



Modelled and actual energy usage comparison results

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Summary

1.1 Introduction

This brief summarises the findings of a comparison between actual gas usage and theoretical gas usage across a wide range of domestic property types across Edinburgh.

Department for Business, Energy and Industrial Strategy (BEIS) have published gas and electricity usage down to the full postcode level for all of the UK, which provides the mean and median consumption per postcode. EPCs have been selected based on property type and location to compare against the median energy usage in the corresponding postcode area.

1.2 Property types

The following property types have been compared in a range of geographical locations across Edinburgh:

1. Large tenement flat (1800s) – Marchmont
2. Small tenement flat (1800s) – Dalry
3. Terraced stone house (1800s) - Leith Links
4. Detached bungalow (1930s) – Blackhall
5. Large detached house (1930s) – Cramond
6. Four-in-a-block flat (1930s) - Stenhouse
7. Cavity tenement flat (1950s) – Clermiston
8. Mid-terrace (1960-70s) – Mortonhall
9. Semi-detached (1970s) – Fairmilehead
10. Modern timber frame terrace (2000s) - South Queensferry
11. New build flat (2000s) – Newhaven

Energy Efficiency bands ranged between B to E.

1.3 Methodology

The following methodology was carried out in order to make this comparison.

1. Utilising extensive knowledge of Edinburgh's housing stock, a range of typical property types ranging from pre-1900 sandstone tenements to modern new build were selected.
2. Selected geographical clusters prominent to the selected property types were identified across Edinburgh.
3. A postcode was selected within each of the clusters and cross referenced with Google Maps, Energy Saving Trust (EST) Home Analytics¹ and the Energy Performance Certificate (EPC) register² to validate prominence.

¹ <http://www.energysavingtrust.org.uk/scotland/businesses-organisations/data-services/home-analytics>

² <https://www.scottishepcregister.org.uk>

4. A property within the EPC database that was typical of the housing type and properties in the postcode was selected.
5. The estimated gas consumption³, property size and energy rating were extracted from the EPC.
6. Compare the kilowatt-hour (kWh) estimation from the EPC data with the median annual domestic gas usage for the postcode.

1.4 Summary of findings

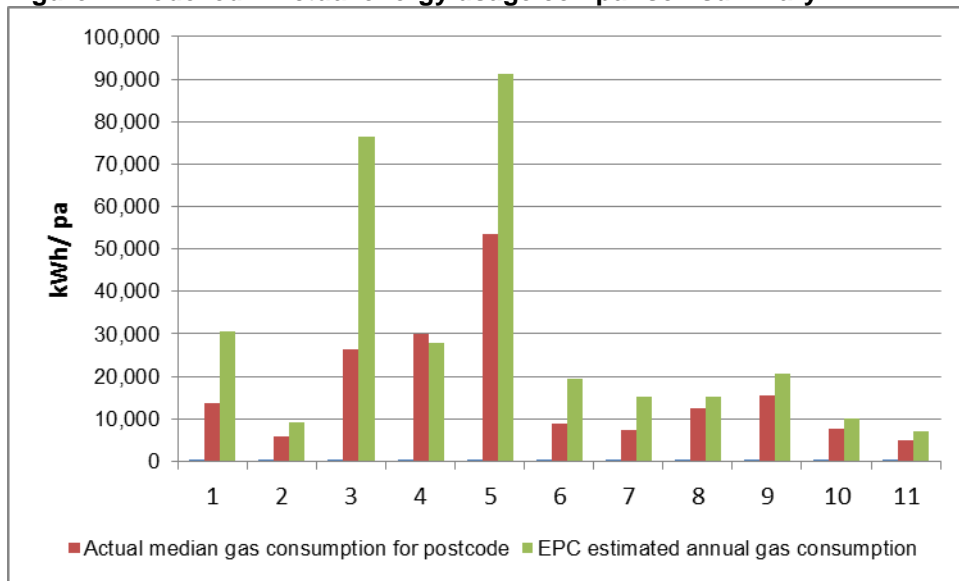
The most notable result was that for ten of the eleven properties, the EPCs over-estimated the energy usage; this ranged from 1.2 times to as much as 2.9 times the actual energy usage. The exception to this was the detached bungalow where actual usage was slightly more than estimated. This suggests that there may be incorrect assumptions with the Standard Assessment Procedure (SAP) methodology for estimating energy usage whereby a standard heating regime is assumed (the main living area heated to 21°C and 18°C in the rest of the property for every week day 9 hours and at weekends 16 hours a day). The incorrect assumptions may cover both the physical performance of the building and heating systems and the heating regime.

For the newer built properties (8-11), a reoccurring trend was that the estimated EPC usage was closer to the actual usage. Conversely, the older properties typically had greater disparity between estimated and actual usage. This comparison is highlighted in Figure 1 below.

³ The kWh figure on the EPC accounts for heating, hot water, lighting and ventilation expressed in Primary Energy per m² (PE/m²). This figure however requires to be converted to household energy. The energy use is not broken down further on the EPC. All properties chosen in this exercise used only mains gas for their heating and hot water fuel to ease conversion. To extract the energy to heating and hot water use in the home, the following was conducted:

- i. The PE/m² figure is multiplied by the floor area to provide a figure for total Primary Energy. The energy use for lighting needs to be deducted. As lighting is only broken down by cost, this requires to be converted to kWh by dividing the cost for lighting by the unit cost of electricity used by SAP at the time the EPC generated. This figure is then multiplied by the Primary Energy Factor (PEF) for electricity and then subtracted from the total PE figure.
- ii. The amended PE figure is then converted to household energy by dividing the figure by the PEF.
- iii. It has been assumed that the properties have gas hobs for cooking. A methodology used by BRE for occupancy assessments was used to estimate cooker use See <https://www.bre.co.uk/filelibrary/SAP/2012/OccupancyAssessment2014.pdf>
- iv. The figure for cooker use is then added to the amended household energy figure.

Figure 1: Modelled v Actual energy usage comparison summary



2. Results

This section provides the comparison results per property type.. A summary is provided in Table 1 below.

Table 1: Modelled v Actual energy usage comparison full results

Case study	Property type	Build period	Geographical location	Total floor area (m ²)	Median annual domestic gas usage for postcode (kWh)	EPC estimated annual gas usage (kWh)	Median annual domestic gas usage for postcode (per m ²)	EPC estimated annual gas usage (per m ²)	Actual / EPC (% difference)	EPC EE rating	EPC band
1	Tenement flat (large)	1800s	Marchmont	212	13,542	30,535	64	144	44%	72	C
2	Tenement flat (small)	1800s	Dalry	63	5,813	9,157	92	145	63%	75	C
3	Terraced stone house	1800s	Leith Links	207	26,256	76,423	127	369	34%	39	E
4	Detached bungalow	1930s	Blackhall	98	29,956	27,755	306	283	108%	53	E
5	Detached house (large)	1930s	Cramond	429	53,368	91,342	124	213	58%	61	D
6	Four-in-a-block flat	1930s	Stenhouse	53	8,829	19,560	167	369	45%	51	E
7	Cavity (as built) tenement flat	1950s	Clermiston	73	7,398	15,100	101	207	49%	67	D
8	Mid-terrace	1960-70s	Mortonhall	82	12,548	15,252	153	186	82%	70	C
9	Semi-detached	1970s	Fairmilehead	94	15,478	20,649	165	220	75%	64	D
10	Modern timber frame terrace	2000s	South Queensferry	102	7,545	9,971	74	98	76%	81	B
11	New build flat	2000s	Newhaven	91	4,942	6,964	54	77	71%	87	B

2.1 Large solid stone tenement flat (1800s)

Image 1: Large solid stone tenement flat (1800s)



Location: Marchmont

Size: 212m² (4-5 bed)

Median annual gas consumption for postcode: 13,542 kWh (64 kWh/m²)

EPC estimated annual gas consumption: 30,535 kWh (144 kWh/m²)

Gas consumption comparison (Actual vs EPC): 44% of the EPC estimation

EPC rating/ band: 72 (C)

2.2 Small solid stone tenement flat (1800s)

Image 2: Small solid stone tenement flat (1800s)



Location: Dalry

Size: 63m² (2 bed)

Median annual gas consumption for postcode: 5,813 kWh (92 kWh/m²)

EPC estimated annual gas consumption: 9,157 kWh (145 kWh/m²)

Gas consumption comparison (Actual vs EPC): 63% of the EPC estimation

EPC rating/ band: 75 (C)

2.3 Solid stone terraced house (1800s)

Image 3: Solid stone terraced house (1800s)



Location: Leith Links

Size: 207m² (4-5 bed)

Median annual gas consumption for postcode: 26,256 kWh (127 kWh/m²)

EPC estimated annual gas consumption: 76,423 kWh (369 kWh/m²)

Gas consumption comparison (Actual vs EPC): 34% of the EPC estimation

EPC rating/ band: 39 (E)

2.4 Detached bungalow (1930s)

Image 4: Detached bungalow (1930s)



Location: Blackhall

Size: 98m² (3-4 bed)

Median annual gas consumption for postcode: 29,956 kWh (306 kWh/m²)

EPC estimated annual gas consumption: 27,755 kWh (283 kWh/m²)

Gas consumption comparison (Actual vs EPC): 108% of the EPC estimation

EPC rating/ band: 53 (E)

2.5 Large detached house (1930s)

Image 5: Large detached house (1930s)



Location: Cramond

Size: 429m² (7 bed)

Median annual gas consumption for postcode: 53,368 kWh (124 kWh/m²)

EPC estimated annual gas consumption: 91,342 kWh (213 kWh/m²)

Gas consumption comparison (Actual vs EPC): 58% of the EPC estimation

EPC rating/ band: 61 (D)

2.6 Four-in-a-block flat (1930s)

Image 6: Four-in-a-block flat (1930s)



Location: Stenhouse

Size: 53m² (2 bed)

Median annual gas consumption for postcode: 8,829 kWh (167 kWh/m²)

EPC estimated annual gas consumption: 19,560 kWh (369 kWh/m²)

Gas consumption comparison (Actual vs EPC): 45% of the EPC estimation

EPC rating/ band: 51 (E)

2.7 Cavity built tenement flat (1950s)

Image 7: Cavity built tenement flat (1950s)



Location: Clermiston

Size: 73m² (2 bed)

Median annual gas consumption for postcode: 7,398 kWh (101 kWh/m²)

EPC estimated annual gas consumption: 15,100 kWh (207 kWh/m²)

Gas consumption comparison (Actual vs EPC): 49% of the EPC estimation

EPC rating/ band: 67 (D)

2.8 Cavity built terraced house (1960/70s)

Image 8: Cavity built terraced house (1960/70s)



Location: Mortonhall

Size: 82m² (3 bed)

Median annual gas consumption for postcode: 12,548 kWh (153 kWh/m²)

EPC estimated annual gas consumption: 15,252 kWh (186 kWh/m²)

Gas consumption comparison (Actual vs EPC): 82% of the EPC estimation

EPC rating/ band: 70 (C)

2.9 Cavity built semi-detached house (1970s)

Image 9: Cavity built semi-detached house (1970s)



Location: Fairmilehead

Size: 94m² (4 bed)

Median annual gas consumption for postcode: 15,478 kWh (165 kWh/m²)

EPC estimated annual gas consumption: 20,649 kWh (220 kWh/m²)

Gas consumption comparison (Actual vs EPC): 75% of the EPC estimation

EPC rating/ band: 64 (D)

2.10 Modern timber frame terraced house (2000s)

Image 10: Modern timber frame terraced house (2000s)



Location: South Queensferry

Size: 102m² (3 bed)

Median annual gas consumption for postcode: 7,545 kWh (74 kWh/m²)

EPC estimated annual gas consumption: 9,971 kWh (98 kWh/m²)

Gas consumption comparison (Actual vs EPC): 70% of the EPC estimation

EPC rating/ band: 81 (B)

2.11 Modern new build flat (2000s)

Image 11: Modern new build flat (2000s)



Location: Newhaven

Size: 91m² (3 bed)

Median annual gas consumption for postcode: 4,942 kWh (54 kWh/m²)

EPC estimated annual gas consumption: 6,964 kWh (77 kWh/m²)

Gas consumption comparison (Actual vs EPC): 71% of the EPC estimation

EPC rating/ band: 87 (B)

2.12 CO₂ comparison

Using CO₂ intensity factors used by SAP for the EPC, a comparison has been made on the tonnes of CO₂. This can have implications on predicted carbon savings. The results are shown on Table 2 below.

Table 1: Modelled vs Actual CO₂ comparison full results

Case study	Property type	Annual CO ₂ emissions (tonnes) based on actual median domestic gas usage for postcode	Annual modelled EPC CO ₂ emissions (tonnes)
1	Tenement flat (large)	2.7	6.0
2	Tenement flat (small)	1.3	2.0
3	Terraced stone house	5.2	15.1
4	Detached bungalow	6.5	6.0
5	Detached house (large)	10.6	18.1
6	Four-in-a-block flat	1.9	4.2
7	Cavity (as built) tenement flat	1.6	3.3
8	Mid-terrace	2.5	3.0
9	Semi-detached	3.1	4.1
10	Modern timber frame terrace	1.5	1.9
11	New build flat	1.0	1.4

3. Conclusions

From the property sample it is evident that EPCs typically over-estimate energy use. This suggests that there may be incorrect assumptions with the Standard Assessment Procedure (SAP) methodology for estimating energy usage whereby a standard heating regime is assumed (the main living area heated to 21°C and 18°C in the rest of the property for every week day 9 hours and at weekends 16 hours a day). The incorrect assumptions may cover both the physical performance of the building and heating systems and the heating regime.

This also means that CO₂ emissions of properties and the CO₂ savings from Energy Efficiency measures are likely to be less than estimated in the SAP model. This has implications if carbon targets are set against theoretical SAP savings.