Findings from a Survey of Wyndford Households and Experiences of New District Heating

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Bringing Warmth to Wyndford: Does the new district heating make a difference?

University of Edinburgh Survey of Cube Housing Association Tenants and Owner Occupiers at the Wyndford Estate, Glasgow, Winter 2012 and Winter 2013/2014

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Figure 1. Residents described the old heating system in their own words.

Figure 2. A transformation of views under the new community heating system.

Table of Contents

Acknowledgements

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EXECUTIVE SUMMARY

- During late 2012 and early 2013, the original electric night storage heating in the multi-storey and low rise housing at the 1960s Wyndford estate, Maryhill, Glasgow was replaced by a district heating system, providing heating and hot water from a gas-fired Combined Heat and Power generator located on the estate. External cladding and new windows have also been installed at most of the multi-storey blocks. Wyndford is owned by Cube Housing Association (HA), and is mainly social housing, but has a small number of privately owned houses, mainly in the maisonettes. SSE operate and maintain the heating system, and provide metering and billing services, under a long term contract with Cube HA.

- Satisfaction with heating for both tenants and owners at Wyndford has risen sharply since the new district heating was installed; in addition, tenants' satisfaction with their housing has improved considerably;

- The overwhelming majority of residents say their homes are warmer now than before, and there has been a dramatic fall in proportion of residents reporting that they felt cold at home during the winter;

- While the effective price of warmth has fallen, most Wyndford residents have taken these changes as improved thermal comfort rather than bill savings;

- The new system has resulted in higher bills for those residents in our sample whose energy consumption prior to the upgrade was low, while residents whose energy consumption was relatively high have seen savings;

- Since the new heating was installed, far fewer residents, especially tenants, report using more extreme ways of coping with cold homes, or paying energy bills;

- Evidence suggests however that some residents do not understand how to set the heating controls; they may also lack understanding of the link between their use of heating and what it is costing them. Hence a proportion of households are likely to be spending more than they need on their heating to keep warm;

- It is too soon to tell whether the improved heating and warmer houses will improve residents' levels of health, although there seems to be modest improvement in reported respiratory conditions;

- We suggest that there was scope for more intensive early engagement between the Housing Association, utility and residents to secure willing consent of all households to installation of the new heating. There was also continuing need for high quality and consistent information and support to enable residents to use the new heating system as efficiently and economically as possible. Cube HA had responded to this by

appointing a fuel adviser, who worked as an intermediary between residents and heat and electricity suppliers to resolve fuel debts, heating repairs and misunderstandings over heating controls and metering and payment arrangements.

- Residents expressed strong attachments to home and a sense of well-being, and welcomed the investment in heating and improved amenities at Wyndford.

THE STUDY

The study examines householder experiences of new district heating installed at the 1960s Wyndford estate, Maryhill, Glasgow in late 2012 and early 2013. District heating replaced the original electric night storage heating in the 1,900 multi-storey and low rise houses. External cladding and new windows have also been installed at most of the high rise blocks. Wyndford is owned by Cube Housing Association, and is mainly social housing, but has around 380 privately owned houses, mainly in the maisonettes. The new heating and hot water is provided by gas-fired combined heat and power and back up gas boilers located on the estate. SSE[1] operate and maintain the heating system, and provide metering and billing services, under a long term contract with Cube HA.

A face to face survey of social housing tenants and owners[2] on the estate was conducted with particular reference to the old and new heating systems, including attitudes to, and methods of payment for, the old electric heating versus new district heating, spending on energy vis-à-vis household income, health of household members, and experiences of using the new district heating (DH).

This report discusses

- The responses of tenants and owners to the new district heating system and other improvements;
- whether the improvements make a difference to satisfaction with housing and heating;
- the extent to which residents think there have been major improvements in levels of warmth in their homes;
- whether they report paying more, less or about the same for their energy bills since the new heating was installed;

[1] SSE also uses "Scottish Hydro" on the estate as a trading name

[2] We chose only to include owner-occupiers, that is, owners on the estate who live in their properties and had opted into connecting to the community heating. We excluded those renting out their houses and those opting not to connect. Those interviewed are referred to as 'owners' throughout the report.

- the mechanisms which residents use to cope with cold homes pre- and post-the new heating, and how these have changed;
- how they manage the new system, what they want from it, and its perceived effects on health;
- the effect, if any, on how residents view the estate, and their willingness or otherwise to remain there.

METHODOLOGY

The survey was carried out using face-to-face interviews in residents' homes at two points in order to track changes over time. The first interviews were in late 2012 (and in early 2013 for owners) as the district heating was being installed, and the second were a year later, in late 2013 and early 2014. Ten per cent of the tenants on the estate were interviewed using a random sample drawn up proportional to house type. At Time 1, 154 tenants were interviewed, and at Time 2, 80 were re-interviewed, reflecting availability and access. The two samples were broadly comparable in demographic terms, with a slight tendency for those tenants re-interviewed to have lived longer on the estate. In terms of owners, we interviewed 50 at Time 1, with 39 re-interviewed at Time 2. Analysis in this document refers mainly to those residents we interviewed at both Time 1 and Time 2. Readers are referred to the Time 1 reports for tenants and owners for full analysis of the Time 1 cohorts (Heat and the City, 2013; 2012).

RESULTS

The Old and New Heating Systems

The old heating system used electric heating, based on night storage heaters, and a time-of-use tariff (usually known as 'white meter'), which has a lower price for electricity used overnight, but a higher than standard rate tariff for daytime use. Many residents paid their electricity bills using a prepayment card meter, and could manage their spending by deciding how much to top up the card and how often. Most (as reported below) were dissatisfied with the electric heating, which was perceived as ineffective and expensive.

The new system, supplying heating and hot water from a gas-fired Combined Heat and Power generator located on the estate, pumps hot water to each household via a network of highly insulated underground pipes. Each household has a heat exchanger, which takes heat from the system to heat radiators and water, and a meter. The household heating controls are very

similar to those used in gas central heating systems and consist of: a programmer to set on/off times for heating, with user control to override the timer (hot water is available at all times); a wall thermostat intended to control the temperature in the house; thermostatic radiator valves (TRVs) to allow the user to vary the temperature in each room. Some households have a credit meter and either pay by direct debit or periodic billing (such as quarterly). Others have a system similar to a prepayment meter in that they charge up their meter using a 'key' at a local shop. Like a prepayment meter, this system is designed to cease supply automatically if the balance on the meter falls into debt.[3] In contrast with prepayment systems, however, the rate at which payments run down depends not on how much heat is used at any one time, but is set at a fixed rate designed to spread the household's annual heating bill evenly through the year. These meters are not strictly 'prepayment' as a proportion of heat consumed in winter may be paid for later in summer. We refer to them in this report as 'constant-rate payment meters'. Initially this rate was based on SSE's estimate of annual consumption for different types of home, and it is revised periodically to reflect actual consumption patterns. All households now have two energy bills: one for heating and one for electricity.

Housing and Heating

We knew from our first-round interviews that both tenants and owners at the Wyndford estate derived considerable satisfaction from their house, even though there was widespread dissatisfaction with the old electric heating. In broad terms, people seemed well able to distinguish between the house itself and the heating, and while a small percentage (1 in 7) were dissatisfied with both, there was overall a strong sense of personal security and attachment to 'home'.

Hence, over 80 per cent of residents at Time 1 expressed satisfaction with their houses (see Table 1), with owners in particular declaring themselves *'very satisfied'* (72 per cent, compared with only 19 per cent of tenants). Among tenants and owners we also found high levels of security attaching to housing even before the heating was replaced. Eighty per cent of tenants considered their house as a place where they felt safe; a similar proportion said that they felt at home there; and only a quarter said that their house was somewhere they wished to get away from. Feelings of personal security and attachment were even higher among owners: over 90 per cent felt safe at home; virtually everyone felt at home there; and only around a

[3] Meters have a £10 buffer before supply is cut. Following a supply cut a household must clear the buffer and be at least £1 in credit on the meter before supply automatically resumes.

fifth said it was a place to escape from. We concluded, then, that even with the old electric heating there was a considerable investment in 'home'.

Table 1. Comparison of resident satisfaction with housing at Times 1 and 2.

% by row	Very satisfied	Fairly satisfied	Neither	Fairly dissatisfied	Very dissatisfied	*base*
Tenants T1	19%	65	1	9	6	80
Tenants T2	41%	44	6	6	2	80
Owners T1	72%	15	3	8	3	39
Owners T2	59%	36	0	5	0	39

After the installation of the new district heating, we asked both tenants and owners the same set of questions about house satisfaction, and we found that it was associated with comparable or even higher levels. The major change occurred among tenants, not so much in general levels of satisfaction, but in the proportion saying they were *'very satisfied'* with their houses which rose more than twofold, from 19 per cent, to 41 per cent. Unsurprisingly, among owners who already expressed high levels of *satisfaction*, the figures were comparable (from 89 per cent either *'very'* or *'fairly'* satisfied recorded at the first interview, to 95 per cent at the second).

A much larger increase in satisfaction for both tenants and owners occurred in relation to the new district heating system. Whereas 53 per cent of tenants were *dis*satisfied with the electric heating, and only 27 per cent satisfied, 71 per cent are now very or fairly satisfied. For owners, 49 per cent were *dis*satisfied, and 38 per cent satisfied; with district heating, 95 per cent were very or fairly satisfied[4].

Table 2. Comparison of resident satisfaction with heating at Times 1 and 2.

% by row	Very satisfied	Fairly satisfied	Neither	Fairly dissatisfied	Very dissatisfied	*base*
Tenants T1	6%	21	19	22	31	80
Tenants T2	38%	33	11	9	9	80
Owners T1	8%	30	13	23	26	39
Owners T2	67%	28	0	3	3	39

[4] Among tenants, those saying they were *'very satisfied'* with the heating system rose from 6 per cent to 37 per cent. Among owners, the 'gain' was even higher: from 8 per cent to 67 per cent.

What do People Want from the New Heating System?

Both before and after installation, we asked residents what was most important to them about the new heating. Tenants at Time 1 focused on a reduction in fuel bills (65 per cent) followed by improved comfort and warmth (56 per cent), and being able to control the heating better (37 per cent). At Time 2, the focus on cutting fuel bills had fallen (51 per cent), with 54 per cent wanting improved comfort and warmth, and 29 per cent better control of the heating. For most owners, the overwhelming focus (75 per cent) before and after installation was on having a warm house rather than lower fuel bills.

We also asked owners whether they thought that being connected to the district heating network would affect the financial value of their property: 73 per cent thought it would improve the financial value of their home, though only 36 per cent said that this was important to them. When we asked owners about the most and least important reason for connecting to district heating, improving the market value of the property did not feature prominently (only 3 said it was the most important reason for connecting). We also asked owners an open ended question about opting in to the system: *'So why did you decide to connect to the district heating network?';* none of the owners reported that it was to improve the financial value of their house. The most frequent responses (around half mentioning each point) were: having the opportunity for a central heating system; having a system that was an improvement in operational terms compared to their electric heating; and because there was no installation cost[5].

Does the New Heating System Deliver Warmth?

Wyndford residents have a strong sense of the place as home, and this has been reinforced by the major investment in a new heating system. Does it actually work in terms of residents' perception of warmth? At Time 2 we asked whether the heating upgrade had made people's homes warmer, and the overwhelming majority (81% of tenants and 90% of owners) reported that it had.

[5] Owners were offered a grant from Scottish Government to cover the installation and connection costs.

Table 3. Percentage of residents saying their home was warmer or colder at Time 2 with the new heating system.

% by row	A lot warmer	A little warmer	No change	A little colder	Much colder	*base*
Tenants	63%	18	12	7	0	76
Owners	87%	3	8	3	0	39

We also asked residents how often their home had been too cold, both for the winter period preceding the installation of new heating, as well as the one following it. We asked: *'were there times your home was too cold last winter?*', and compared their responses at Time 1 and Time 2. The turn-around was dramatic:

Table 4. Percentage of residents saying they were cold at Times 1 and 2.

% by row	All of the time	Most of the time	Some of the time	A little of the time	No, never	*base*
Tenants T1	29%	24	24	15	9	80
Tenants T2	3%	1	9	8	80	79
Owners T1	31%	8	18	18	26	39
Owners T2	0%	8	5	3	84	37

For both groups we see a transformation in their assessment of warmth, but especially among tenants, with a ninefold increase in the proportion who said they had *never* been cold in the previous winter. Furthermore, the proportions saying that cold housing was a *'serious'* problem for them fell to one-third of previous levels (from 42 per cent to 14 per cent). We can see the change more dramatically if we focus on how the *same* people respond at the two time-points rather than comparing the aggregates. Thus, among tenants who said that in the previous winter they had been cold all or most of time, 70 per cent now said that they had *never* been cold in the subsequent winter. If anything, the warmth 'gain' is higher among tenants than among owners, given that a higher proportion of the tenants were cold at T1 than owners. Furthermore, the multi-storey flats were insulated as part of the upgrade, whereas the maisonettes where the majority of owners live were not. Decisions on insulation were largely conditioned by whether this was fundable under the terms of energy company obligations to finance energy efficiency measures in low-income households.

We also asked residents whether their homes had been too *warm* over the last year and if this was a problem for them. While 59 per cent of tenants and 53 per cent of owners stated their

homes were too warm at times, few perceived this to be a significant issue (18 per cent of this group found it to be a *'serious problem'* or *a 'bit of a problem'*, the remaining 82 per cent finding it *'not very much of a problem'* or *'not a problem'*).

We asked residents whether the heating controls were easy enough to understand and if they gave them the control they desired. Residents who reported being too warm as a *'serious problem'* also said they could understand and control the system as they wanted. However, as many as half of residents (tenants as well as owners) who reported being too warm had solved the problem by opening the windows. Most people reporting it was too warm in the winter also said that they turned the heating on and off with the wall thermostat, suggesting that their actual control over their heating was limited[6].

Table 5. Percentage of residents saying their home was too warm with the new system.

% by row	All the time	Most of the time	Some of the time	A little of the time	No, never	*base*
Tenants	3%	3	33	21	41	80
Owners	5%	3	29	16	47	38

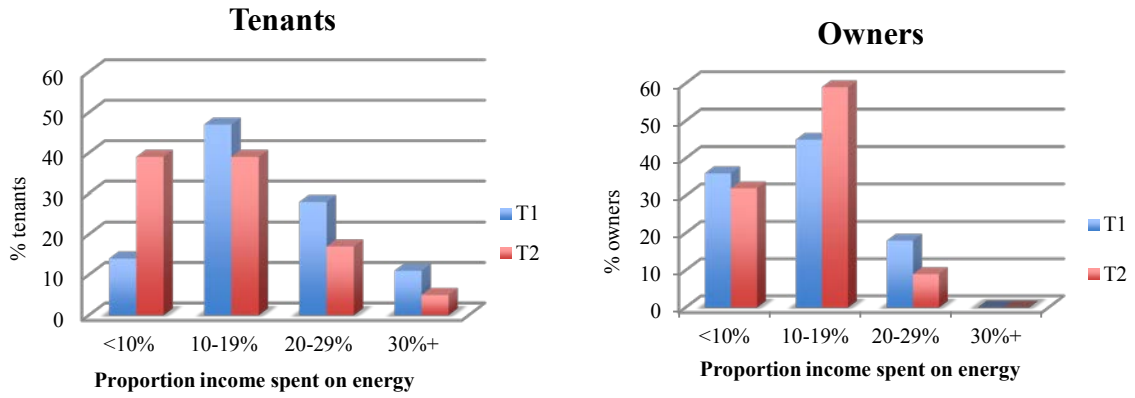
Paying for Energy and Fuel Poverty: Before and After the New Heating

Fuel Poverty

The Scottish Government's threshold for fuel poverty is more than 10 per cent of household income spent on fuel for heating. Figure 3 shows the Time 1 and Time 2 comparisons for tenants and owners in terms of their own estimates of what they were paying for energy.

[6] Instructions and advice provided by SSE and Cube indicate that the programmer enables users to set on/off timings for heating and the thermostat controls the temperature the flat is heated to. Using the wall thermostat to turn heating on and off is likely to result in higher bills.

Figure 3. Estimated Proportion of Household Income spend on Energy.



There has been an appreciable improvement particularly in terms of tenants' assessments of what they are paying from energy. Whereas at Time 1, only 14 per cent thought they were paying 10 per cent of their household income on energy, by Time 2 this had risen to 39 per cent. Around one-third of owners estimated that on both occasions they were spending 10 per cent or less. While these figures do not measure fuel poverty rates directly (as they report actual spending rather than modelled costs), and they combine heating and other energy uses, they indicate that fuel poverty was prevalent on the estate at Time 1, and that spending significantly above the fuel poverty threshold still resulted in inadequate warmth prior to the installation of the new heating system.

The issue is framed more broadly by the extent of income poverty at Wyndford. Almost three-quarters of tenants interviewed had gross incomes of below £10,000 pa, which is 39 per cent of the comparable median income for Scotland in 2012[7] (SPICe, 2012). As many as 6 out of 10 households on the lowest incomes (less than £5,000pa) reported that they spent 20 per cent of their income on energy. This compared with less than 2 in 10 of those with annual household incomes of £15,000 or more. Despite the low income and high energy spend reported, when we asked respondents how their households were managing financially they said that they were managing to get by. Almost half, 48 per cent, of tenants said they were *'getting by alright'* compared with 28 per cent *'very well'* or *'quite well'*. Twenty four per cent reported that they were *not* getting by *very well*, or were in *'some'* or *'deep financial difficulties'*. This is a judgement which tenants are making in the contexts of their lives and circumstances. Those who said they did not cope well or were in *'some'* or *'deep financial*

[7] Median Full-Time Income was £25,960 in 2012.

difficulties' (about one-quarter of tenants) were disproportionately the unemployed, young people under 35, and those who have lived there for 5 years or less, but *not* retired people.

What of owners? In terms of their own assessment as to how they managed financially, half of them said they managed *'very'* or *'quite well'* (compared with 28 per cent of tenants), with only 12 per cent saying that did not manage well (24 per cent of tenants). This is a reflection of higher income levels among owners, with 20 per cent having gross household incomes of £20,000pa or more, compared with only 6 per cent of tenants. Similarly, at the other end of the scale, just over a third had annual household incomes of £10,000 or less, compared with three-quarters of tenants.

Paying for Energy

Given that residents' assessment is that they now live in warmer houses, are they paying more, less or about the same energy bills compared with before? This is a difficult calculation to make, reliant as it is on accurate data. What people spend on energy in a given period is determined by multiple factors including the amount of energy consumed (which varies seasonally), their tariffs, and any discounts or additional charges, including charges to clear debts which may have built up in a previous period. As far as possible we have based estimates of households' annual energy consumption and expenditure on data in energy bills or statements. For others, particularly households using constant-rate payment meters, the data we were able to gather through the survey was a household's estimate of their expenditure in a given period. Using this data we have extrapolated to annual energy consumption and expenditure, correcting for seasonal variation, before and after installation:

Table 6. Household annual energy bills before and after installation of district heating and insulation upgrade (sd=standard deviation)[8].

	Tenants T1	Tenants T2	% change	Owners T1	Owners T2	% change
Mean (sd)	£818 (£449)	£936 (£359)	+14%	£1082 (£377)	£1197 (£284)	+11%
Median	£731	£790	+8%	£1082	£1238	+14%
base	65	66		24	25	

[8] The base numbers for households at Times 1 and 2 are different because the estimate of household annual energy bills at Time 1 (from the information we asked – costs in winter time) requires an estimate of electricity consumption for non-heating purposes to extrapolate heating across the year (because heating is so seasonally variable). Therefore we can only estimate Time 1 annual bills for households with data available at Time 2 and there are two households (one tenant and one owner) who were only able to provide information at Time 2.

These data (Table 6) indicate that, comparing like with like, both tenants and owners seem to be spending more on energy since installation of the new heating system and insulation. Such comparisons do not however take into account retail energy price increases since the new heating was installed; when we do that, households tend to see a modest saving (Table 7). From people's energy spend we estimated their consumption at Time 1 in kWh and asked how much this would cost using Time 2 electricity tariffs (which had risen). This allows us to compare what people pay after the heating upgrade with what they would have paid in the same year had the upgrade not taken place.

Table 7. Household annual energy bills assuming Time 2 electricity prices at Time 1 (sd=standard deviation).

	Tenants T1	Tenants T2	% change	Owners T1	Owners T2	% change
Mean (sd)	£963 (£547)	£936 (£359)	-3%	£1268 (£463)	£1197 (£284)	-5%
Median	£863	£790	-8%	£1123	£1238	+10%
base	65	66		24	25	

These comparisons should be treated as indicative of the short-term impact of the new heating system. Some residents have found the new heating controls (particularly programmer and thermostats), constant-rate payment metering, standing charges and billing arrangements challenging, and have run up debts on constant-rate payment meters where overall consumption has exceeded weekly expenditure before SSE identified the problem and changed the payment rate. For these households our estimate of annual expenditure is likely to overestimate long term costs for two reasons: first, reported expenditure may cover both the cost of energy in that period plus an excess levied to clear debts accrued in a previous period; second, as households become more familiar with the system, they are likely to improve their control over consumption. Where we have not been able to inspect household bills, we were unable to identify the households to which the former issue applies.

One factor contributing to residents' finding it difficult to manage their heating costs is the lag between using the heating and impact on bills. The constant-rate payment meter system, introduced by SSE, charges a fixed weekly amount to the household based on estimated heat consumption averaged across a year. SSE review and revise charges quarterly in response to actual consumption, and seek to be proactive where customers may be running up debts. Once bedded in, this approach should enable residents to spread their heating costs across the year, paying the same amount each week, and making budgeting for energy more straightforward.

However, during the transition, a household which uses the heating a lot, or sets the wall thermostat to a high temperature (perhaps because they have not understood the controls, or because keeping the house very warm does not seem to impact on how much money the meter takes off each week), may unwittingly run up debts.

Part of the change in energy bills also results from changes in standing charges. Before installation of district heating, households paid a single electricity bill and standing charge; the new system added to this a second bill for heating including a standing charge for heat. From May 2013 tenants paid a fixed charge for heating equivalent to £157/year (including VAT) and owners paid £249/year[9]. Electricity standing charges vary with different tariffs, with the median being £105/year for both tenants and owners. While the variable costs of energy services should have fallen (due both to district heating and additional insulation), the fixed costs have risen. In this context we found that households with higher levels of consumption at time 1 are more likely to save money than households with low consumption levels at time 1. A low heat user tariff has recently been introduced by SSE for households using less than 1500 kWh per annum. In 2014, this tariff is 9.33p/kWh (inc. VAT), with a zero standing charge. A secondary qualifying criterion for acceptance onto the tariff follows the Warm Homes Discount matrix, and largely relates to recipients of welfare benefits. All households who meet the criteria have been invited by SSE to switch to the tariff, via two letters and an open day event in the local Community Centre; call centre staff are also trained to identify such households. In addition, Cube's home energy adviser is seeking out households likely to be eligible. Very few have so far transferred to the tariff.

Energy bills also vary with type of housing. Most tenants live in the multi-storey flats, while most owners live in the maisonettes; the multi-storey flats have had greater investment in insulation[10]. Thus, if we compare median bills[11], the rate of increase has been greater for people living in the maisonettes than the multi-storey flats, and greater for owners than tenants.

[9] The charge is lower for tenants because the housing association, which owns the property, pays part of the charge.

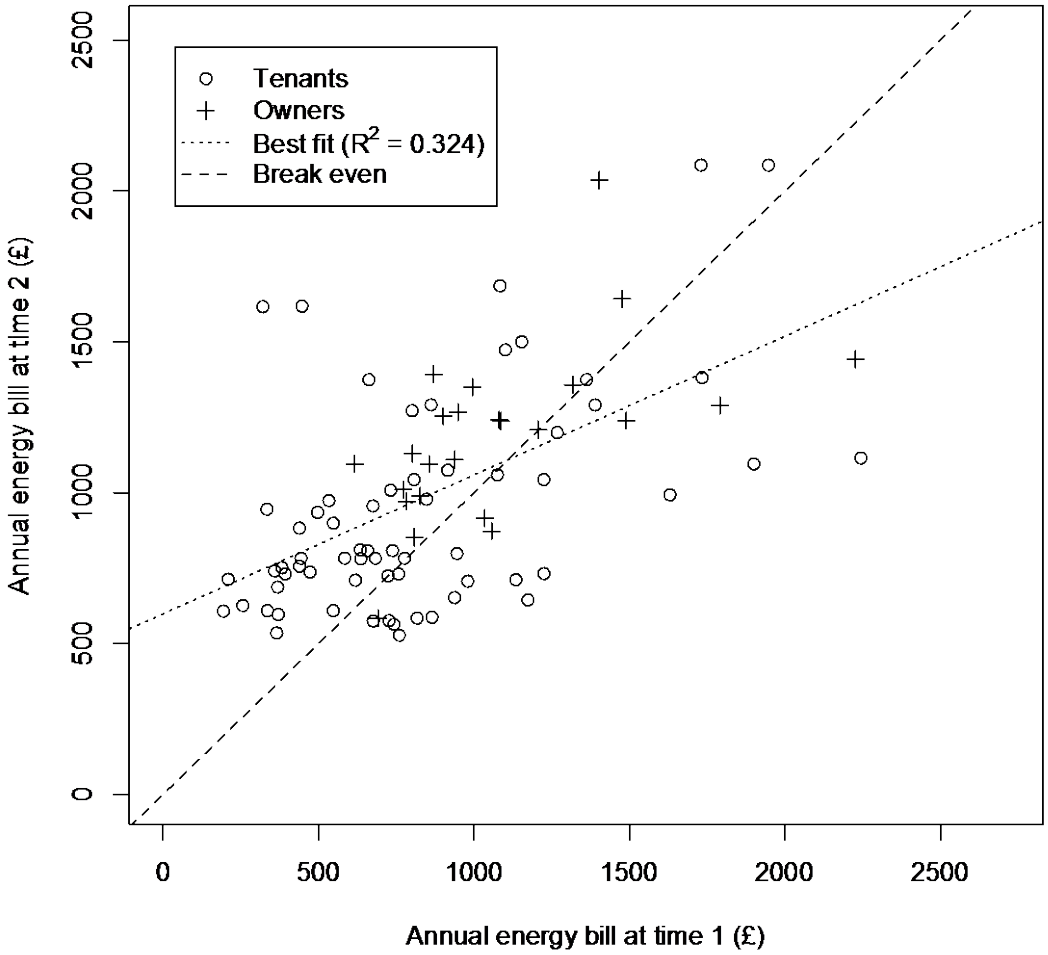
[10] Work is still ongoing on the estate providing insulation to the remaining properties.

[11] As reflected in the size of the standard deviations about the mean, there is considerable inter-personal variation, especially among tenants, so we have focused here on the median bills.

There are also high correlations between what people pay at Time 1 and Time 2 (for tenants, r=0.524 (p<.001); and for owners, r=0.564 (p=.004)). Looking more closely at the relationship between what people spend on energy at Time 1 and Time 2, with data on the subset of households (tenants and owners) for whom we have reliable data, we find the following (see Figure 4, p15):

- Most households are spending £500 to £1000pa on energy before and after the new heating.
- The 'break even' line on Figure 4 indicates energy costs being equal at Times 1 and 2. Most households are above this line, reflecting the fact that in nominal terms most households are paying more with the new heating than they were before.
- The 'best fit' line on Figure 4 indicates the best-estimate linear relationship between bills at Time 1 and Time 2. The 'best fit' and 'break even' lines cross each other at a little over £1,000: while there is much variation, households paying more than £1,000 at Time 1 tend to make savings at Time 2, while conversely households paying less than £1,000 at Time 1 tend to face higher costs at Time 2.
- The same point is illustrated by the fact that there are many whose spending at Time 1 was less than £500pa, but is now (Time 2) between £500 and £1000.
- Various interpretations of these patterns are possible:
    - Low users may have rationed their heating at Time 1, whereas they are now more willing to use it, even to the extent of paying more. High users, by contrast, were willing to pay to achieve warmer homes, so the 'warmth gain' is less for this group.
    - They are also now subject to both electricity and heating standing charges, which are higher in total than before.
    - Households may have limited understanding of how to use the new heating controls, which are very new to households accustomed to controlling their bills by pre-payment meter and the on-off switch on a wall heater or electric storage heater. (The new heating uses a programmer to set heating and hot water times, a wall thermostat and radiator thermostats).

Figure 4. Comparison of estimated household energy bills per annum at Time 1 and Time 2.



The above figure for household spending on energy at Times 1 and 2 also indicates the high level of variation in energy use between households living in broadly comparable dwellings. Notable contrasts include two tenant households who are high spenders on both occasions and two tenant households who were low spenders at Time 1 (less than £500pa) but high spenders at Time 2 (more than £1500pa). There are also four tenant households who spent above £1500pa at Time 1, but reduced spending at Time 2. The point is not that these households are deviating from a notional economically 'rational' average, but that consumption of energy has to be understood in the context of household routines and specific needs; this is reflected in the relatively loose fitting regression line, and a low R-squared.

What of the owners? Spending by most owners was between £500-£1000pa at Time 1, and £1000-£1500pa at Time 2, indicating that most are spending more on energy since installation of new heating; relatively few spend less. Once more, there are however high- and low-spend

examples such as two households who are spending significantly more at Time 2 than Time 1, matched by another two spending considerably less.

Below are examples of households with contrasting responses to the new heating, resulting in differential impacts on energy bills[12]:

Households with high annual energy bills at both Time 1 and Time 2

Confused Energy Users: Household A is a three-person tenant household in a two bedroom flat on the ground floor of a multi-storey block. Time 1 annual energy costs were £1729 and at Time 2 are £2086. They are paying (an estimated) 20 per cent more with the new heating. This household reported not understanding how to control the heating: *"maybe I am using more because I don't know how to work it… something's wrong with the system"*. They turn the wall thermostat to its highest setting to switch the heating on, and commented that the radiators then turn off within an hour or so. They use electric heaters to provide additional top-up heating and their weekly electricity cost, paid by prepayment card, has only reduced from £35 per week at Time 1 to £31 per week at Time 2. At Time 1 Scottish Power was the electricity supplier, but the resident was unsure which tariff they were on. At Time 2 the household is still unsure which electricity tariff they are on, and they have not changed the electricity meter. It is likely that they were, and still are, on a white meter tariff.

High Spenders who save with the New Heating: Household B is a four-person owner-occupier household in a lower maisonette. Their Time 1 annual energy bill was £2226, decreasing to £1443 at Time 2. This household had the highest estimated Time 1 annual energy bill for owners[13] and they are saving 35 per cent at Time 2. They explained that they could afford to spend a lot on heating, because three family members work. They used to pay for electricity by a prepayment meter on a white meter tariff. At Time 2 they were on a fixed rate electricity tariff and had switched supplier. They now pay their heating bill by fixed direct debit paying £50 per month. Even though their energy bill has reduced they think they are using their heating more now than before. To control the heating they use the programmer on advance and manual setting, as well as the wall thermostat. They reported understanding and control of the system and were very satisfied with the new heating.

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[12] See appendix for further information on a selected number of residents.

[13] There was only one resident (a tenant) paying more than this household at Time 1: we estimated they paid £18 more than this household at Time 1 (£2244). At Time 2 this tenant saw their annual energy bills fall by 50%, to £1115.

Low annual energy bills at both Time 1 & Time 2

Careful Energy User: Household C is a single person tenant household who works night shifts and lives in a one bedroom flat. The occupant had an annual energy bill of £194 at Time 1 and £607 at Time 2. This person had the lowest Time 1 annual energy bill and is spending roughly three times more at Time 2. At Time 1 they were using storage and additional electric heating, and at Time 2 were using both the new heating system and additional electric heaters. They have the thermostat set at 22ºC and mostly use the 'advance' setting on the programmer to control the heating. They think they are using heating more than before and reported to us that they have the control they want, and they keep records of their energy spending. They are very satisfied and told us they have a *"better feel of well-being with new heating"* and are happy now to be at home – it is a lot warmer.

Energy Saver: Household D is a single person owner-occupier household (currently not working) living in a three bedroom upper maisonette. They had an annual energy bill of £691 at Time 1 and £584 at Time 2. This household had the lowest estimated Time 2 annual energy bill for owners, saving an estimated 15 per cent at Time 2. They paid for their electricity at Time 1 (£56 per month) and Time 2 (£28 per month) by direct debit on a white meter tariff, and have therefore continued to pay a higher daytime rate for electricity, even though they no longer have electric storage heaters. At Time 2 they are paying £20 per month by prepayment card for heating. At Time 1 they had storage and additional electric heaters and mostly used an electric fire to keep warm, reporting that the storage heaters were too expensive. With the new heating system, if they are cold they put the heating on for around half an hour and commented that it stays warm for hours; they also turn the thermostat up and down as required and use the individual radiator valves. They said they had the understanding and control required and thought they were paying about the same as before but were a lot warmer.

Low annual energy bills at Time 1 & high annual energy bills at Time 2

Distressed Energy User: Household E is a single person tenant household in a one bedroom flat in a maisonette block. They had an annual energy bill of £320 at Time 1 and £1616 at Time 2, hence paying five times more (£1296) at Time 2. At Time 1 they reported being very cold, did not want to move around the flat from room to room and only used their electric heating *"when I can afford to*". They pay for both electricity and heating by purchasing credit to 'top-up' the meters. Their electricity supplier is Scottish Power, and they have not changed to a standard tariff meter. At Time 1 they estimated that they were spending about £5 per week on electricity, but at Time 2 their estimated winter spending was about £30 every 10

days for electricity, and £20 per week for heating. It is possible they underestimated their Time 1 electricity costs having reported at Time 2 they thought their electricity use (for domestic appliances) had not changed much. In addition, a recent family bereavement seems to have affected this person's willingness and ability to manage their spending on energy. At Time 2 they told us they had run out of credit on their constant-rate payment meter and gone into the £10 emergency credit buffer. They control the heating by turning the thermostat right up or completely off; they perceived that the hot water takes a long time to get hot. They had felt pressured by Cube to accept the new heating system: *"got no choice. Just have to live with it"*.

Increased Spending, but Resolving Problems: Household F is a two person owner occupier household in a three bed upper maisonette (at Time 1 only one person lived in the house). The household had the lowest Time 1 annual energy bill for owners at £615. This increased to £1095 at Time 2 (estimated increase of 78 per cent at Time 2). At Time 2 they reported using the new heating about the same amount as the electric heating at Time 1. Overall the house is a lot warmer, although colder in the kitchen since the immersion heater was removed; they felt that the hot water had not been hot enough; SSE staff had visited three times to address the problem. They control the heating using the wall thermostat, and reported they had enough control, but are unsure how to use the programmer. They commented: *"maybe if I used the programmer it would be better"*. If they are too warm they turn the heating down or off and open windows. They paid for electricity by fixed monthly direct debit (at Time 1 on a white meter tariff and a fixed rate tariff at Time 2). They had had problems with incorrect heating bills, and though this was now resolved they attributed their increase in energy costs to the heating standing charge, which they felt had not been explained properly. They noted that because they *"earn well"* (household annual income is over £30,000) they have not had to cut back spending on anything else to manage the increased energy costs.

High annual energy bills at Time 1 & low annual energy bills at Time 2

In Control and Saving: Household G is a two-person tenant household (parent and child) living in a two bedroom flat in a 14-storey block. They had an annual energy bill of £1630 at Time 1 and £993 at Time 2, saving them an estimated £637, or around 40 per cent. At Time 1 they had three electric heaters (two storage and one panel heater); they paid for their electricity by pre-payment on a white meter tariff spending £30-40 per week on electricity. On an income of £5,000-10,000pa they estimated they spent over 30 per cent of their income on home energy bills. At Time 2, they credit the constant-rate payment meter with £10 per

week. They also pay £10 per week for electricity on a single rate tariff, using the same payment method. At Time 1 they reported being cold most of the time and using all of the coping mechanisms listed in Table 8, (p23). They now estimate spending 10-19 per cent of their income on energy and reported using the heating about the same as before but being a lot warmer. They use the heating programmer, the wall thermostat (set at 20^{o}C) and individual radiator valves. They reported the heating controls were easy enough to understand and control and told us they were very satisfied.

In Control and Saving: Household H is a two-person owner-occupier household (one person retired and one working) living in a two bedroom lower maisonette. They had an annual energy bill of £1791 at Time 1 and £1289 at Time 2, saving them an estimated 28 per cent. At Time 1 they had electric central heating and paid by monthly direct debit (£190 per month on an economy 7 tariff, on income of £15,000-20,000pa). They did not report being cold in the winter, but had to cut their spending on food and leisure, and turn the heating down or off in order to pay heating costs. At Time 2 they paid for the heating by a direct debit of £50 per month, and the same for electricity (total £100 for the two bills); they have not switched electricity supplier. To control the heating they use the programmer, wall thermostat and individual radiator values; they were pleased with hot water temperature and pressure.

These examples show the complexity of household heating practices and the variation in degrees of understanding and control. Thus, in two cases (A & B) where residents were relatively high spenders on each occasion, they differ with regard to whether they understand the new heating and hence save (B saves 35%), or feel confused about how to control the heating and spend more (A spends 20% more). B manages to save more than a third, while remaining a relatively high spender by choice, while A does not appear to manage either the old or the new system well. Both 'low' spenders, C and D, appear to be highly organised and instrumental in their use of the heating system. Nevertheless, one (C) is paying three times what they spent previously, while D has reduced spending by 15%. Turning to two residents (E and F) who moved from low to high spending on energy, both seem confused about the new heating system, reflected in significantly higher spending. Finally, the two households (G and H) who moved from being high to low spending (saving, respectively, 40% and 28% on energy bills) seem to be efficient users of the new heating, setting the programme timer and using the radiator thermostatic valves.

We conclude that *as a group* Wyndford households are paying roughly the same for energy services had they continued using electric heating (with rising electricity prices), but they have experienced significant improvements in levels of warmth. The fact that overall energy costs have stayed much the same is true in relative as well as absolute terms, as reflected in the fact that few owners or tenants report a significant fall in the proportion of household income spent on energy. Reported spending at Time 1 and Time 2 remains highly correlated for both tenants and owners (statistically significant at $p<.001$ and $p<.006$ respectively) indicating that people who spent lower (or higher) amounts at Time 1 also spent similarly at Time 2. Households whose energy consumption before the upgrade was high have seen absolute savings in their bills, while lower consumption households tend to have higher bills with the new system. The overwhelming majority of households report that the changes have resulted in considerably warmer homes and a dramatic fall in the frequency of periods when their homes are too cold (in most cases to '*never'*).

People's expectations at Time 1 of what they would end up paying for the new heating displayed ambivalence or even scepticism as to whether savings would be made. Thus, we found that 41 per cent of tenants, and 38 per cent of owners, expected that they would *'end up paying more'*, and only 32 per cent of tenants and 24 per cent of owners thought that they would pay less[14]. When we returned at Time 2, those tenants who considered they were now paying less for their energy mostly thought that any savings would simply go on *'just getting by'* or on buying more food. Similarly, among tenants who thought they were paying more for energy, cutting back on food was the most common response to increased energy bills.

The Heat Tariff at Wyndford

The costs seen by households at Wyndford are an interaction between patterns of usage and the heat tariff SSE has adopted. It is important to emphasise that across different heat networks there is a wide variety of both total costs of providing heat, and ways of sharing that cost among users.

SSE use a market-comparator approach to setting the heat tariff. The headline summary of this approach is that the heat tariff is cheaper than using gas heating, but it is important to bear in mind the complexity of establishing this comparison (for example, the 'cost' of using gas to heat a home is in part dependent on the efficiency of the boiler). The heat tariff is set on the

[14] 21 per cent of tenants, and 30 per cent of owners thought they would end up paying *'about the same'* as before.

basis of the average of the 'Big Six' energy companies' gas tariffs in the area, meaning both the standing charge and the energy charge are determined by factors outside the Wyndford scheme. The balance between standing and energy charges in the Wyndford heat tariff may be a contributing factor in our finding that, while thermal comfort has improved, low energy users were less likely to see savings in their overall energy bills than were high energy users. A lower standing charge and higher energy charge may have resulted in more low energy users (but fewer high energy users) seeing a saving[15].

A market comparator is one approach to setting heat tariffs. Other approaches include cost-reflective pricing, fixed charging (where users pay a sum independent of the amount of heat they use), and top-up charging (users pay a fixed sum for a minimum quantity of heat, and pay a variable amount for any consumption above this level). Each of these approaches may have resulted in different patterns to those we found above.

In addition to the variety of ways charges may be levied, the revenue required by a heat network operator from users is sensitive to a range of factors, differentially applicable to schemes. Findings from the Edinburgh University Heat and the City project indicate that the following factors are important influences on what users pay for heating:

1. Whether any surpluses generated are taken as profit, are reinvested into the system (for example, in increasing the number of users), or are returned to existing users in lower tariffs
2. Rates of return and interest rates can powerfully affect the cash-flow model for heat networks, given that the infrastructure is capital intensive and long lived.
3. The configuration of the network influences the relationship between costs and heat provision. While network economics are complex, the following are rules of thumb:
    a. Areas of concentrated heat demand (such as tower blocks) tend to increase the ratio of heat delivered to pipe length
    b. Connecting users with different heat demand patterns tends to increase the ratio of total heat delivered to peak heat demand, meaning both pipes and generators are used more efficiently

[15] The issue is, however, complicated by the possibility that households' use of the heating may have been different had the tariff been set differently.

c. Networks tend to show increasing returns to scale, meaning the average cost per user of a large network tends to be lower than the average cost per user of a small network.

4. The balance between standing and energy charges that make up the heat tariff. A higher standing charge tends to bring the overall cost to households with different levels of consumption closer together, though the issue is complicated to the extent that households adjust their use of the heating in response to their tariff.
5. The costs and revenues associated with heat generation, including any subsidies (for example, the Renewable Heat Incentive) and the revenues from electricity produced by Combined Heat and Power (CHP) generators.

Where heat network costs are passed through to consumers, the heat tariff will be sensitive to these parameters. SSE uses a market comparator to set the tariff at Wyndford (so the tariff does *not* vary with other costs in the system), but the tariff is nonetheless related to these parameters: SSE's commercial model for Wyndford is confidential, but their judgement of the viability of the scheme is likely to depend on whether revenues generated from the sale of heat are judged sufficient to meet their requirements in the context of other costs and revenues. Hence, in broader terms, addressing the issues above could either lead to lower tariffs for schemes which charge in proportion to costs, or to an increased range of viable schemes where tariffs are set by market comparator.

Coping with Cold Houses and the Effects of the New District Heating

We now focus on how Wyndford residents coped with cold houses, and whether there has been a significant change in the mechanisms they use to cope. Keeping warm at home in a cold climate like Scotland's, when housing energy efficiency standards have historically been poor, presents challenges. The pan-Scottish survey, carried out between 2002 and 2006, of 1281 households who received central heating under the Scottish Government-funded Central Heating Programme examined coping mechanisms which respondents used to help keep warm and pay for their heating. These provide a useful benchmark against which we are able to compare responses in our surveys of Wyndford pre- and post-installation of new heating. The reported improvements at Wyndford are dramatic.

Table 8: Percentage reporting use of various coping mechanisms or experiences of cold after new heating had been installed (pre-installation responses in brackets[16]).

% mentioning	Tenants	Owners	Scottish Central Heating Programme study
Wore outdoor clothing indoors to keep warm	25 (66)	9 (28)	26
Turned off heating in some rooms	23 (49)	34 (32)	21
Not move from room to room because of the cold	16 (48)	9 (36)	27
Turned heating down in some rooms	26 (42)	31 (34)	21
Gone to bed early in order to be warm	17 (42)	6 (32)	19
Found yourself shivering with cold when sitting still	16 (40)	3 (42)	21
Turned off heating for few days	17 (39)	12 (12)	8
Gone somewhere else to stay warm	9 (35)	3 (10)	N/A
Borrowed money for heating	14 (34)	3 (4)	8
Cut back on social or leisure activities	21 (44)	3 (16)	12
Cut back on food expenditure	14 (27)	9 (10)	9
Put off paying other important bills	17 (27)	3 (6)	9
Avoid going outside as too hard to get warm upon re-entry	5 (26)	3 (22)	13

The findings show significant reduction, especially among tenants, in the proportion of residents who struggled to keep warm. There is now greater use of 'conventional', less drastic, measures used by many residents to control heating costs, such as turning the heating down or off in some rooms, not moving from room to room, putting on warm clothing, and sometimes *'shivering'*. While at Time 1 Wyndford residents were far more likely to use all of the coping mechanisms than the Scottish Central Heating Programme sample, by Time 2, they were more in line with the national sample.

What can we say about people's use of combinations of different mechanisms? At Time 1, only 4 per cent of tenants used all the mechanisms, but 13 per cent used all three of the more serious ones in order to pay their energy bills: cutting back spending on food, borrowing money or running up debts, and deferring paying other bills. After the installation of the new heating system, only 4 per cent of tenants used these three 'serious' mechanisms, and none

[16] The question asked of tenants at Time 1 was *'Thinking back to last winter, did you do any of these things to help you pay for heating?'*

used all the mechanisms[17]. Virtually no owners, on the other hand, used the serious mechanisms either at Time 1 or Time 2[18].

With the old electric heating at Time 1, being young, unemployed, and living in the multi-storey flats resulted in a greater propensity to defer paying other important non-energy bills, but at Time 2 it is those who are unemployed who experience most difficulty, and new heating has eased the difficulties faced by younger people and people living in multi-storey flats.

Installing and Using the New Heating System

Installation of the new system

At Time 1, more tenants than owners were critical of the disruption caused by the installation; half found it *'very'* or *'fairly disruptive*', and about the same proportion continued to say this when interviewed the second time around. Owners, on the other hand, possibly because they *chose* to opt in, had more choice about the location of new radiators and had the system installed later than tenants, which may have resulted in streamlining, were far less critical; 7 out of 10 had not, on reflection, found it disruptive.

Of the minority who did find installation disruptive, two areas of concern were expressed, one relating to preparation and clean up in houses before and following installation, and the other relating to contractor reliability and quality of work. For example work was not always carried out at the agreed time, contractors were not always perceived to be courteous, and sometimes requests had to be made for contractors to return to relocate or replace wall thermostats or radiators, or to repair damage to properties.

Engagement between residents, Cube HA, SSE, and contractors

Major housing renovation, such as that entailed in retrofit of building insulation and new heating, is disruptive and demanding on all parties, as it proved to be in Wyndford. Perceptions and experiences of the installation process, and quality and consistency of information, advice and support, differed between Housing Association, heating utility and householders. Cube consulted with tenants prior to decisions about the contractor, and Cube and SSE aimed to inform all residents systematically about the new system. Before

[17] It might seem anomalous that fewer use coping mechanisms when the median spending on energy has risen. The median is what the 'middle person' in the sample spends, and is less susceptible than the mean to extreme variations around the mean, which are considerable (see Table 6 and Table 7, p11).

[18] On each occasion, only a single owner (though this was a different respondent at Time 1 and Time 2) did so.

construction commenced, there were some joint SSE/Cube daytime and evening events where the system, tariffs and programme of works were presented. Attendance was encouraged by the offer of entry into a raffle to win Tesco vouchers. A further event was organised at the point when owners were offered Scottish Government funding to cover the costs of connecting to the new heating. Before and during the installation, three visits were made to each house by Cube Project Officers. The first visit informed residents about the new heating, location of radiators and noted any assistance required. Following a letter to notify residents about the date and time when the heating would be installed in their house, the second visit involved project officers organising access for contractors and ensuring that the work proceeded on schedule. The third visit involved the heating switch on and removal of old electric storage heaters. At this point, residents were expected to sign a Heat Supply Agreement with SSE. After the heating had been running for a few months, a fourth visit was offered. This was to answer queries about the system, and provide system use and energy efficiency advice. Help sheets on how to use the programmer, thermostat and TRV's were attached to every HIU. Other detailed printed information was provided by both SSE and Cube, and was adapted over time to answer frequently asked questions.[19]

At the time of our second interviews, a year after the system was commissioned, there were high levels of satisfaction with the effectiveness of the new heating, but some residents struggled with heating controls, understanding the relationship between heating use and cost, and the relationships between meter readings, payments, bills and statements. They expressed a sense of frustration over who to approach with queries in order to get consistent and reliable information. This extended to a sense of grievance among some tenants who felt they had been pressured into accepting the system on a tight timetable, generating criticism about a perceived lack of interest by both Housing Association and utility, and the perception that the estate housing office was unsupportive. There was also a sense among some residents that Cube and SSE had lacked confidence or full control, and some reported that they felt like subjects in an 'experiment' which they had not consented to take part in.

Evidence from Housing Association Fuel Adviser records, during the period March 2013-September 2014, indicates that approximately 10% of households were experiencing difficulties with the new heating and its costs; some of these also found the utility call centre system and fault reporting hard to manage, and some did not trust the accuracy of bills. In our

[19] A selection of these documents can be found at www.heatandthecity.org.uk/wyndford

sample, 18% of tenants said the heating controls were not easy enough to understand, and 30% said they had not received any information or support. Just under half said they had received *'a little'* and 2 in 10 said they had received *'a lot'*. Owners were more likely to say they had received neither information nor support (4 in 10), although again 2 in 10 said they had received *'a lot'*. Some perceived that information from SSE was insufficient; others reported being visited by SSE to explain queries about bills. Both tenants and owners reported discussing the new heating with family and friends, suggesting that they relied on informal networks as much as they did on 'formal' ones such as letters from, or meetings organised by, SSE or Cube HA.

The sense of grievance expressed by some seems likely to be related to the time pressure under which the system was installed. In order to qualify for a financial contribution to system costs, which Cube needed in order to proceed with the heating upgrade, the project had to meet a December 2012 deadline imposed by UK Government under the Community Energy Saving Programme (CESP). This created a very tight timescale for the Housing Association and contractors, and imposed a strict schedule of work. In a wider sense, it is also likely to be related to people's life circumstances and experiences of struggling to get by, possibly intensified by having to manage more complex energy bills.

Understanding how to use the new heating

Most tenants and owners expressed high levels of satisfaction with the size and position of radiators and levels of warmth, but less satisfaction with the heating programmer. Eighty five per cent of tenants, and seventy per cent of owners said they did not use the programmer to set the on/off timings in advance, and almost half (46 per cent of tenants and 49 per cent of owners) did not use the radiator valves to set the temperature of radiators.

Qualitative evidence gathered during interviews further confirmed a frequent lack of understanding in how to manage heating settings. This limited understanding was associated with perceived lack of information and support: residents saying they received no information and support were *less* likely to use the programmer to set the on/off timings in advance, and *were less likely* to use the radiator valves to control the heating. The following were common difficulties:

1. Some residents found the heating controls too complicated, and/or learnt to use the heating by 'trial and error'. Others relied on friends and neighbours for help, or contacted SSE and Cube HA. Only one resident explicitly mentioned using the heating manual.

2. Conflicting information about how to set the heating was sometimes provided by different sources, at different times.
3. In some instances, residents reported that someone had programmed the heating settings for them (for example contractors, a Cube Adviser or SSE employee) leading to reluctance to adjust the heating themselves; this may lead to unintended over- or under-use of heating.
4. The most frequently reported method of overcoming the perceived complexity of controls was to use the wall thermostat, turning the dial up until the heating 'clicked' on. Those using the wall thermostat, rather than the programmer, were often unable to achieve the control they desired, with many reporting that the thermostat did not seem to work properly, because radiators cooled down before the householder achieved the desired level of warmth.

Understanding the connection between heat used & price paid

In households where there was evidence of confusion about how to manage heating costs, two factors seemed important: misunderstanding of the constant-rate payment meter system and a perceived lack of clear, regular bills. The constant-rate payment meter system was intended to spread spending evenly over a year, enabling residents to budget by making the same regular payment. This appears however to be a source of confusion about the relationship between heat use, and its variable costs and standing charges. As a result some remain unsure about the link between how much heating and hot water they are using and how much it costs. SSE provides users with various forms of feedback, including quarterly or half-yearly bills for credit meter users, and periodic statements and advice notices for constant rate payment meter users. Initially constant-rate payment meter users only received statements annually, but in response to the considerable variation in users' consumption levels SSE has started issuing quarterly advice letters indicating the relationship between their weekly payments and heat consumption, and advising whether the weekly payment rate may need to be altered.

Those on pre-payment electricity meters at Time 1 were accustomed to controlling their spending by checking the meter balance, and topping up when they could afford to. Those using constant-rate payment heat meters are no longer able to use the meter balance to find out how much they are spending on heating and hot water at the time. Some residents expressed concern over meters drawing off payments when the heating was off; some did not purchase meter credits during the summer months, or after being away, and thus accrued unpaid 'debt'. Residents also sometimes attributed such debt to standing charges. Some

residents (18 per cent) also reported that they had not received regular bills or statements, or had received incorrect bills, and as a result were unsure if they were in credit or in debt.

Effects of New Heating on Health and Well-being

Given the interest in measuring the health and well-being effects of improving warmth in houses, notably in cold and damp climates with high rates of respiratory complaints, we collected information on self-reported health at Time 1 and Time 2 to see what, if any, change there had been. In terms of the reported incidences of colds and flu symptoms, or visits to GP clinics or hospital outpatient departments, there is no strong evidence of improvement, at least in the short term, although we observed a moderate tendency for owners to report fewer episodes of colds and flu since installation. Data on health at Time 1 had shown relatively low levels of respiratory ailments[20], but high levels of reported serious illness or disability (51 per cent of tenants, and 58 per cent of owners); at Time 2 rates were broadly comparable (respectively, 58 per cent, and 42 per cent). Most tenants and owners also reported high levels of use of prescribed medication (around three-quarters) on both occasions.

Will the new heating system, and warmer houses, make an appreciable change to people's health? Certainly, a one-year time period is too short to assess this, nor does it take into account exogenous effects such as the ageing process and the concomitant deterioration in health. Nevertheless, given that most people report considerable improvements in standards of warmth, improvements in feelings of well-being and generic health are possible although it is too soon to tell what direct effect these will have on serious illnesses.

Community and Social Life on the Estate

When we carried out the first round of interviews in late 2012, we noted that many residents had strong kinship and friendship patterns on the estate, although a significant proportion also expressed the desire to move house; in the second round of interviews, we addressed these issues more systematically.

What effects, if any, have the new heating and estate improvements had on residents' desire to move house? At Time 1, most tenants (56 per cent) said they would like to move, and at Time 2 this was still high (51 per cent). Owners gave comparable responses (52 per cent at

[20] Of owners reporting the following conditions at Time 1, the number saying they no longer do so at Time 2 are as follows: asthma: 4 out of 6; nasal allergies: 3 out of 4; shortage of breath: 4 out of 9; tightness in the chest: 4 out of 7. We take these improvements in respiratory conditions as illustrative rather than definitive over the period.

Time 1 and 42 per cent at Time 2) but in both cases this had more to do with finding a house that would be more in keeping with people's needs (for example, one which was a different size, with a garden or in sheltered housing), than in major disaffection with the estate, although some wanted to move to escape the area. When asked whether they would like specific work to be done on the estate, *'improving community amenities'* had the support of 1 in 5 tenants and owners, and *'improving the physical fabric'* of the estate had particular support from owners (32 per cent) but also from tenants (17 per cent).

We also asked on both occasions about other people coming to visit[21], and whether residents thought people had been deterred from visiting because the house was cold. For both tenants and owners there was no major change in patterns of visits before and after installation. For example, those with few visitors at Time 1 continued to have few at Time 2, and those with many (defined in the survey as six or more visits in a fortnight) at the other end of the scale continued to have the same number. Nevertheless, both tenants and owners reported a fall in the number of visits deterred by cold housing (for tenants, from 22 per cent to 8 per cent; and for owners, from 12 per cent to 3 per cent). Of the 17 tenants who reported at Time 1 that people were put off visiting by the cold, only 3 did so at Time 2, and for owners, all 5 who reported that people were put off at Time 1 said no-one was at Time 2. We conclude that improving the warmth is likely to have had a modest effect on people's patterns of home sociability.

Both tenants and owners reported that they have friends and/or family on the estate (75 per cent, and 90 per cent respectively) and that they see them daily or weekly; just under half claim to know their immediate neighbours *'very'* or *'quite well'*, even though social interaction is largely confined to taking in post or parcels in their neighbour's absence; and while few tenants or owners are active members of local associations, there is a general commitment to Wyndford reflected in the length of time many have lived there (for tenants, a median of 12 years; and for owners, over 40 years). At Time 1, 44 residents said they wanted to move out of their flat to *'escape the area'* (in our post-code category). Of those we spoke to again at Time 2, of the 21 who had said that they wanted to escape the area at Time 1, only 9 said so at Time 2. The new heating and related improvements hence seem to be associated

[21] We asked: *'How many times have you been visited by family or friends at home in the past two weeks?'*; and *'During the past year, have family/friends not come to see you because of poor housing conditions such as dampness or cold?'*.

with improved attitudes to the estate. This is confirmed by the fact that the majority welcome the new heating and would recommend it to others. Owners were the most positive (with 90 per cent saying they would recommend the new system to family or friends), and tenants split 2 to 1 in favour.

Linked to a strong sense of 'home' and personal security among both tenants and owners, this suggests that improving the heating system does not simply add to people's personal warmth and comfort, but contributes to the levels of 'community capital' on a fairly typical urban housing estate in central Scotland.

LESSONS FOR POLICY AND PRACTICE

1. Gaining the active consent and agreement of households to renovation of heating is critical to the subsequent ease of operation and management of the scheme and payment of heating bills. In this case, the tight timetable, created by government funding deadlines under the Community Energy Saving Programme (now ECO), resulted in significant pressures on all participants. For some residents, the rapidity of the process contributed to scepticism about the attributed benefits of the new heating, confusion about how to get the best from it, and reluctance to accept it. This indicates the central importance, and value, of early, systematic, and on-going face to face engagement with the community of users by both RSL and energy supplier. In low income households, some of whom have no prior experience of central heating systems, such engagement needs to be customised to the financial situation and composition of the household and the differences between their existing heating, its controls, metering and price, and the new system. In other cases, detailed one-to-one discussions before the project is fully specified have been valuable in adapting the business model to the characteristics of the local households, and ensuring their understanding of the process, and heating costs and benefits. Active consent may for example be secured by asking each household to sign a letter of agreement to the installation of the new heating, regardless of whether consent to such improvements is already part of the tenancy agreement.
2. At government level, the need for rigid funding deadlines for energy efficiency and related housing improvements, under schemes such as ECO, should be reviewed in relation to the demands of complex housing retrofit programmes.

3. The diverse, and sometimes haphazard, ways in which some residents reported using the heating controls indicates the need for considerable, on-going, support in relation to using the heating, setting the programmer and understanding the metering and payment system. The design and dissemination of information needs to be geared to type of user to enable all to be in control of their heating, without paying more than they need to. A 'single point of contact' for information and advice about the system may help avoid the perception that different parties say different things. Standardising the terminology used to describe the heating system may also be helpful. For example in this case, heat meters were variously described as key meters, prepayment meters, dry meters, credit meters and there was an additional meter, described as the Sharkey, which records actual heat used. The heating and hot water supply was sometimes referred to as 'CHP' and sometimes as heating; heat bills carried the header 'your energy bill', the HIU was sometimes described as 'the boiler', and some residents could apply for a Warm Homes Discount, but any payment was made via their electricity (not their heating) supplier.
4. Heat metering and billing need to be simple and transparent. In this case, residents had a heat payment meter, which did not show real time consumption, and a separate heat use recorder/meter, which seems to have been installed inside the HIU, and hence not immediately accessible to users. Hence the link between meter payments and heat use was indirect. Residents may unknowingly run up debt, especially if they have previously been able to see immediately the financial consequences of their energy consumption via a prepayment meter, and then transfer to a system where this link becomes apparent only over a longer period. Steps need to be taken during the very early stages to inform and advise customers on how to match their use of heating to what they are willing and able to pay for it. Cube HA commented that a heat meter able to provide real time feedback on heat use and cost would have been preferable.
5. The RSL, energy supplier and all subcontractors need to be confident and consistent in how they explain the new system, metering, billing and credit/debit payment arrangements, and the structure of tariffs and tariff review. The tight timescales for development of the Wyndford scheme, a consequence of the external funding deadlines, meant there was little time once agreement had been struck to discuss details with residents.
6. RSLs could recruit and work with properly supported 'local ambassadors' who are using the heating effectively; such ambassadors could work with other similar

households until all have a shared level of understanding. In this case, following the installation and first few months of operation of the new heating, Cube HA recruited a full time fuel adviser who worked with households on request, sought contact with high users to ensure that they understood their pattern of use, and visited residents with increasing fuel debts. The Adviser worked as an intermediary between residents and heat and electricity utilities, resolving difficulties, clarifying bills, advising low heat users about the availability of the revised tariff for low use, negotiating payment plans for debt reduction, and managing fault reporting and repairs.

7. Heat tariffs, and the structure of the tariff in relation to fixed and variable charges, play a crucial role in setting overall costs, and in the distribution of costs across households using different amounts of heat. Various approaches can be taken to reducing the heat tariff, both by heat network developers and by local, devolved and state governments. These include lowering the cost of capital (for example, through underwriting schemes), shaping the configuration of networks to ensure that efficient use of the infrastructure is maximised (for example, by using local planning policies to require neighbouring new developments and regeneration areas to connect to available heat networks), and using a business structure designed to protect the affordability of heat for low income households by minimising their contribution to infrastructure costs. In this case Cube HA are proceeding with a second district heating scheme, but this time will operate the scheme in-house and take responsibility for billing, payment collection and debt risk. They may subcontract elements of business operation, but will retain overall control. They aim to make heating costs as affordable as possible for residents.

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APPENDIX

Cameos of Different Heating Practices

This section describes common patterns of heating use and gives composite examples of 'typical' households.

Heat savers

Residents who ration heat use. This may be because of other commitments or preference (for example they may be out at work for much of the time or may prefer a cool house) or because of personal circumstances – they may be unable to afford the cost of energy on a low income. Some also ration heat use early on after district heating has been installed for fear of running up large bills (especially if they are elderly and/or on a tight budget) and have since begun to use more heating. A small proportion intentionally ration their use of heating, because they object to its installation. They are often disillusioned with the energy company and/or housing association and have 'self-disconnected' by switching the heating off or refusing to add credit to the meter (resulting, after a time, in disconnection). They use electric heaters and boiling water from a kettle.

Example 1:

- Kevin lives in a one bedroom flat. He uses very little heating, and is out of the house most of the time; he works shifts and often visits elderly relatives in the afternoon and at weekends. He showers rather than running a bath. He is happy with the new heating system, feels the house is a lot warmer than before, and is pleased with the hot water, which has good pressure and warms up quickly when he gets in from work.

Heat seekers

Residents who are use the heating as much as they need to achieve the thermal comfort they desire. The new heating distributes heat effectively and their houses are, for the first time, *"warm and cosy"*. Generally these residents are happy with the new system and it has made a considerable difference to their sense of well-being. If their homes suffered from damp, this has reduced or ended. They may have used the old electric heating extensively but were never very warm; or they may not have used the old heating and lived in a cold (often described as *"freezing"*) house. Their energy bills will have risen if they were using very little or no electric heating beforehand, or fallen if they were using their electric heating but were cold in the past.

Example 2:

- Amanda and John live in a two bedroom flat with their two small children. The flat suffered from damp, and used to be very cold and draughty. The single storage heater was ineffective and three halogen heaters were moved around the flat between the living room and bedrooms. When it was especially cold they would all sleep in the same room to keep warm. Now the flat is much warmer and the damp has receded. The heating is on quite a bit so that it is warm when the children are at home and so they can sleep in their own bedroom. They are very pleased with the new heating, because they can use it for longer and actually get the house warm, whilst it costs less than before. The new windows and the cladding have also made the flat warmer and it is less draughty.

Confused users

Residents who are unsure how to operate and control the new heating system. As a result it is often too warm or too cold either throughout the house or in particular rooms. Someone else has often set their heating and/or they have been given confusing information on how to use the system. They lack confidence in using the heating controls and may resort to operating the heating by turning the wall thermostat right the way up/down to get more or less heat. In addition, windows may be opened instead of adjusting the wall or radiator thermostats and/or the heating timings. They may be unsure how much their heating and hot water is costing. If they have a constant-rate payment meter, they often do not understand why the balance shown on the meter is reducing when the heating is off.

Example 3:

- Anna is a pensioner and lives in a maisonette. She was in and out of hospital during the installation work and missed going to meetings about the heating. Someone set the heating for her around the time it was installed and she has not changed the settings. Anna uses the thermostat if it is too warm or cold in the house, but is not sure how to change the timings or temperature of the heating. Her neighbour told her to turn the radiator down in the spare bedroom. Anna's energy bills are paid by direct debit from her bank account but she is not sure how much each payment is; she does not know whether her account is in credit or debit. She did have a letter from the energy company, but thinks she threw it away by mistake, and has not had any further letter, bill or statement.

Vulnerable individuals

Residents who for a variety of reasons (such as learning difficulties or health conditions) are uncertain about how the heating system works. They may have difficulty in understanding information about the heating. Those with support (from family, friends, professionals) often have help in explaining information, setting heating controls and paying energy bills. Those who have had changes to income (through redundancy, bereavement, or benefits) may find it hard to cover their living costs, including energy bills.

Example 4:

- Glenn lives alone in a flat. He has been having problems with the heating, particularly the living room radiator, but finds the hot water is fine. He is confused about how the heating works and unsure how to change the settings. Glenn's support worker helps him to manage his finances since his benefits were reviewed, and helps arrange to pay his energy bills. He had letters about the heating but he was unsure what they meant and did not keep them to show to anyone. He was unaware of any meetings about the heating that he could have gone to.

BRINGING WARMTH TO WYNDFORD: DOES THE NEW DISTRICT HEATING SYSTEM MAKE A DIFFERENCE?

Survey of Housing Tenants and Owner Occupiers, Winter 2012 and Winter 2013/2014

David McCrone, David Hawkey, Margaret Tingey and Janette Webb
University of Edinburgh

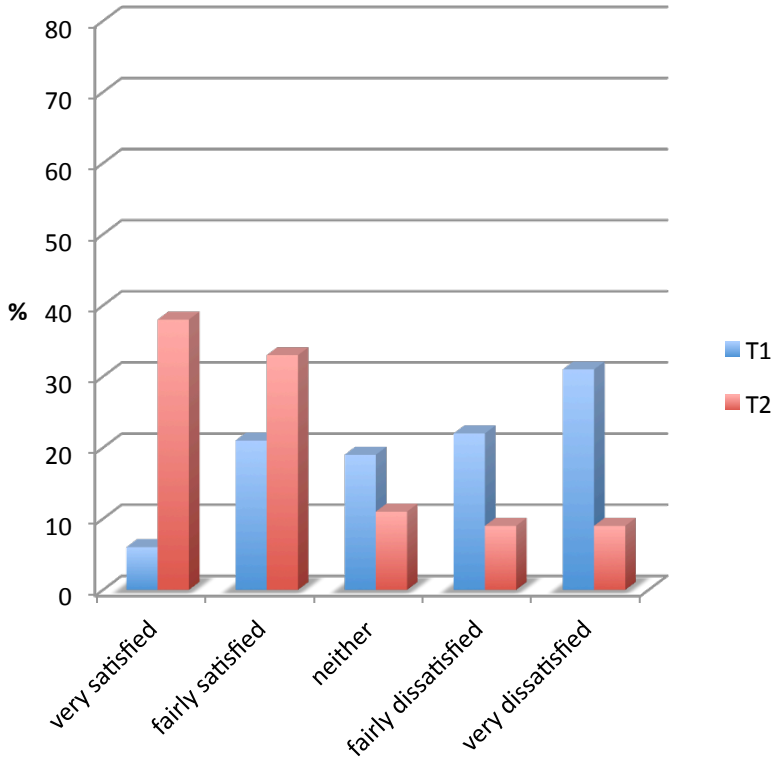
What people said about the heating at Wyndford

the old electric heating

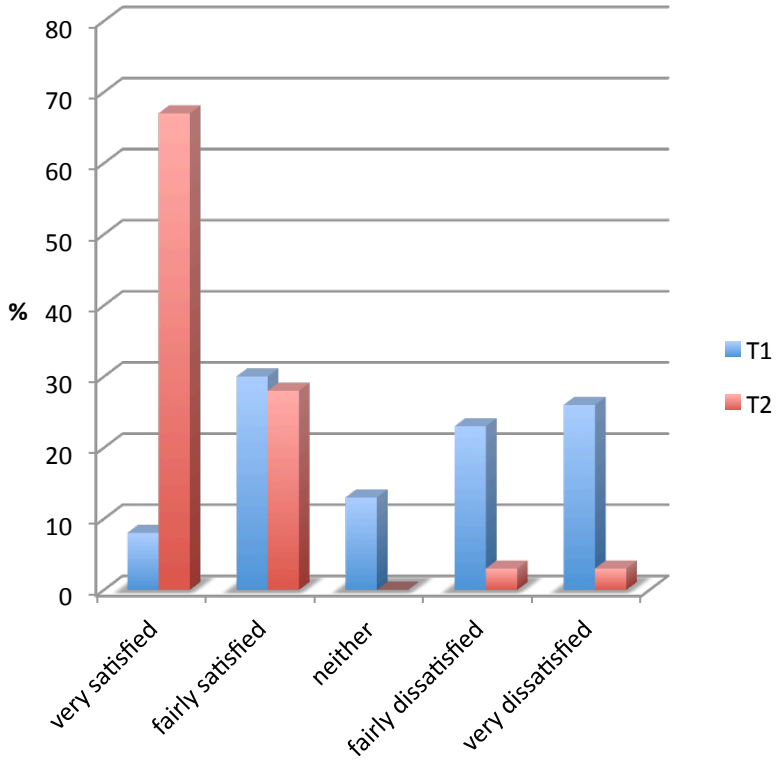
the new district heating

Heating satisfaction

Tenants at T1 & T2

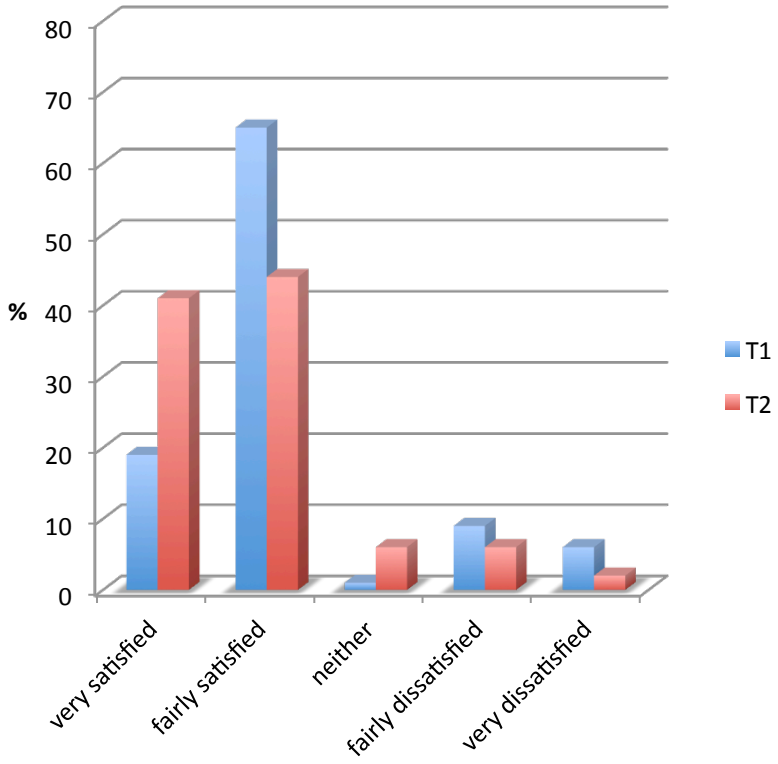


Owners at T1 & T2

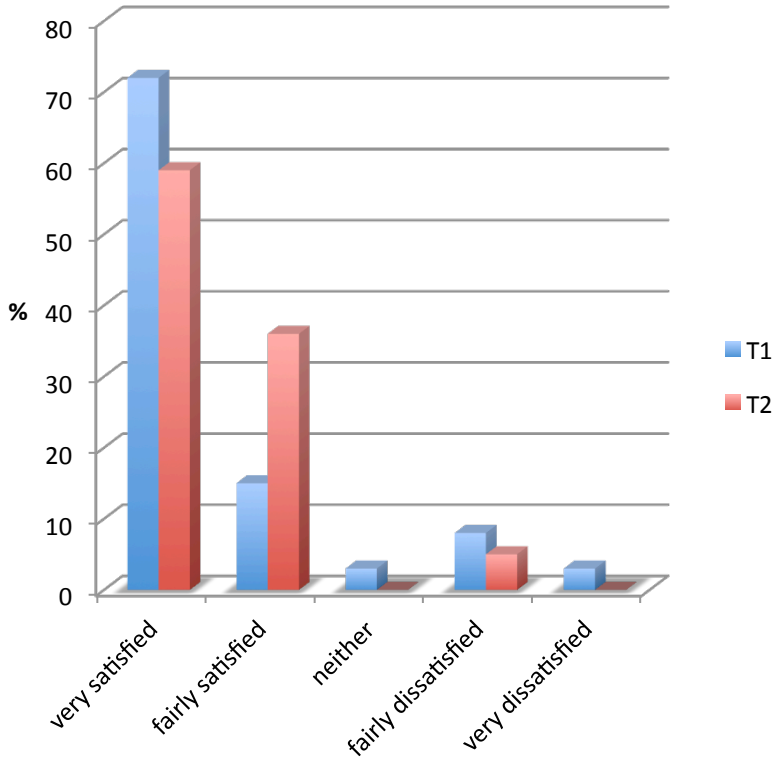


Housing satisfaction

Tenants at T1 & T2

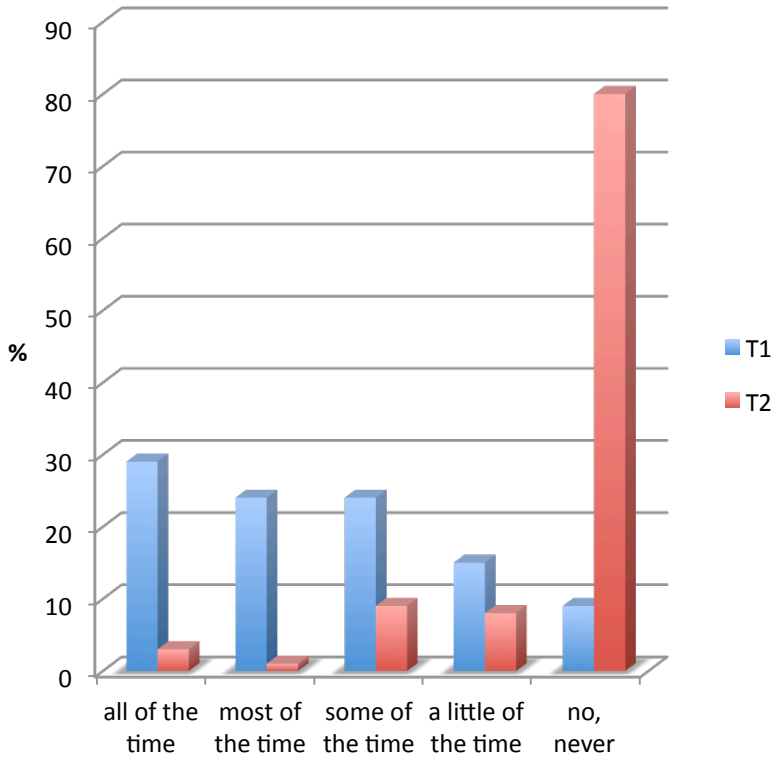


Owners at T1 & T2

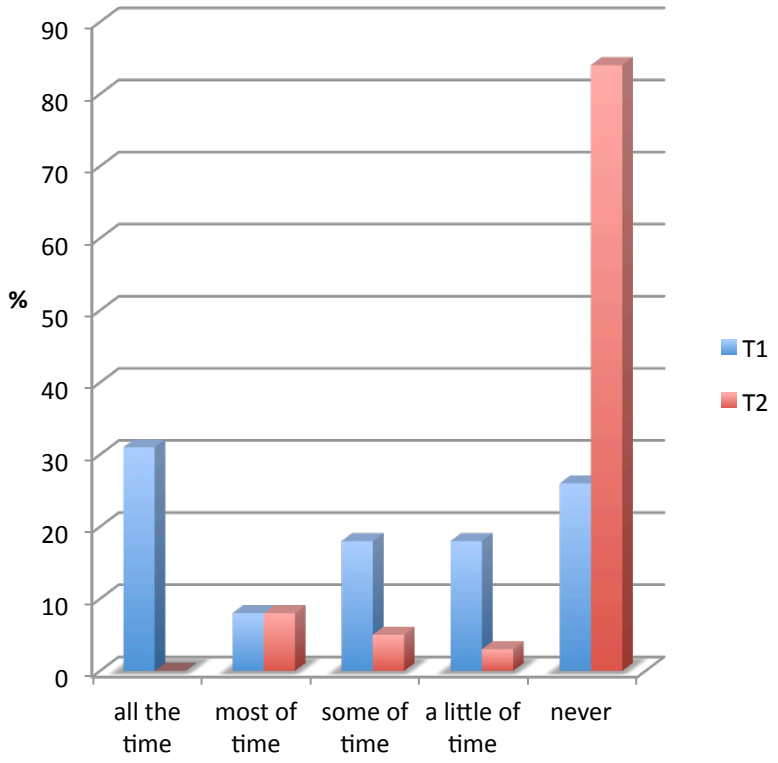


Were there times last winter when your home was too cold?

Tenants at T1 & T2

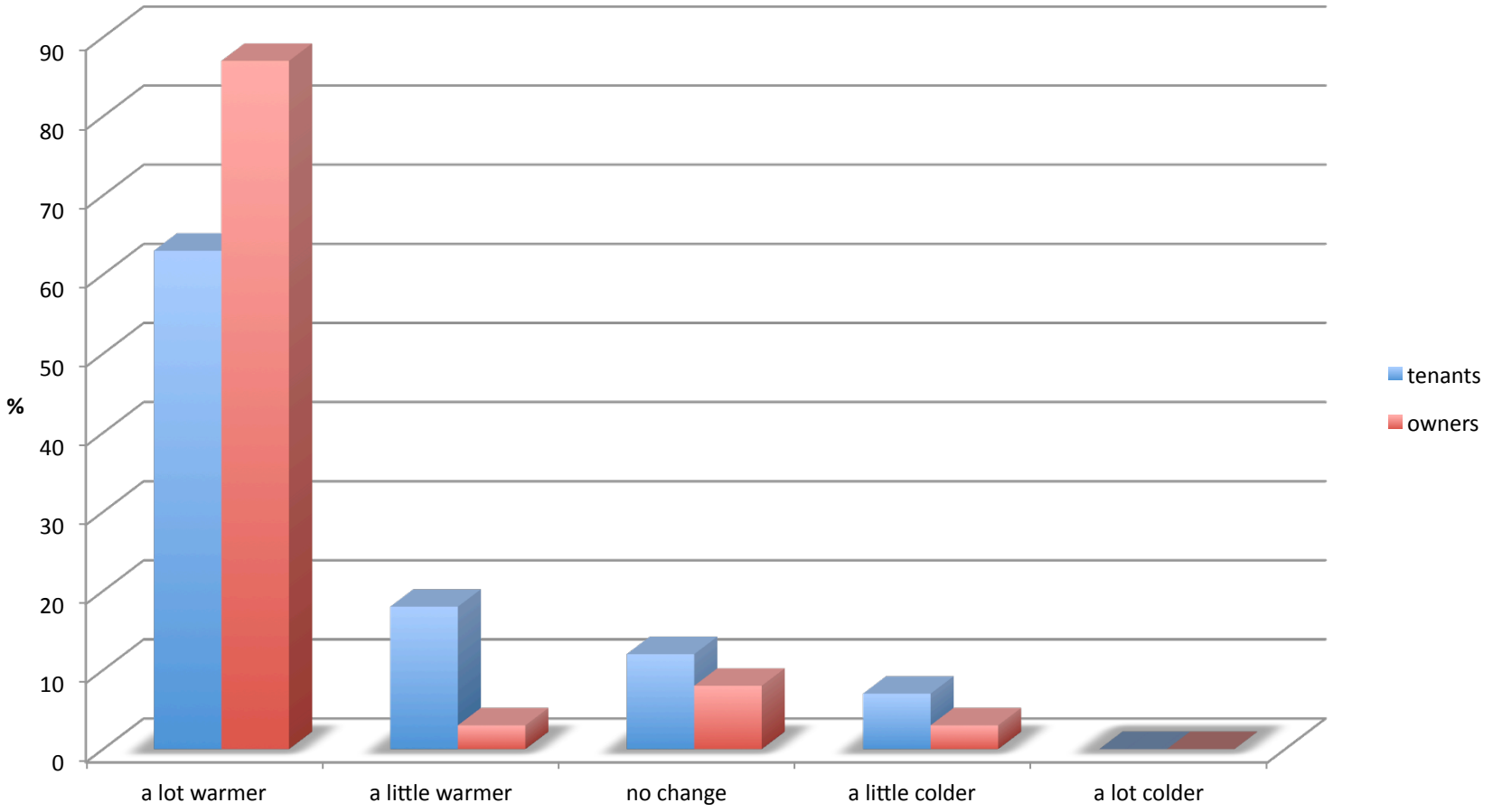


Owners at T1 & T2

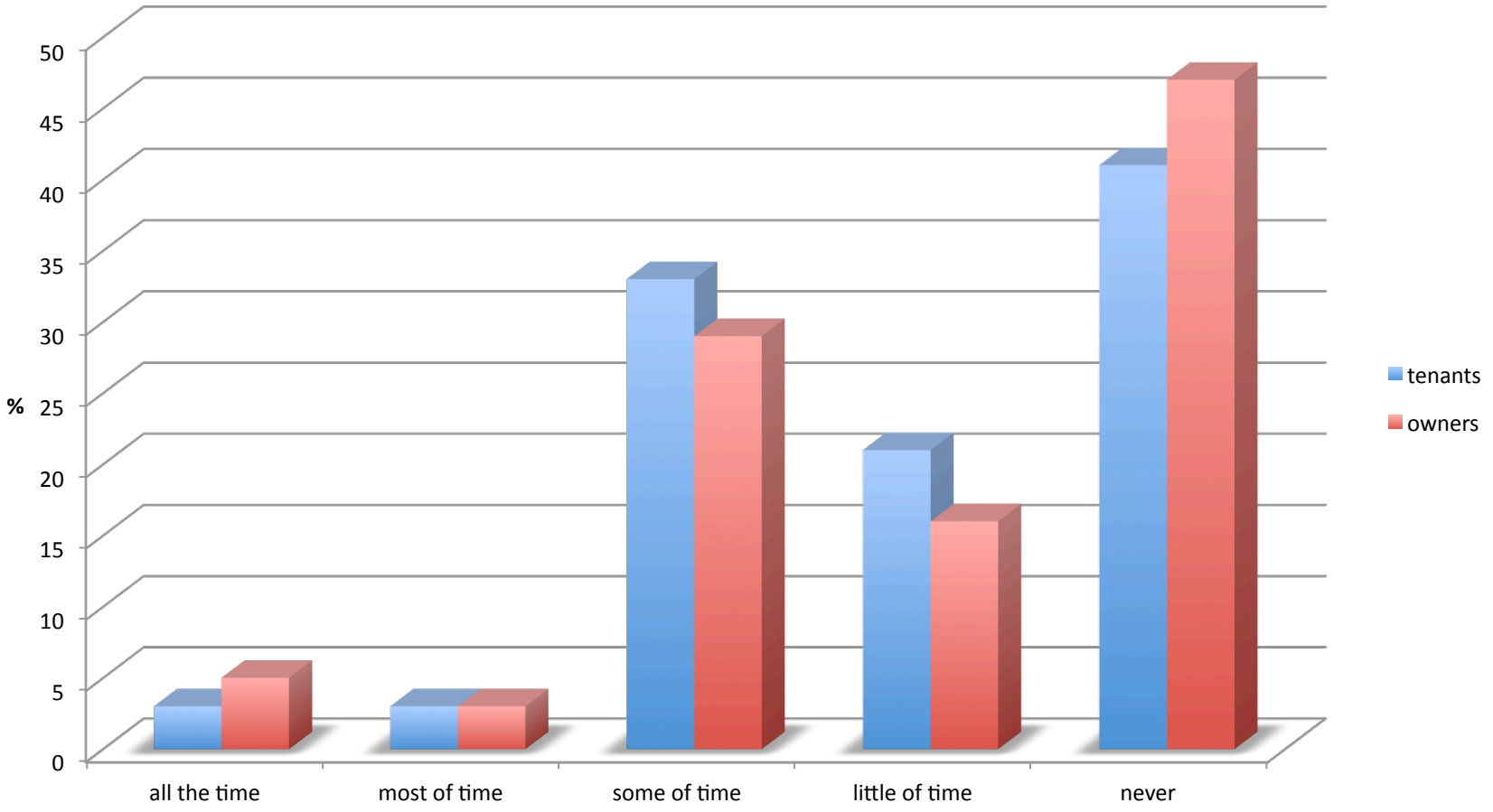


HEAT and the CITY

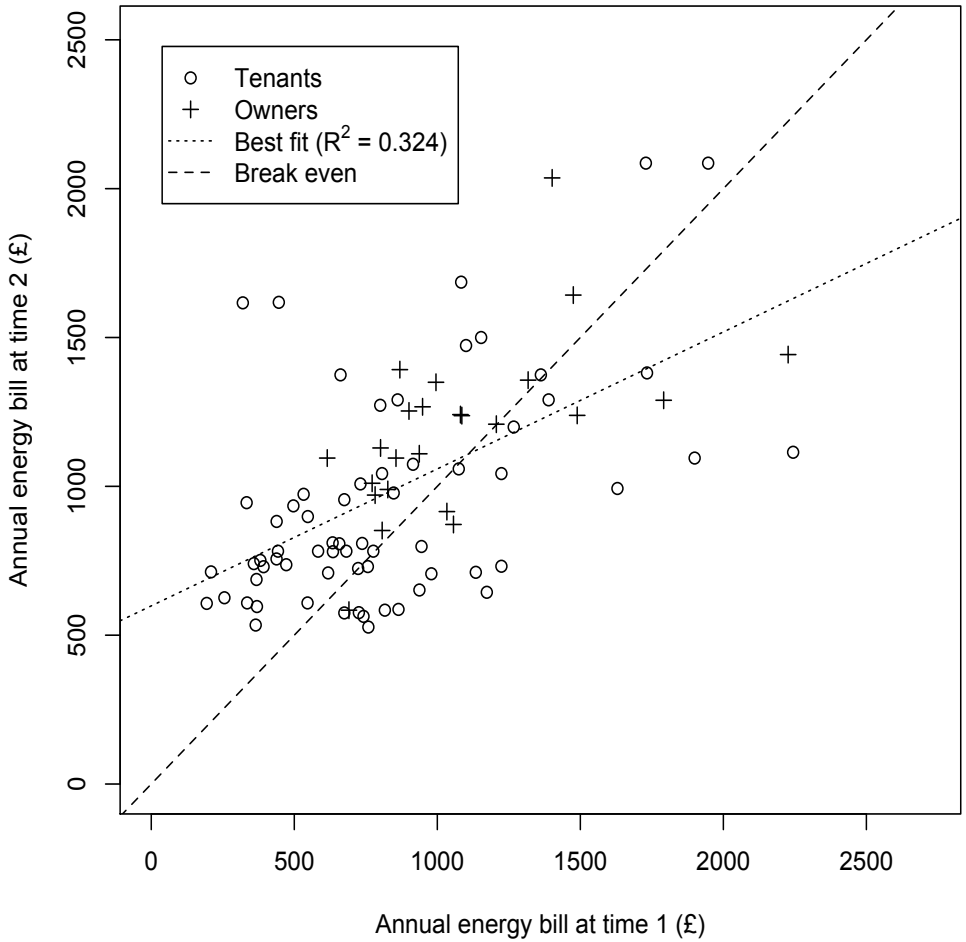
Households saying home was warmer or colder since new heating



Households saying home was too warm with new system

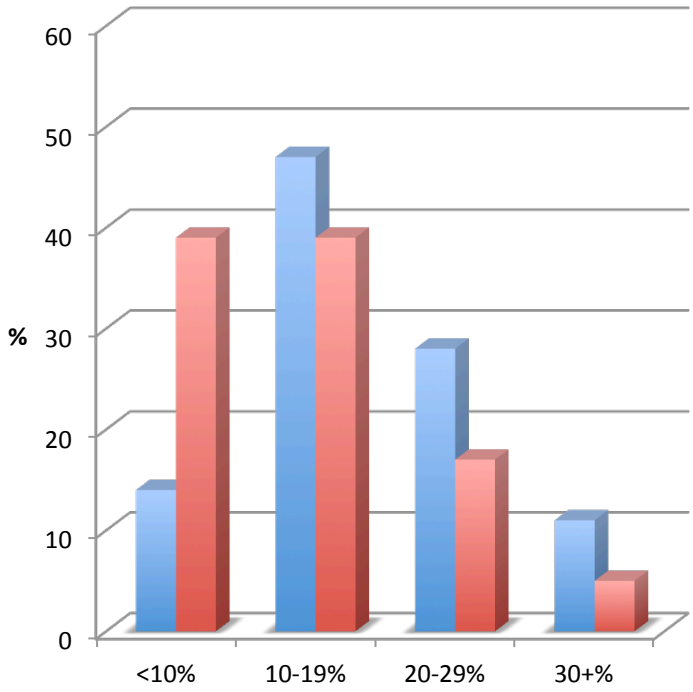


Estimated energy bills at T1 & T2 for tenants and owners

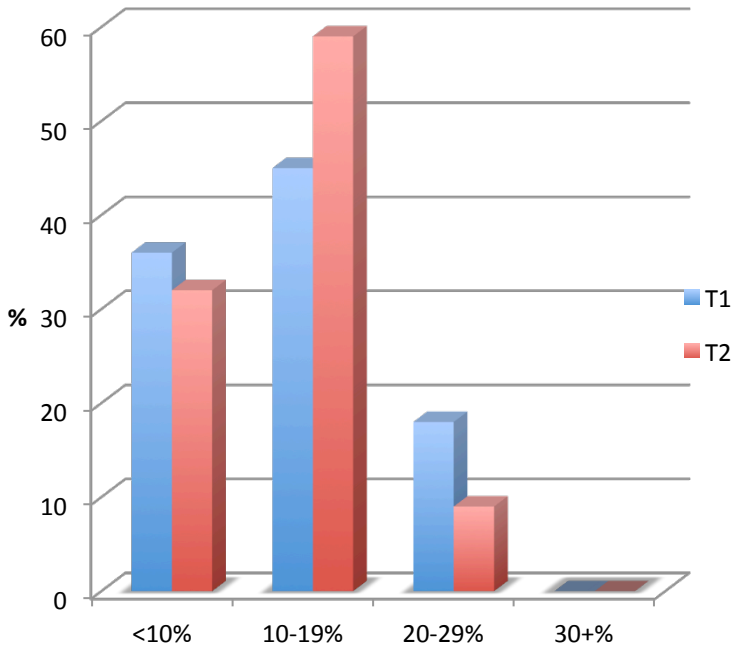


Estimated % of household income spent on energy at T1 & T2

Tenants at T1 & T2



Owners at T1 & T2

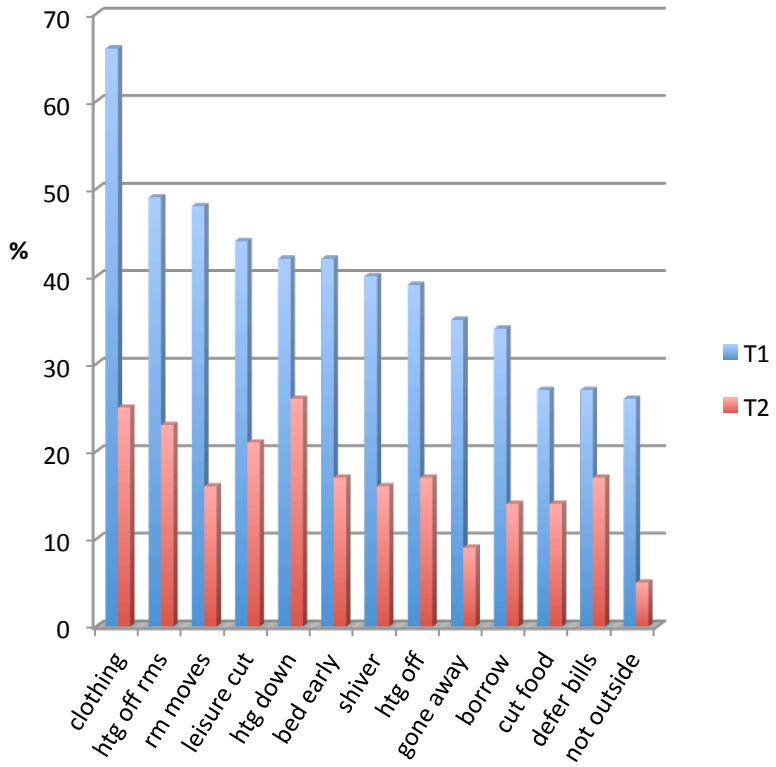


Estimated annual energy bills pre- and post-installation (medians)

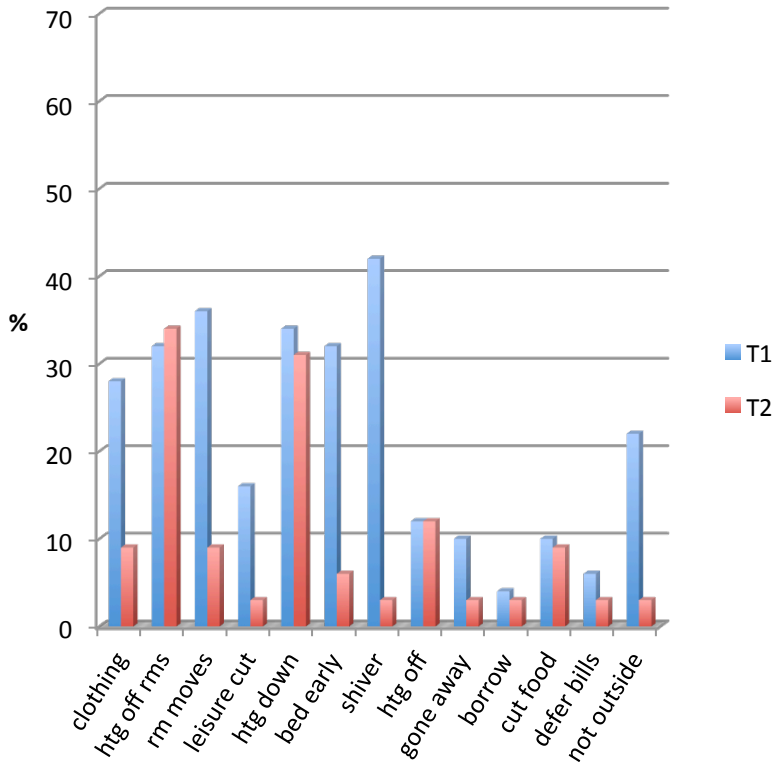
	change T1 to T2	Assuming T2 electricity prices at T1
tenants	£731 to £790 (+8%)	£863 to £790 (-8%)
owners	£1082 to £1238 (+14%)	£1123 to £1238 (+10%)

Coping with cold

Tenants at T1 & T2



Owners at T1 & T2



Some inefficiencies

- More than half of residents open the windows when their house is too warm;
- More than three-quarters do not use the programmer to set on/off timings in advance;
- Around half do not use the radiator valves;
- Those saying they have received no information and support are *less* likely to use the programmer and the radiator valves.

Summary points

- Satisfaction with heating for both tenants and owner-occupiers has risen sharply since installation of district heating
- In particular, tenants' satisfaction with their housing has improved considerably
- The overwhelming majority say their homes are warmer now than before
- There has been a dramatic fall in residents' reporting that they felt cold at home during the previous winter
- Far fewer residents, especially tenants, report that they had to use more extreme ways of coping with the cold at home
- While the effective price of warmth has fallen, Wyndford residents have taken these changes as improved thermal comfort rather than bill savings

Summary points

- The new system has resulted in higher bills for residents whose energy consumption prior to the upgrade was low, while residents whose energy consumption was relatively high have seen savings
- There is scope for improving levels of information and support so that residents can use the new heating system more efficiently
- It is too soon to tell whether the improved heating and warmer houses will improve residents' levels of health, although there seems to be modest improvement in reported respiratory conditions
- Residents expressed strong attachments to home and a sense of well-being, and welcomed the investment in heating and improved amenities at Wyndford.