Final Report

Temperature Monitoring: January – July 2008
Lucht LHZ Combination Electric Radiators

prepared by

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1. INTRODUCTION

Alembic Research was commissioned by The Electric Heating Company to monitor the performance of the electric heating systems recently installed in 4 flats in the Motherwell area. These flats each had the Lucht LHZ electric combination radiator system installed by The Electric Heating Company (see Appendix B for more details on these heating systems).

The temperature monitoring equipment was installed in the first 2 flats on January 10th, 2008 and installed in the other 2 on January 24th, 2008. One set of data recorders was removed on July 15th, 2008 (as the householder was going on holiday); this is the only dwelling without a full six month data set. All of the others were removed on July 23, 2008.

This report represents the final report, presenting the combined results for these 4 dwellings for the period monitored between January and July 2008.

2. METHODOLOGY

The 4 flats being monitored were selected by The Electric Heating Company and North Lanarkshire Council, with the addresses passed to Alembic Research. Alembic Research was commissioned to install, collect and analyze the temperature data. In addition, Alembic Research also carried out a SAP 2005 energy audit assessment of each of the properties involved in the project using the NHER Plan Assessor (version 3.1) computer program[1].

Gemini temperature data recorders (i.e. Tinytag Ultras) were installed in each of the 4 dwellings: 2 were installed on January 10th, 2008, and the other 2 on January 24th, 2008. Data from the first day of the monitoring period was ultimately discarded to allow the recorders to become acclimatised to the room being monitored. In 3 of the dwellings, all of which were 2-bedroom flats, room temperatures were monitored in all 6 rooms. The 4th dwelling was only a one-bedroom flat, with only 5 rooms monitored. All of the data recorders were downloaded in March, in May and for the final time in July 2008. This collected information was combined for this final report.

The temperatures recorded for every dwelling included:

- the main living room
- the bedrooms
- the hallway
- kitchen
- bathrooms

External air temperatures were recorded on the different sites as well. All of the data recorders were set to log the respective room or external air temperature every thirty minutes.

A complete data set is available for all 4 dwellings.

[1] Earlier versions of SAP programs would not be able to assess these direct electric radiators charged on an off-peak tariff as these heating systems were not included in the heating systems available.

The information on the data loggers was downloaded from each of the data recorders using Gemini Data Logger Tinytag Explorer software (version 4.6.95). This software allowed individual data files from a dwelling to be combined with the external air temperature data and the results graphed. The information was then exported into an Excel spreadsheet to enable further graphing and analysis of the data. The results from this analysis form the basis of this report.

When the dwellings were visited to install, and subsequently to check or download the temperature recorders, the electricity meters were also read. Additionally, an attempt was made to obtain a meter reading by contacting each of the householders each week at roughly the same time by telephone. The results of the meter reading exercise are also presented in this report. Additionally, a representative of The Electric Heating Company also made regular visits to the flats, and took meter readings which were made available to Alembic Research.

3. MONITORING RESULTS

The information from the temperature monitoring was organized to produce a variety of graphs for each dwelling.

A **temperature profile** was produced for each dwelling showing all of the temperatures monitored in the dwelling as well as the external air temperature on a weekly basis for the whole of the monitoring period. These are the actual temperatures recorded by the data loggers. This information was then disaggregated on a room by room basis, with a single graph for each of the individual rooms monitored in the respective dwellings for the whole of the monitoring period (26 to 28 weeks, depending on when the data loggers were installed and removed).

In the tables accompanying these graphs, the temperature information sets out the average (mean) air temperatures and the minimum and maximum air temperatures recorded in each of the rooms and the external temperature, for each room on a weekly basis, as well as an overall summary for the dwelling.

The temperature profiles may display different features depending on the heating and insulation characteristics of the dwelling, and the use of heating by the occupants. For example:

- room temperatures in badly insulated, poorly heated houses (for example, the heating being switched off in the room) are generally low, and follow closely the changes in the external air temperature
- in well-heated but badly insulated properties, a rapid fall off in the room temperatures occurs when the heating is switched off;
- temperatures in dwellings with uncontrolled heating will show sudden, steep increases in the recorded temperatures, sometimes to very high levels;

- where such dwellings are badly insulated, there will be just as sudden, sharp falls in the recorded temperatures when the heating is switched off or left to die out (referred to here as spiking);

- temperatures in dwellings with controlled heating (such as TRVs or a room thermostat) will show more rounded profiles, without the extreme highs;
- room temperatures in well-insulated, well-heated dwellings with well controlled heating systems will show a fairly steady temperature profile, without extreme highs or lows, and with more-rounded temperature traces. When the heating is on, it will compensate for falling external temperatures by putting out more heat; when it is off, the insulation will retain heat within the property.

A scatter graph was produced for each of the rooms monitored to demonstrate the **response** of the room temperatures to changes in the external temperature over the monitoring period. A 'best fit line' for each of the three rooms monitored was calculated and is shown on the graph. These graphs are supplemented by information in the accompanying tables on the coefficient of determination (known as r^2) and the 'slope' of the graph.

The r^2 value tells us how closely the independent (i.e. the external temperature) and dependent variables (i.e. the room temperatures) are correlated – that is, how much variation in the room temperature is explained by variation in the external temperature. The value of r^2 is between 0 and 1. The closer the r^2 value is to 1, the more closely the change in the room temperature is accounted for by changes in the external temperature. At an r^2 value of 1, the best fit line would be a line sloping downwards at 45 degrees from left to right in these graphs.

The "slope" of the best fit line is also provided. This provides an indication of the average the change in the internal room temperature for a 1^{o}C change in the external temperature. In a few dwellings, the slope is negative. That is, on average the room temperature rises as it gets colder.

Finally, bar charts were produced to demonstrate the **frequency distribution of the temperatures** for each of the rooms monitored across the whole of the monitoring period. The bar charts indicate the percentage of the total readings recorded from 15^{o}C or less, to greater than 25^{o}C. Some dwellings and some rooms within them are certainly much warmer than others are. Conversely, some are colder.

Finally, information is provided on the electricity meter readings and the cost of consumption over the period monitored. **The total fuel costs (this includes ALL consumption in the home, that is, cooking and appliance use as well as space and water heating)** are broken down in two ways:

- first, by dividing the total fuel cost by total consumption to calculate the average cost of a kWh taking account of overall consumption on both the high and the low rate (the prices used are set out in Appendix 1)
- second, dividing the total fuel cost by the number of days to calculate the average cost per day

Additionally, a table summarizing the meter readings and the costs of consumption for each dwelling a weekly basis for the whole of the monitoring period was produced. Where there was a gap of more than a week between meter readings (for example, because of a household going on holiday or for other reasons) the consumption and costs were averaged.

The prices used are set out in Appendix A. The E10 tariff prices increased in April 2008. These price rises are factored into the calculation of the fuel costs for each dwelling.

From this information, a mean total weekly fuel cost for each dwelling was produced, as well as an average unit cost of electricity was produced.

A summary of the results are set out for each dwelling are set out in the next section of the main report. The full range of graphs and tables are set out in the annex to the main report.

A commentary on the monitoring results has been produced for each dwelling. This commentary highlights the essential features arising from the monitoring, or any additional circumstances to be taken into consideration (where such considerations are known to the monitoring team).

As well as discussing the monitoring results, the commentary includes a classification of the 'level of comfort' achieved for each room on a monthly basis, and for each room and the whole dwelling for the whole of the monitoring period using a colour coded 5-point scale (see Table 1).

Table 1: 5-point Comfort Scale

5-point scale	Average temperature range
Hot	**More than 23°C**
Warm	**From 22°C up to and including 23°C**
Comfortable	**From 19°C up to, but less than 22°C**
Cool	**From 16°C up to, but less than 19°C**
Cold	**Less than 16°C on average**

An overall discussion of the results is set out at the end of the main report.

4. DWELLING PERFORMANCE RESULTS

This section presents a short individual summary of each of the 4 dwellings monitored, providing a physical description of the dwelling, its installed heating and insulation characteristics, and other information used in the energy audit calculation. It also presents the SAP 2005 score for the dwelling taking account of the changed heating system.

A summary of the room and whole house temperatures, a summary of the monthly assessment of the comfort conditions in each room, and a summary of the consumption data and calculated fuel costs are also set out.

The full range of temperature graphs and the results are set out in the Annex to the main report.

15 Coursington Tower

House Details

House Type: 4th floor flat
House Age: 1964 - 1974
House Size: lounge, 2 bedrooms, kitchen Bathroom and hall

Total floor area: 68.9 m^2 (internal dimensions)
Exposed perimeter: 22.5m (internal dimensions)
Corridor wall: 1.5m (internal dimensions)

Construction and Insulation Details
Floor construction: non-heat loss floor
Wall construction: system construction
Wall insulation: external cladding: U-value 0.6
Roof insulation: non heat loss roof
Windows: uPVC 6mm double glazing

Space and Water Heating
Before heating upgrade
Primary Space Heating: Electric storage heating with direct acting heaters, manual charge control

After heating upgrade
Primary Space Heating: Direct electric Lucht LHZ combination radiator on E10 tariff, with room thermostat, appliance thermostats and programmers.

Water Heating – Single immersion off peak: 110 litre cylinder with 38 mm spray foam

Location Details

Degree day region:	west of Scotland
Wind speed region:	5.0 m/s
Site Exposure:	urban
Height above sea level:	80 m
Number of sides sheltered:	2
Overshading:	average

Occupancy / Heating Pattern

Occupants: 2 adults
Heating Pattern: whole house heating

SAP 2005 Score

After heating upgrade: Electric Radiators
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Temperature Summary: Overall Summary - January – July 2008

OVERALL	Lounge	bed 1	bed 2	hall	kitchen	bathroom	whole house	external
minimum	13.39	14.24	12.84	15.66	16.24	16.54	12.84	-6.00
maximum	27.58	22.73	22.73	29.45	24.74	23.39	29.45	24.74
mean	**19.27**	**18.51**	**16.98**	**19.06**	**20.54**	**20.23**	**19.10**	8.62

Temperature Comfort Summary – Monthly: January – July 2008

	Lounge	bed 1	bed 2	hall	kitchen	bathroom	whole house	external
January	**19.23**	**17.29**	**14.88**	**19.52**	**20.90**	**21.13**	**18.83**	**4.75**
February	**18.81**	**17.59**	**15.69**	**18.90**	**20.28**	**20.37**	**18.61**	**4.51**
March	**18.99**	**17.80**	**15.86**	**18.71**	**20.43**	**20.78**	**18.76**	**4.45**
April	**18.85**	**17.90**	**16.45**	**18.40**	**19.62**	**20.06**	**18.55**	**6.90**
May	**18.67**	**18.33**	**17.00**	**18.36**	**20.04**	**18.90**	**18.55**	**12.22**
June	**20.20**	**20.66**	**19.49**	**19.85**	**21.35**	**20.28**	**20.31**	**12.63**
July	**20.39**	**19.98**	**19.51**	**20.11**	**21.56**	**20.45**	**20.34**	**15.26**

Consumption and Cost Summary: January – July 2008

SSE E10 Tariff	**kWh**	**Cost**
Normal Rate	2686	£257.03
Low Rate	3111	£174.51
Standing Charge	-	£47.08
Total	5797	£478.61
Average price: pence per kWh (Total Cost ex SC / Total kWh):		**7.444 p / kWh**
Average cost per day (Total Cost / 195 days):		**£2.45 / day**

OVERALL COMMENT on 15 Coursington Tower

Overall, temperatures within this dwelling range from cool to comfortable; with the house just being comfortable with the comfortable range overall across the whole of the monitoring period.

The bedrooms are poorer heated compared to the rest of the house, particularly Bedroom 2 as it falls into the cold range during the period of January to March, and only gets into the comfortable range during June and July. It is likely the heating is not being used in this room. Only the kitchen fell within the comfortable range throughout the whole monitoring period. The lounge and the hall varied between cool and comfortable, but were comfortable overall.

The direct electric heating system appears to be able to deliver very comfortable temperatures even in the coldest weather. Where it appears that the heating was used, temperatures of 20^{o}C and higher were recorded even when the external temperature was below 0^{o}C.

36 Coursington Tower

House Details

House Type: 7th floor flat
House Age: 1964 - 1974
House Size: lounge, 2 bedrooms, kitchen Bathroom and hall

Total floor area: 68.9 m^2 (internal dimensions)
Exposed perimeter: 22.5m (internal dimensions)
Corridor wall: 1.5m (internal dimensions)

Construction and Insulation Details
Floor construction: non-heat loss floor
Wall construction: system construction
Wall insulation: external cladding: U-value 0.6
Roof insulation: non heat loss roof
Windows: uPVC 6mm double glazing

Space and Water Heating
Before heating upgrade
Primary Space Heating: Electric storage heating with direct acting heaters, manual charge control

After heating upgrade
Primary Space Heating: Direct electric Lucht LHZ combination radiator on E10 tariff, with room thermostat, appliance thermostats and programmers.

Water Heating – Single immersion off peak: 110 litre cylinder with 38 mm spray foam

Location Details

Degree day region:	west of Scotland
Wind speed region:	5.0 m/s
Site Exposure:	urban
Height above sea level:	90 m
Number of sides sheltered:	2
Overshading:	above average

Occupancy / Heating Pattern

Occupants: 1 adult
Heating Pattern: whole house heating

SAP 2005 Score

After heating upgrade: Electric Radiators

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Temperature Summary: Overall Summary - January – July 2008

OVERALL	Lounge	bed 1	bed 2	hall	kitchen	bathroom	whole house	external
minimum	18.62	15.09	11.46	17.13	18.02	18.02	11.46	-6.00
maximum	25.78	24.40	28.31	22.40	24.74	23.72	28.31	24.74
mean	**22.25**	**19.41**	**17.91**	**19.93**	**21.09**	**20.87**	**20.24**	8.62

Temperature Comfort Summary – Monthly: January – July 2008

36	Lounge	bed 1	bed 2	hall	kitchen	bathroom	whole house	external
January	**21.91**	**17.81**	**15.23**	**19.50**	**19.87**	**20.85**	**19.20**	**4.75**
February	**21.75**	**17.93**	**15.19**	**19.34**	**20.30**	**20.71**	**19.20**	**4.51**
March	**21.51**	**18.04**	**15.83**	**18.88**	**20.76**	**20.19**	**19.20**	**4.45**
April	**22.11**	**19.56**	**17.88**	**19.74**	**21.14**	**20.73**	**20.19**	**6.90**
May	**22.47**	**20.68**	**20.30**	**20.41**	**21.78**	**20.93**	**21.09**	**12.22**
June	**22.96**	**20.84**	**20.30**	**20.85**	**21.70**	**21.40**	**21.34**	**12.63**
July	**23.20**	**20.87**	**20.37**	**20.90**	**21.90**	**21.40**	**21.44**	**15.26**

Consumption and Cost Summary: January – July 2008

SSE E10 Tariff	**kWh**	**Cost**
Normal Rate	2294	£220.13
Low Rate	2289	£128.23
Standing Charge	-	£47.08
Total	4583	£395.44
Average price: pence per kWh (Total Cost ex SC / Total kWh):		**7.601 p/kWh**
Average cost per day (Total Cost inc SC / 195 days):		**£2.03 / day**

OVERALL COMMENT on 36 Coursington Tower

Overall, the range of room temperatures across this dwelling ranged from cold to warm. The lounge fell within the warm range overall (that is, a mean temperature between 22 and 24 ^{o}C). Bedroom 2 fell within the cool range, with a mean temperature between 16 and 18 ^{o}C, and between January and March was in the cold range (that is, a mean temperature of less than 16^{o}C). However, it is apparent that this household occasionally heats the second bedroom as there is occasional spikes in the room temperature, but this heating is only occasional and only for short periods.

The rest of the rooms were in the comfortable range (that is, mean temperatures of between 19 and 21^{o}C) for the overall monitoring period, with the kitchen and bathroom comfortable across each of the months as well. The main bedroom was only in the cool range between January and March (though comfortable over all), and the hall dropped into the cool range in March 9which was the coldest month on average).

The warmest room on average was the lounge, with the kitchen being the second warmest room.

The direct electric heating system appears to be able to deliver very comfortable temperatures even in the coldest weather: temperatures of 20^{o}C and higher were recorded even when the external temperature was below 0^{o}C.

This household is not making particularly good use of the off peak tariff as the consumption figures show a greater consumption on the peak rate than on the off-peak tariff. The effect of this peak rate consumption is a higher average unit price than in other dwellings.

6 Allan Tower

House Details

House Type: 1st floor flat
House Age: 1964 - 1974
House Size: lounge, 2 bedrooms, kitchen bathroom and hall

Total floor area: 68.9 m^2 (internal dimensions)
Exposed perimeter: 22.5m (internal dimensions)
Corridor wall: 1.5m (internal dimensions)

Construction and Insulation Details
Floor construction: non-heat loss floor
Wall construction: system construction
Wall insulation: external cladding: U-value 0.6
Roof insulation: non heat loss roof
Windows: uPVC 6mm double glazing

Space and Water Heating
Before heating upgrade
Primary Space Heating: Electric storage heating with direct acting heaters, manual charge control

After heating upgrade
Primary Space Heating: Direct electric Lucht LHZ combination radiator on E10 tariff, with room thermostat, appliance thermostats and programmers.

Water Heating – Single immersion off peak: 120 litre cylinder with 38 mm spray foam

Location Details

Degree day region:	west of Scotland
Wind speed region:	5.0 m/s
Site Exposure:	urban
Height above sea level:	90 m
Number of sides sheltered:	2
Overshading:	below average

Occupancy / Heating Pattern

Occupants: 2 adults
Heating Pattern: whole house heating

SAP 2005 Score

After heating upgrade: Electric Radiators
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Temperature Summary: Overall Summary - January – July 2008

OVERALL	Lounge	bed 1	bed 2	hall	kitchen	bathroom	whole house	external
minimum	14.24	12.28	12.84	12.28	18.02	15.66	12.28	-4.60
maximum	25.43	22.40	24.06	21.43	25.43	22.40	25.43	24.62
mean	18.99	18.12	18.03	18.40	21.16	19.15	18.98	8.30

Temperature Comfort Summary – Monthly: January – July 2008

6	Lounge	bed 1	bed 2	hall	kitchen	bathroom	whole house	external
January	**18.78**	**18.81**	**18.99**	**17.94**	**21.64**	**19.31**	**19.24**	**6.54**
February	**18.30**	**17.97**	**17.72**	**17.50**	**20.80**	**18.67**	**18.49**	**4.46**
March	**18.06**	**16.47**	**17.37**	**17.55**	**20.57**	**18.25**	**18.04**	**4.43**
April	**18.51**	**17.84**	**17.02**	**17.80**	**20.43**	**18.17**	**18.29**	**6.86**
May	**19.68**	**19.05**	**18.81**	**19.31**	**21.35**	**19.74**	**19.66**	**11.82**
June	**19.84**	**18.56**	**18.49**	**19.21**	**22.08**	**20.22**	**19.73**	**11.88**
July	**20.35**	**19.28**	**19.10**	**19.82**	**22.12**	**20.54**	**20.20**	**13.19**

Consumption and Cost Summary: January – July 2008

SSE E10 Tariff	**kWh**	**Cost**
Normal Rate	1441	£173.45
Low Rate	3014	£171.19
Standing Charge	-	£42.35
Total	4755	£386.99
Average price: pence per kWh (Total Cost ex SC/ Total kWh):		**7.248 p / kWh**
Average cost per day (Total Cost inc SC / 173 days):		**£2.24 / day**

OVERALL COMMENT on 6 Allan Tower

Monitoring started in this dwelling later than in all but one dwelling, and ended a week earlier than all of the rest.

Overall, this house is considered on the 5-point scale to be cool – that is, the mean temperature was lass than 19^{o}C, but as can be see with an overall mean house temperature of 18.98 ^{o}C for the whole of the monitoring period that it just falls into this category, as does the lounge. On the other hand, it is the warm kitchen temperature that is pulling up the average temperature in the dwelling. The kitchen was comfortable to warm over the monitoring period, while no other room was in the comfortable range every month. Bedroom 2 was the coldest room – only getting into the comfortable range in July – the warmest month of the monitoring period. The warmest room on average was the kitchen, with the second warmest room being the bathroom.

The direct electric heating system appears to be able to deliver very comfortable temperatures even in the coldest weather. Temperatures of 20^{o}C and higher were recorded even when the external temperature was below 0^{o}C.

This household is not a particularly low consumer of electricity, but it is making good use of the off peak tariff. The consumption figures show a much greater consumption is occurring on the off-peak rate (approximately 66% of the total consumption) than on the peak tariff. The effect of this off-peak rate consumption is the resultant average unit price being amongst the lowest of the dwellings monitored here.

97 Draffen Tower

House Details

House Type: 17th floor flat
House Age: 1964 - 1974
House Size: lounge, 1bedroom, kitchen bathroom and hall

Total floor area: 46.2 m^2 (internal dimensions)
Exposed perimeter: 13.3m (internal dimensions)
Corridor wall: 7m (internal dimensions)

Construction and Insulation Details
Floor construction: non-heat loss floor
Wall construction: system construction
Wall insulation: external cladding: U-value 0.6
Roof insulation: non heat loss roof
Windows: uPVC 6mm double glazing

Space and Water Heating
Before heating upgrade
Primary Space Heating: Electric storage heating with direct acting heaters, manual charge control

After heating upgrade
Primary Space Heating: Direct electric Lucht LHZ combination radiator on E10 tariff, with room thermostat, appliance thermostats and programmers.

Water Heating – Single immersion off peak: 120 litre cylinder with 38 mm spray foam

Location Details

Degree day region:	west of Scotland
Wind speed region:	5.0 m/s
Site Exposure:	urban
Height above sea level:	110 m
Number of sides sheltered:	2
Overshading:	exposed

Occupancy / Heating Pattern

Occupants: 1 adult
Heating Pattern: whole house heating

SAP 2005 Score

After heating upgrade: Electric Radiators

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Temperature Summary: Overall Summary - January – July 2008

OVERALL	Lounge	bed 1	hall	kitchen	bathroom	whole house	external
minimum	16.54	16.83	17.42	15.09	14.80	14.80	-4.60
maximum	24.06	24.74	23.72	24.74	23.72	24.74	24.62
mean	**19.81**	**19.74**	**20.22**	**19.70**	**18.55**	**19.60**	**8.72**

Temperature Comfort Summary – Monthly: January – July 2008

97	Lounge	bed 1	hall	kitchen	bathroom	whole house	external
January	**18.37**	**18.21**	**18.93**	**18.15**	**17.73**	**18.28**	**6.54**
February	**18.34**	**18.44**	**19.22**	**17.70**	**17.65**	**18.27**	**4.46**
March	**18.63**	**18.56**	**19.29**	**18.26**	**17.69**	**18.49**	**4.43**
April	**19.21**	**19.08**	**19.65**	**18.87**	**17.72**	**18.90**	**6.86**
May	**20.55**	**20.43**	**20.82**	**20.70**	**18.90**	**20.28**	**11.82**
June	**21.40**	**21.36**	**21.47**	**21.70**	**19.89**	**21.16**	**11.88**
July	**21.26**	**21.14**	**21.30**	**21.53**	**19.88**	**21.02**	**13.19**

Consumption and Cost Summary: January – July 2008

SSE E10 Tariff	**kWh**	**Cost**
Normal Rate	693	£69.07
Low Rate	1652	£94.96
Standing Charge	-	£43.68
Total	2345	£207.72
Average price: pence per kWh (Total Cost ex SC/ Total kWh):		**6.995 p / kWh**
Average cost per day (Total Cost inc SC / 181 days):		**£1.15 / day**

OVERALL COMMENT on 97 Draffan

Overall, the recorded temperatures within this dwelling are consistent across the whole house without being particularly warm. During the winter months (January to March) all of the average monthly room temperatures were less than 19^{o}C but for one room – the hall. All of the rooms were not in the comfortable range of temperatures until June. However, overall, only the bathroom was not in the comfortable range of temperatures. This appears to reflect the householder's consumption as generally speaking it is not particularly high.

It is uncertain whether the direct electric heating system here is capable of delivering comfortable temperatures in cold weather as it does not appear that the householder is using the heating very much at all.

The overall low temperatures may reflect the low fuel consumption, as this dwelling had the lowest consumption and the lowest weekly fuel bill of all the 4 dwellings. At the same time the householder is making good use of the off peak tariff. The consumption figures show a much greater consumption is occurring on the off-peak rate (approximately 66% of the total consumption) than on the peak tariff. The effect of this off-peak rate consumption is the resultant average unit price being the lowest of the dwellings monitored here.

5. OVERALL SUMMARY

The four dwellings being monitored show very different use of the electric heating systems: some of the dwellings are making very extensive use of the systems and heating their homes to very comfortable standards. Others may be using the heating minimally. This is reflected in the mean daily expenditures of the monitored households, which range between £1.15 and £2.45 per day (the equivalent of between £8.19 and £17.15 per week). As this was a six months monitoring exercise, the estimated total household fuel bill for the full year costs would range between £419 and £892 (see Table 5.1).Some 58% of the consumption was on the cheaper rate of the tariff.

Table 5.1: Summary results - all dwellings

dwelling	heating type	mean house temp (^{0}C)	peak rate units (kWh)	off peak rate units (kWh)	total units (kWh)	total peak cost (£)	total off peak cost (kWh)	total cost* (£)	mean unit price (p/kWh)	mean cost (£ per day*)
15	Rad	19.50	2686	3111	5797	257	175	479	7.444	£2.45
36	Rad	20.24	2294	2289	4583	220	128	395	7.601	£2.03
6	Rad	18.98	1441	3014	4756	173	171	387	7.248	£2.24
97	Rad	19.60	693	1652	2345	69	95	208	6.995	£1.15

*includes standing charge

Compared to the storage heating installed in these dwellings, the costs associated with using this direct electric heating system may be favourable. In Table 5.2, the total energy consumption and fuel costs for these dwellings and their respective households, given the electric storage heating system, were estimated using the NHER Plan Assessor program. The total energy consumption and annual fuel costs, for the same standardised heating and temperature pattern assumptions, are set out for the two direct electric systems using two different assumptions on the split of electricity consumption between day and low E10 tariff rates – 60% day / 40% low and 40% day / 60% low.

Table 5.2: Estimated Total Energy Consumption and Fuel Costs - all dwellings

dwelling	**Economy 7 Storage heating kWh per year**	**Economy 7 Storage heating £ per year**	**Economy 10 as installed kWh per year**	**Economy 10 60% day: 40 % low £ per year**	**Economy 10 40% day: 60 % low £ per year**
15	8951	£829	8228	£863	£781
36	8312	£729	7478	£791	£717
6	8868	£817	8173	£856	£774
97	7728	£681	6894	£737	£668

For all of the dwellings, the estimated energy consumption for all of the direct electrically heated dwellings is less than that estimated for a storage heating (varying between 7.8% and 10.8%). The estimated fuel costs for the direct electric systems is dependent on when the fuel is consumed – the more that is used in the peak charging period, the more costly the fuel bill. Under the current split used within SAP for direct electric heating on an Economy 10 tariff (i.e. 60:40 split between the day and low rate)[2], electric storage heating would appear to be the cheaper option for all of these households. However, under the split found in these dwellings between the use of electricity on the day:low rate (which was 40:60 in these dwellings), the direct electric systems were estimated to be cheaper than the storage heating systems by between 1.6% and 5.8%.

What emerges as extremely important is the use made of the low rate E10 tariff. Some dwellings do appear to be making better use of the off-peak heating period than others. To take advantage of the low rate tariff, the use of heating should be used as much as possible during the low rate periods and as little as possible during the high tariff rate periods. This does not appear to be happening in all households. The average kWh price ranges between 6.995 p/kWh and 7.601 p/kWh (see Table 5.1).

The overall mean temperatures being achieved found that most of the dwellings would be categorised as being comfortable with regards to their achieved room temperatures (that is, the mean internal temperature was between 19 and 22^{o}C). One dwelling was actually achieving higher average temperatures, and would be categorised as being warm on the five-point scale used here; the other would be categorised as cool as it achieved a mean overall temperature of 18.98^{o}C (just below the threshold temperature of 19^{o}C to be categorised as comfortable) (see Table 5.1).

Individual room temperatures varied. Overall, the heating systems themselves appear to be able to cope with cold weather, as they appear to be able to deliver 20^{o}C and much more, when the external temperature was below 0^{o}C, if they are used. What is obvious is that in some dwellings, the households are using very little heating in some rooms, particularly the second bedroom, and this is reflected in the low temperatures recorded in this room.

On total consumption and total cost, 97 Draffen emerges as the best performing dwelling, but on these parameters that may be expected as the property is smaller (1 bedroom flat) compared to all of the others (which were 2 bedroom flats), and it was monitored for a shorter period than all of the other dwellings but one. However, it also has the lowest average unit cost, which reflects using more units on the cheaper rate. This will explain in part why it also has the lowest average daily cost which takes account of the actual number of days the dwelling was monitored. Variations in the mean daily costs and in the mean unit cost will reflect the better use of the off peak tariff being made by the householder.

[2] See Table 12A in the SAP 2005 manual The Government's Standard Assessment Procedure for the Energy Rating of Dwellings (both version 9.8 (published 2006) and version 9.81 (published 2008) – available from http://projects.bre.co.uk/sap2005/

APPENDIX 1: Economy 10 Tariffs used in calculating fuel costs

Standing Charge	22.659 p per day (inc 5% VAT) up to 4/4/2008 26.1 p per day (inc 5% VAT) from 4/4/2008
Normal Rate	9.167 p/kWh (inc 5% VAT) up to 4/4/2008 11.3 p/kWh (inc 5% VAT) from 4/4/2008
Low Rate	5.282 p/kWh (inc 5% VAT) up to 4/4/2008 6.33 p/kWh (inc 5% VAT) from 4/4/2008
Low Rate applies	between 4.30 AM and 7.30 AM (3 hours) between 1.00 PM and 4.00 PM (3 hours) between 8.30 PM and 12.30 AM (4 hours)

All household electricity used during the Low rate is charged on the low rate.

APPENDIX B: Technical Information on Electric Fusion Boiler and Electric Combination Radiator heating systems

EHC Electric Combination Radiators

Installation and technical manual

THESE INSTRUCTIONS SHOULD BE READ CAREFULLY AND RETAINED FOR FUTURE REFERENCE. BE SURE TO OBSERVE ALL LABELS AND WARNINGS ON THE APPLIANCE.

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6. Technical Data

Manual

Model No.		*Colour*	*Rating* **BTUs**	*Width* **mm**	*Height* **mm**	*Depth* **mm**	*Weight* **kg**
EH500.38.63	500W EHC ELECTRIC RADIATOR	White	1706	380	630	70	22
EH800.38.63	800W EHC ELECTRIC RADIATOR	White	2730	380	630	70	22
EH1000.68.63	1000W EHC ELECTRIC RADIATOR	White	3412	680	630	70	36
EH1500.98.63	1500W EHC ELECTRIC RADIATOR	White	5118	980	630	70	50
EH2000.128.63	2000W EHC ELECTRIC RADIATOR	White	6824	1280	630	70	62
EH2400.128.63	2400W EHC ELECTRIC RADIATOR	White	8189	1280	630	70	62

Radio Frequency

Model No.		*Colour*	*Rating* **BTUs**	*Width* **mm**	*Height* **mm**	*Depth* **mm**	*Weight* **kg**
EH500.38.63RF	500W EHC ELECTRIC RADIATOR RF	White	1706	380	630	70	22
EH800.38.63RF	800W EHC ELECTRIC RADIATOR RF	White	2730	380	630	70	22
EH1000.68.63RF	1000W EHC ELECTRIC RADIATOR RF	White	3412	680	630	70	36
EH1500.98.63RF	1500W EHC ELECTRIC RADIATOR RF	White	5118	980	630	70	50
EH2000.128.63RF	2000W EHC ELECTRIC RADIATOR RF	White	6824	1280	630	70	62
EH2400.128.63RF	2400W EHC ELECTRIC RADIATOR RF	White	8189	1280	630	70	62

Conservatory radiators

Model No.		*Colour*	*Rating* **BTUs**	*Width* **mm**	*Height* **mm**	*Depth* **mm**	*Weight* **kg**
EH500.68.34	500W EHC ELECTRIC CONSERVATORY RAD	White	1706	680	340	70	21
EH1000.85.34	1000W EHC ELECTRIC CONSERVATORY RAD	White	3412	850	340	70	24.5
EH1600.128.34	1600W EHC ELECTRIC CONSERVATORY RAD	White	5459	1280	340	70	34.5
EH2000.158.34	2000W EHC ELECTRIC CONSERVATORY RAD	White	6824	1580	340	70	38

Tall radiators

Model No.		*Colour*	*Rating* **BTUs**	*Width* **mm**	*Height* **mm**	*Depth* **mm**	*Weight* **kg**
EH1200.38.124	1200W EHC ELECTRIC RADIATOR	White	4094	380	1240	70	35
EH1800.55.124	1800W EHC ELECTRIC RADIATOR	White	6142	550	1240	70	58

Towel rail

Model No.		*Colour*	*Rating* **BTUs**	*Width* **mm**	*Height* **mm**	*Depth* **mm**	*Weight* **kg**
2003.06WE	1200W EHC ELECTRIC TOWEL RADIATOR	White	4094	640	1020	140	33

Bathroom radiators (IPX4)

Model No.		*Colour*	*Rating* **BTUs**	*Width* **mm**	*Height* **mm**	*Depth* **mm**	*Weight* **kg**
EH600.38.63IPX4	600W EHC ELECTRIC BATHROOM RADIATOR	White	2047	380	630	70	22
EH1000.68.63IPX4	1000W EHC ELECTRIC BATHROOM RADIATOR	White	3412	680	630	70	36

Accessories and controls

Model No.	
CAST/1	EHC RADIATOR CASTORS
FEET/1	EHC RADIATOR FEET
S/PACK/1	EHC MANUAL RADIATOR CONTROLS
TEI 6	EHC MILUX R/F CONTROLLER
TEI 8	EHC R/F DIGITAL THERMOSTAT

Model No.	
HORST/1	ELECTRONIC 7 PROGRAMMER
NSPE 3839/3	EHC 5 Way CONTROL BOX
NSPE 3839/1	EHC 8 Way CONTROL BOX
NSPE 3839/2	EHC 12 Way CONTROL BOX

For further installation information, call us now on **01698 820533** and request one of our free Product guide and Installation DVDs.

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