Sustainable technologies

The experience of housing associations

NHBC FOUNDATION

Housing research & guidance

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Researched and written by

Acknowledgments

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About the NHBC Foundation

The NHBC Foundation, established in 2006, provides high quality research and practical guidance to support the house-building industry as it addresses the challenges of delivering 21st century new homes. To date we have published over 60 reports on a wide variety of topics, including the sustainability agenda, homeowner issues and risk management.

The NHBC Foundation is also involved in a programme of positive engagement with the Government, academics and other key stakeholders, focusing on current and pressing issues relevant to house building.

NHBC is the standard-setting body and leading warranty and insurance provider for new homes in the UK, providing risk management services to the house-building and wider construction industry. All profits are reinvested in research and used to improve the construction standard of new homes for the benefit of homeowners. NHBC is independent of the Government and house builders.

Further details on the latest output from the NHBC Foundation can be found at: www.nhbcfoundation.org.

The NHBC Foundation Expert Panel

The NHBC Foundation's research programme is guided by an Expert Panel of senior representatives from Government and industry:

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Foreword

Much progress has been made by the house-building industry to address environmental issues, particularly in relation to improving energy and water efficiency. This progress was stimulated by the introduction of the Code for Sustainable Homes and the 2006 announcement of the ten-year goal of zero carbon new homes together with the milestones to guide progress on the journey. With 2016 fast approaching, it is opportune that the NHBC Foundation has undertaken a review of experiences to date of sustainable technologies.

It is the housing association sector that has been at the forefront in the adoption of sustainable technologies, mainly because their funding for new house building has required compliance with the Code for Sustainable Homes. For this reason our research has centred on housing associations' experiences of the variety of energy-efficient technologies and water-saving features.

Gathered through focus groups and telephone surveys with a large number of housing association representatives, the report identifies those technologies that have delivered good levels of satisfaction and those that have failed to delight. Among the key findings of the research is that, beyond looking at utility bills, there has been a relative lack of monitoring of performance of sustainable homes. Additional data obtained through physical monitoring would certainly be useful in confirming good technology choices.

Throughout the life of the Code there has been a growing acceptance of the important role that the building fabric has to play in conserving energy and it is encouraging that there is now general consensus around the 'fabric-first' approach. But as we make that final step towards zero carbon, it is expected that most new homes will also need to be fitted with energy-efficiency and water-saving technologies. I hope that this latest research from the NHBC Foundation will help guide designers and specifiers towards making good future choices.

We are very grateful for the support received from the large number of housing association colleagues who took the time to assist the researchers with this important work.

Rt. Hon. Nick Raynsford
Chairman, NHBC Foundation

1   Introduction

Background and objectives

Since its introduction in 2006, the Code for Sustainable Homes[1] has driven the sustainability agenda in new home construction and led to considerable changes in the specification of new homes. Together with changes to building regulations, the Code has resulted in greater use of technologies to meet the challenges of energy and water efficiency.

The social housing sector, working generally to more stringent Code levels, has led the way in the use of sustainable technologies. Because of their ownership and management of significant portfolios of high-Code-level sustainable homes, they have been in a position to gain experience of the installation, performance and resident satisfaction with the various technologies.

Box 1: Energy efficiency technologies	
Photovoltaics (PV)	Mechanical ventilation and heat recovery (MVHR)
Solar thermal	Wastewater heat recovery
Ground source heat pumps (GSHP)	Flue gas heat recovery
Air source heat pumps	Exhaust air heat pumps
Biomass communal heating	Voltage optimisers
Gas/other forms of communal heating	Boiler flow restrictors

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1   Code for Sustainable Homes. Available from the Department for Communities and Local Government Planning Portal: http://www.planningportal.gov.uk/buildingregulations/ greenerbuildings/sustainablehomes.

Box 2: Water efficiency technologies	
Low-flush toilets	Rainwater harvesting
Low-volume baths	Greywater recycling
Low-flow taps and showers	

This primary research was commissioned by the NHBC Foundation to investigate the sector's experiences of these technologies, with the aim of helping the wider house-building industry and others to make better-informed choices. This project identifies technologies that have worked well, those that have given rise to concerns and the nature of those concerns.

Objectives of the research were to establish:

- the uptake of specific technologies among housing associations to satisfy the sustainability and zero carbon agenda challenges

- their reasons for choosing specific technologies

- experiences in design, installation, commissioning, use by residents, maintenance, and other important issues

- which technologies they would use again and which they would seek to avoid

- lessons learned and advice to others seeking to use such technologies.

It should be noted that during the research for this report several housing associations remarked that in their current development programmes they have moved towards a 'fabric first' policy, ie aiming to achieve building regulations or Code requirements through the building fabric wherever possible. As building regulations tighten and move towards zero carbon targets, it is likely that 'fabric first' will not be sufficient on its own and sustainable technologies will have to be used.

2   Key findings

There is widespread use of sustainable technologies by housing associations

Since 2006, the start of the first funding period for homes built to the Code for Sustainable Homes, housing associations have increasingly installed sustainable technologies. Almost two-thirds of those contacted to participate in this research had experience of at least one technology, and by far the most used energy-related sustainable technology is photovoltaics (PV), with the percentage growing within each Homes and Communities Agency (HCA) funding round from 12% to 61% most recently.

Code for Sustainable Homes, planning or funding requirements influences technology use

All those questioned in the focus groups and by telephone indicated that planning, funding requirements, and meeting the Code for Sustainable Homes requirements were the main drivers to using and installing technologies. Only 5% saw the installation of technologies as a revenue opportunity.

Cost of the technology influences its installation

Two-thirds stated that the main reason for choosing which specific technology to install into homes is the upfront capital cost. Maintenance costs were also high up the priority list with 38% citing this as a consideration. Over half considered resident 'ease of use' to be important in choosing a specific technology, and, although costs appear to be front of mind, only 19% considered the technology's payback term to be an influencing factor.

Water efficiency measures are installed four times more often than energy efficiency

Housing associations taking part in the survey have fitted over 75,000 new homes with low-flush toilets and over 66,000 with low-flow taps and showers. These are now regarded as standard specification items. The choice and installation of energy efficiency technologies have been far less consistent, with communal heating systems estimated to be serving 18,000 new homes, PV installed for over 16,500 homes and MVHR installed in almost 14,000 homes.

Inadequate installation skills is an issue

Despite the ease of installation only being mentioned by 10% of respondents as a main driver for technology choice, almost two-thirds experienced problems during installation due to a lack of skilled or experienced trades. Quality installation also influences how successful a project is, with 23% agreeing that good quality installers who understand the product can make a difference.

Technology use is benefitting residents

43% of those surveyed said that benefitting tenants and reducing their fuel poverty was one of the main drivers for installing sustainable technologies into their new homes. While little robust data exists to quantify this, almost half of the housing associations thought that residents were benefitting in general, although about half thought tenant experiences had been mixed. However, 81% perceived their residents to have benefitted from reduced energy bills, and almost a quarter cited better air quality.

But residents could benefit further with better understanding

In both the focus groups and telephone survey, respondents commented that providing residents with a good understanding of technologies is fundamental to success, with 86% stating that resident instruction and knowledge could positively affect the successful use of sustainable technologies. 72% thought that the best way to help their residents understand the technologies was through a personal demonstration, with 50% offering printed information. 87% agreed that the most effective approach was to ensure that user controls were simple and easy to use.

Associations have encountered difficulties in measuring performance and benefits

Measuring performance of installed technologies and assessing the benefit and return has proved challenging because of different use and behaviour patterns, access to energy costs and bills and lack of widespread accurate monitoring. Many installation decisions have been made on perceptions of performance and return rather than measured, analysed data. On-site and remote monitoring has been installed, particularly with PV, but many have relied on resident surveys and maintenance feedback to assess performance and satisfaction. Almost two-thirds have been able to analyse energy bills to some extent, but little consistent or conclusive data has been shared across the sector.

Heat pumps are delivering poor levels of satisfaction

The three types of heat pumps surveyed (air source, ground source and exhaust air) all attracted low general satisfaction levels. 60% of those questioned scored air source heat pumps as poor or fair, with 63% scoring ground source heat pumps and 93% scoring exhaust air heat pumps in the same way. Interestingly, despite these low satisfaction scores, 45% said they would use air source heat pumps again and it was the most identified technology which was considered to be sound but not yet delivering against expectation.

Some infrequently installed technologies have high levels of satisfaction

Boiler flow restrictors, voltage optimisers and wastewater heat recovery were installed by less than 10% of the housing associations surveyed, but the levels of satisfaction with these were higher than several widely installed technologies.

The broad use of photovoltaics is likely to continue

The housing associations surveyed had installed photovoltaics on more than 16,500 new homes since 2006, with 82% indicating that this was the main technology that they used. General satisfaction scores are high, with over two-thirds rating them as good or excellent, which combined with a high score for ease of installation, and perceptions of low user involvement with controls, appears to confirm a preference for this technology. Almost 80% expect this to be the technology they will use to meet the challenge of future building regulation changes.

The main lessons learned from incorporating the technologies, monitoring their performance, user experience feedback and issues encountered in maintenance are a need to:

- get the building fabric right first before considering the use of sustainable technologies

- research fully the technologies available and develop a good understanding of the options

- involve all departments (development/asset management/maintenance and housing management) when technologies are under consideration

- ensure integration into the whole house design

- plan for effective commissioning to avoid problems at this stage

- consider ease and cost of maintenance at the outset

- use installers who understand the products

- provide good training and instructions for residents

- use technologies involving minimal use of controls by users where possible

- consider the training and maintenance needs of shared owners, leaseholders and freeholders, as well as residents

- improve data collection and recording of experiences, and be more willing to share results with the sector as a whole

- identify and highlight good practices and develop a structured approach to data collection with a centralised resource to promote further learning and development around the use of these technologies.

3   Methodology

To meet the objectives, the research involved focus groups with housing associations to give insight, followed by a wider programme to quantify views.

Stage 1: Three focus groups

Focus groups were held in Manchester, Birmingham and London, attended by 34 people representing 27 housing associations. These discussions, each lasting two-and-a-half hours, provided insight into the drivers for using technologies and experiences in use. This provided guidance for the design of the second-stage questionnaire.

Stage 2: 200 in-depth telephone interviews

Of 319 housing association respondents that were contacted, 119 had no direct experience of sustainable technologies; this includes small, non-developing associations.

In-depth interviews were conducted with 200 people in 174 different housing associations that had used sustainable technologies in newbuild developments. Respondents were a mix of development directors/managers (predominantly), technical and asset managers, and design and quality/energy/sustainability managers.

While 70% of the 200 people interviewed were responsible for, or involved in, the decision to install technologies in newbuild homes, 43% were involved in maintenance and asset management and 57% with resident engagement and feedback. Some were involved in several roles, accounting for the discrepancy in percentage.

Although the aim of the survey was to understand experiences of technologies in newbuild homes, housing associations are also fitting these technologies to existing homes. Almost half of the respondents were also involved in decisions to install in retrofit programmes.

Participating housing associations are acknowledged in Appendix 1.

4 Drivers to the use of sustainable technologies
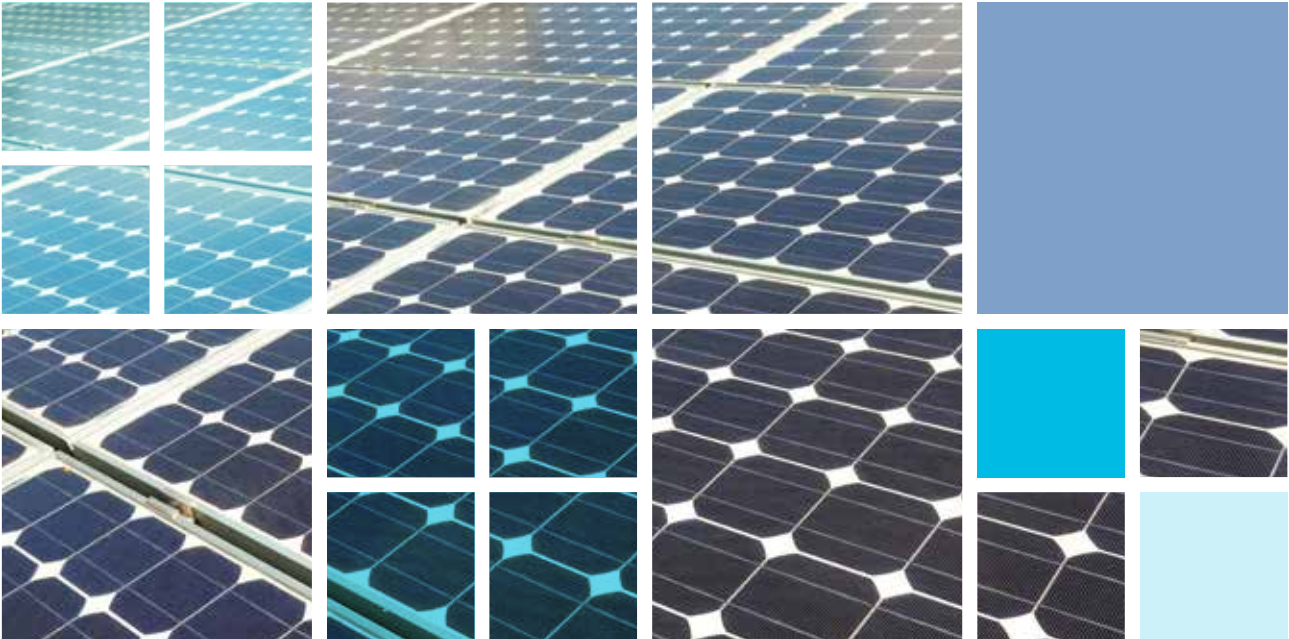
Feedback indicated that planning, funding requirements, and meeting the Code for Sustainable Homes requirements were the main drivers to installing sustainable technologies.

However, other external and internal factors have also supported their use. Several housing associations had made commitments to use sustainable technologies to benefit their residents and tackle fuel poverty through reducing their energy bills.

Many respondents across both stages of the survey commented that with more recent changes affecting funding their current policy is 'fabric first'.
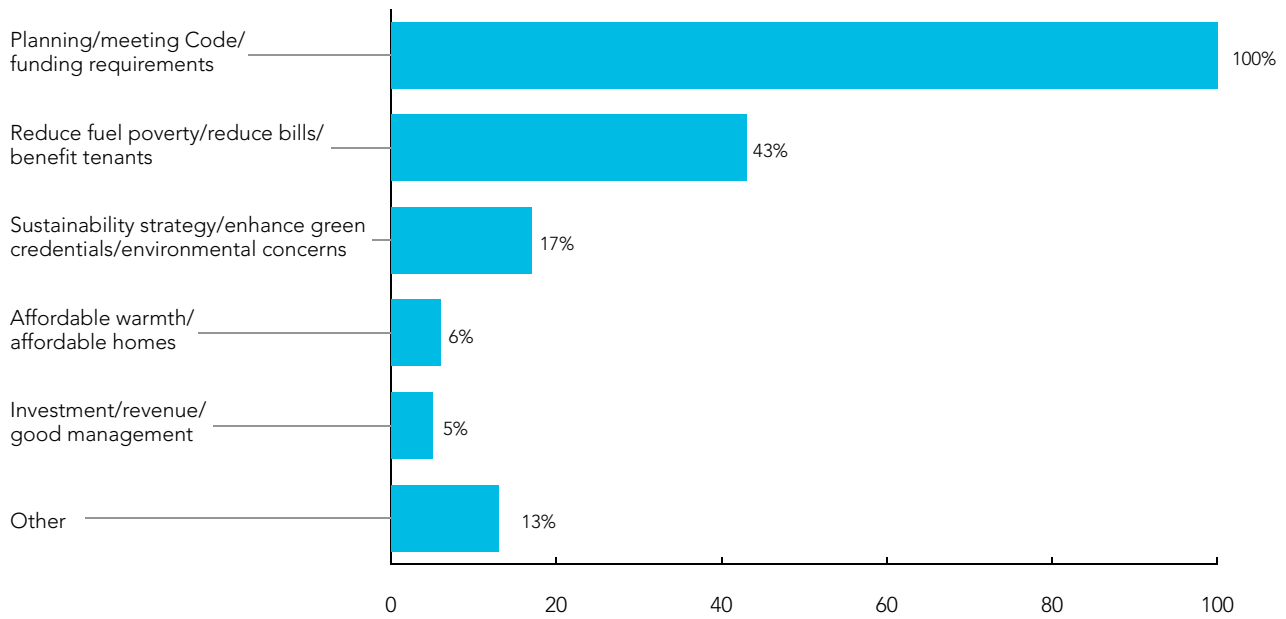
Figure 1 Reasons for installing sustainable technologies

Base: 200. Note some respondents provided more than one answer.
'Other' includes: energy efficiency, where gas is not available, seen to be doing the right thing, innovation, the best solution for that project/site.

'If we tackle fuel poverty, great. But that means that person has got more money in their pocket to pay the bills, to pay us to invest in the local economy.'

'A lot of the new houses we build at the moment don't have renewable technologies, because we can't afford them. It's that tight because of the funding limits that we are on, and we are on the maximum amount per property. We'll build them as thermally efficient, and put in the energy saving boilers and use the A-rated windows and doors, all that stuff in them, but we can't deliver an £11 per month utility bill like we have done on one scheme which we built to Code 4. We put in greywater harvesting, solar thermal and PV; those residents' combined utility bills are £11 per month.'

5   Uptake of technologies

This section looks at the uptake of different technologies: those installed for energy efficiency and those designed to reduce water use.

PV was used by 82% building new homes since 2006, making them by far the main technology used to achieve energy efficiency. MVHR was used by 62%, solar thermal by 61% and air source heat pumps by 56%. Some form of communal heating was installed by 43%.

The least-used technologies were wastewater heat recovery, voltage optimisers and boiler flow restrictors.

Popular products used to meet the requirements for reduced water usage are low-flush toilets and low-flow taps and showers.

52% have installed rainwater harvesting systems but only 18% have tried greywater recycling in newbuild homes.

Energy efficiency

Technology	Percentage
PV	82%
MVHR	62%
Solar thermal	61%
Air source heat pumps	56%
Gas communal heating	36%
Biomass communal heating	11%
Other communal heating (eg GSHP)	7%
Flue gas heat recovery	23%
Ground source heat pumps (GSHP)	20%
Exhaust air heat pumps	17%
Boiler flow restrictors	6%
Voltage optimisers	4%
Wastewater heat recovery	2%

Water efficiency

Technology	Percentage
Low-flush toilets	86%
Low-flow taps and showers	75%
Low-volume baths	64%
Rainwater harvesting	52%
Greywater recycling	18%

Figure 2 Percentage of housing associations installing technologies in newbuild homes

Base: 185 organisations, including different branches or development businesses of some groups.
In total 43% installed communal heating but some used more than one type.
Half of those using biomass boilers have also used another form of communal heating.

The extent of installation of technologies during the HCA funding rounds has been analysed, starting with the 2006–2008 round, the first to require compliance with the Code for Sustainable Homes. The extent to which technologies installed early on are used in later rounds may be taken as an indication of satisfaction.

Figure 3 is based on all those interviewed, and shows the proportion of housing associations installing these technologies in each of the last three HCA funding rounds.

While only 12% installed PV in 2006–2008, there has been steady growth and 61% of all organisations have installed them in the 2011–2015 period.

Several respondents have repeated their use at each round.

In 2011–2015, 46% have installed MVHR, a large increase from 28% in the previous round. Installation of air source heat pumps has also increased notably.

Energy efficiency

Legend: 2006–2008 | 2008–2011 | 2011–2015 | Not installed at all

PV: 12%, 48%, 61%, 18%
MVHR: 6%, 28%, 46%, 38%
Solar thermal: 10%, 35%, 37%, 39%
Air source heat pumps: 6%, 26%, 39%, 44%
Communal heating: 9%, 22%, 30%, 57%
Flue gas heat recovery: 2%, 10%, 18%, 77%
Ground source heat pumps: 4%, 13%, 6%, 80%
Exhaust air heat pumps: 2%, 10%, 8%, 83%

Water efficiency

Low-flush toilets: 20%, 55%, 69%, 14%
Low-flow taps and showers: 16%, 47%, 61%, 25%
Low-volume baths: 15%, 39%, 54%, 36%
Rainwater harvesting: 4%, 25%, 37%, 48%
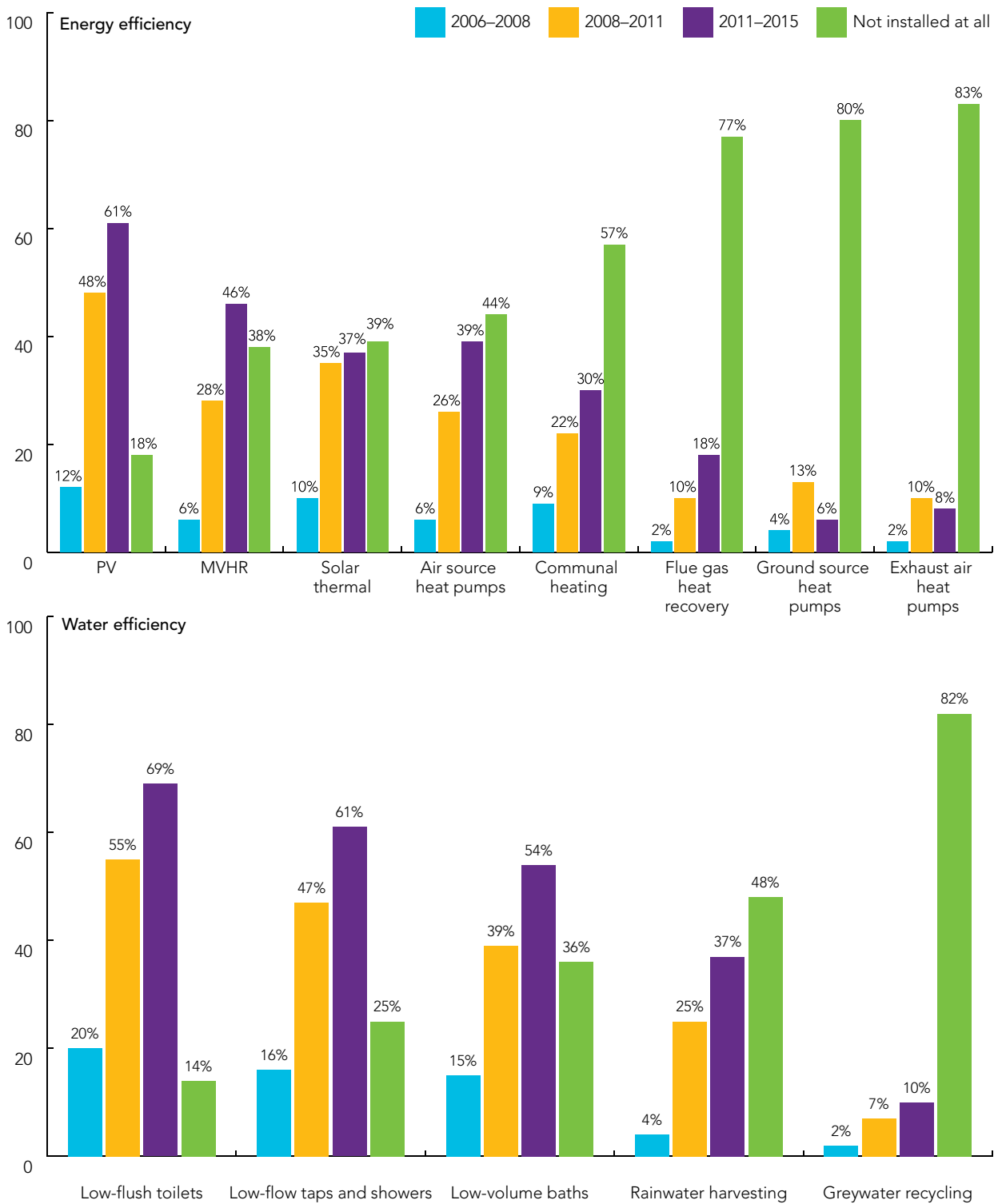Greywater recycling: 2%, 7%, 10%, 82%

Figure 3 Proportion of housing associations installing in each funding round

Base: 185 organisations, including different branches or development businesses of some groups.
Communal heating asked as a general question here rather than the specific type.
Low-use technologies are not shown (installed by under 10%).

The figures given in Table 1 suggest that biomass boilers used for communal heating are losing popularity. Only 40% installed one or more such systems in the 2011–2015 funding round, 30% lower than in 2008–2011. Gas communal heating systems appear to have been the favoured alternative, increasing by 26% in 2011–2015.

Table 1 Communal heating – date of installation, by fuel type

	2006–2008	2008–2011	2011–2015
Those who have *only* installed biomass communal systems	20%	70%	40%
Those who have *only* installed gas communal systems	18%	45%	71%

'Each new scheme gives us a new opportunity to test new products, new ways of thinking and new ways of working. For some in the pipeline we are looking at joining PV and Solar and we are also testing other new elements together to see how they work.'

The number of new homes built since 2006 in which each technology has been installed across those interviewed is given in Figure 4. Almost 19,000 homes are served by communal heating systems, some 17,000 have power available from PV panels and 14,000 have MVHR.

Low-flush toilets, low-flow taps and showers, and low-volume baths have been installed in four times more homes than the energy efficiency technologies over the same period.

Many of the housing associations interviewed have also installed sustainable technologies as part of retrofit or refurbishment programmes. The main products installed are PV (39% of housing associations have installed these in existing homes), air source heat pumps (31%), solar thermal (26%), low-flush toilets (34%), and low-flow taps and showers (27%).

Energy efficiency – number of new homes (in sample)

Technology	Value
Communal heating (ie a centralised system for more than one dwelling)	18,881
PV	16,655
MVHR	13,990
Solar thermal	8478
Air source heat pumps	5511
Flue gas heat recovery	4077
Boiler flow restrictors	3532
Ground source heat pumps	748
Exhaust air heat pumps	839
Voltage optimisers	202
Wastewater heat recovery	37

Water efficiency – number of new homes (in sample)

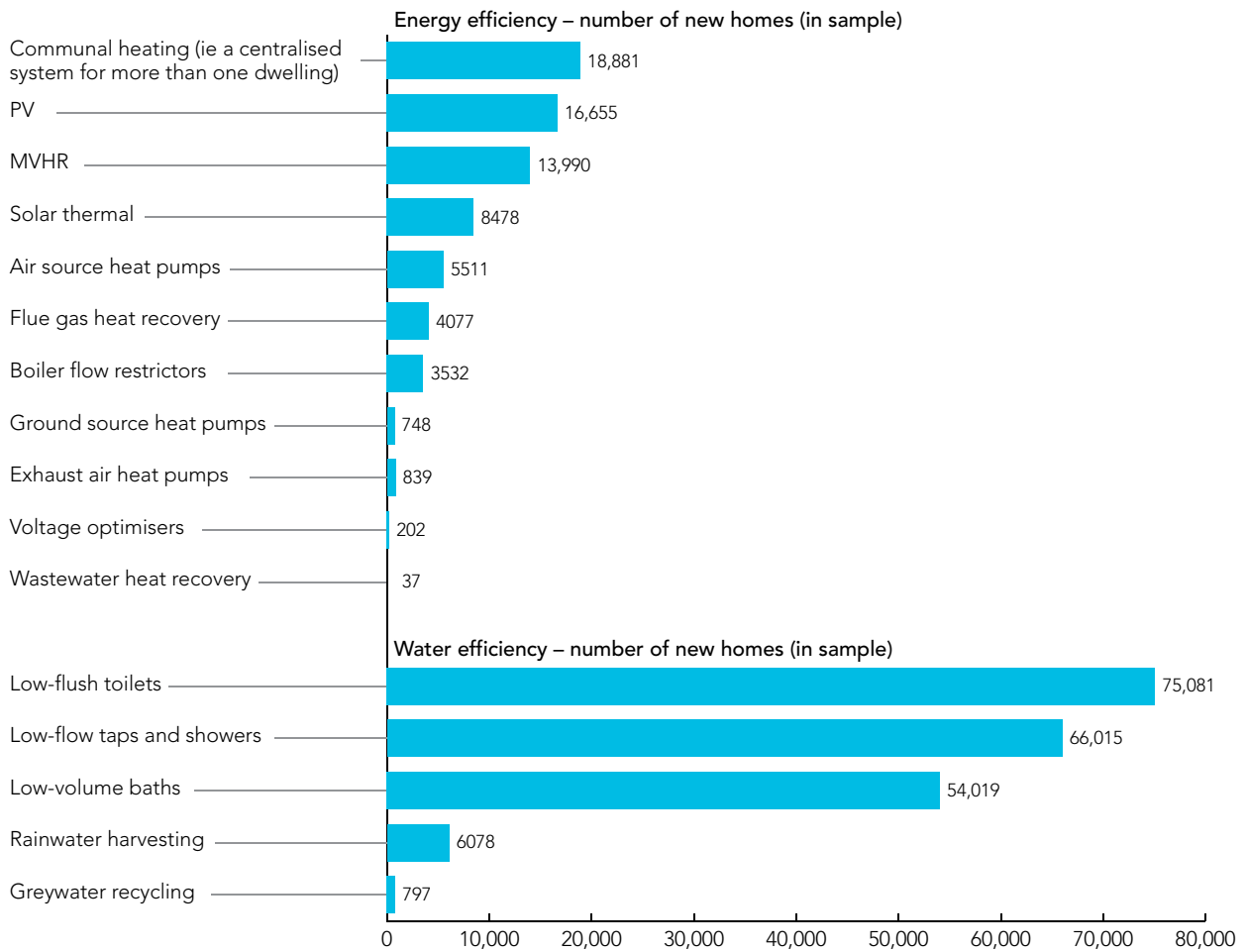| Technology	Value
Low-flush toilets	75,081
Low-flow taps and showers	66,015
Low-volume baths	54,019
Rainwater harvesting	6078
Greywater recycling	797

Figure 4 Number of housing association new homes with installed technologies across those interviewed in the sample

Base 185 organisations.
Number of homes served by communal heating systems estimated by respondents – does not relate to number of installations.

6 Factors influencing choice of technology

Main considerations

When choosing between technologies to install in newbuild homes, the main deciding factors for more than half of respondents are the capital cost and ease of resident use.

Surprisingly, only four in 10 regard the running and maintenance costs as one of their top three considerations. Factors such as payback term, durability and ease of installation are a main consideration for fewer than two in 10.

These figures suggest different levels of influence are being applied by those responsible for the capital expenditure for development, the operational expenditures for asset management and those focused on the home user experience. Capital investment is placed ahead of the user experience with lifetime costs appearing to be the third consideration.
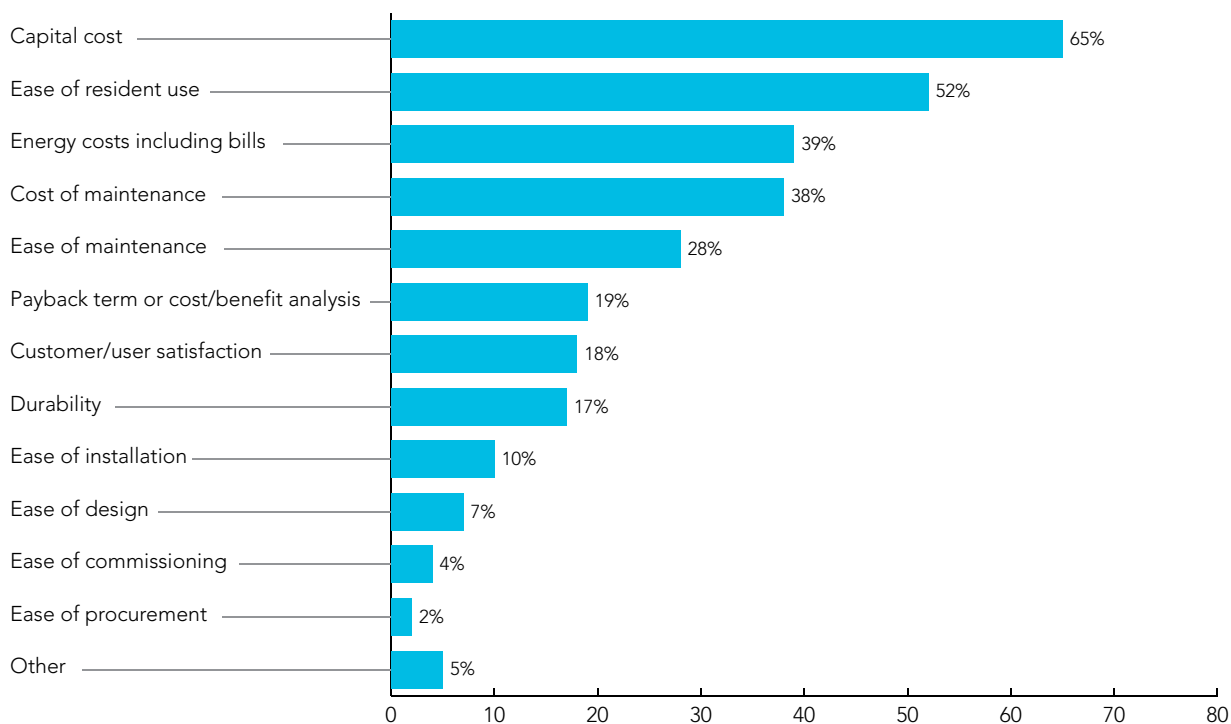
Figure 5 Main considerations when considering whether to install a sustainable technology in newbuild – respondents were asked to name three

Base: 193 (those involved in, or able to comment on, the decision to install technologies in newbuild homes).

'Other' includes: satisfying the Code for Sustainable Homes, regulation requirements, benefit to the residents.

Identification of technologies that reduce energy bills

Figure 5 shows that running costs including energy bills were in the top three considerations for 39% of housing associations in their choice of technology.

However, most have based their choices on technologies that have demonstrated the potential to reduce energy bills rather than information about those that consistently and significantly do so. Of the respondents, 22% felt that the impact of technologies is not always clear or that they have been unable to identify technologies that could help to reduce energy bills.

These results suggest that the sector, and the manufacturers working within it, have not been effective in sharing hard performance evidence on which to base decisions. Many choices appear to have been based upon anticipated rather than evidenced performance with the expectation that a positive effect on energy costs will emerge over time.
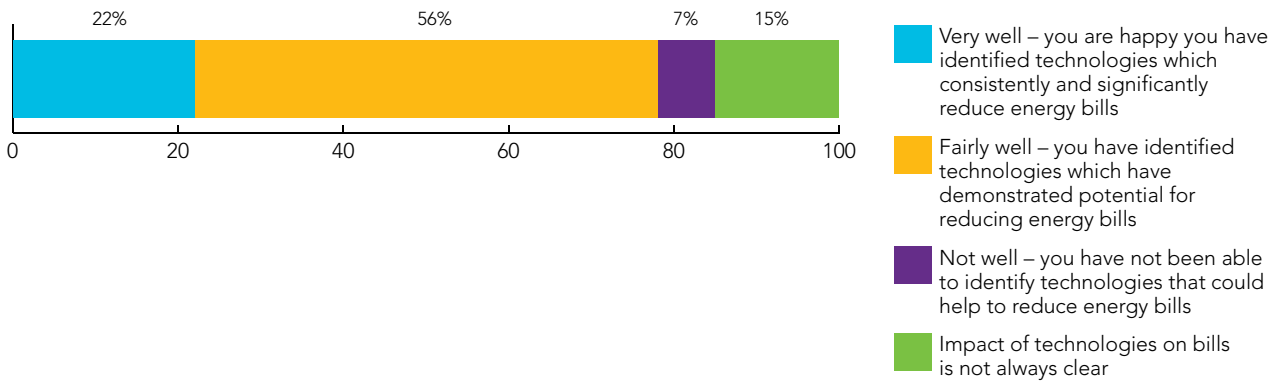
22%   56%   7%   15%

0   20   40   60   80   100

Very well – you are happy you have identified technologies which consistently and significantly reduce energy bills

Fairly well – you have identified technologies which have demonstrated potential for reducing energy bills

Not well – you have not been able to identify technologies that could help to reduce energy bills

Impact of technologies on bills is not always clear

Figure 6 How well do you feel that you or your organisation has identified technologies that have worked best to reduce energy bills?

Base: 200.

'It's difficult for us to do another project again when it's our residents' money that we are putting into this new technology that we don't fully appreciate and understand.'

Preferred primary heat source

The focus group discussions made it clear that primary heating choices are influenced by whether a gas supply is available. If gas is available, 98% prefer to use a gas boiler as the primary heat source.

Where a gas supply is not available, electric storage heaters or air source heat pumps are the preferred heating options.

Electric storage heaters	36%
Air source heat pumps	32%
Electricity/electric/electric boilers	7%
Ground source heat pumps	5%
Oil	4%
Electric panel heaters	3%
Exhaust air heat pumps	1%
Other	7%
No preference	2%
Not applicable/gas only	15%

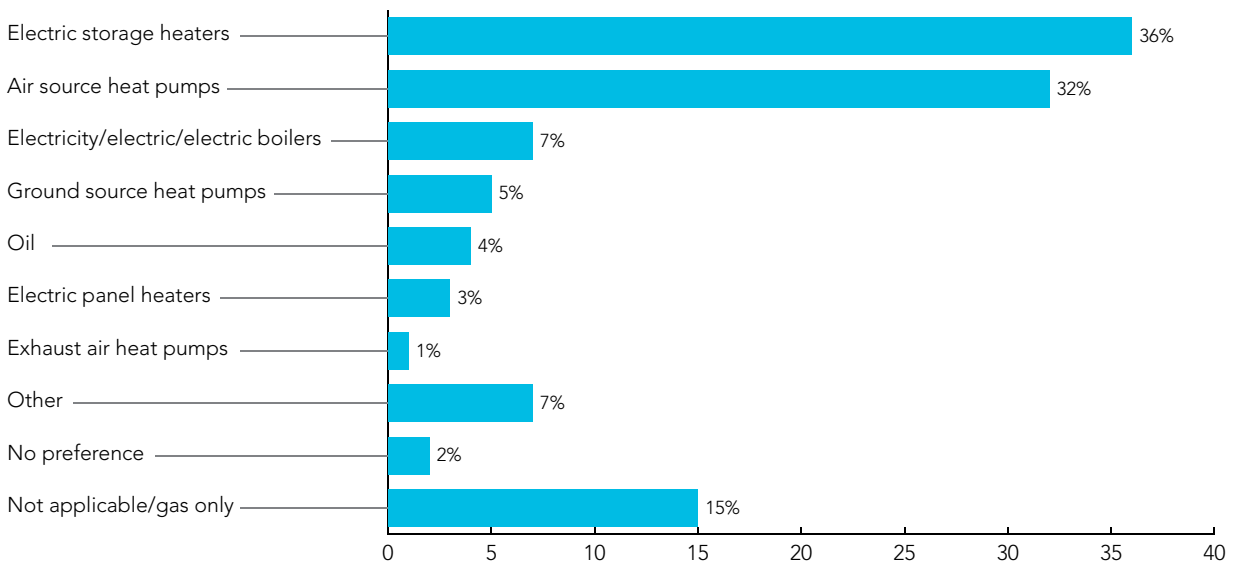0   5   10   15   20   25   30   35   40

Figure 7 Preferred primary heat source where there is no gas supply available

Base: 200. Note respondents provided more than one answer.

'Other' includes: biomass, down-flow heaters, electric wet systems, communal heating, liquified petroleum gas (LPG), gas in cylinders.

7 Assessing performance in-use

Monitoring the performance of technologies in use was discussed within the focus groups. Some participants described projects undertaken to monitor energy bills and to understand the performance of technologies installed. These projects were typically not conducted on a widespread basis and were often limited to a small group of homes. Some had used grant funding to set up monitoring programmes.

Many commented on the difficulties of achieving reliable results, for several reasons:

■ gaining access to residents' homes and energy bills

■ different patterns of usage and 'comfort levels' by residents in the same home types

■ no 'before' results in new homes on which to base comparisons

■ residents are unable to make a comparison with a previous property as this is their first home or it is of a different/newer style to their previous home

■ energy costs have been changing, making historical comparison difficult

■ early product developments where incidences of problems in design, commissioning and installation may have contributed to poor performance.

Some technologies lend themselves to external/remote monitoring, for example PV. Almost one-third of housing associations have used this approach to successfully monitor performance and usage, and identify any issues.

Other associations have used alternative approaches to identify satisfaction with ease of use and energy bills, conducting specific customer satisfaction or more general resident surveys to look at the issue. Some have relied on their maintenance teams to provide views on technology performance.

Assessing the extent of different approaches in the telephone survey, almost three-quarters have relied on resident satisfaction surveys, 70% on maintenance feedback and 63% have instigated an analysis of utility bills.

Most participants used several approaches. Almost half have used some form of monitoring system in the property. Those with such systems in the focus groups had the best knowledge of how residents have benefitted.

Approach	%
Resident satisfaction surveys	73%
Views from maintenance	70%
Some analysis of utility bills	63%
Anecdotal views	49%
Monitoring systems in the property	45%
Remote monitoring systems	30%
Performance through the Feed-in Tariff	26%
Not gathered any feedback	7%
Other	6%
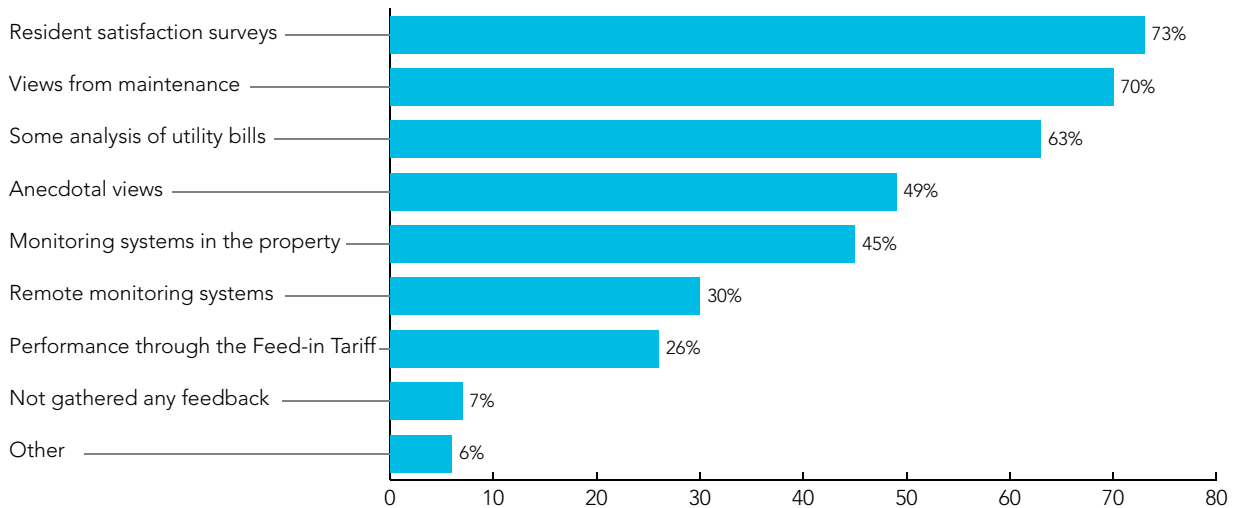
Figure 8 How housing associations have assessed performance in-use

Base: 200.

'Other' includes: looking at resident behaviour and how they have used the system, inspections on site, an audit on site, the number of phone calls we receive saying this isn't working (it is working, but they are not using it correctly), independent test monitoring, analysing reported defects and repairs, academic research, analysis with an academic institute.

Several approaches were used by each housing association.

> 'We can get the Feed-in Tariff and the consumption and therefore the export, we can get that information through (PVs). We can benefit from alarms when systems are not working.'

8   Resident benefits and issues

Although a high percentage of respondents have instigated some analysis of energy bills or conducted customer satisfaction surveys, when asked how they thought residents are benefitting from the installed sustainable technologies 43% thought they are benefitting very or fairly well.

A further 44% have had mixed experiences and only 5% think there have been no perceived benefits.
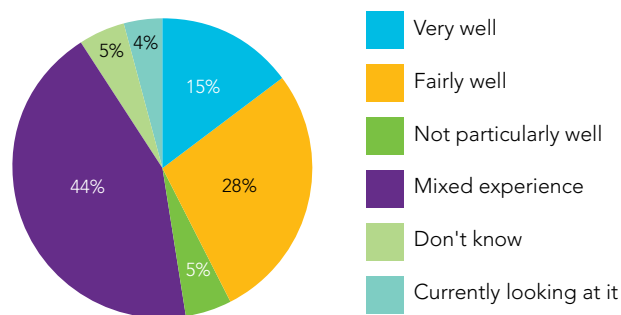

- Very well
- Fairly well
- Not particularly well
- Mixed experience
- Don't know
- Currently looking at it

Figure 9 How well residents are thought to be benefitting from sustainable technologies incorporated in their homes

Base: 196.

Many respondents are unable to robustly quantify the benefits because of the issues involved in monitoring (see section 7), but 81% believe that residents are seeing reduced energy bills.

One in five perceive that air quality in the home is better. Of those citing better air quality, three-quarters were MVHR users. Some in the focus groups said they had installed MVHR where residents had respiratory issues and feedback from these residents was positive, but this is based on a limited amount of anecdotal evidence.
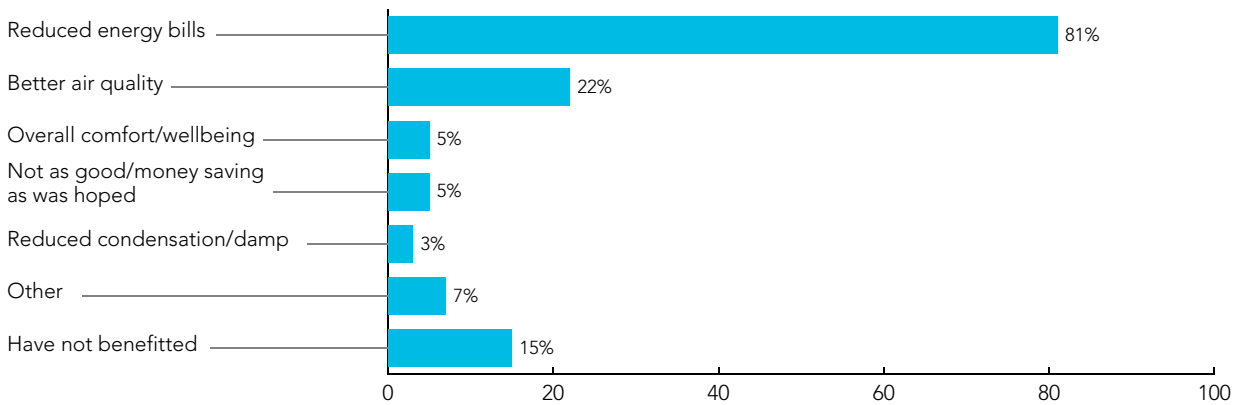

Figure 10 Perceived resident benefits

Base: 196.

Note some respondents indicated more than one benefit.

'Other' includes: better design of the homes, increased reliability, make the controls easy to use, some experienced increased bills, some tenants find it is too hot.

93% of those who think their residents have benefitted 'very well', say they have benefitted from reduced energy bills.

9 Experiences with individual sustainable technologies
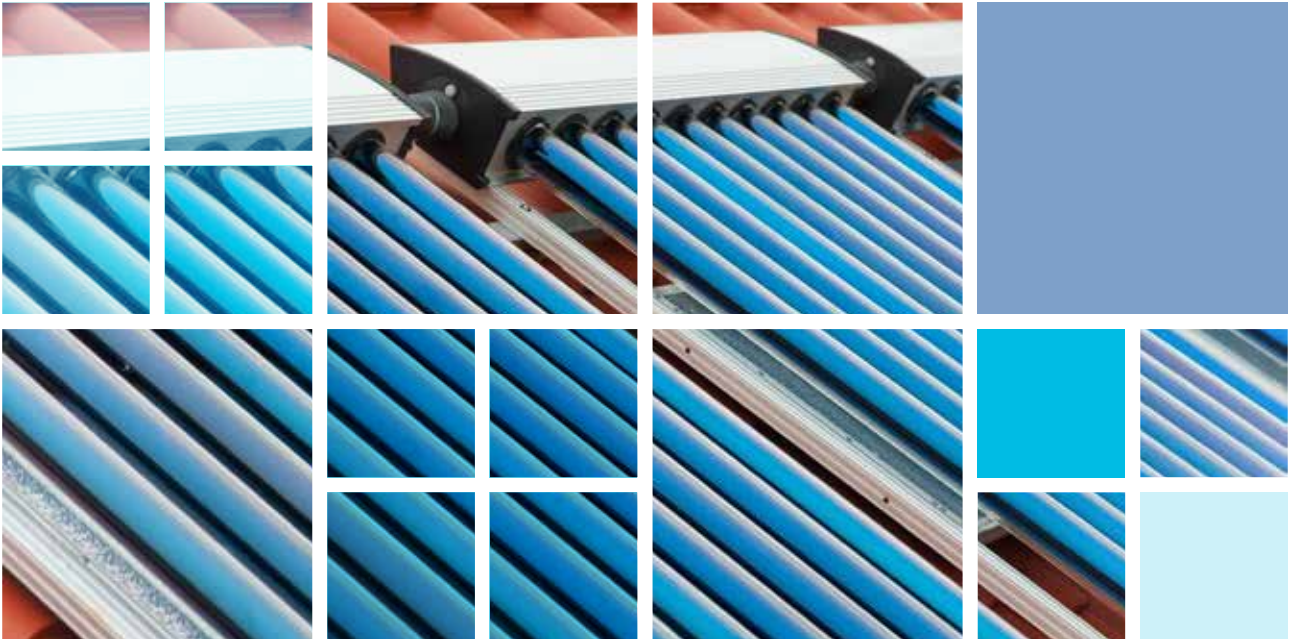
General satisfaction

There was consensus across the focus groups on the technologies that worked well or badly, but some differences emerged, possibly due to different circumstances of use. To confirm more widespread views, respondents in the telephone survey were asked to rate each technology they had used on a scale of 'poor', 'fair', 'good' and 'excellent'.

The most widely used energy technology, PV (installed by 82%), had one of the highest satisfaction ratings. Two-thirds of users considered it to be good or excellent.

There are several technologies considered to be poor or fair by 50% or more of users. This includes exhaust air heat pumps, for which almost three-quarters described either poor or fair satisfaction, biomass boilers in communal heating and ground source heat pumps. Air source heat pumps appear to have suffered from poor satisfaction ratings early on, but later results suggest that new technological developments are changing attitudes and interest in these systems. Experiences with MVHR are divided.

The energy-related performers with the highest proportion of good and excellent experiences are technologies with currently few users: boiler flow restrictors, used by only 8%, and voltage optimisers used by 4%.

Figure 11 shows that the established water-reducing technologies in widespread use (low-flush toilets and low-flow taps and showers) are widely viewed as performing well. Experiences with greywater recycling and rainwater harvesting have resulted in poor levels of satisfaction.
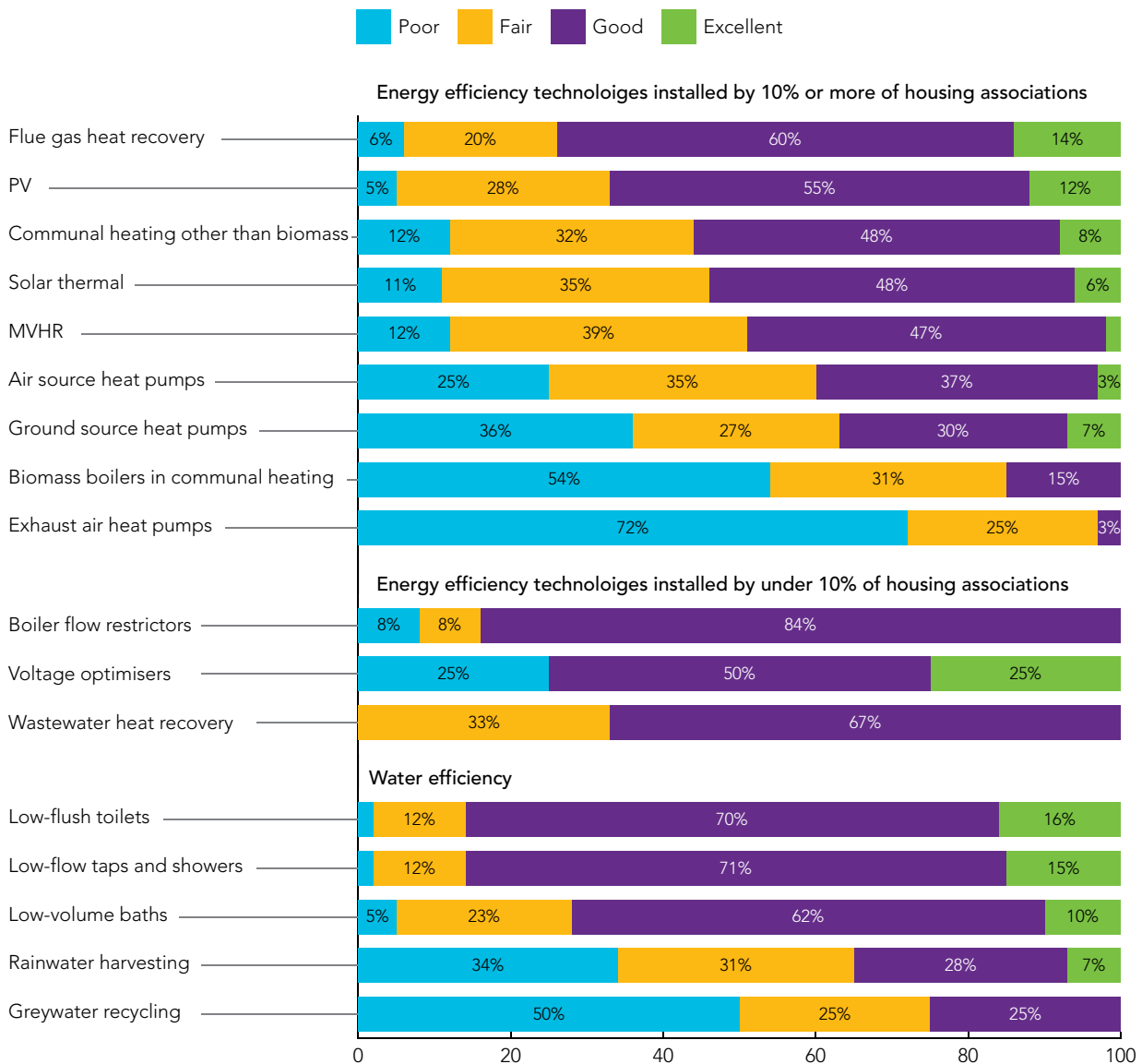
Figure 11 General satisfaction with technologies

Analysis of satisfaction across the last three HCA funding rounds suggests improved experiences for some technologies (see Figure 12).

Allocating a rating to the four-point scale of poor, fair, good and excellent (where four is the highest score) allows an average satisfaction rating to be calculated.

Technologies for which satisfaction ratings have improved by more than 25% in the current funding round compared with 2006–2008 are:

- communal heating other than biomass

- flue gas heat recovery

- air source heat pumps

- ground source heat pumps, exhaust air heat pumps, greywater recycling (satisfaction has improved, but is still low for all three).

The satisfaction levels of those installing biomass boilers has deteriorated by 25% and rainwater harvesting systems by almost 20% during the current funding round (2011–2015) compared with those installing them during 2006–2008. (Rainwater harvesting is not shown in the graph.)

Average score: 1 = poor, 4 = excellent
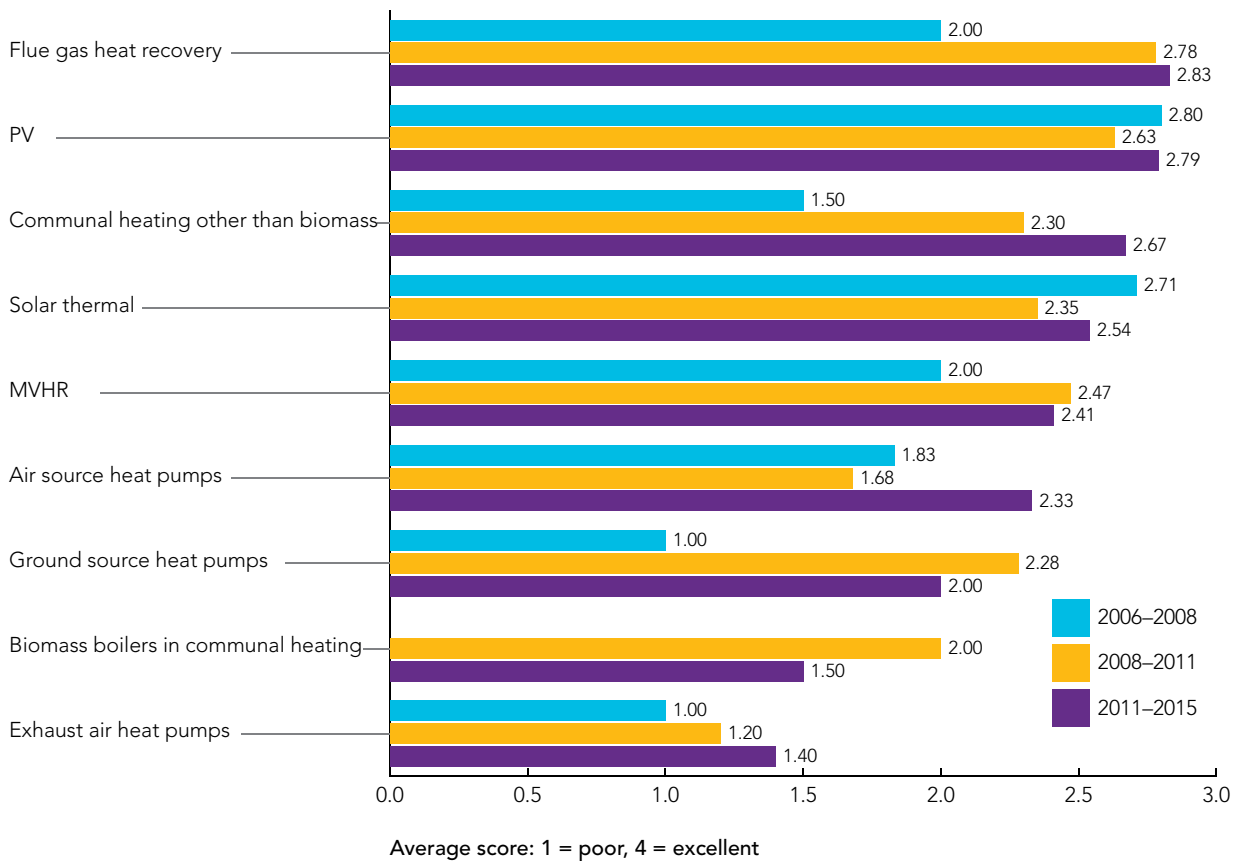
Figure 12 Overall satisfaction, by latest funding round/period of installation
Energy efficiency – technologies installed by 10% or more of housing associations

Satisfaction with technologies in key areas of performance

Satisfaction ratings shown in the previous section are based on all aspects of performance, from initial choices through to resident use and maintenance issues. In order to identify benefits and issues, respondents were asked to rate each technology with which they had experience on a range of key performance factors. Points were allocated on a four-point scale to allow an average to be calculated for each.

Results are shown in the tables in Appendix 2, with averages given according to the nature of involvement or responsibility of each respondent. Some respondents have involvement in more than one area.

This analysis highlights benefits and issues with technologies and shows that those with good satisfaction ratings overall, such as PV, perform well across the range of criteria. However, the individual scores for each technology reveal some interesting and consistent views which are listed below.

- PV panels are rated more highly than solar thermal systems across most criteria, by installation decision-makers, maintenance and home management personnel alike. Those involved in resident feedback rated PV higher than solar thermal on all criteria.

- MVHR performs well in the factors related to installation decisions, such as capital cost, ease of procurement and ease of installation. Its main issues relate to performance in-use. Because it must be run constantly there are perceptions of high running costs, leading to poor user satisfaction. Educating users to leave it running and the need to service filters has proved challenging.

- The main issues with air source heat pumps are resident satisfaction and ease of use, capital cost and ease of commissioning, running costs and performance failing to meet expectations.

- Satisfaction with biomass boilers in communal heating is very low across all factors except ease of resident use (because they are not generally involved in day-to-day system operation). Initial cost, running cost, maintenance, durability, payback and general performance appear to be issues here. Participants in the focus groups told of poor experiences due to erratic supplies and prices for fuel pellets. Satisfaction with other forms of communal heating is much higher.

- For the 20% who have installed ground source heat pumps, experiences are mixed. While resident satisfaction is reasonable (in fact better than for air source heat pumps), the main issues are capital cost, payback, ease of design, commissioning and cost of maintenance.

- Several participants in the focus groups had experienced problems with exhaust air heat pumps and this is reflected in the satisfaction scores, which all fall below two on a four-point scale. The lowest rating was for ease of resident use and their satisfaction. Only 17% of respondents have used this technology.

- Low-flush toilets and low-flow taps, which are now commonly installed, have high levels of satisfaction. Low-volume baths meet the housing associations' criteria, but residents have not been particularly satisfied with them. However, focus group comments about ultra-low-flow toilets (4–5 litre) indicated problems with poor cleansing performance and frequent blockages, requiring increased rodding.

- Although satisfaction overall is low for rainwater harvesting, with two-thirds answering poor or fair, satisfaction for specific performance factors does not indicate what the issues are. The lowest satisfaction scores are for payback, capital cost, ease of design and user satisfaction, but all these averaged at least two out of four.

- Greywater recycling has been used by only 18% of housing associations, with three-quarters describing their experience as poor or fair. Reasons for this include poor payback or cost benefit analysis, low durability and high maintenance costs, with low customer satisfaction.

Based on the aggregate of all scores, Figure 13 shows a satisfaction index for each technology.

Scores are calculated as the percentage achieved from the maximum available points (ie 13 factors x 4 points each = 52). Tables giving all satisfaction ratings upon which this is based are in Appendix 2.

The same pattern emerges as in the earlier satisfaction ratings, with PV, flue gas heat recovery, communal heating other than biomass, several water-saving technologies and low-use energy-related technologies having high indices.

When asked which technologies have sound technical principles, but do not yet live up to expectations, 23% of respondents identified air source heat pumps, followed by 16% naming ground source heat pumps. There is an expectation that products harnessing these technologies will continue to develop and feature more prominently in the future.

■ Satisfaction index

■ % of housing associations thinking that the principle is sound but products do not yet live up to expectations

Energy efficiency – technologies installed by 10% or more of housing associations

Technology	Satisfaction index	% sound but not up to expectations
Flue gas heat recovery	76%	3%
PV	67%	5%
Communal heating other than biomass	65%	5%
Solar thermal	62%	10%
MVHR	60%	7%
Air source heat pumps	56%	23%
Ground source heat pumps	49%	16%
Biomass boilers in communal heating	41%	
Exhaust air heat pumps	37%	10%

Energy efficiency – technologies installed by under 10% of housing associations

Technology	Satisfaction index	% sound but not up to expectations
Voltage optimisers	74%	6%
Boiler flow restrictors	72%	3%
Wastewater heat recovery	65%	5%

Water efficiency

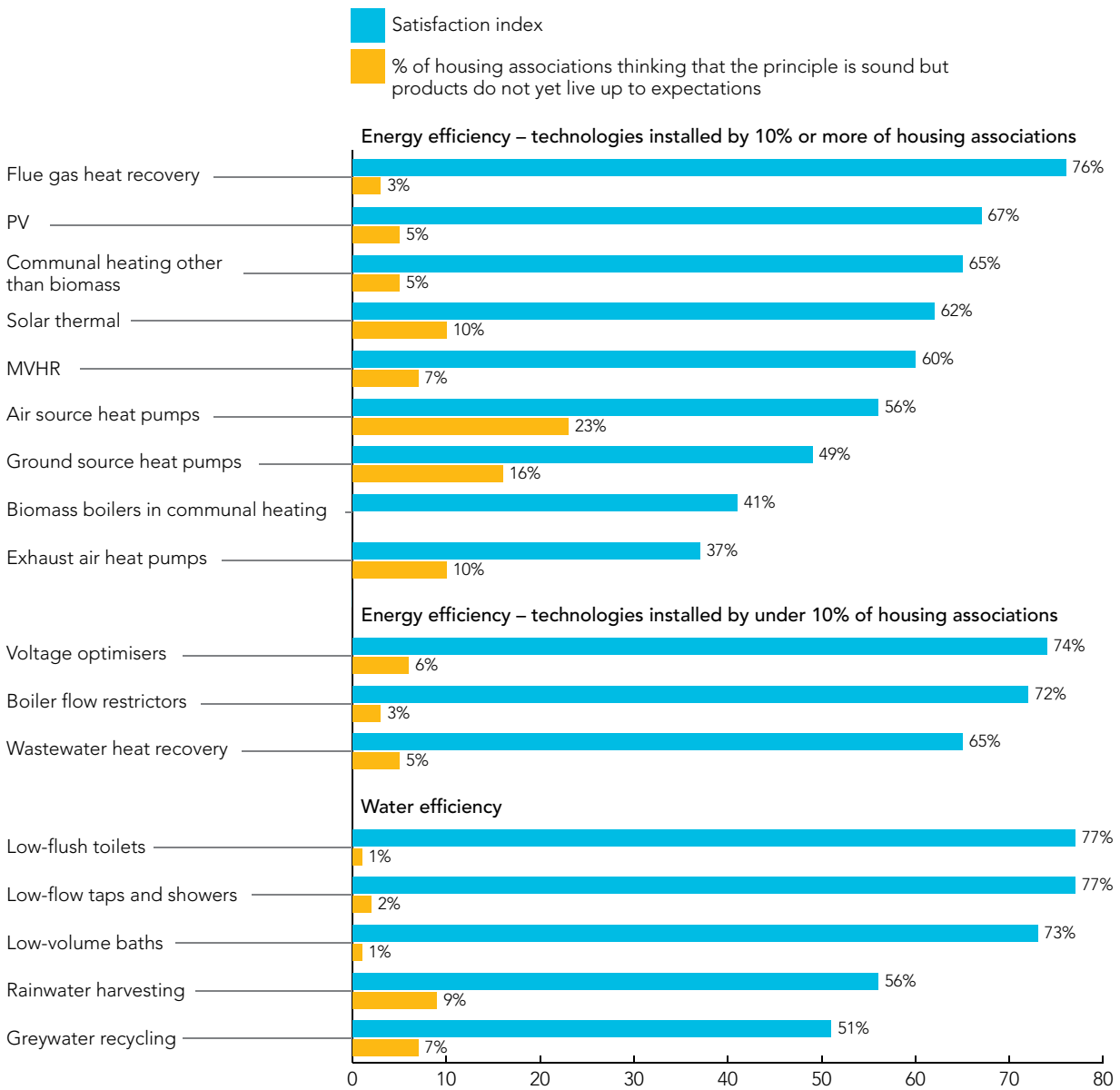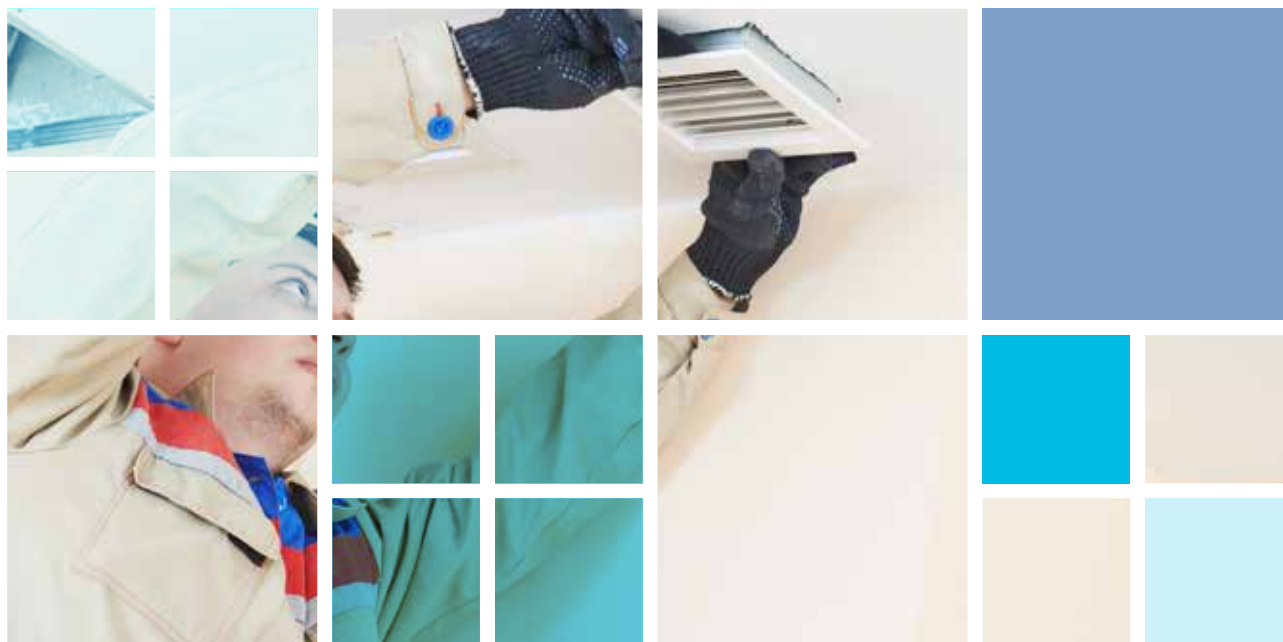| Technology	Satisfaction index	% sound but not up to expectations
Low-flush toilets	77%	1%
Low-flow taps and showers	77%	2%
Low-volume baths	73%	1%
Rainwater harvesting	56%	9%
Greywater recycling	51%	7%

Figure 13 Satisfaction index for technologies and development potential

Base: 185 organisations, including branches.

10 Examples in use

Respondents shared further experiences of the main energy and water efficiency technologies through comments added during the interviews. These were collected verbatim, analysed and the main themes are summarised in this section. Illustrative comments are reproduced verbatim.

Photovoltaic panels

Approximately 80% of associations interviewed had used PV in newbuild developments, ranging from tens to thousands of homes. Widespread experience of performance, maintenance and resident reaction indicates they are considered easy to use and maintain – regarded as 'fit and forget'. The 'product' is easy to understand, needs little control and reduces energy costs significantly – by between a third and a half quoted in some cases.

This technology is best suited to residents who are at home during daylight hours. Education to ensure efficient consumption and to identify when systems stop working is the main challenge.

There is disappointment in some cases about the inability to claim the 'Feed-in Tariff' or unfulfilled expectations for the levels of income. A few respondents had encountered residents who found the technology complex or did not see the anticipated energy bill reductions that had been promoted.

To address these issues, some organisations have invested in online monitoring of their installations, which has proved invaluable. One detailed analysis showed residents' bills had been reduced by between 10% and 40%, achieving payback for the association in 10 years, with the prospect of 15 years of guaranteed income.

> 'This is our preferred renewable energy source; it's one of the most developed technologies. It's easy for both us and residents to understand, saves money as it provides communal lighting and has a long life span. There's a low amount of upfront planning required, you can bolt it on. Aesthetically they are ok.'

> 'Of all the technologies this seems to cause the least issues. Generally it's been a good experience for us with smooth commissioning and installation. We have had some issues with PV when they've gone down without residents knowing. Residents don't understand enough to know when they're working or not.'

> 'Difficult to understand. The Feed-in Tariff changed. The customers turned it off, there are no easy instructions for them and they were very confused. In some cases it increased bills.'

> 'Some residents just don't understand the more advanced technologies and the problem with this is it results in more calls to us and more time spent in trying to resolve issues which are just a case of residents' misunderstanding.'

Solar thermal panels

Well over half of the housing associations had also used this technology, with lots of positive experiences being shared. It is widely regarded as cost-effective, easy to install, low-maintenance and requires little user education or control.

Among the few poor experiences described, the common themes were design and installation quality and failure to educate users. Incorrect operation resulted in dissatisfaction because of unexpected energy bills caused by the need to boost water temperature using other heat sources.

> 'It's brilliant, no problems, it gets serviced once a year. Residents say they hardly use any gas. It's one of the best technologies we have had, very economical!'

> 'Residents found it difficult to control. It wasn't responsive and the interplay between solar hot water and gas heating was poor and difficult for residents. It did reduce bills but at a cost of customer satisfaction. The residents remain unconvinced.'

> 'I think poor installation, poor design, and lack of knowledge exists in the industry around how to design and install it. Our residents didn't get any savings or only very, very low marginal savings.'

Mechanical ventilation and heat recovery (MVHR)

Over half of housing associations interviewed had installed MVHR and they provided broadly positive feedback. Identified benefits included perceived air quality improvements, particularly in very airtight homes, addressing condensation risks and delivering energy savings.

MVHR suffers from some confusion with exhaust air heat pumps and air-conditioning systems. The importance of evaluating it as a supplement to, rather than a substitute for, the main heating source was stressed by experienced respondents. Correct design and installation, particularly of ductwork, was emphasised, as was ease of access for the cleaning of filters. Inadequate maintenance has been found to reduce efficiency and encourage moisture build-up within the system.

Poor resident experiences were mainly attributed to incorrect operation of complex controls or disabling systems to reduce fan noise. User misconceptions that electricity bills would be reduced by switching systems off instead of leaving them constantly running appears to be a common occurrence and needs to be addressed. One system using low-energy DC motors had been found to have an annual running cost of only £15 per annum. User education is key to acceptance of the low cost and full benefits of this technology.

> *'Our buildings are very airtight now, and the technology has very effectively reduced condensation, which brings with it positive health benefits. We are happy with the technology, it's very effective at maintaining the ambient room temperature, and has served to reduce bills.'*

> *'The system, although installed to specification, did not provide enough ventilation for the home. It was often switched off to avoid cost of electricity and allowed the build up of moisture in kitchens and bathrooms and that in turn led to significant problems with condensation and mould growth in some flats.'*

> *'Education of residents; they kept turning it off as they thought it would save money and it caused condensation.'*

> *'Issues of noise and perception of it being costly as it's running all the time, so it's disabled.'*

> *'Residents' understanding of how it works. Positioning of vents above beds and dining tables, residents complained of draughts and turned it off.'*

> *'It's very difficult to understand the running costs. Access for changing the filters can be a problem.'*

Biomass boilers in communal heating

The issues with biomass boilers relate to performance falling below expectations, high levels of maintenance with the associated costs, sourcing and the cost of fuel and accessibility issues for deliveries, particularly in built-up locations such as London.

'The storage for the pellets was not well designed; pellets got damaged. The installation was poorly specified and installed and there was no cost benefit. It ticked the box in the 'Green' criteria but high maintenance costs and fuel delivery have been critical. We've reverted some back to the back-up gas boilers.'

'Excessive maintenance and servicing resulted in high costs to our residents, along with the high costs of fuel. We ripped it out, it was running at such a loss.'

Communal heating (other than biomass)

Feedback on communal heating systems not using biomass boilers was mixed. Some respondents found it cheaper for residents, improving efficiency and reducing maintenance costs. Eliminating the need to visit individual properties for annual gas servicing and certification was seen as a major cost and logistics benefit.

However, some respondents spoke of problems with unevenly distributed heat and heat loss through lengthy distribution networks coupled with complex maintenance regimes. Resident satisfaction has suffered in some instances because the ability to choose their own energy supplier was being constrained. Challenges in ensuring accurate metering of individual usage has led to billing difficulties, which has resulted in some housing associations relying on estimates of consumption, or failing to recover costs at all.

'It has always been good, it's simple. You have one point of contact only, one boiler only to maintain and service, you don't have to access different properties. It has definitely met our objectives and reduced bills.'

'The metering system does not comply with the latest regulations. There are poor running costs.'

'For a long time our residents weren't billed and now it's based on an estimated figure. Running costs are poor.'

'Wasted heat, overheating in some areas. Maintenance proved to be difficult. Resident satisfaction was very poor. There was a lack of choice for residents in terms of energy provider which means residents lose out on some benefits. Less satisfied with being told who they have to use rather than choosing themselves. Increased residents' costs. Not efficient as use more carbon than other types of heating.'

'Mega problems with metering and billing. It is costing housing associations millions in lost service charges.'

Ground source heat pumps

Early adopters of ground source heat pump technology have had mixed experiences. One large 2009 installation is working effectively with no issues to date. Experiences of smaller installations described consistent performance and a similar lack of issues. Resident satisfaction appears to have been positive in these cases.

However, some respondents have experienced problems related to common issues: poor system design and installation, difficulties with maintenance and the costs of rectifying or recommissioning a system in the event of a major failure.

'When working they were fine but when they stop working it is impractical to repair as one has to dig the whole garden up.'

'Fitted them in the ground and a few months later the soil moved, kicked out all the pipe work and pump. So we cut off the ground source heat pump and replaced it with air source heat pumps otherwise we would have had to drill again to provide a new borehole for another ground source heat pump. We left the pump in the ground as it was not economical to remove it.'

Air source heat pumps

Air source heat pump technology appears to have had a shaky start, with some poor early experiences and resident dissatisfaction. Inappropriate design and installation appear to be the consistent causes of underperformance or failure. This technology also suffers from being incorrectly associated with issues relating to exhaust air heat pumps.

Experience of more recent installations suggests that they are delivering better performance, proving more user friendly and gaining support for more widespread adoption. Running costs in some instances have proved comparable with gas boilers. User education is key to effective operation – to ensure that the unit is left turned on. There have been some instances where noise from the large external units has proved problematic.

'They tend to have performed better on a newbuild, as you can control the specification of your walls and size of radiators etc. They are very easy to use and act like a conventional boiler. Residents have seen a good reduction in their energy bills. It's met our objectives, especially in off-gas areas. It is more affordable than, for example, oil.'

'It was very positive, we have had good outputs in terms of the level of energy costs. It has saved and reduced bills compared to properties nearby that have storage heaters of a similar size. I would say they have saved 40–50% on bills.'

'Local maintenance contractors are not keen to take these on. Contractors down south will do it, but they are reluctant to come up to an emergency.'

'Some installers don't understand them. It's easy for users to press the wrong buttons which means more maintenance for us (eg the reset system) and higher bills.'

'There are simple things that you don't consider when you are in that design phase. We had an air source, the flow round the radiators went kitchen, round the house to the living room. So, the last radiator on the run was the living room, so the residents thought it was terrible. It's a low temperature system anyway, so the resident complained about it for quite a long time. We swapped the flow around, he got the heat in the main room straight away and the issue started to disappear.'

Exhaust air heat pumps

The levels of dissatisfaction with exhaust air technology almost exclusively relate to poor experiences with two manufacturers that were early entrants into the UK market. Lack of installer knowledge and poor installation and back-up were consistent themes of the feedback. Incidence of poor performance, high running costs (as much as £60 per week given in one example), and high maintenance costs were frequently highlighted. Users found them difficult to understand, complex to control and could not grasp the nature of the heat provided. As a result, many have now been removed and replaced with alternative technologies. However, a few of the respondents are now giving the technology a second chance.

'Happy to install it now, but initially the installation was bad, as the units were so big. The control panels had too many options for customers. You need good quality consistent training of staff to ensure you get the best out of them. It did meet our objective eventually, but only after initial teething problems.'

'Difficult to commission and difficult for people to understand how to use.'

'Residents didn't understand how to use it and treated it like a gas boiler, turning it on and off. Installers didn't know how to install it.'

Rainwater harvesting

Those who have installed rainwater harvesting systems consistently recalled poor experiences and failures. Incorrect tank design and installation, pump failures, smells and silting, with associated high maintenance costs were widely identified issues. The consequential impact on toilet flushing inevitably resulted in resident dissatisfaction leading to many systems being decommissioned.

'We've had constant complaints that it's not effective, there's not enough water for effective flushing. We've had issues with the pumps which need replacing regularly. They're not worth it and have involved too much maintenance. They're more trouble than they are worth.'

'The product's just not up to the job, it's not really fit for purpose. We had installation problems and lots of maintenance problems. Also it was difficult for the residents to understand the technology and it really was not easy to educate them.'

'Pumps have failed. There's been a build-up of silt so needed to change filters – high maintenance.'

'The system doesn't work properly and there's no way of knowing if it is not working.'

'We have removed them on nearly all properties, been awful in terms of use/ maintenance etc.

Low-flush toilets

Dual-flush toilets are now recognised as a standard specification, but ultra-low-volume flush toilets have also been introduced by some associations.

The main issues raised related to experiences with ultra-low-volume flush toilets and poor flushing performance; failing to cleanse waste at the first attempt, reflushing negating the water saving and the consequential inconvenience for users. In addition, some people found the water volumes insufficient to provide effective waste transport through the sewage connection, leading to more frequent incidences of blockages, with the associated increase in maintenance costs.

> 'We have had issues with the flush and the dual-flush mechanism, we have had a lot of call outs. I think it's a combination of people not understanding fully how it works and a lack of experience or attention in fitting the units in the first place.'

> 'We have had some issues where it doesn't take away the waste, so they have to flush again, which takes away the benefit.'

Low-flow taps and showers

Low-flow or aerated taps and showers are also now considered to be standard specification items.

However, failure to set user expectations appears to have been the source of issues with these water-saving technologies. The length of time to fill baths and poor flows in showers are consistent themes that have caused user dissatisfaction. User education appears to be essential to develop realistic expectations.

> 'Residents complain baths take too long to fill up. High pressure water area makes a whistling noise.'

> 'That's more to do with the shower heads, residents like a more powerful one. We do sometimes get complaints they would rather have a greater flow, particularly those not on meters.'

> 'Residents don't like the fact you can't run a hot bath in a few minutes. With the flow restrictors and the temperature flow, from their point of view it's never hot enough. They say that once they've waited for it to run, it's tepid.'

> 'Residents don't see the benefit of the low-flow taps and complain they don't get enough water quickly enough.'

Low-volume baths

Low-volume baths have also been a source of user dissatisfaction (see Appendix 2) through failing to meet the expectations of new-home residents who had not been made aware of this water-saving feature, or by failing to meet specific residents' needs.

'We had residents who wanted really deep baths; that was the expectation. We have now fitted showers to everyone's property. Now expectation has changed and to a great extent we retain baths for young children.'

'We provide housing for people with disabilities, we have had a few difficult Code assessors in situations where we have residents who need to be able to fully submerge in baths due to health conditions, eg eczema, but the Code assessors won't approve scoring points.'

11   Future use of technologies

Technologies that housing associations would or would not use again reflect the general pattern of experience and satisfaction in use. The most popular products, which three-quarters or more expect to use in future, to meet anticipated tighter building regulations are:

- PV
- low-flush toilets
- low-flow taps and showers.

Between 50% and 60% expect to use:

- MVHR
- solar thermal
- low-volume baths

However, at least one-third will seek to avoid using:

- ground source heat pumps
- exhaust air pumps
- greywater recycling
- rainwater harvesting.

There are mixed views on air source heat pumps, as 28% would try to avoid using these and 45% would use them in future. Results in Figure 13 show that 23% nominated these as the sustainable technology for which they feel the principle is sound but products do not yet live up to expectations.
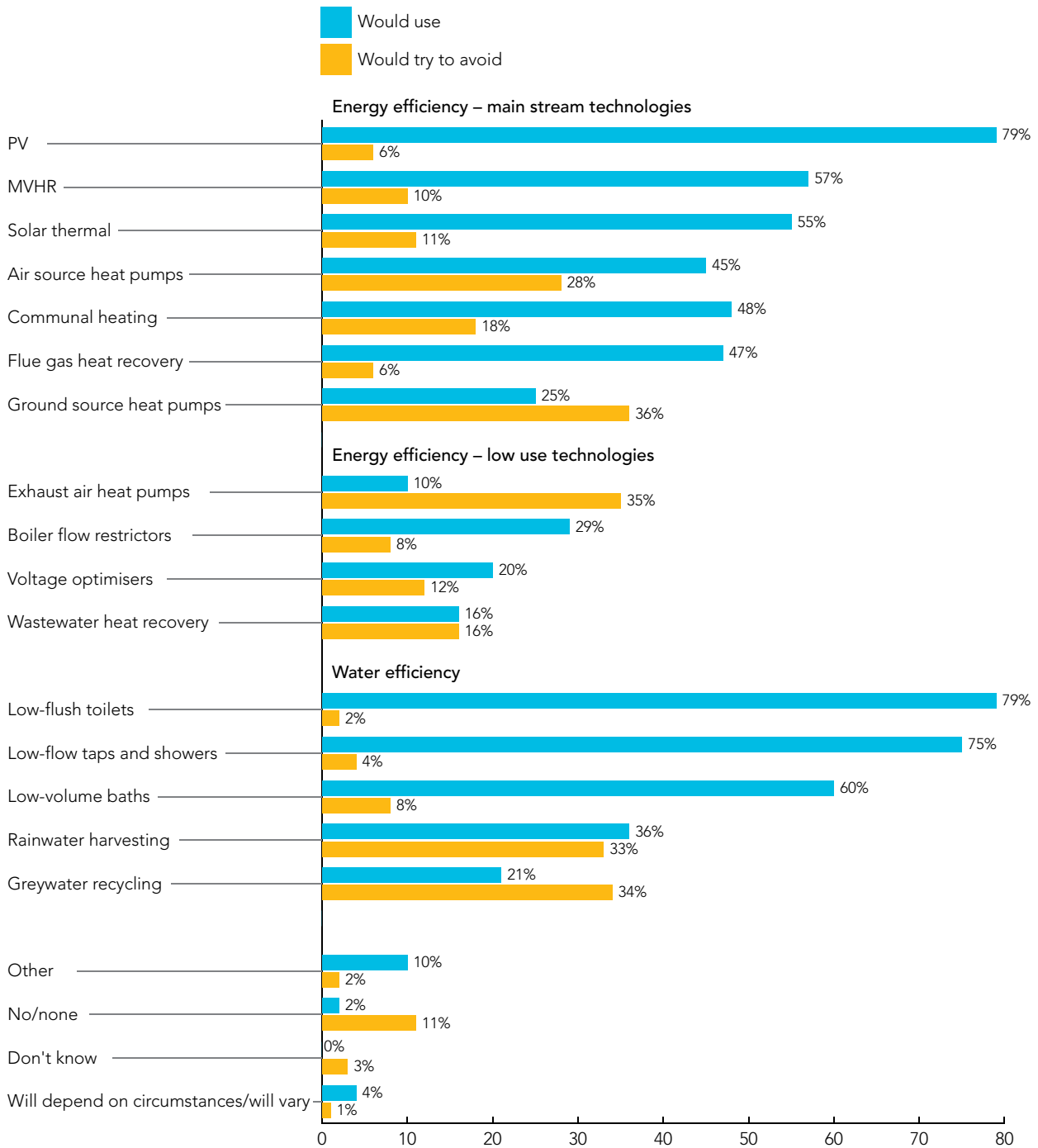
Legend:
- Would use
- Would try to avoid

Energy efficiency – main stream technologies

Technology	Would use	Would try to avoid
PV	79%	6%
MVHR	57%	10%
Solar thermal	55%	11%
Air source heat pumps	45%	28%
Communal heating	48%	18%
Flue gas heat recovery	47%	6%
Ground source heat pumps	25%	36%

Energy efficiency – low use technologies

Technology	Would use	Would try to avoid
Exhaust air heat pumps	10%	35%
Boiler flow restrictors	29%	8%
Voltage optimisers	20%	12%
Wastewater heat recovery	16%	16%

Water efficiency

Technology	Would use	Would try to avoid
Low-flush toilets	79%	2%
Low-flow taps and showers	75%	4%
Low-volume baths	60%	8%
Rainwater harvesting	36%	33%
Greywater recycling	21%	34%

Technology	Would use	Would try to avoid
Other	10%	2%
No/none	2%	11%
Don't know	0%	3%
Will depend on circumstances/will vary	4%	1%

Figure 14 Future use of technologies to address expected building regulation changes

Base: 200.

'Other – would use' includes: hydrogen cells, fuel cell combined heat and power (CHP), wind, biomass boilers, passive design, LED lighting, glazing, very efficient gas boilers. 'Other – would try to avoid' includes: biomass boilers, wind, geothermal.

When asked which technology is taking the lead, 66% of housing associations answered 'PV'. Although this was the main answer, those with larger build programmes have a greater expectation than those with smaller programmes that PV will take the lead. The development of a means of storing surplus power within the home was thought by some in the focus groups to be a strong possibility in future.

The next most mentioned technologies considered to be taking the lead were air source heat pumps, named by 15%, and solar thermal, named by 13%.
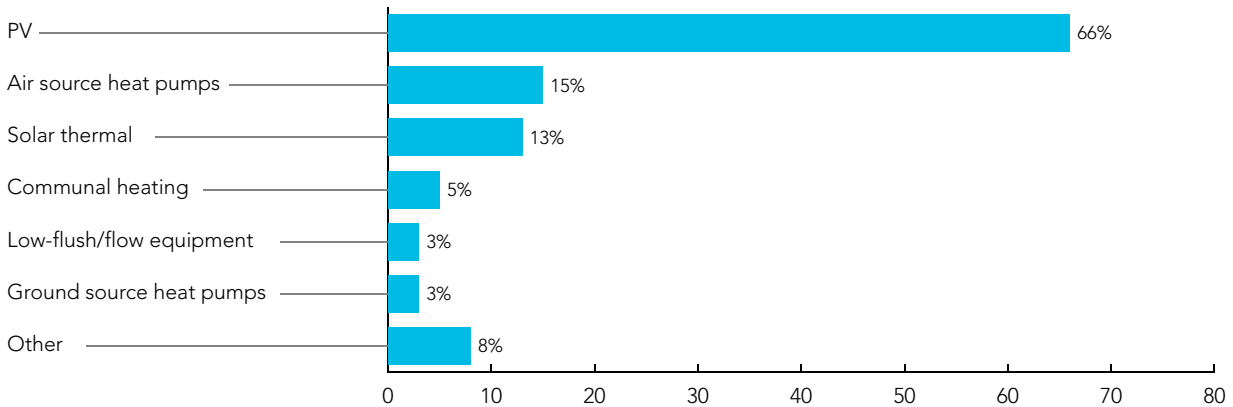

Figure 15 Technology thought to be taking the lead

Base: 200.

'Other' includes: flue gas recovery, wind turbines, CHP, warm roofs, electrical heating, infra-red heating.

'These things (technologies generally) have improved tremendously, it all comes down to good installation and commissioning, it's a skill issue for installation and maintenance.'

12 Design, installation and maintenance issues
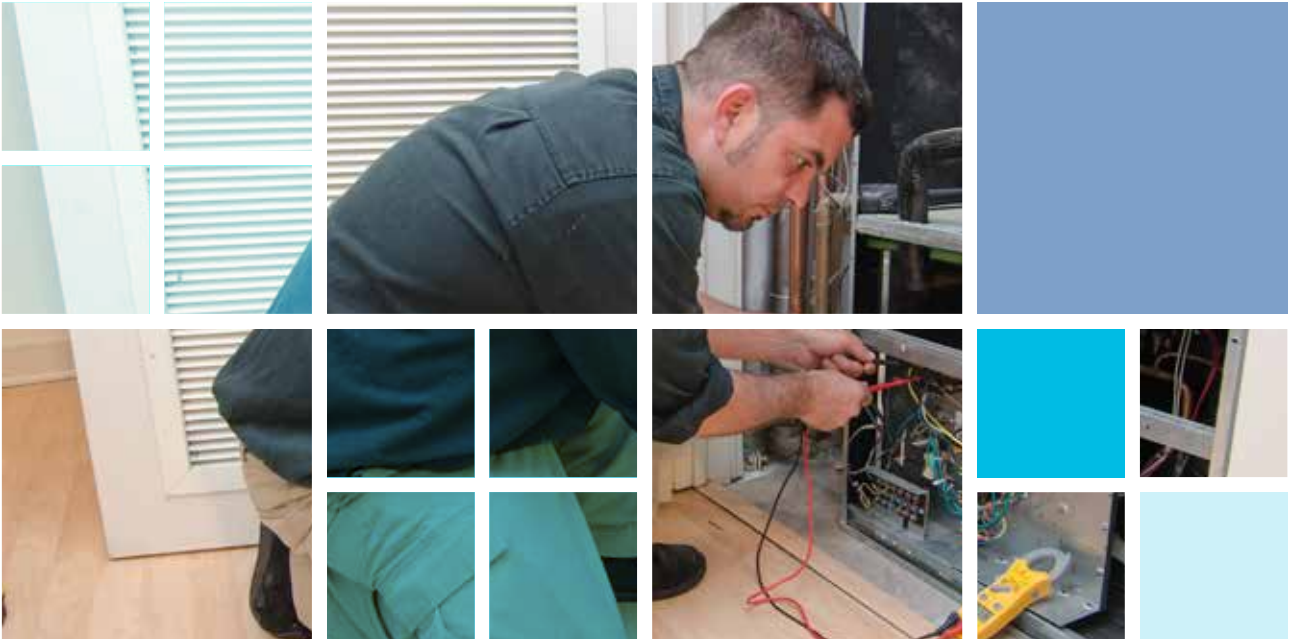
Briefing energy consultants

Energy consultants normally play a key advisory role in meeting building regulations, the Code for Sustainable Homes and other requirements including use of technologies where appropriate. They are also usually responsible for providing the UK Government's standard assessment procedure (SAP)[2] calculations to assess and compare the energy and environmental performance of dwellings.

In the early years of using sustainable technologies, many of the focus group participants felt that the consultants they were using had little understanding of the best technologies to use. However, they thought that this has improved with experience.

Those housing associations that had spent some time acquiring expertise felt that they had benefitted internally and made better investment decisions when they were fully involved in the choice of products. The practice of briefing energy consultants, utilising this acquired expertise, was highlighted as a key success factor during the telephone survey.

Most housing associations have a high level of involvement, being prescriptive about the technologies they wish to consider, evaluate or use. The majority, 60%, specify the technologies they wish to be considered, half of these also indicating manufacturers. Around 40% give a performance specification, including the regulations or performance targets only.

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2   For more information about SAP, visit https://www.gov.uk/standard-assessment-procedure.

NHBC Foundation Sustainable technologies

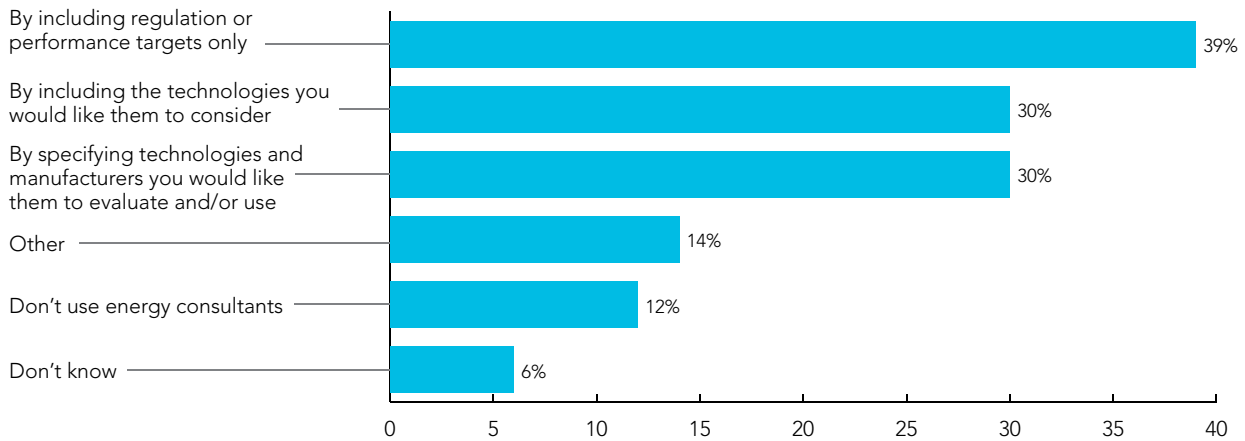| Category	Value
By including regulation or performance targets only	39%
By including the technologies you would like them to consider	30%
By specifying technologies and manufacturers you would like them to evaluate and/or use	30%
Other	14%
Don't use energy consultants	12%
Don't know	6%

Figure 16 Information included in briefs to energy consultants on new developments

Base: 200. Note some respondents use several approaches.

'Other' includes: through partnership with another housing association, leave it to the consultants to advise us, leave it to the contractors, or any/all of the three options, depending on the project.

A further issue at design stage, identified during the focus groups, was lack of consideration within the building design for sufficient, convenient space to incorporate technologies. Airing cupboards filled with pipework and controls and lofts having to be reinforced to accept inverters and switch gear were some of the examples given.

> 'I wrote the technical brief for our company because I was fed up of contractors, consultants and designers leading our development teams by the nose. I was the one picking up the pieces at the end.'

> 'We work through the development consortia. They will have a toolkit and include what they feel should go into new developments. Because a lot of contracts are 'Design & Build', we lose control of the exact manufacturer that goes in. It's almost a performance-related requirement that goes into the toolkit.'

> 'Housing associations get properties through either section 106, and the design solution is pretty much given to us by house builders, or if we are developing our own sites, because we are encouraged to go down the 'Design & Build' procurement route, the energy and heating system is never that far advanced. It tends to be taken on by the main contractor. We do brief to a degree but we don't feel able to take full control and tend to end up with what the house builder or energy consultant want. The only driver is how you can achieve the Code at minimal cost. I think sometimes that delivers a bad outcome for the housing association and the end user.'

Installation and commissioning

Although only 10% indicated that ease of installation was a consideration in the choice of sustainable technologies, the focus group participants shared experiences where incorrect installation and commissioning (eg adjusting operational settings) had led to poor product performance. The phone interviews revealed that 63% of housing associations experienced problems during installation, attributed to a lack of availability of suitably skilled or experienced trades.

Asked to explain further:

- 34% said the overall quality of installation was poor

- 28% thought there was a lack of understanding of the products or a lack of skills in the supply chain

- 19% commented that the technology simply didn't work

- 14% had problems positioning or locating the products within the home

- 7% thought the problem was due to poor design

- 6% experienced problems during commissioning.

Technologies with the highest scores for ease of installation (2.5 or more out of 4) are given below.

Energy efficiency

- PV

- Solar thermal

- Flue gas heat recovery

- Communal heating (other than biomass)

- Voltage optimisers (used by a low number of people)

- Wastewater heat recovery (used by a low number of people)

- Boiler flow restrictors

Water efficiency

- Low-flush toilets

- Low-flow taps and showers

- Low-volume baths

These technologies were identified as having particular installation issues (average score for ease of installation below 2 out of 4).

- Exhaust air heat pumps

- Ground source heat pumps

- Biomass boilers

Maintenance issues

Early adopters of technologies admitted to a lack of consideration of maintenance in initial choices. Several comments in the focus groups related to a lack of communication between those responsible for the decision to install technologies in newbuild homes and those responsible for resident use and after-care including maintenance. Experiences suggest that, where all parties are involved at the outset, there is usually a better outcome in terms of successful product selection and use.

MVHR systems were highlighted in discussions as an illustration of the importance of considering maintenance requirements and resources. Filter cleaning is a key issue, with some asking residents to do it and others requiring their maintenance teams to do it during a routine visit for another purpose, such as boiler servicing. A growing number of housing associations are asking their maintenance departments to undertake filter cleaning, but some have concerns that the cost is not being recovered through service charges.

Of 50 housing associations telling us how the filters are changed on their MVHR installations, only 16% expect their residents to do it and 80% have instructed maintenance teams to change the filters (almost two-thirds of these are using external maintenance providers).

'[Our] internal maintenance team changes the filters. Actually it is done every 11 months at the same time as the gas boiler service. We felt we could not rely on our residents to change the filters. And we realise this is at odds with some of the servicing regimes which require filter cleans every three months or six months.'

'The first systems we installed we expected the residents to clean/change the filters but they did not and so the systems started to fail. Shared ownership and private sales units are 100% the resident's responsibility. They have detailed user manuals and instructions and a physical induction on site.'

Technologies with highest scores for ease of maintenance (2.5 or more out of 4) are given below.

Energy

- PV
- Flue gas heat recovery
- Communal heating (other than biomass)
- Voltage optimisers (used by a low number of people)
- Boiler flow restrictors (used by a low number of people)

Water

- Wastewater heat recovery (used by a low number of people)
- Low-flush toilets
- Low-flow taps and showers
- Low-volume baths

Low satisfaction with maintenance was identified with these technologies (average score for ease of maintenance below 2 out of 4).

- Biomass boilers
- Exhaust air heat pumps
- Ground source heat pumps
- Greywater recycling

Some concern was expressed in the focus groups about the cost of unforeseeable repairs and end-of-life replacement, and whether the sector is making sufficient provision for these. The telephone survey confirmed there are grounds for concern with a little over half indicating they have sufficient information to budget and plan for the cost of maintenance, repairs and replacements.
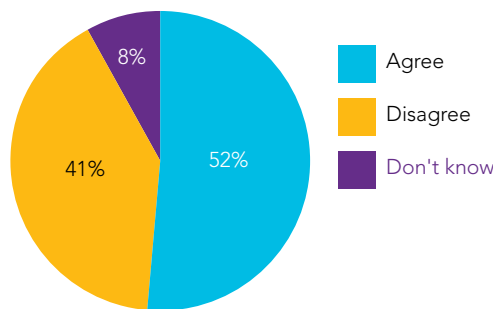

Figure 17 Do you agree or disagree with this statement: Your organisation has sufficient information on the sustainable technologies you are using to budget and plan for the cost of maintenance, repairs and replacements?

Base: 200.

In schemes where there are shared owners alongside rental residents, maintenance of systems can be an issue. While maintenance services are provided and charged for within tenancies, shared owners typically have to source maintenance themselves, which can prove challenging with some new technologies. Ideally, maintenance arrangements need to consider the needs of shared owners and help them access suitable resources to avoid poorly maintained systems.

'Maintenance with shared owners is a nightmare, because as far as our asset management is concerned shared owners don't actually get any attention. So we have a situation on one scheme where we have air source heat pumps and they are a specialist item, where you have to get a particular engineer to manage them. That's fine, the rented part of the scheme have a contract in place. The shared owners just had a piece of paper in their manuals saying you are on your own you might want to take a contract out, but what about the cost of the individual contracts?'

13   Factors for successful use
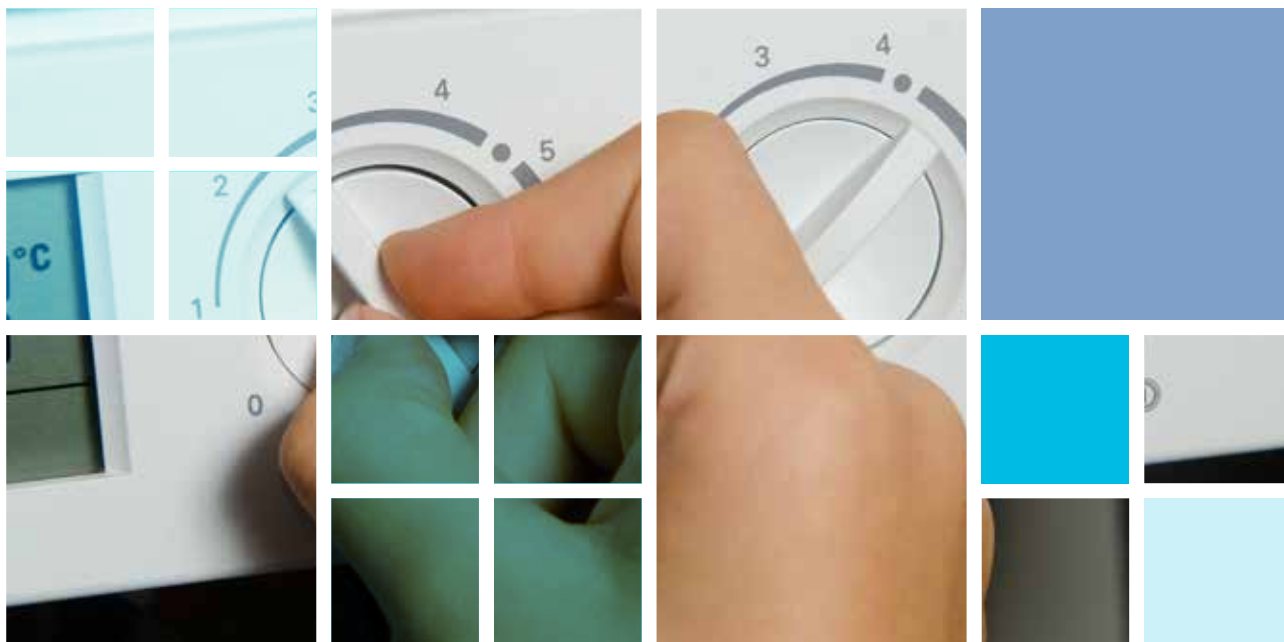
Factors for successful use of sustainable technologies

Housing associations have had at least eight years' experience of working with most of the sustainable technologies. It is evident that they have learned from the experience of early mistakes and have changed processes and considerations as a result.

The main suggestions made by respondents for successful incorporation of sustainable technologies in newbuild projects include:

- installing products that are easy to use and maintain, preferably with minimal user involvement

- using contractors with experience of the products and their installation

- ensuring there is clear communication between all parties including those involved in instructing users and in maintaining the equipment

- developing a clear understanding of the products.

Factor	Percentage
Easy to use products, simple, minimal user involvement	36%
Low maintenance/easy to maintain	23%
Good quality installers who understand the product	23%
Develop a clear understanding of the technologies	20%
Clear communication and involvement of all parties including those responsible for training occupiers and the maintenance staff	21%
Check cost effectiveness	19%
Fit for purpose, good design	19%
Desirability for occupiers, clear benefits	9%
User tried and tested technology	8%
Design and install by same company	8%

Figure 18 Suggestions for successful projects involving sustainable technologies (unprompted)

Base: 200.

When prompted with some success factors raised in the focus groups, most emerged as important. However, over 80% placed particular importance on early consideration of maintenance, providing resident instructions and consideration of how residents are likely to behave, developing a good understanding of the available technologies and attention to incorporation in whole-house design.

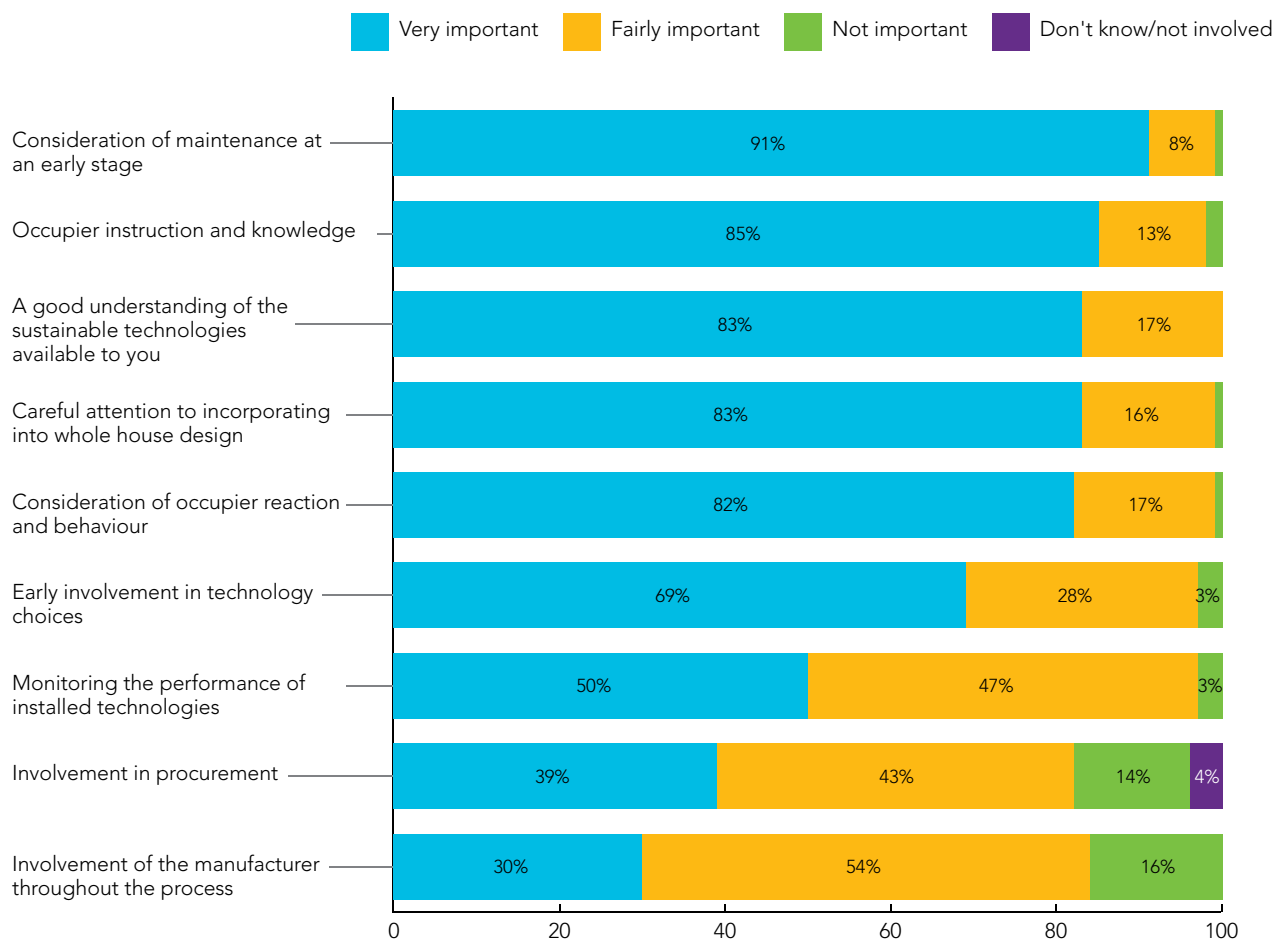Figure 19 Importance of prompted factors in the successful use of sustainable technologies

Base: 200.

Helping residents to correctly use technologies

In both research stages participants commented that providing residents with a good understanding of technologies, thus encouraging correct use, is fundamental to success.

Making the products easy to use is the main way to achieve this, with almost nine in 10 wanting simple and easy-to-use controls.

Personal product demonstrations have been found to be the best way of providing training, often combined with printed information. Some participants in the focus groups described using contractors on site to give the demonstrations, others use their maintenance or other internal teams. One association told of problems arising after residents shared incorrect instructions with neighbours.
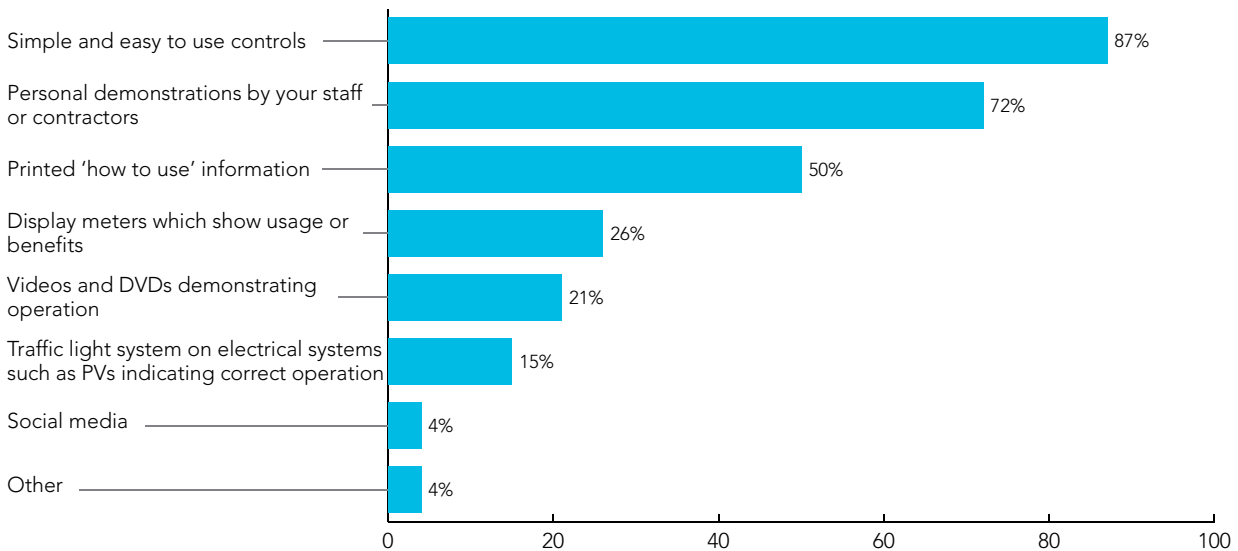
Simple and easy to use controls — 87%

Personal demonstrations by your staff or contractors — 72%

Printed 'how to use' information — 50%

Display meters which show usage or benefits — 26%

Videos and DVDs demonstrating operation — 21%

Traffic light system on electrical systems such as PVs indicating correct operation — 15%

Social media — 4%

Other — 4%

Figure 20 Approaches that work best to help residents understand and use technologies: respondents were asked to nominate 2–3

Base: 200.

'Other' includes: YouTube clips, repeating demonstrations where needed, information available online, none (we deal with dementia sufferers/our residents would struggle to understand it).

> *'Education is massive. That underpins everything that we do.'*
>
> *'It's only as good as the knowledge of the person that's giving it (training). You put a new system in or a different manufacturer's product then you have to learn it all again. There is no guarantee that person is teaching the next person that moves in. Constantly trying to train staff is hard enough.'*
>
> *'It was a traffic light system, green, amber, red. They found that to be far more beneficial than talking to them with different papers (user manuals), sitting there for an hour having a chat with them. It's far better for them.'*

Requirements of sustainable technology manufacturers

Respondents were asked, in both unprompted and prompted questions, about services that their experience has shown to be important for manufacturers of sustainable technologies to provide. Unprompted, easy to understand instruction manuals and effective training/support for users and maintenance teams were the top identified criteria.

In Figure 21, three-quarters indicated that training in maintenance is very important and two-thirds said that a maintenance service should be provided by the manufacturer. A sizeable 79% want accredited or approved installers.

The evaluation and design stages, data on performance, durability and payback plus help with design are very important to at least 60%.
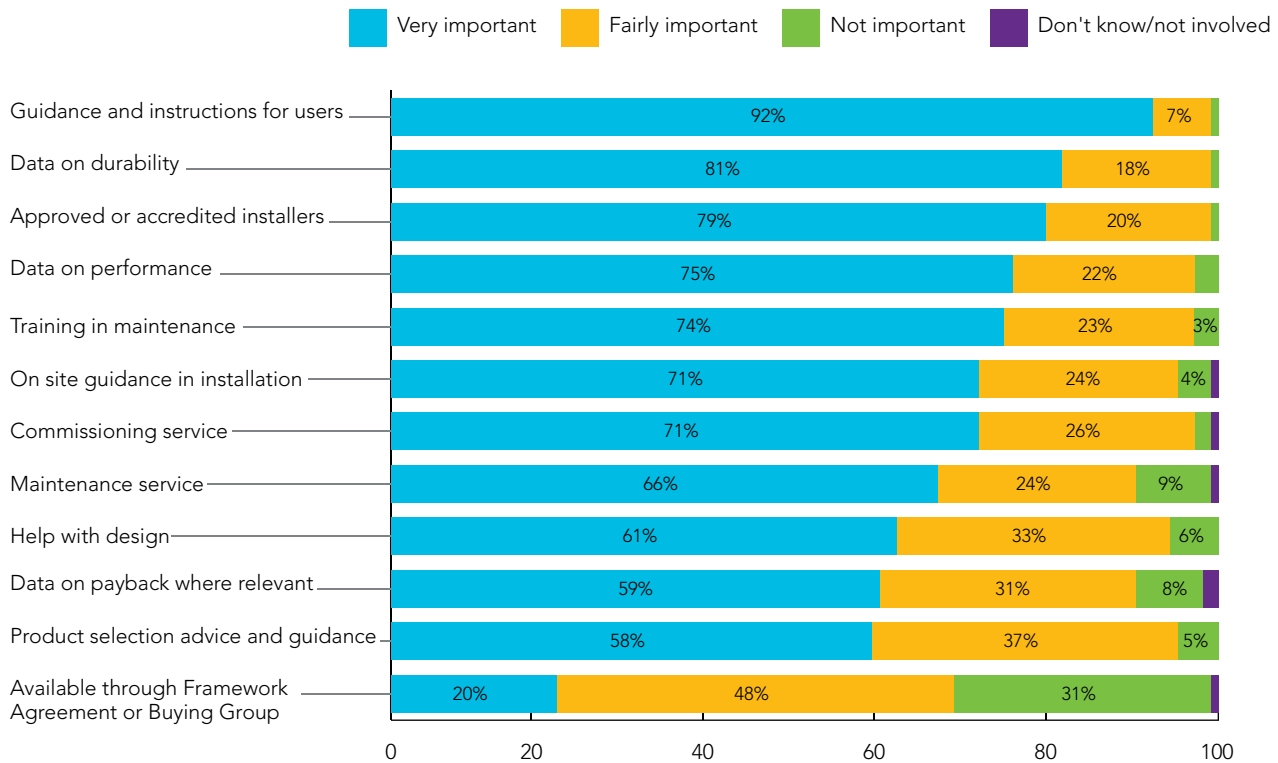
Figure 21 Services that are considered important for successful manufacturers of sustainable technologies to provide (prompted)

Base: 200.

Of the respondents, 28% think that manufacturers can improve the guidance and instructions they provide for users. Other suggested improvements were on-site guidance (14%), a maintenance service (12%) and training in maintenance (12%).

'Individual manuals are good but it is the sheer plethora of products. It is difficult to get a handle on the merits and demerits. Make the abilities of the technologies clearer.'

'Like the car industry, it would be good to move to better warranties, all inclusive to include maintenance. Trying to get a suitable maintenance contractor to take on a system they were not involved in designing or are not accredited to maintain is a major issue.'

'The relationship between manufacturer and installer is the weakness in the chain.'

'Not making false claims about their product. Too many manufacturers make false claims - they promise the earth and in practice can't provide it. Some of my peers in other companies have really fallen foul, particularly with MVHR.'

'Data should be independently tested and verified. End-to-end service from design through to monitoring for contractors.'

'On commissioning manufacturers should check that the installation is fit for purpose.'

Advice to others

Among those with experience of using sustainable technologies, the main piece of advice they would pass on to others is to fully research the subject. Several also commented that it is important to get the fabric of the building right first before considering the use of sustainable technologies.

The focus group participants felt that housing associations were not good at collating data, recording experiences or being willing to share this with the sector as a whole. There are examples of good practice in this area, but the sector lacks a structured approach or centralised resource to support further learning and development around the use of these technologies.
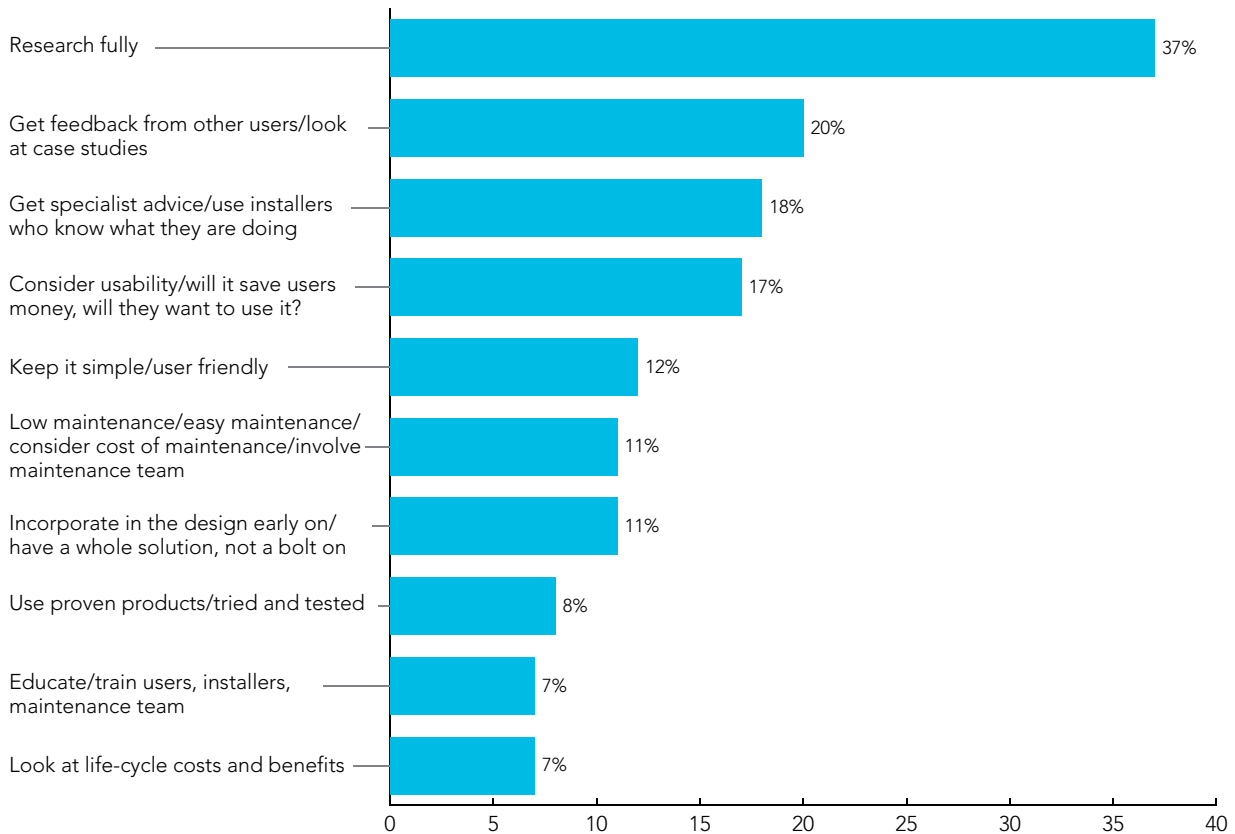
Figure 22 Advice to others considering sustainable technologies for the first time

Base: 200.

'You've got to design it right, install it right, commission it correctly and I believe you have also got to take control of procurement as well, then you've got to monitor and prove that what you have done is right and at the same time you have to teach the residents how to use it.'

'...and don't forget you also need to think about maintenance.'

'The key to all these technologies for me is simplicity. You can definitely over-specify things and make things more complicated than they need to be. It's all about getting that simplicity because it's ultimately your end users that need to understand it.'

Appendix 1
Acknowledgements

The NHBC Foundation is grateful to the following housing associations for their participation in this research.

A2 Dominion Housing
Ability Housing Association
Accent Group
Access Homes / Newlon
Acclaim Housing Group
Accord Group
Adullam Homes HA Ltd
Advance Housing & Support Ltd
Aldwyck Housing Group Ltd
Almond Housing Association
Amicus Horizon Ltd
Apna Ghar Housing Association Ltd
Arcadia Housing Group
Arches Housing
Arcon Housing Association Ltd
Arhag
Aspire Housing Ltd
ASRA Group

Barnsbury Housing Association
Bernicia Group
Bield Housing & Care
Black Country Housing Group
Bolton at Home
Bourneville Village Trust
BPHA
Bracknell Forest Homes
Broadland Housing Group
Broadway Park Housing Association
Bromford Housing Group
Bromsgrove District Housing Trust
Brunel Care
Buckinghamshire Housing Association

Cadarn Housing Group
Cairn Housing Association
Caledonia Housing Association
Cardiff Community Housing Association
Cartreti Conwy Housing Association
Catalyst Housing Group
Central & Cecil
Cestria Community Housing Association
Christian Action (Enfield) Housing Association
Circle Housing Group
City South Manchester Housing Trust
City West Housing Trust
Coast & Country Housing Association
Coastline Housing
Community Gateway Association
Community Housing Group
Connswater Homes
Cornwall Rural Housing Ltd

Cross Keys Homes Ltd
Crown Simmons
Curo
Cymdeithas Tai Clwyd Cyf

DCH
Derwentside Homes
Dolphin Living
Ducane Housing Association
Dunedin Canmore Housing
Durham Aged Mineworkers Housing Association

East Boro Housing Trust
East Lothian Housing Association Ltd
East Midlands Housing
Eden Housing Association
Eildon Housing Association
Eldon Housing Association
Eldonian Community Housing Association
Elim Housing Association
English Rural Housing Association
Enham Trust

Falcon Rural Housing Ltd
Family Mosaic Housing
First Choice Homes
First Wessex
Flagship Housing Group Ltd
Fortis Living
Four Housing Group
Futures Housing Group
Fyne Housing Association Ltd

Gentoo
Golden Gates Housing Trust
Grampian Housing Association
Grand Union Housing Group
Great Places Housing Group Ltd
Green Square Group Ltd
Greenoak Housing Association
Guinness Trust

Hebridean Housing Partnership
Helm Housing Association
Hendre Ltd
Hexagon Housing Association Ltd
Hillcrest Housing Association
Home Group
Housing Plus Group
Howard Cottages Housing Association Ltd
Hundred Houses Society Ltd

Islington & Shoreditch Housing Association Ltd
ISOS Housing

Lace Housing Ltd
Langley Housing Trust

Magenta
Magna Housing Group Ltd
Manningham Housing Association
Maryhill Housing Association
MCCH Society Ltd
Mercian
Merlin Housing Society Ltd
Merthyr Valleys Homes
MHS Homes Ltd
Midland Heart Ltd
Mossbank Homes Ltd
Muir Group

Network Housing Group
New Charter Homes
Newlon Housing Trust
North Devon Homes Ltd
North Hertfordshire Homes
North London Muslim Housing Association Ltd
Notting Hill Housing Group

Oaklee Housing Association
Ocean Housing Group Ltd
One Housing Group
Orbit Group
Origin Housing Group
Orwell Housing Association
Papworth Trust
Paragon Community Housing
Parkhead Housing Association
Peabody Trust
Peaks and Plains Housing Trust
Pembrokeshire Housing Association
Places for People
Plymouth Community Homes

Radcliffe Housing Society
Raven Housing Trust Ltd
RCT Homes
Regenda
Rhondda Housing Association
Richmond Housing Partnership
Riverside Group Ltd
Rooftop Housing Group

Saxon Weald Housing Association
Selwood Housing
SHAC Housing Association

Shepherds Bush Housing Group
Shian Housing Association
Shropshire Housing Group
South Yorkshire Housing Association Ltd
Southern Housing Group
Southside Housing Association
Sovereign Housing Association Ltd
Spectrum Housing Group Ltd
St Vincent's Family Housing
Stafford and Rural Housing Association
Staffordshire Housing Association
Suffolk Housing Society Ltd
Sussex Housing & Care
Symphony Housing Association
Synergy Housing Group

Taff Housing Association Ltd
Teign Housing
Thames Valley Housing Association Ltd
Thirteen Group Tees Valley Housing Ltd
Together Group
Tower Hamlets Community Housing Ltd
Town & Country Housing Group
Trafford Housing Trust
Transform Housing & Support
Trent & Dove Housing
Triangle Housing Association
Trident Charitable Housing Association
Two Castles Housing Association Ltd
Two Rivers Housing

Vale of Aylesbury Housing Trust
Vectis Housing Association
Victory Housing Trust

Wakefield and District Housing
Wales & West Housing Association Ltd
Wandle Housing Association
Waterloo Housing Group
Watford Community Housing Trust
Wellingborough Homes Ltd
Westward Housing Group
Westworks Procurement Ltd
Wheatley Housing Group
Whitmore Vale Housing Association
Wiltshire Rural HA Ltd
Wirral Methodist HA Ltd
WM Housing
Worthing Homes Ltd
Wythenshawe Group

Yarlington Housing Group
York Housing Association
Yorkshire Housing Group

Appendix 2
Satisfaction scores for each technology by responsibility/ involvement of respondent

Technologies to improve energy efficiency Satisfaction score out of 4 where 1 is poor and 4 is excellent, expressed as a %					
	PV	Solar thermal	MVHR	Air source heat pumps	Ground source heat pumps
% of housing associations that have installed	82%	61%	62%	56%	20%
Views by responsibility/involvement					
Decision to install in new homes					
Ease of design	69%	66%	65%	59%	48%
Ease of installation	72%	65%	61%	58%	52%
Ease of procurement	71%	70%	69%	65%	53%
Capital cost	56%	60%	65%	53%	42%
Ease of commissioning	65%	61%	60%	53%	47%
Durability	67%	62%	62%	58%	53%
Payback term or cost/benefit analysis	58%	61%	57%	59%	44%
Performance against specification and expectations	63%	62%	60%	53%	54%
Overall satisfaction	67%	64%	61%	54%	48%
Maintenance and management of homes					
Running costs including bills	67%	62%	53%	52%	64%
Ease of resident use and operation	69%	58%	50%	48%	54%
Customer/user satisfaction	66%	61%	53%	53%	63%
Ease of maintenance	69%	56%	52%	55%	51%
Cost of maintenance	65%	54%	53%	54%	47%
Durability	69%	60%	55%	56%	56%
Payback term or cost/benefit analysis	57%	57%	54%	53%	50%
Performance against specification and expectations	64%	58%	55%	53%	56%
Overall satisfaction	69%	61%	55%	53%	56%
Resident feedback and engagement					
Running costs including bills	69%	68%	60%	56%	60%
Ease of resident use and operation	70%	62%	55%	48%	55%
Customer/user satisfaction	68%	64%	55%	52%	61%
Performance against specification and expectations	65%	62%	60%	54%	56%
Overall satisfaction	70%	64%	59%	54%	58%

Note: As some respondents have more than one involvement, they appear in more than one of the sections above.

Technologies to improve energy efficiency Satisfaction score out of 4 where 1 is poor and 4 is excellent, expressed as a %			
	Biomass boilers (in communal heating)	Other communal heating	Flue gas heat recovery
% of housing associations that have installed	11%	43%	23%
Views by responsibility/involvement			
Decision to install in new homes			
Ease of design	48%	59%	76%
Ease of installation	45%	64%	73%
Ease of procurement	42%	64%	74%
Capital cost	35%	60%	70%
Ease of commissioning	45%	64%	74%
Durability	45%	64%	74%
Payback term or cost/benefit analysis	38%	57%	70%
Performance against specification and expectations	36%	61%	73%
Overall satisfaction	40%	61%	71%
Maintenance and management of homes			
Running costs including bills	35%	61%	75%
Ease of resident use and operation	55%	66%	78%
Customer/user satisfaction	35%	59%	78%
Ease of maintenance	30%	63%	72%
Cost of maintenance	25%	64%	69%
Durability	40%	69%	69%
Payback term or cost/benefit analysis	38%	64%	65%
Performance against specification and expectations	25%	64%	69%
Overall satisfaction	30%	61%	66%
Resident feedback and engagement			
Running costs including bills	40%	67%	76%
Ease of resident use and operation	55%	66%	85%
Customer/user satisfaction	40%	63%	83%
Performance against specification and expectations	30%	63%	76%
Overall satisfaction	35%	62%	72%

Technologies to improve energy efficiency Satisfaction score out of 4 where 1 is poor and 4 is excellent, expressed as a %				
	Exhaust air heat pumps	Boiler flow restrictors	Voltage optimisers	Wastewater heat recovery*
% of housing associations that have installed	17%	6%	4%	2%
Views by responsibility/involvement				
Decision to install in new homes				
Ease of design	43%	68%	75%	63%
Ease of installation	40%	68%	69%	63%
Ease of procurement	47%	75%	69%	63%
Capital cost	38%	77%	56%	63%
Ease of commissioning	39%	77%	63%	63%
Durability	40%	73%	75%	63%
Payback term or cost/benefit analysis	39%	72%	25%	63%
Performance against specification and expectations	39%	70%	50%	63%
Overall satisfaction	35%	68%	50%	63%
Maintenance and management of homes				
Running costs including bills	32%	63%	66%	–
Ease of resident use and operation	27%	63%	74%	–
Customer/user satisfaction	32%	67%	66%	–
Ease of maintenance	37%	71%	83%	–
Cost of maintenance	39%	71%	83%	–
Durability	36%	67%	83%	–
Payback term or cost/benefit analysis	32%	79%	66%	–
Performance against specification and expectations	30%	71%	66%	–
Overall satisfaction	29%	67%	66%	–
Resident feedback and engagement				
Running costs including bills	34%	67%	63%	63%
Ease of resident use and operation	29%	63%	69%	63%
Customer/user satisfaction	34%	67%	63%	63%
Performance against specification and expectations	31%	70%	66%	63%
Overall satisfaction	33%	67%	66%	63%

* Small installation base with no maintenance/management respondents with responsibility/involvement.

Technologies to improve water efficiency Satisfaction score out of 4 where 1 is poor and 4 is excellent, expressed as a %					
	Low-flush toilets	Low-flow taps and showers	Low-volume baths	Rainwater harvesting	Greywater recycling
% of housing associations that have installed	86%	75%	64%	52%	18%
Views by responsibility/involvement					
Decision to install in new homes					
Ease of design	79%	78%	76%	55%	60%
Ease of installation	80%	79%	76%	56%	56%
Ease of procurement	79%	78%	75%	65%	59%
Capital cost	77%	77%	73%	54%	51%
Ease of commissioning	79%	78%	75%	58%	48%
Durability	75%	76%	73%	55%	47%
Payback term or cost/benefit analysis	75%	76%	73%	54%	37%
Performance against specification and expectations	76%	76%	73%	59%	42%
Overall satisfaction	75%	73%	69%	53%	41%
Maintenance and management of homes					
Running costs including bills	79%	81%	76%	63%	59%
Ease of resident use and operation	77%	77%	70%	61%	56%
Customer/user satisfaction	70%	68%	57%	52%	53%
Ease of maintenance	77%	79%	73%	56%	50%
Cost of maintenance	75%	77%	73%	56%	47%
Durability	74%	76%	73%	57%	52%
Payback term or cost/benefit analysis	75%	76%	73%	52%	48%
Performance against specification and expectations	76%	78%	75%	58%	59%
Overall satisfaction	75%	78%	69%	53%	55%
Resident feedback and engagement					
Running costs including bills	80%	80%	77%	64%	50%
Ease of resident use and operation	80%	79%	74%	63%	50%
Customer/user satisfaction	71%	65%	57%	54%	44%
Performance against specification and expectations	77%	78%	74%	56%	44%
Overall satisfaction	77%	77%	69%	53%	46%

Sustainable technologies
The experience of housing associations

Since the introduction of the Code for Sustainable Homes in 2006, housing associations have increasingly installed sustainable technologies. Almost two-thirds of those participating in this research had experience of at least one technology. This NHBC report summarises the findings from focus groups and in-depth telephone interviews with 174 housing associations which aimed to understand their experiences of installing technologies in newbuild homes in relation to:

- the uptake of specific technologies to satisfy sustainability and zero carbon challenges
- their reasons for choosing specific technologies
- experiences of design, installation, commissioning, use by residents and maintenance
- which technologies they would use again and which they would avoid
- lessons learned and their advice to others.
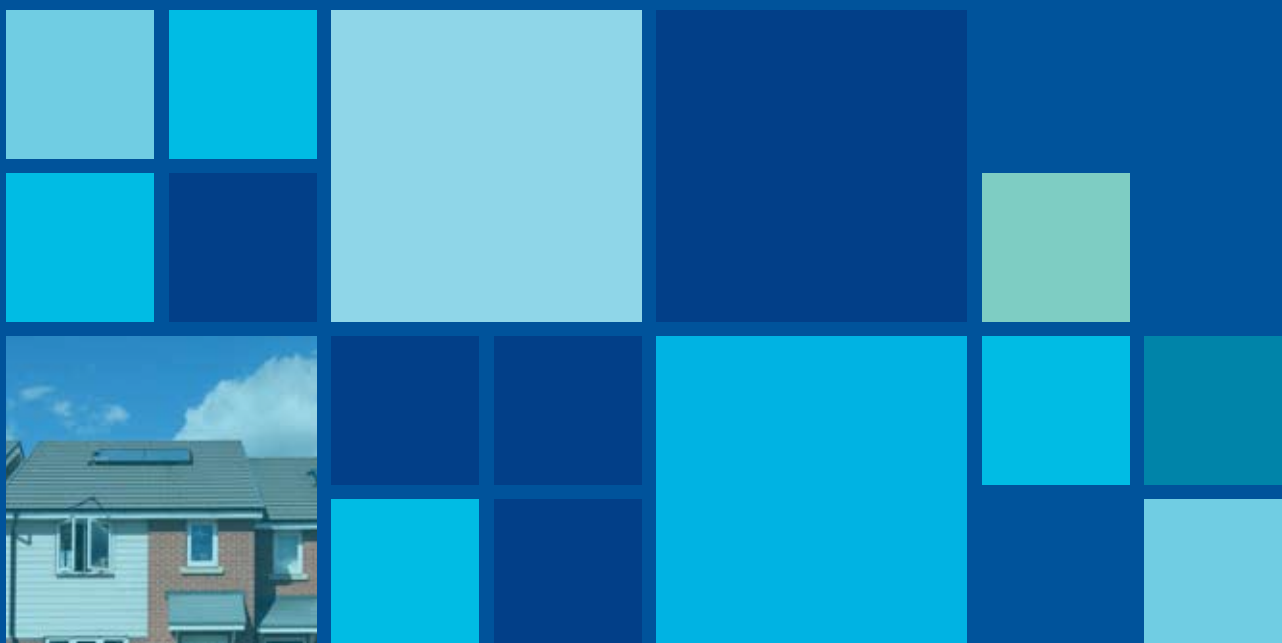
The NHBC Foundation, established in 2006, provides high quality research and practical guidance to support the house-building industry as it addresses the challenges of delivering 21st century new homes. To date the NHBC Foundation has published over 60 reports on a wide variety of topics, including the sustainability agenda, homeowner issues and risk management. Visit **www.nhbcfoundation.org** to find out more about the NHBC Foundation research programme.

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