent design standards.'

Summary

An award winning development of nine affordable houses and three flats. Winner of Inside Housing's 'Sustainable Smaller Housing Project' award in 2008, and certified EcoHomes 'Excellent' standard.

Metropolitan Housing Partnership has worked with University College London (UCL) on a number of POEs. UCL student, Polyxeni Tzachrista, undertook the POE with residents at Angela Carter Close to improve knowledge of the in-use performance of their homes, provide feedback to and from residents, and close the gaps between design, installation and use of technologies.

Technical overview

Fabric:

- Timber framed cassette walls with 195mm Warmcell recycled newspaper insulation, achieving 0.18W/m^{2}K
- Green roofs with 300mm Warmcell insulation, achieving 0.13W/m^{2}K
- Pre-cast concrete floor with 120mm Jablite 70 insulation, achieving 0.16W/m^{2}K
- Low-e double glazed windows, achieving 1.2W/m^{2}K
- Air permeability of 8m^3/m^2/h at 50Pa.

Technologies:

- Passive stack ventilation
- 100% low energy lighting
- 90% efficient condensing gas boilers
- Flat plate solar thermal collectors with 250 litre twin coil cylinders (plus electric immersion back-up).

Controls:

- Room thermostat.
- Thermostatic radiator valves (TRVs)
- Boiler controls (temperature output for space heating and hot water)
- Boiler programmer (separate to boiler controls – timings for space heating and hot water)
- Immersion heater switch
- Solar thermal controls.

Post-occupancy evaluation

Working with UCL, POE was undertaken using in-situ monitoring of energy consumption and environmental indicators (temperature, humidity), resident interviews and dynamic thermal analysis. This monitoring took place over six months between February and July 2009, with results being extrapolated to annual figures where necessary.

Results

- All homes achieved significantly lower energy consumption levels (kWh/m^2 floor area) than Chartered Institution of Building Services Engineers (CIBSE) Good Practice guidelines
- Relative humidity levels were constantly within good practice guidelines (30-70%) in all homes
- Winter temperatures in bedrooms and living rooms were often higher than recommended levels (average living room temperatures between 19.6°C and 24.5°C, average bedroom temperatures between 20.4°C and 24.6°C)
- Outputs of the solar thermal systems were lower than expected in all homes, and significantly lower in one
- Residents were happy with the thermal comfort levels and air quality within their homes
- Overall energy consumption normalised by floor area varied by 280% between the lowest and highest energy consuming homes.

Analysis

Overall there was strong satisfaction from all occupants regarding the performance of their homes. They stated that the homes 'maintain the heat' and no draught or stuffiness problems were noticed. However, the large differences in energy consumption between the different homes evaluated were explored to determine why this occurred.

The design of each property, including technologies, controls and fabric, were all very similar, so this could be discounted as a major factor.

Installation and commissioning of technologies underwent standard checks, and only one commissioning fault was discovered (in the solar thermal controls of the property with significantly lower than anticipated solar thermal output).

Resident behaviour and interaction with the building services was found to be the major factor behind the differences:

- Desired internal temperatures during the heating season varied significantly by occupant – a dynamic model of one property revealed that a 4°C reduction in thermostat temperature could reduce predicted energy consumption by more than 35% per year
- Occupancy levels varied between homes. Predicted energy loads were based on standard 16 hour/day occupancy. A four hour reduction in this level was found to reduce overall energy consumption by up to 9%
- Ventilation activities (ie opening windows) varied between homes and could explain why one home was significantly warmer than the others, but used less gas
- Building service controls were reported to be confusing by all residents interviewed
  - No residents fully understood the control strategy
  - Some used the room thermostat as a switch for the heating system
  - The immersion heater was used instead of the solar thermal system in one flat as no obvious feedback was present to demonstrate output from the solar thermal system

- All but one property ignored the boiler controls altogether
- The programmer was not used to set times for heating and hot water systems, but instead as a simple on/off switch.

Outcomes

The overall energy consumption of these homes demonstrated that energy savings can be made through excellent design and construction standards. However, further savings were identified by going beyond these stages of the project and allowing residents to fully understand their homes and the services within them.

Metropolitan Housing Partnership saw the outcomes of this study as a key driver to implement a campaign to raise awareness of the importance of resident behaviour and their interactions with their homes.

The New Homes Team has driven a renewed focus on getting the right staff and contractors to attend Mechanical and Electrical, or 'M&E' days, and raising the importance of attendance. This team is also delivering the piloting of a new process for supporting residents over the first 6 months of the scheme with ongoing opportunities to access support specifically targeting at understanding the building/heating controls in the home.

Beyond this, e-learning modules have been provided throughout the organisation on a range of topics including fuel poverty. These are intended to help resident-facing staff provide help and information on how to maximise the energy saving potential of their homes.

'Set It Right' is also being launched. This is a campaign to ensure residents are provided with clear and concise instructions on how to adjust their heating and hot water controls to best suit their needs and keep their fuel bills to a minimum.

Wherever controls are needed, they are carefully selected to be as simple and straightforward for the future users as possible.

8.3 Exhaust air heat pumps at Princess Road

Hexagon Housing Association

Summary

A new development of 14 homes with one block of 11 flats and three town houses.

The scheme was built to meet a Code for Sustainable Homes Level 4 rating. This required a substantial carbon reduction of 44% over building regulation levels. In addition there was a planning requirement to achieve a 10% reduction in carbon emissions through on-site renewable energy technologies.

To achieve this level the scheme was designed to have high building envelope performance through high levels of insulation, high performing windows and a high air tightness. Exhaust air heat pumps were used to achieve the 10% renewable energy target and to reduce the dwelling carbon emission rate.

Why exhaust air heat pumps?

The scheme is of a compact nature and has limited roof area per dwelling. The developer was also concerned about the aesthetic impact of multiple solar panels on different roof areas.

The visual impact of both wind turbines and the external units of air source heat pumps were also considered unfavourable for the scheme. The cost and logistics of drilling bore holes for heat pumps and concerns over super cooling the ground excluded ground source heat pumps.

Exhaust heat pumps were the preferred option as they could be integrated into each property with no external visual impact.

Installation

The installer of the units had to complete a training course before they were qualified to install the Nibe units. The installation involved a standard wet radiator system, ducting to extract warm wet air from the kitchen and bathroom, ventilation ducts in the external walls to draw in fresh air, and thermostatic temperature controls.

The units are installed into cupboards in the hallway. The units are very heavy to manoeuvre into location

Cost of installation
The cost of each heat pump was approximately £3,300, with an additional £700 per home for ducting and vents.

Maintenance
The unit includes a filter which initially will need cleaning monthly. This drops to every three months as the dust goes down.

The resident will have responsibility for cleaning the filter which is taken out of the unit and either vacuumed or rinsed.

A light will flash when the filter needs cleaning. If they are not cleaned an immersion heater will be required to provide the heating, increasing operating costs to residents so the cleaning requirement has been stressed to all residents in their handbooks and verbally.

An annual pressure check of the system will also be required. The filters will also be checked as part of this process.

Training
The housing managers were given training as to how to operate and maintain the units. Officers will be asked to check filters when visiting residents.

An open day was also held for residents with a representative from Nibe attending to give an explanation of the system and show how to clean the filters.

The housing manager has direct contact with Nibe.

Operation
Due to the heat pumps working continually it is recommended that a low single rate electricity tariff is used rather than one with a differential day and night tariff.

Nibe highlighted to residents and housing managers that they should not let the flats get too cold, as the heat pump works by using waste heat within the property.

It is recommended that temperatures are kept above 16°C at night, and systems left running whilst residents are out.

Due to the high efficiencies of the properties and the gradual heat characteristic of the heating system it is not recommended to set the thermostat above 21°C. Turning up further will not heat the building any faster but can result in overheating.

The hot water store is large enough for three good showers and will then reheat by lunch time and again by evening. Large numbers of baths close together will however mean that the immersion heater will be needed.

The immersion has three elements so that the system will only use as many elements as required to meet the heat demand.

Reporting faults
Faults will be managed by the same contractor as all the other Hexagon schemes. A free-phone number for residents goes direct to the heating contractor who will attend and fix any faults. Hexagon Housing repairs team can also be contacted if required.

The association is reliant on education of residents, via training and literature in the home user guide, to ensure that filters are cleaned. Because this is new technology for the association, there is no

existing knowledge on how residents will cope. However, there is currently no process for what to do if residents do not clean filters or misuse the system.

Faults reported to the heating contractors or repairs team will be logged. If it is found that a particular resident is regularly calling out when only the filters need cleaning then new thinking may be required.

Warranty

There is a two year warranty on the whole system.

Anticipated lifetime

Nibe have systems operating since the first units were installed in 1978. An indicative 20 year life expectancy has been given.

The parts can be replaced individually so the whole unit does not need to be replaced. The weight and size of the unit mean that if it were to be replaced then it would have to be broken up for removal.

Monitoring of fuel consumption

Hexagon intend to monitor fuel consumption from the unit in order to assess the ongoing costs of these systems and aid future decision making.

8.4 Community heating with biomass and gas combined heat and power

Catalyst Housing Group

Summary

Catalyst Housing Group have developed a community heating system for over 250 homes on the South Acton Estate. Heat is produced using biomass, gas-fired CHP and gas boilers.

Catalyst own and manage the scheme using in-house management structures as well as subcontractors.

Development

The original project was to develop a district heating network for 750 homes, but was subsequently scaled down to 250 units by the local authority.

A specialist consultant was appointed to develop a performance specification before the design and installation contract was put out to tender.

The development process included consideration of all practicalities of implementation, including biomass fuel supply, delivery access, electricity distribution, metering, billing and maintenance. Catalyst approached potential ESCo partners to manage the schemes on a turnkey basis, but the reduced scale of the project meant that the market was not able to provide an economically viable solution. Catalyst therefore decided to bring the management and operation of the system in-house, using existing management and procurement systems as well as developing new skills.

The first 129 homes are now complete and the heating system is up and running successfully. The remaining homes are scheduled to be completed in 2011.

Implementation

- **Electricity distribution:** Catalyst decided that, due to regulatory uncertainty and the additional cost of private wire networks, the electricity generated by the CHP would be used only for the landlord's supply, with the surplus being exported to the Grid. An export tariff has now been negotiated, securing an income for all exported electricity.

- **Biomass fuel procurement:** Wood pellets are currently purchased from a supplier in Suffolk. Storage on-site is sufficient for 21 days' supply, and in order to minimise transport costs for pellet deliveries, the procurement for this site is combined with another biomass plant in Harrow. This minimises journeys required by delivery trucks, keeping costs and additional emissions to a minimum.

- **Fuel profile:** Residents receive a reliable supply of heat to their homes due to the diverse fuel and heat generating profile of the site. CHP is designed to meet the basic demand of the site, with biomass boilers meeting any additional demand. For peak periods and during any maintenance down-time, gas boilers are also present to guarantee the supply of heat.

- **Maintenance:** Imtech Aqua installed the plant, and they have been contracted to provide the first year's maintenance for the scheme. Catalyst's Asset Management team, which includes services engineers, are taking this opportunity to shadow the contractors in order to develop a thorough knowledge of the scheme.

Management

- **Metering:** Willmott Dixon Housing, the constructor partner for the project, procured heat meters manufactured by Switch2 for the scheme. These can be read remotely. Although Catalyst could develop software in-house in order to read these meters, it was decided that a more cost-effective solution would be to outsource metering and billing to Switch2.

- **Billing:** Catalyst are responsible for signing up new residents to the heat supply. Bills are generated by Switch2 who send these out on Catalyst branded paper. Residents pay direct to Switch2, although overall responsibility for bad debt and chasing payment lies with Catalyst. Tenancy and leaseholder contracts stress the implications of failure to pay for any heat consumed.

- **Tariffs:** Heat tariffs were originally set using estimates from other schemes, although these are under constant review to ensure all costs are covered and that residents receive the best value for money. Catalyst use existing procurement structures to ensure the best deals on fuel are secured for the scheme.

- **Service charges:** Shared ownership homes are charged for depreciation and maintenance costs via a service charge. These are reviewed annually.

- **Rent:** For general needs tenants the basic rent is meant to cover the maintenance costs of boilers, as this is a basic landlord obligation. The rent is set independently of the scheme. Tenants are not charged via the service charge for maintenance or depreciation of boilers, be they communal or individual to the home.

All residents are charged for the cost of administration and paying Switch2 to do the billing. This is part of the standing charge.

8.5 Wind turbines at Braunton, Barnstable and Bideford Mansions

Origin Housing

Summary

Although not a new build project, this highlights some of the challenges of installing wind turbines and ways of overcoming them by cooperating with residents.

A refurbishment project of 84 flats within five Victorian blocks to bring the homes to Decent Homes standard and beyond. The project commenced in 2007 and the final block is due for completion in August 2010.

Before the project, the flats were poorly insulated with individual solid fuel open fires as their main heating source.

Technologies

- Three Airdolphin 1kW (12m/s wind speed) micro wind turbines across three blocks for communal electricity supply.
- Each block has been provided with a communal gas boiler which provides space heating and hot water via heat interface boards at each dwelling.
- Communal solar thermal systems have also been installed on each block.

Description

Origin recognised this as an opportunity to trial micro wind turbines in an urban environment on their stock. The turbines were recommended by the design team for the project as an opportunity to contribute to communal electricity supply.

The rated output of each turbine is 1kW at 12m/s (43kph) wind speed. The turbine was chosen due to its applicability to urban environments. Low weight (175kg) and the rudder design are intended to allow it to track wind direction accurately in turbulent conditions. The blades also have grooves cut into them to minimise noise output.

The turbines are designed to operate in 'stall mode' at higher wind speeds (→23m/s) reducing

the rotation speed to one suitable for its size. This increases the range of wind speeds in which it can produce electricity.

Installation and commissioning

Installation and commissioning was carried out by Semplice Energy who mounted the turbines on the roof of each block on 3m high masts.

The absence of any remote monitoring systems means that, up to now, no automatic notification of operational issues has been available, and Origin Housing have relied on visual inspections to highlight issues.

Energy360, who are responsible for addressing any problems with the turbines, have been called out to rectify two issues which were both unconnected with the turbine itself. Problems with the DC relay and control circuits were both quickly fixed and the turbines were made fully operational

Resident considerations

Origin have worked closely with residents to ensure the turbines have no negative impact on their homes.

One resident complained of excessive noise during periods of high wind speed. The issue was quickly dealt with by initially resetting the turbine to shut down overnight. Noise and vibration specialists were then appointed to identify ways of rectifying the problem. Following works to the base of the turbine in question to reduce vibration, the noise has decreased and the resident is happy.

Service charges

All maintenance and sinking funds are being charged to residents through a service charge.

Lessons learned

One of the key lessons of this project is the need to ensure all residents fully understand the technologies being applied to their homes. Origin found that residents were far more willing to accept the technologies once they had them explained and demonstrated to them.

The need for monitoring is also a key issue. Systems are now being installed which will track output of the turbines as well as wind speed in order to give a better understanding of their performance. This will also allow any problems with the system to be identified and rectified quickly.

8.6 Community heating with combined heat and power

The Hyde Group

Summary

The Hyde Group have four community heating schemes providing space heating and hot water for 660 homes. Two of these schemes run CHP systems to provide electricity as well as heating to residents. There are currently plans for another 2,000 homes to be linked up to new community heating schemes.

The specialist nature of providing energy to residents has been a steep learning curve for The Hyde Group. To tackle the challenges, an energy services company (ESCo) has been established as part of the group in order to ensure residents receive the best possible service.

Despite the ESCo's efforts to optimise all aspects of community heat and power delivery, the costs of delivering heat and power at this scale have proved excessive. The challenge has been to balance the social responsibility of tackling fuel poverty with a planning authority-led agenda to develop heat networks. The Hyde Group have consistently found that the extra capital costs of heat networks, metering and billing fees, and management costs have resulted in such high costs that the housing association has had to subsidise resident fuel bills to avoid fuel poverty.

Background

The delivery of energy services has been recognised by The Hyde Group as a service that requires specialist skills and a level of involvement that would be unreasonable to add to the workload of housing officers.

By establishing an ESCo to deal with energy services, The Hyde Group can ensure that the necessary skills and knowledge are developed in order to deliver the most efficient service to residents in its existing community schemes, as well as ensuring new schemes are designed to meet the operational constraints and characteristics of each specific site.

Design

Close involvement of the ESCo at the planning, design and procurement stages of any new scheme is paramount. The following issues are considered for all new schemes:

- **Continuity:** The Hyde Group employs an external company to oversee the whole design and commissioning process to maintain continuity of information over time and between all project team members.
- **Metering:** The specification of specialist meters which can be set to either direct billing or pre-payment means that residents are offered the most suitable payment method for their circumstances. If budgeting for direct billing becomes a problem for a resident, the meters can be switched to pre-payment. All billing methods are subject to the same tariff and standing charges. Meters have pulsed outputs and are hardwired to MBUS collectors in the plant room of each scheme which transmit readings to the billing company.
- **Monitoring:** Monitoring equipment is needed within each plant room to closely track fuel consumption and heat and power outputs. This allows accurate tariff setting and tracking of the heating system efficiency.
- **Building Management Systems (BMS):** These are specified to optimise the efficiency of the heating system and to provide a link to the world outside the plant room to report any problems via GPRS and broadband.
- **Plant room security:** Often overlooked in community heating schemes, excellent security for the plant room is essential to ensure specialist equipment is not altered by anyone unless the company contracted to maintain it is present to oversee any adjustments.
- **Procurement:** Those appointed to run the plant room are involved in the specification and procurement of any kit in order to ensure that all factors are considered, from troubleshooting and support services, through to spare parts and replacements.
- **Private wire network:** Where electricity is generated by CHP, this is then sold to the residents by The Hyde Group. This requires a private wire network to be installed (ie owned by The Hyde Group, not the DNO).

Commissioning

The Hyde Group recognise that complex systems require in-depth commissioning. This begins at the design stage, by specifying a system that allows straightforward commissioning procedures. A specialist company is contracted to coordinate and oversee all commissioning, and provide the specialist knowledge necessary to guarantee that all issues are covered.

Commissioning continues during and after completion of the project. The maintenance company is contracted to oversee entry into the plant room during the defects period in order to retain a thorough knowledge of any alterations to the original settings and set-up and to control any changes.

The BMS is programmed to provide detailed information and feedback to the plant room manager allowing the system efficiency to be optimised and any technical issues to be dealt with swiftly.

Metering and billing

Metering and billing services are carried out by a billing company, who receive readings from MBUS transmitters and send out bills to residents accordingly. This income is then passed on to The Hyde Group. Similar to large utility companies, a standing charge is paid by all households for all administration services associated with delivering energy services.

Heat tariffs are set according to the fuel prices secured by The Hyde Group's procurement department. Commercial awareness in this process is key to ensuring all expenditure is covered at the lowest cost to the resident. There are significant challenges involved in achieving efficient delivery of heat at this scale, however. Often over-sized central plant leads to inefficiencies and the Hyde Group have found that this, combined with excessive distribution losses due to a lack of demand, have resulted in far lower overall fuel efficiencies than predicted during design stages. This increases costs to the ESCo, which can either be passed on to residents at a risk of pushing them into fuel poverty, or, as is the case

with The Hyde Group, be subsidised by the housing association themselves.

Heat and electricity tariffs are equal to or lower than the average cost of a selection of tariffs provided by the largest six suppliers. Where the CHP generated electricity is not sufficient to meet demand, supplementary electricity is bought by The Hyde Group and sold on to residents in line with Ofgem regulations.

Tariffs can be altered as knowledge of the system develops in order to cover costs and ensure residents are fairly charged for their energy.

Residents

Residents have total control and flexibility over their heat and electricity. The interface unit between the community heating and their home acts very much like a traditional boiler, and billing processes are straightforward. Tariffs for heat are calculated to ensure transparency.

Systems are now in place to ensure that, if a problem does occur within the plant room, maintenance is carried out before residents are affected.

9 Conclusion

Housing associations must consider all costs associated with LZC technologies from the initial stages of a project through to its ongoing management. These are often challenging to determine early in the design stages, but for both housing associations and their residents it is essential to make sure they are transparent from the outset.

Many technologies are specified and installed by contractors with different priorities to the housing associations and residents who have to manage, pay for and live with the systems. Residents and housing management teams should be directly involved in the decision making processes behind specification and procurement to ensure maintenance requirements can be dealt with effectively, costs can be adequately covered in rents and service charges, and that those using the systems fully understand how to use them effectively.

Deciding which technologies and controls are most appropriate will be an ongoing process, and the importance of post-occupancy evaluation in determining this cannot be underestimated. Developing knowledge of in-use performance of LZC technologies will help future decision-making. It will also enable housing associations to provide feedback and advice to residents on how best to operate the LZC technologies in their homes to maximise the benefits they stand to receive.

Costs for maintenance, servicing and depreciation of LZC technologies should all be recoverable from net rent, for tenants, or service charges, for leaseholders. Due to rent caps, the total costs recoverable from rented properties are limited. If costs exceed those allowable under current rent constraints, housing associations are at risk of signing up for items which cannot be paid for from existing income streams.

For communal systems, metering and billing needs to be brought in-house or outsourced. It is extremely challenging to do this cost-effectively in order to keep residents' fuel bills to affordable levels comparable to individual gas heating systems and avoid the risk of fuel poverty. Again, this must be considered at an early stage in order to truly understand the whole costs of a LZC technology installation.

Good design and installation of LZC technologies must always be combined with a primary focus on reducing carbon dioxide emissions and fuel bills through energy efficiency. Only in this way can affordable rents, service charges and fuel bills be achieved while achieving real reductions in energy use and carbon dioxide emissions.

Appendix

LZC technology handover template

Project Name and Address	

Housing Manager

Name		Telephone	
Email			
Address			

Main Contact for Technology

Name		Telephone	
Email			
Address			

Installer

Name		Telephone	
Email			
Address			

Commissioning Manager

Name		Telephone	
Email			
Address			

Systems Details

Manufacturer		Product	
System Size			

Commissioning

Date Commissioned		Seasonal Commissioning	
Problems Identified and Rectified			

Documentation

Operation and Maintenance Manuals		Non-Technical Literature	
User-Guides		Alternative Guides	

Defects and Warranties (enter dates and cover/exclusions)

Planned Maintenance and Servicing

Action Required		Frequency	
Initial Date		Responsibility	
Contact			

Unplanned Maintenance

Main Contact		Out of Hours Contact	

Additional Information

Further reading

General Information

- BSRIA Commissioning Guides: 'Application Guide 5/2002 – Commissioning Management'
- Carbon Trust: *www.carbontrust.co.uk*
- The Chartered Institution of Building Services Engineers: *www.cibse.org*
  - 'CIBSE Guide A: Environmental Design'
  - 'CIBSE Guide L: Sustainability'
  - 'CIBSE Guide M: Maintenance Engineering and Management'
- Communities and Local Government: 'Code for Sustainable Homes: A Cost Review' Available to download from: *www.communities.gov.uk/publications/planningandbuilding/codecostreview*
- Energy Saving Trust: *www.energysavingtrust.org.uk*
- Feed-in-Tariff information: *www.fitariffs.co.uk*
- The Microgeneration Certification Scheme: *www.microgenerationcertification.org*
- National Energy Foundation: *www.nef.org.uk*
- Ofgem: *www.ofgem.gov.uk*
- Renewable Heat Incentive information: *www.rhincentive.co.uk*
- Soft Landings Framework (BSRIA): *www.softlandings.org.uk*

Low and zero carbon technologies

- Bioenergy Capital Grants: *www.bioenergycapitalgrants.org.uk*
- Biomass Energy Centre: *www.biomassenergycentre.org.uk*
- Combined Heat and Power Association: *www.chpa.co.uk*
- Combined Heat and Power Quality Assurance programme: *www.chpqa.com*
- Ground Source Heat Pump Association: *www.gshp.org.uk*
- Renewable Energy Association: *www.r-e-a.net*
- Renewable Energy Assurance Limited: *www.realassurance.org.uk*
- RenewableUK: *www.bwea.com*
- Solar Trade Association: *www.solar-trade.org.uk*

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This report was written and researched by Matt Bailey, CEN Services Ltd.

NATIONAL HOUSING FEDERATION
london

Lifetime costs of installing renewable energy technologies

- A practical guide to incorporating low and zero carbon technologies into new-build affordable housing developments.
- For housing associations, there are no 'fit and forget' technologies. This guide explores the lifetime costs and implications of installing tomorrow's technologies today.
- The guide shows how housing associations can bridge the gap between target-driven design processes and the day-to-day actual use of these technologies.

The National Housing Federation represents 1,200 not-for-profit, independent housing associations who together provide 2 million homes for around 5 million people in England.

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