Carbon Assessment of Domestic Housing in London Borough of Merton

version 1.0

parity
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Parity is an award-winning provider of environmental and energy solutions to the residential building sector. We help our customers identify the most effective ways to reduce the running costs and environmental impact of their properties.

The backbone of our work is the Parity Home Energy Master Plan which identifies the most appropriate measure for specific properties based on impartial physics.

Parity also provides a number of other related services such as eco-renovation project management, training installers and consulting services to local government, housing associations and other organisations.

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DOCUMENT HISTORY

This document is version 1.0

Version History:

Draft Version 0.1	26 Nov 09	DJS
Version 1.0	26 Jan 10	DJS

Approval

Draft Version 0.1	27 Nov 09	BCS
	30 Nov 09	CJN
Version 1.0	31 Jan 10	RS

Distribution

LB Merton	30 Nov 09	0.1
Parity (internal)	30 Nov 09	0.1
LB Merton	26 Jan 10	1.0
Parity (internal)	26 Jan 10	1.0

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1. Introduction

Typical Merton Homes

This report provides an overview of the survey and analysis conducted for the domestic housing stock within the London Borough of Merton to assess the potential for reducing the carbon emissions as part of an organised and systematic Low Carbon retrofit.

The aim of the work was to look at the potential for carbon reduction in the housing stock, to derive an itemised estimate of the cost and cost effect of addressing this potential, and to provide recommendations based on analysis of the above.

The broad process which will be explained in greater detail later was:

- a visual inspection of every dwelling in the borough, noting characteristics for each dwelling relevant to energy performance and applicable energy saving measures
- use of a computer model to estimate the energy usage and carbon footprint of each dwelling surveyed
- use of the computer model to estimate the numbers of energy saving measures applicable in the area, and to calculate the likely cost and impact of each of these measures

This report describes and explains the method that was used, and presents an analysis of the results of the survey and of the modelling. As well as assessing the potential for and geographical distribution of various types of measure in the borough the analysis includes some consideration of how the options available and scale of investment would relate to financial paybacks and other benefits for individual householders.

The final section of the report considers how future work could make use of and build on the work summarised in this report.

1 Methodology

The work has taken place in two main phases: a street survey of every dwelling in the borough and a computer model assessment.

1.1 STREET SURVEY

Street surveyors conducted a visual survey of every building in the Borough, noting all visible characteristics of each dwelling with bearing on energy efficiency. This exercise took just under 80 person-days and was conducted between late June and early October 2009.

Dwellings were assessed based on the characteristics visible from the street:

Dwelling is a **house/~~flat~~/~~block~~**

↓

House type is **~~terrace~~/semi/~~detached~~**

↓

Estimated build date is **1912**

↓

Walls are **solid brick/~~empty~~/~~filled cavity~~/~~new construction~~**

↓

Number of Storeys is **2**

↓

Estimated Bedrooms is **3**

↓

Roof is **flat/~~sloping~~**

↓

Extensions visible are **none/~~loft~~/~~building~~**

Where the dwelling was a flat, the flat types used were *in block of 5 or fewer flats / in block of 6 or more flats / converted house / above shop*.

1.2 DETAILED ASSESSMENTS

We conducted 10 detailed assessments as part of the project. The properties for the assessments were chosen to represent the most common archetypes in the borough.

9 surveys were conducted on relatively conventional dwellings, and the data generated was were added to the existing pool of assessments used by our modelling software to produce generic archetypes. Some details of the properties surveyed are given below.

Detailed Assessment #	Street	House / Flat / Maisonette	Bedrooms	Storeys
1	Kings Road	House	4	2
2	Bayham Road	House	2	2
3	Florence Road	Flat in purpose built block	2	1

4	Aylward Road	House	3	2
5	Vineyard Hill Road	House	5	2
6	Rose Avenue	House	3	1
7	Grand Drive	Flat in purpose built block	2	1
8	Lansdowne Road	Flat in converted house	2	1

In addition two detailed assessments were made of 'Wimpey' homes, an unusual type of dwelling built in the borough in moderate numbers in the 1960s and early 1970s (see section 5). These houses have a no-fines concrete structure, with timber frame panels and metal cladding. The two types were for the house and the flat variants of the type. Based on these surveys a new archetype was added for the Merton analysis, and custom recommendations were produced and extrapolated to the 1500 or so Wimpey homes in the borough.

1.3 MODELLING

Our in-house DREM[1] software was used to:

1. populate the non-visible characteristics of each dwelling based on assumptions
2. extract the carbon saving measures possible for each dwelling in the area
3. calculate the base energy cost and carbon saving for each dwelling in the area
4. calculate the energy, cost and carbon saving for each carbon saving measure identified

1.3.1 Domestic Carbon Modelling

The DREM software was used to estimate the energy use, carbon footprint, and potential energy saving initiatives for every dwelling in the area. Broadly the software does this by using the basic characteristics of the property (house/flat, number of storeys, estimated number of bedrooms, house/flat type) to produce a more detailed model based on an archetype with the characteristics needed to make energy use calculations (e.g. wall area, window area, etc). The modelling clearly requires use of a large number of assumptions, but with more complete data the model can produce increasingly accurate results.

As stated in the previous paragraph, the detailed model is based on a detailed individual archetype. This archetype is allotted to a particular address in one of two ways:

- 'normal' dwellings require an archetype based on dwelling type (house/flat/maisonette), number of storeys, and number of bedrooms
- more unusual dwellings can use a custom archetype which will be based on a detailed assessment of a sample dwelling

1.3.2 Extrapolation of non-visible dwelling characteristics

Information from Parity's database of previous surveys was used in combination with data from EST Home Energy Checks in the area to populate representative numbers of dwellings in the area with characteristics not visible from the street survey (e.g. loft insulation, heating times). These characteristics were allotted proportionally and intelligently: for example, if 5% of lofts are expected to have no insulation, a randomly selected 5% of the dwellings with sloping roofs were allocated an assumption of no loft insulation. However, as buildings built after the mid-1980s can be expected to have been constructed with insulation in place, no buildings of this age were allocated as having no insulation.

Note: our model allows for these characteristics to be added at a later date for individual houses as actual data becomes available, perhaps through the roll out of energy saving projects.

[1] Domestic Renovation Energy Model, based on BREDEM and CIBSE Guide A, see Appendix A

1.3.3 Carbon Saving Initiatives

Carbon saving initiatives are automatically generated by DREM based on dwelling characteristics (e.g. if the model finds a dwelling with solid walls, the model is set to generate initiatives for various solid wall options). These initiatives are used to adjust the model of the individual dwelling, and to calculate the energy, carbon and cost effect of each initiative on the particular dwelling.

We have used DREM to identify a range of energy saving initiatives for each dwelling in the borough, and to estimate the cost, energy and carbon saving effect, and payback of each of these measures. The result of this modelling is a very long list of carbon saving measures which is the basis for the analysis presented in sections 5 and 6 of this report.

2 Survey Data

This section is an overview of the success with which the data was collected.

2.1 DATA STATUS OVERVIEW

LB Merton supplied an address list with 87022 addresses. Before the data collection started the address list was processed to remove obviously commercial addresses, leaving 84658 addresses. The survey status of this shorter list of addresses is given below:

Status	Count
Dwelling - surveyed	78056 (92.2%)
Not found	988 (1.2%)
Parent address	3470 (4.1%)
Not dwelling	1236 (1.5%)
Poor data	908 (1.1%)

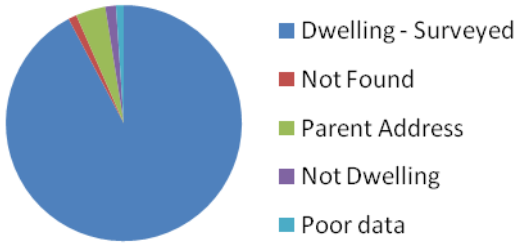


Figure 1: survey status of all Merton addresses supplied

The 'not found' addresses are spread fairly randomly around the borough: where clusters were found we re-surveyed.

Only about 1% of addresses were rejected because of poor data quality. 'Poor data' addresses are addresses rejected by DREM because the data was incomplete (e.g. no house type) or had logical contradictions (e.g. wall type 'new', house build date 1900). The data errors were due to errors on the part of the street surveyors, and where possible the addresses were re-investigated by re-surveying.

The 'parent addresses' are address entries for blocks of dwellings (independent of the individual address entries of the component dwellings) which are present in the data. For example the addresses 1-8 Alexandra Court might have a parent address 'Alexandra Court' as an additional line in the address list. It was not necessary to include these in the analysis.

Discounting the parent addresses and the non-dwellings, 97.6% of the dwellings in Merton have been surveyed. We regard this as an excellent success rate. The database will remain available for LB Merton to record updates (e.g. new addresses, installation of measures, survey of remaining addresses). In the following analysis only the surveyed addresses have been considered, but the estimated numbers of measures have been normalized as if 100% of addresses had been surveyed.

3 Overview of Merton Housing Stock

This section describes the age and distribution of different types of housing across the borough. The aim of this section is to provide an overview of what the main types of dwellings in Merton are like and includes a description of the most predominant dwelling types in detail.

3.1 DWELLING AGE

Most of Merton was built between about 1905 and about 1935, especially during the period 1905-1924. This is shown clearly in the first graph in
Figure 2 below.

In interpreting this data it should be noted that the build dates of dwellings were estimated by our surveyors based on visual inspection and are only approximate, but we have tried to minimise errors by choosing age categories within which distinctive dating characteristics are present. (E.g. the distinctive 'Metroland' type styling which is visible from 1905, the distinctive Tudor styling from homes built circa 1925, the preponderance of cavity wall construction from circa 1935, etc). These dating characteristics used to train surveyors in dating houses were taken from contemporary photographs from a number of sources[2].

2.1: % of borough's dwellings built per age band **2.2: Building rate: dwellings built per year by age band**

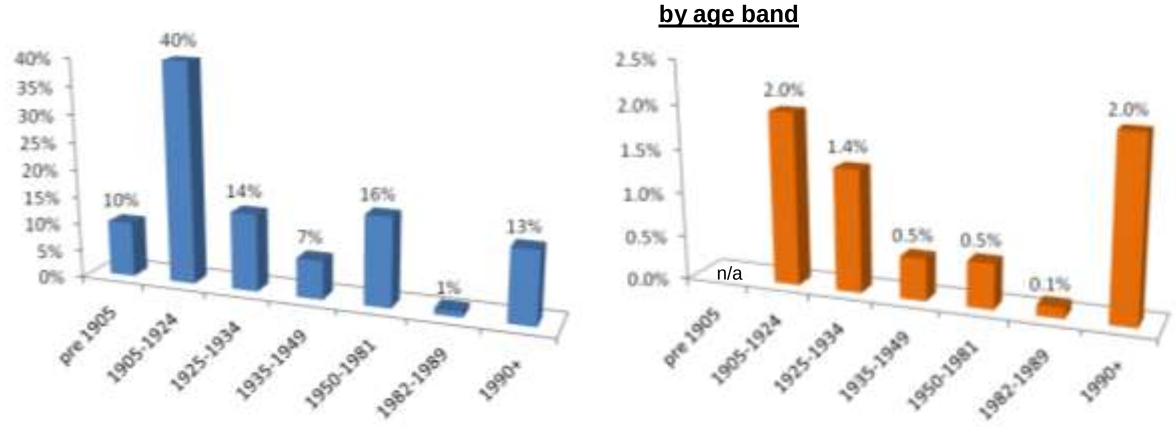


Figure 2: dwelling ages in Merton

The graph 2.1 above does not use equal time intervals for the age categories, and this masks the interesting trend shown by the second graph 2.2 that shows that the boom in house building between 1905 and 1934 seems to be matched by a new boom in house building which has taken place since 1990.

The housing aged between 1905 and 1934 seems likely to provide a very useful area of potential for carbon reductions in Merton, and we have provided photographs of typical dwellings from the periods 1905–1924 and 1925-1934 in figures 3 and 4 overleaf.

[2] E.g. Semi-detached London: Suburban Development, Life and Transport, 1900-39, Alan A Jackson, Allen & Unwin 1973


c.1905


c. 1910-14


c. 1905-14


c. 1910-14


c. 1920

Figure 3: typical Merton houses built between 1905 and 1924


c.1928


c. 1928


c. 1934, St Helier estate
(Note cavity walls, unusual in homes of this age in Merton)

Figure 4: typical Merton houses built between 1925 and 1934

The geographical distribution of dwellings of different ages is shown in figure 5, with areas of predominantly pre 1935 houses in shades of green, 1935-1981 in shades of pink, and 1982+ shades of blue.

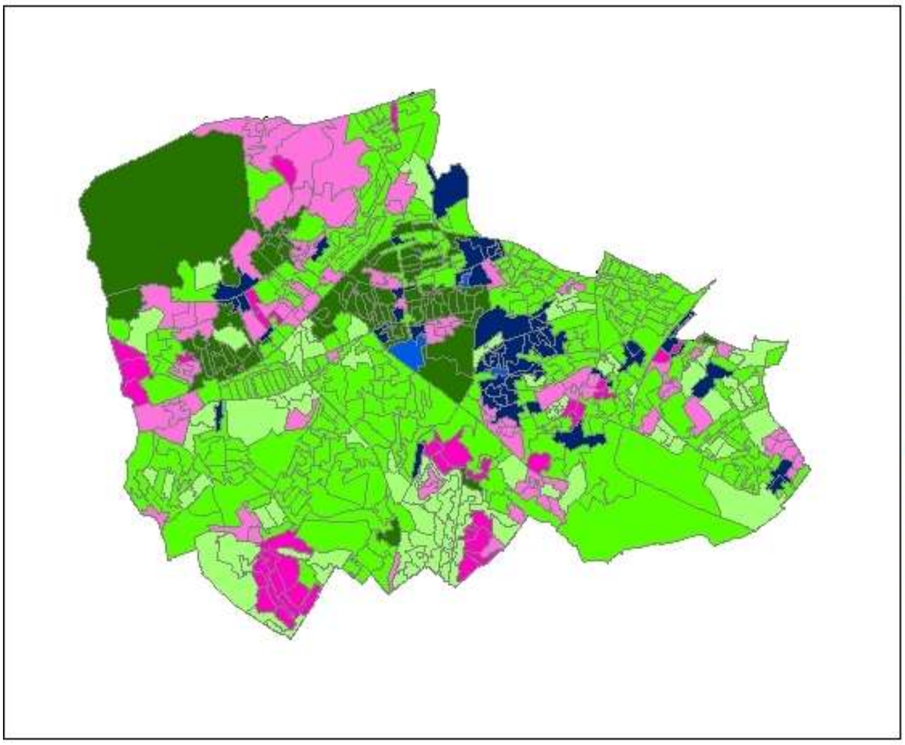


Figure 5: Predominant age of housing in Census Output areas across Merton

The railway lines seem to provide the clearest obvious delineation between different ages of houses, and how rail and underground connections seem to have dictated the stages of development in the borough.

- The core areas of pre-1905 housing cluster round the more central locations of Wimbledon, Raynes Park, Wimbledon Village and Merton as might be expected.
- The 'suburban sprawl' of 1905-1934 housing seems to cluster around rail stations and underground stations, with areas with high densities of homes built in between the 1940s and 1970s apparently in areas of the borough with poorer historic transport connections.
- There is a clear area with high density of newer housing between Collier's Wood and Phipps Bridge tram stop.

3.2 DWELLING TYPES

We suggest that the three most important dwelling types in the area in terms of their contribution to Merton's domestic carbon footprint are:

- terraced and semi detached houses
- detached houses
- flats in large blocks

Together, these three dwelling types account for almost 89% of the borough's carbon footprint. This is illustrated in figure 6 below shows, which gives a breakdown of the housing stock by dwelling type, showing count of dwellings alongside their combined carbon footprint.

68% of Merton's dwellings are houses: these account for about 75% of the borough's domestic carbon footprint.

The figure illustrates that the most important types of housing in the borough in terms of carbon footprint are terraced and semi detached houses which account for about 78% of the borough's domestic carbon footprint. From the figure it is also clear that detached houses in the borough have a carbon footprint well above the average carbon footprint per home for the borough.

6.1: % of borough's dwellings by dwelling type

6.2: % borough's carbon footprint accounted for by dwelling type

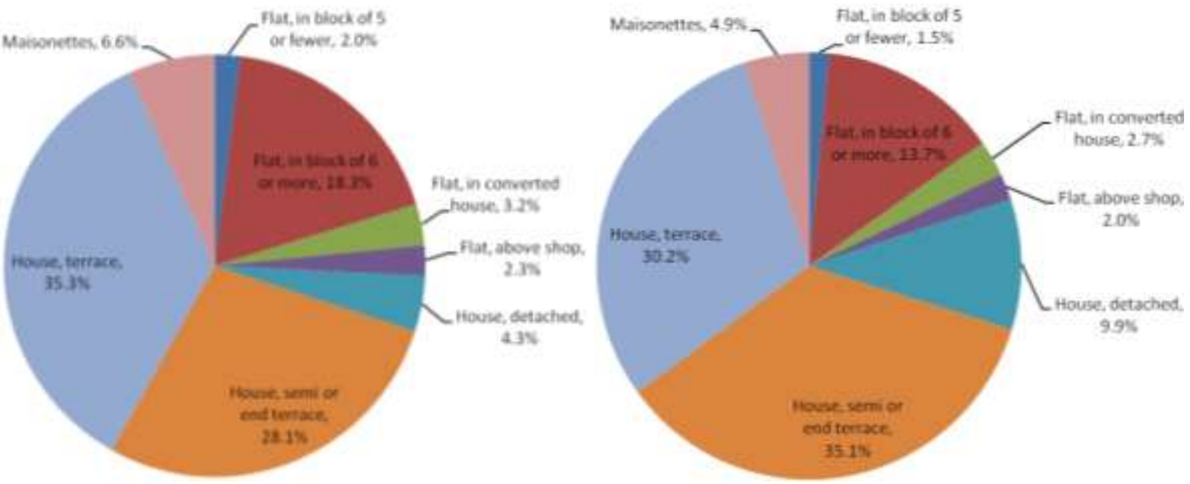


Figure 6: Percentages of various dwelling types in Merton by number and by combined CO2 footprint

We will now look at the main dwelling types (in terms of carbon footprint) briefly in turn: the most notable characteristics of each are presented in the following sections.

HOUSING STOCK OVERVIEW

3.2.1 Terraced and Semi Detached Houses

We have grouped these two housing types because of their many similarities in Merton: typically the semi-detached houses have only minor build variations from adjoining terraced houses.

As can be deduced from Figure 6 above, semi-detached houses in Merton have a larger carbon footprint than the average dwelling in the borough: the typical semi has a carbon footprint about 25% greater than the typical terrace. However, as can be seen by the graphs in Figure 7 below the types are also very similar in terms of number of storeys, number of bedrooms, and age. This is as might be expected given the typical short terrace form (i.e. 1-3 terraced houses between two semi-detached houses) of much of Merton housing.

7.1: Number of storeys **7.2: Number of bedrooms** **7.3: Age of dwelling**

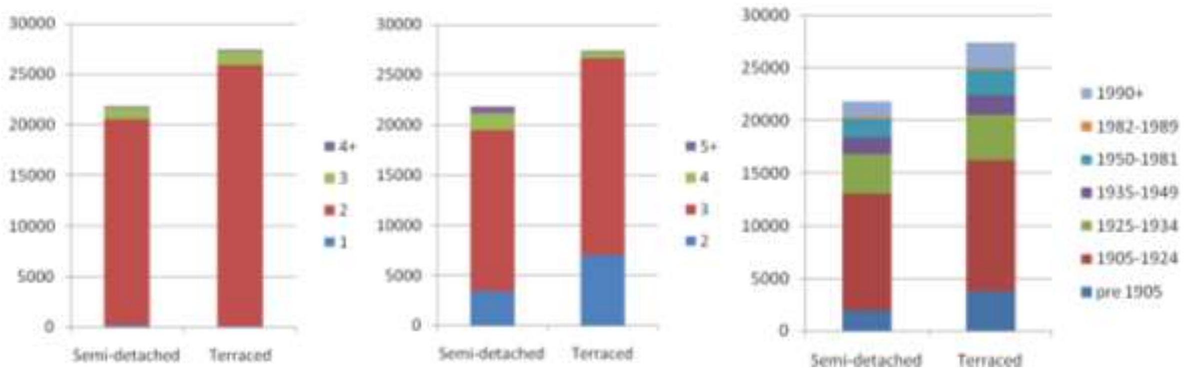


Figure 7: main characteristics of semi detached and terraced housing in Merton

Figure 7 shows clearly that the typical Merton semi or terrace (and therefore the typical Merton dwelling) is slightly more likely to be terraced than semi detached, probably has three bedrooms but might have two, and was built with two storeys.

The age profile shows most variability, and for this reason we have included an indication of the typical estimated carbon footprint for terraced and semi-detached houses for each date range in Figure 8. These figures are derived from the DREM model described in the methodology section.

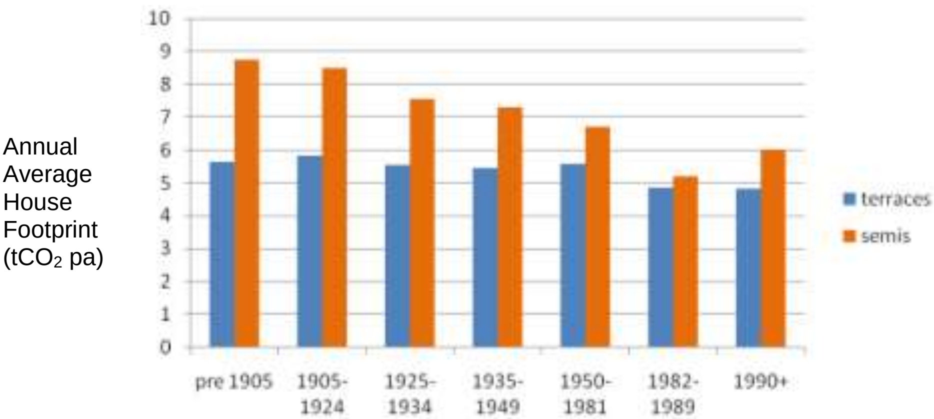


Figure 8: Average annual carbon footprint of Merton houses per age band.

It is clear that the variability with age is most pronounced in semi-detached houses, which illustrates that the improved thermal envelope of modern housing results in largest energy savings when it is large compared with the house volume. Despite this, the reduced carbon footprint of more modern houses contributes to the result that terraced and detached houses built before 1935 account for 48% of the borough's housing stock, but account for about 60% of the borough's carbon footprint from domestic housing.

We therefore suggest that pre-1935 semis and terraces be regarded as Merton's most important house type for domestic carbon reduction, a result that might be expected.

3.2.2 Detached Houses

As might be expected, the typical detached house in Merton is large and relatively old. However, there is plenty of variation as illustrated by the graph in Figure 9.

Just fewer than 75% of Merton's detached houses were classified by our surveyors as having 4 bedrooms or more, and while the trend of average carbon footprint by age has a similar shape to that of semi-detached and terraced houses, the average carbon footprint per house is about 40% larger.

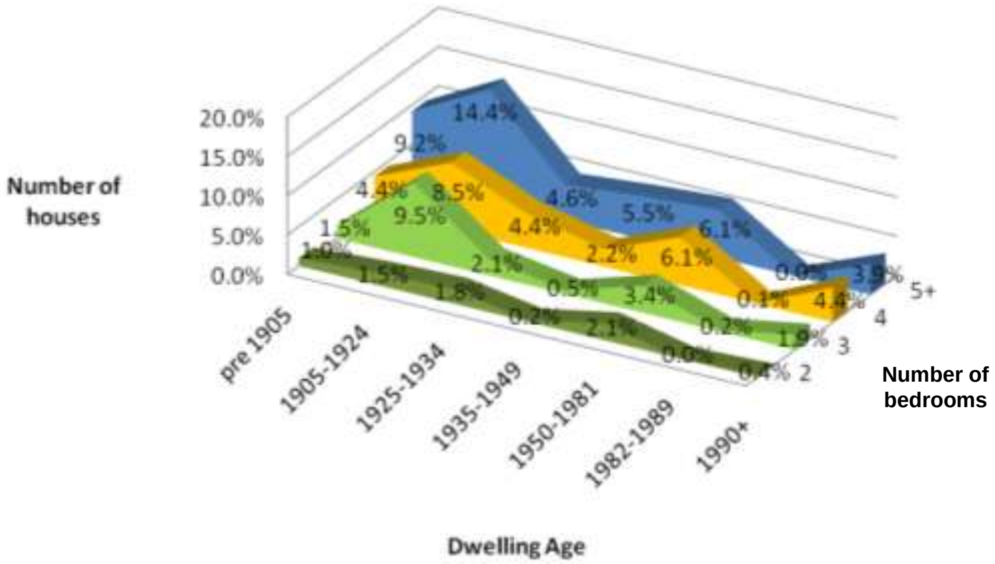


Figure 9: Proportions of detached Merton houses in different age categories and with different numbers of bedrooms

Based on a fair knowledge of the borough it seems reasonable to expect that many detached houses should be found in the Wimbledon Common end of the borough: this is the case as illustrated clearly by
Figure 10 below. In fact, the three most northwestern wards in Merton (Village, Hillside and Raynes Park) contain almost two thirds of all the detached houses in Merton, and Village ward (about 36% detached houses) on its own has more than a third of all the detached houses in the borough.

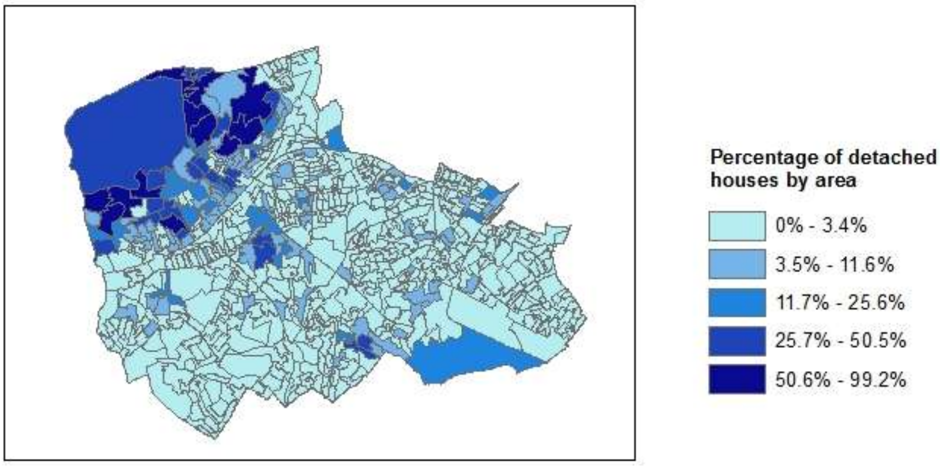


Figure 10: Distribution of detached houses in Merton Borough

The variability with age is much more pronounced than in semi-detached or terraced houses as would be expected given the larger proportion of wall area that is exposed. The carbon footprint per house is very large: this is partly a reflection of the relative inefficiency of detached houses, but is also largely because of the fact that the detached houses in the borough are generally so large.

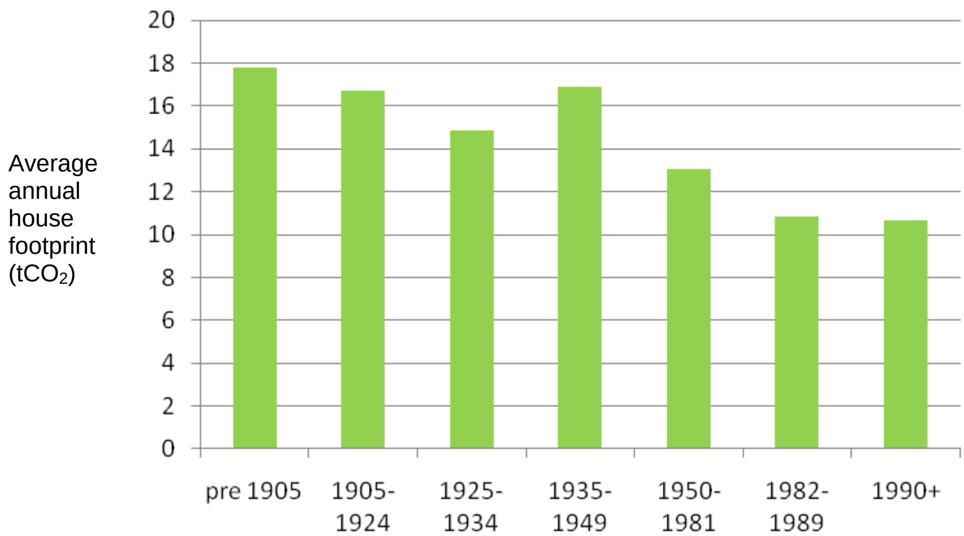


Figure 11: Average annual carbon footprint of detached Merton houses per age band.

3.2.3 Flats in Large Blocks

As illustrated by Figure 12, most of the larger blocks of flats in the borough seem to have been built recently (37% post 1990) or in the 1950s – 1970s (38% 1950-1981). This is as might be expected, and suggests that the major opportunities for energy/carbon improvement through major refurbishment of these properties are likely to be most applicable to the 50s 60s and 70s blocks.

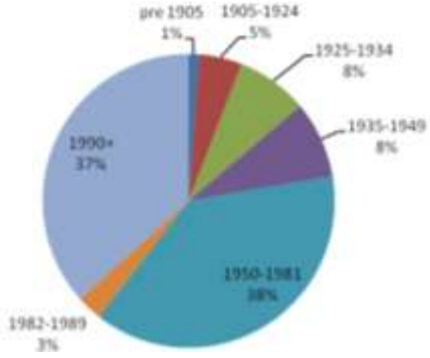


Figure 12: Proportions of large blocks of flats by age category

A key observation about the flats modelled was the relatively small variation in carbon footprint between older flats and more modern flats, shown in Figure 13: Average carbon footprint of flats by age category. Even the newest flats have a footprint only about 20% lower than old flats with solid wall construction. We interpret this as a reflection of the fact that flats tend to be by their very nature fairly thermally efficient with walls, ceilings and floors typically adjoining another flat. This means that factors less affected by dwelling age, including hot water demand, lighting and appliance use, contribute a proportionally greater part of the carbon footprint.

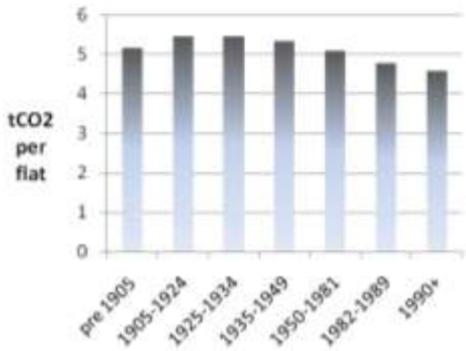


Figure 13: Average carbon footprint of flats by age category

Figure 14 shows the geographical distribution of flats of different ages across the borough. We noticed particular patterns in the two more modern age categories of flats mapped, marked by A-B and C-D on the figure, with the mid 20[th] century blocks clustered around the rail line that passes through Wimbledon, and the more modern blocks more typically found in the Tooting/Mitcham area.

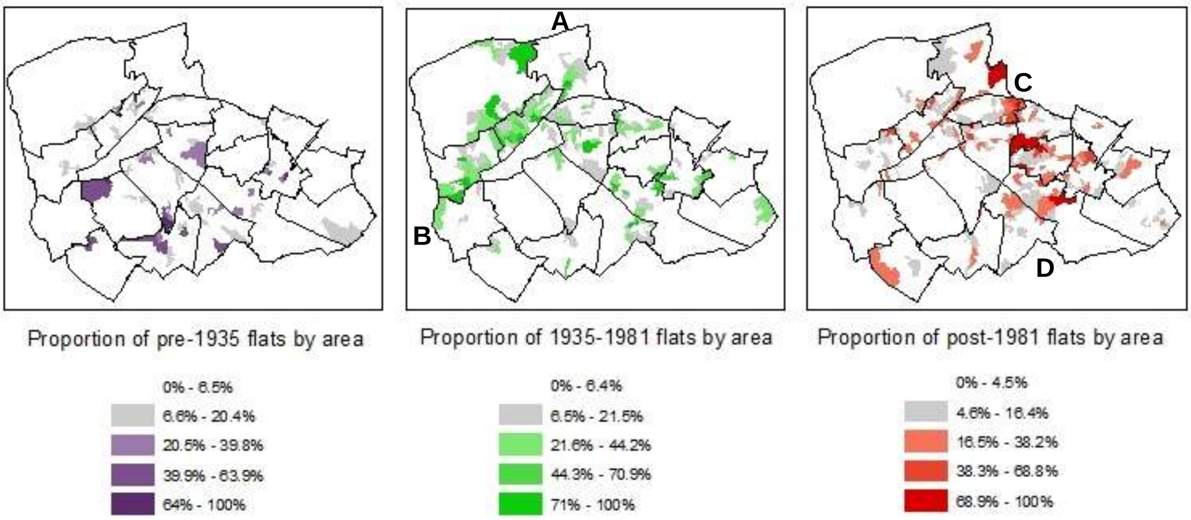


Figure 14: Distribution of flats of different ages in Merton Borough: A-B and C-D mark apparent trends where areas of greater density appear to roughly follow the

Waterloo and Victoria rail lines respectively

4 Carbon Saving Initiatives: Potential and Opportunities

In this section we have sought to present the key information that will contribute to an understanding of the potential for energy and carbon saving measures in Merton and that will inform both strategic and tactical approaches to realising this potential. We believe that this is the most important section in the report.

As described in Section 1 (Methodology) a computer model has been used to estimate the energy use of every dwelling in the borough, and to generate a range of energy saving initiatives for each dwelling. These are summarised in Table 1 overleaf, where they are presented in decreasing order of total carbon saving potential in Merton. (The price structure used to cost the measures is provided in Appendix C). Building on this summary we have considered the measures in more detail in two sections.

1 – Overview:
This section is a very basic analysis of the collated results by measure, as presented in Table 1. The aim of this section is to cut through the apparent complexity of a big table of numbers like Table 1 and to present some context for the analysis that follows. The issue that it aims to address is that a measure can be judged to have good 'potential' based on varying factors including good payback, high carbon saving potential per measure, large numbers, and so on.

2 – In-depth analysis of initiative potential:
We have considered the types of initiatives individually, with particular emphasis on:

- Description of patterns observed in the distribution of the measures including potentially useful geographical distributions, and patterns of dwellings of different types/ages.
- Analysis of the characteristics of a dwelling that make it most suitable for a particular measure. The aim of this is to provide information about what occupant/dwelling characteristics make a measure most likely to be effective.

We have considered all measures, but we have generally presented more analysis for measures with most 'potential' (see 'Overview' section above).

In addition, a special analysis of 'Wimpey' homes was made based on a detailed analysis conducted for the Merton Low Carbon Zone. These houses are unusual in a number of ways, and almost 1500 were identified in the borough.

Note on payback periods: *in the following analysis we have assumed that fuel prices will not rise in real terms in the future. However, a trend of rising fuel prices might be expected in the long term. We have therefore included in Appendix C a table to allow the paybacks presented in the following text to be converted to paybacks that might be expected in various fuel price rise scenarios.*

Note on fuel costs: *we have assumed fuel prices per kWh of £0.035 for gas, £0.12 for on peak electricity, and £0.045 for off peak electricity. Carbon intensity of fuels were taken from the methodology document of DECC's Act on* CO_2 *carbon calculator.*

RESULTS

Table 1: average estimated carbon saving, payback and number of measures in Merton for the range of energy saving measures considered.

#	Initiative	Average tCO_2 saving per measure	Average payback (yrs)	Count of measures possible	Total tCO_2 saving possible	% saving of Merton CO_2 possible
1	Install internal solid wall insulation to solid wall (U becomes 0.175 ~100mm PIR)	1.85	10.1	50920	94050	18.13%
2	Install external solid wall insulation to solid wall (U becomes 0.25)	1.77	26.5	50920	90300	17.41%
3	Install internal solid wall insulation to solid wall (U becomes 0.35 ~50mm PIR)	1.7	7.7	50920	86500	16.68%
4	2 shorter heating periods instead of 1 all-day heating period	1.88	0	40550	76080	14.67%
5	Turn down heating from 22 to 18 degrees C	2.03	0	24190	49030	9.45%
6	2 shorter heating periods instead of heating 24 hours	6.41	0	4130	26470	5.10%
7	Turn down heating from 24 to 18 degrees C	3.29	0	7980	26240	5.06%
8	Install CFLs where possible (most light fittings in dwelling)	0.67	0.6	36400	24310	4.69%
9	Turn down heating from 20 to 18 degrees C	0.91	0	24440	22320	4.30%
10	Upgrade old boiler (15yrs+, ~65% efficient)	1.5	8.9	12130	18150	3.50%
11	Install 4m2 solar PV panels	0.33	63.0	49720	16200	3.12%
12	Install 4m2 solar PV panels: access Feed In Tariff	0.33	19.9	49720	16200	3.12%
13	Upgrade old boiler (10yrs+, ~75% efficient)	0.79	16.9	20160	15840	3.05%
14	Install CFLs where possible (half of light fittings in dwelling)	0.33	0.6	36480	12160	2.34%
15	Upgrade single glazing to new double glazing	0.78	103.6	14420	11180	2.16%
16	Upgrade old double glazing to new double glazing	0.28	280.3	39090	11070	2.13%
17	Solar hot water (4m2 flat plate)	0.16	136.6	66300	10800	2.08%
18	Insulate cavity walls	0.77	4.2	13650	10530	2.03%
19	Insulate empty loft to 11 inches	1.58	1.3	6120	9665	1.86%
20	Upgrade old boiler (5yrs, ~82% efficient)	0.4	32.6	20350	8220	1.59%
21	Replace storage heaters with gas central heating	5.53	n/a	990	5460	1.05%
22	Upgrade 15 year old cold appliances to top rated new	0.22	7.1	16080	3610	0.70%
23	Upgrade 10 year old cold appliances to top rated new	0.21	7.6	16340	3430	0.66%
24	Insulate loft from 2 to 11 inches	0.27	6.1	12570	3370	0.65%
25	Draughtproofing	0.07	11.2	35400	2380	0.46%
26	Upgrade 5 year old cold appliances to top rated new	0.12	12.8	16196	2010	0.39%
27	Insulate loft from 4 to 11 inches	0.07	13	16066	1130	0.22%
28	Insulate pre-1981 flat roof externally	0.39	174.4	2590	1020	0.20%
29	Insulate pre-1981 flat roof internally	0.39	37.4	2590	1020	0.20%
30	*Add 50mm rockwool into spaces in timber frame wall and 50mm PIR internally	0.65	7.6	1450	940	0.18%
31	*Add 100mm PIR internally to concrete upper walls	0.26	10.4	1450	380	0.07%
32	*Add 50mm PIR internally to concrete upper walls	0.24	8.1	1450	350	0.07%
33	*Add 50mm rockwool into spaces in timber frame wall	0.23	9.7	1450	330	0.06%

*These measures specifically apply to the 'Wimpey houses and flats in the borough

RESULTS

4.1 OVERVIEW

Our modelling indicates that Merton housing currently averages about 6.6 tonnes of CO_2 per dwelling, a number in line with national averages[3]. For the whole borough:

Result 1: the modelled carbon footprint of heating, hot water and electricity for all dwellings in the borough is about 531,000 tonnes of CO_2.

The most recent actual figure (from aggregated meter readings) is 409, 050 tonnes. Our modelled figure is within 30% of the actual, which we believe is an excellent result and gives credibility to the modelled figures presented in this report. We would expect the modelled carbon footprint to converge with the actual as improved data about the housing stock becomes available and is added to the model.

To model the effect of multiple initiatives it is not possible simply to add up the savings. This is because measures interact in complex ways: for example, savings possible through turning down a thermostat AND insulating the walls of a house are not the sum of the savings that might be expected if the two measures were implemented individually; turning down the thermostat would leave less heat to be saved through insulation. However, we can use the model to estimate the combined effect of measures:

Result 2: if all measures with individual potential to save more than 2% of the borough's carbon emissions with payback less than 20 years were implemented, a 64% CO_2 reduction might be expected.

The measures that might be regarded as most important are those with high total potential and fast payback. This is an over-simplification which we will return to this in the final part of this section. However, it allows us to put the measures considered into useful categories.

A - Key measures

- Average CO_2 saving potential greater than 10% of borough footprint
- Payback less than 10 years

#	Initiative	Average payback (yrs)	% saving of Merton CO_2 possible
3	Install internal solid wall insulation to solid wall (U becomes 0.35 ~50mm PIR)	7.7	16.68%
4	2 shorter heating periods instead of 1 all-day heating period	0	14.67%

B – Other important measures

- Average CO_2 saving potential greater than 2% of borough footprint
- Payback less than 30 years

#	Initiative	Average payback (yrs)	% saving of Merton CO_2 possible
1	Install internal solid wall insulation to solid wall (U becomes 0.175 ~100mm PIR)	10.1	18.13%
2	Install external solid wall insulation to solid wall (U becomes 0.25)	26.5	17.41%
5	Turn down heating from 22 to 18 degrees C	0	9.45%
6	2 shorter heating periods instead of heating 24 hours	0	5.10%
7	Turn down heating from 24 to 18 degrees C	0	5.06%

[3] Example figure from on Act on CO_2: average 3-bed semi built before 1930 with 3 occupants has footprint of 6.85 tCO_2 from heating, hot water and electricity; average 2-bed flat of similar age with 2 occupants has a footprint of 5.45 tCO_2.

8	Install CFLs where possible (most light fittings in dwelling)	0.6	4.69%
9	Turn down heating from 20 to 18 degrees C	0	4.30%
10	Upgrade old boiler (15yrs+, ~65% efficient)	8.9	3.50%
12	Install 4m^2 solar PV panels: access Feed In Tariff	19.9	3.12%
13	Upgrade old boiler (10yrs+, ~75% efficient)	16.9	3.05%
14	Install CFLs where possible (half of light fittings in dwelling)	0.6	2.34%
18	Insulate cavity walls	4.2	2.03%

C – High Impact Poor Payback

- Average CO_2 saving potential greater than 2% of borough footprint
- Payback greater than 30 years

#	Initiative	Average payback (yrs)	% saving of Merton CO_2 possible
11	Install 4m^2 solar PV panels	63.0	3.12%
15	Upgrade single glazing to new double glazing	103.6	2.16%
16	Upgrade old double glazing to new double glazing	280.3	2.13%
17	Solar hot water (4m^2 flat plate)	136.6	2.08%

D – Strategically less important measures

- Average CO_2 saving potential less than 2% of borough footprint

#	Initiative	Average payback (yrs)	% saving of Merton CO_2 possible
19	Insulate empty loft to 11 inches	1.3	1.86%
20	Upgrade old boiler (5yrs, ~82% efficient)	32.6	1.59%
21	Replace storage heaters with gas central heating	n/a	1.05%
22	Upgrade 15 year old cold appliances to top rated new	7.1	0.70%
23	Upgrade 10 year old cold appliances to top rated new	7.6	0.66%
24	Insulate loft from 2 to 11 inches	6.1	0.65%
25	Draughtproofing	11.2	0.46%
26	Upgrade 5 year old cold appliances to top rated new	12.8	0.39%
27	Insulate loft from 4 to 11 inches	13	0.22%
28	Insulate pre-1981 flat roof externally	174.4	0.20%
29	Insulate pre-1981 flat roof internally	37.4	0.20%
30	*Add 50mm rockwool into spaces in timber frame wall and 50mm PIR internally	7.6	0.18%
31	*Add 100mm PIR internally to concrete upper walls	10.4	0.07%
32	*Add 50mm PIR internally to concrete upper walls	8.1	0.07%
33	*Add 50mm rockwool into spaces in timber frame wall	9.7	0.06%

Looking at measures in this way provides a number of fascinating insights. In particular:

- Such conventional measures as loft and cavity wall insulation has relatively low strategic importance in Merton if the aim is to generate large carbon savings: this is especially the case with loft top-ups

- Behavioural heating measures appear to have the potential to reduce the borough's footprint by more than 35%: we suggest that large savings will be difficult to attain without addressing behaviour

- Internal solid wall insulation and solar PV (with feed in tariff) stand out as important physical measures, with boiler upgrades and CFLs also well placed

These and other observations will be explored further in the following sections.

Cost Effectiveness

In this section so far we have considered payback to a householder interested in investing in energy saving measures. However, with financing tools likely to be implemented at local and national levels in the close future we have added this section of the report to help inform decisions about how financing might best be applied to carbon saving measures.

Figure 15 below indicates where money invested in measures would generate maximum cost effect in terms of annual CO_2 saved. Note that we have used a logarithmic scale, and values at opposite ends of the graph differing by a factor of about 300.

Apart from the 'super measures' of CFLs, insulation of empty lofts, and to a lesser extent cavity wall insulation, there are a relatively large number of measures around the £1 - £2 mark which are potentially good candidates for finance mechanisms from the point of view of the finance provider.

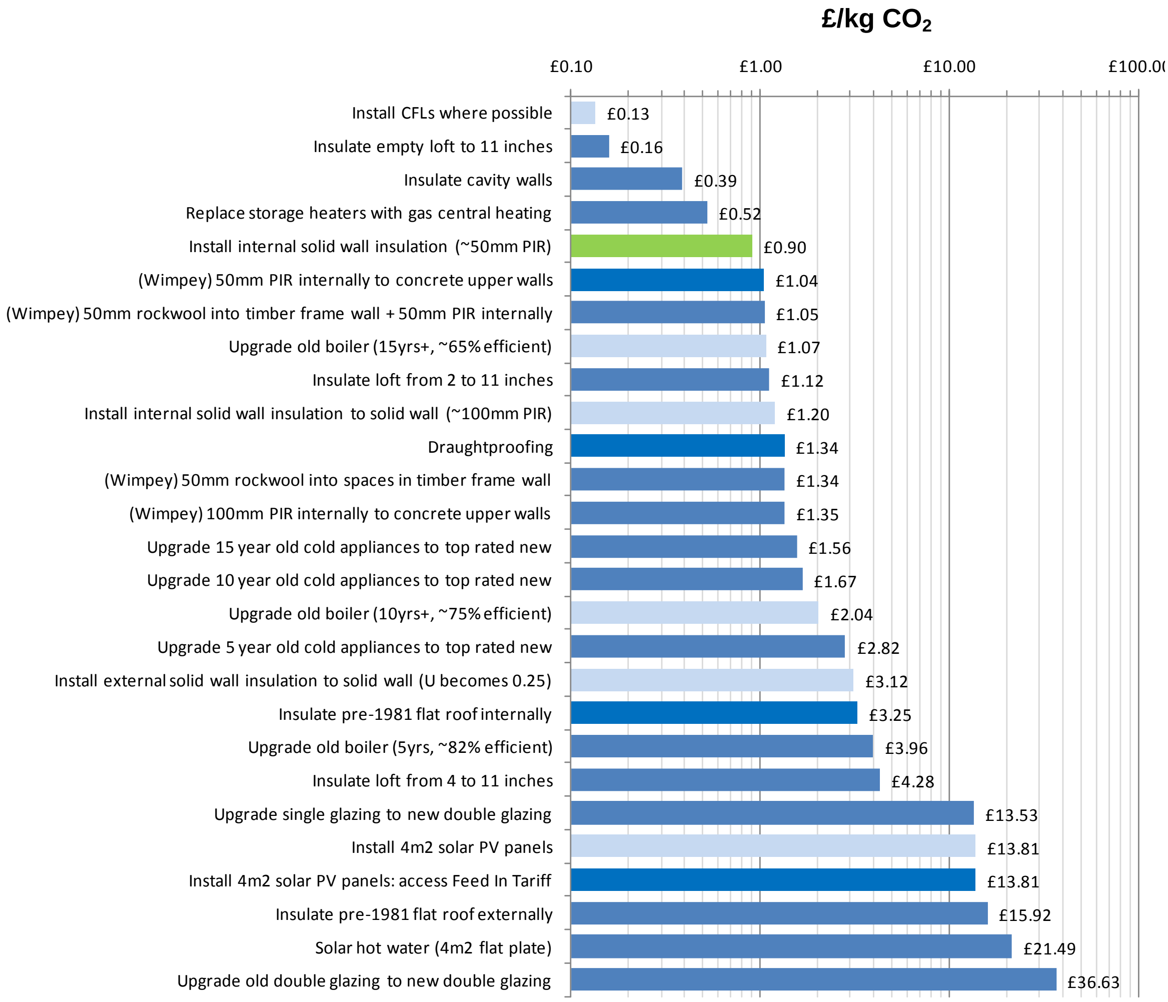


Figure 15: Cost spent in measures installation per unit of CO_2 saved annually for all measures considered (£/kg CO_2).

Measures classed as 'A – Key Measures' in an earlier part of the section have green bars; measures classed as 'B – Other Important Measures' have light blue bars. Behavioural and other no cost measures are not included (as the calculated £/kgCO_2 would be infinite).

4.2 IN-DEPTH ANALYSIS OF INITIATIVE POTENTIAL

4.2.1 Solid Wall Insulation

As described above, solid wall insulation has the potential to reduce the borough's carbon footprint by 16-19% with relatively modest average paybacks ranging from 7 to 25 years, depending on the type of system used. This makes it a key measure strategically, and this section will therefore present an analysis in some depth.

The potential is so high because of the large number of dwellings with solid walls in the borough (see Figure 16 below), and because of the high performance of the measure per house. In Merton, solid wall insulation results in an average carbon saving per house more than twice as great as for cavity wall insulation.

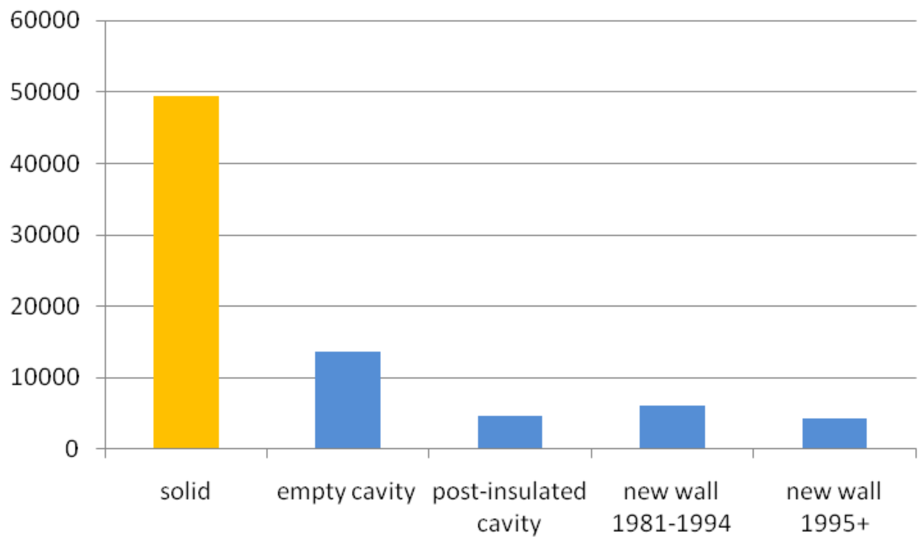


Figure 16: Numbers of dwellings by wall type in Merton

We modelled the effect of three main measures applied to every solid walled dwelling in the borough:

1. Internal wall insulation - 50mm PIR[4], reducing total U value of wall from 2.1 to 0.32 W/m^2K
2. Internal wall insulation - 100mm PIR, reducing total U value of wall from 2.1 to 0.17 W/m^2K
3. External wall insulation system, reducing total U value of wall from 2.1 to 0.25[5] W/m^2K

Figure 17 overleaf shows the percentages of each measure with various paybacks rounded to the nearest even number of years.

[4] Polyisocyanurate (PIR) foam insulation board, suppliers include Celotex, Knauff etc
[5] as required by current building regulations

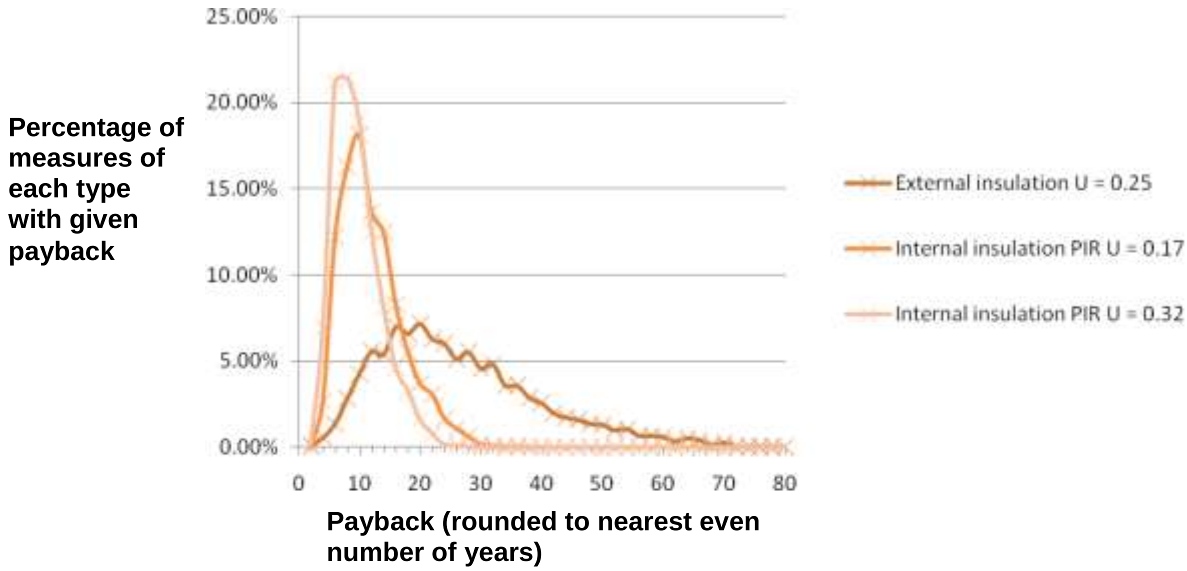


Figure 17: Performance of the three types of solid wall insulation modelled on all solid wall dwellings in Merton

Figure 17 illustrates both that the slimmer internal wall insulation option is the most cost effective, and also that households vary quite widely in how much benefit can be derived from solid wall insulation.

This is as expected: regarding comparison of the three measures, insulation provides diminishing return of energy saving with increasing thickness as the remaining energy to be saved diminishes, so we would expect the slimmer internal PIR option to provide the most cost-effective internal option. External wall insulation provides a similar improvement in energy performance to the other two measures, but at significantly greater cost.

Regarding variation in saving potential across the housing stock, we would expect both resident heating behaviour and house type to have an effect on energy saving potential of insulation. This is explored in more detail in the rest of this section.

<u>Dwelling Type and Characteristics</u>

Figure 18 shows the variability in the paybacks for 50mm internal wall insulation for flats and the three main different house types. It indicates that solid wall insulation as a measure is likely to be most cost-effective in detached houses, and least cost-effective in terraced houses. The spread on the graph is likely to be due to variations in heating temperature, heating regime, heating system efficiency, dwelling configuration etc.

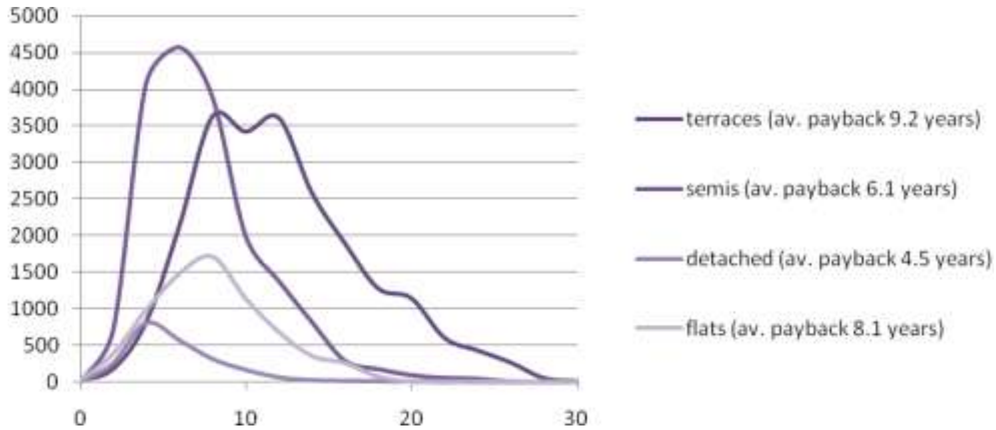


Figure 18: Variation in payback of 50mm PIR internal solid wall insulation for different dwelling types

A similar pattern (summarised in Table 2) is observed for dwellings of different assumed boiler age: insulation is more cost effective as a measure in homes with less efficient heating systems. The converse of this is that insulation saves less carbon if implemented after an upgrade to more efficient heating.

Assumed Boiler Age	Average payback (yrs)
~15 year old, non condensing	5.9
~10 year old, non condensing	6.8
~5 year old, non condensing	7.4
New, condensing	8.1

Table 2: Average payback of 50mm PIR internal wall insulation for dwellings with different assumed boiler efficiencies

Resident Behaviour

Internal temperatures and heating patterns also have an effect on the carbon savings possible through insulation. This is summarised in tables 3 and 4 which show the average payback possible for internal solid wall insulation for dwellings grouped by internal heating temperature, and by heating regime type. This data illustrates how insulation can save more energy in homes where more energy is being used, either to heat the living spaces to a higher temperature, or to provide longer heating periods.

Internal Temperature	Average payback (yrs)
18ºC	9.1
20ºC	7.5
22ºC	5.8
24ºC	4.6

Table 3: Average payback of 50mm PIR internal wall insulation for dwellings with different assumed internal temperatures

Heating Regime	Average payback (yrs)
Morning and evening weekdays (6-8am, 5-9pm), all day at weekends (7am-9pm)	9.2
All day (7am-9pm)	5.8
24 hours, every day	3.1

Table 4: Average payback of 50mm PIR internal wall insulation for dwellings with different assumed heating regimes

Implications of effect of resident behaviour on effectiveness of measure

The conclusions we draw from the data above are that:

1. Various factors increase the likely cost effect of solid wall insulation in a home. A detached or semi-detached home with high occupancy (e.g. residents at home rather than out working during the day) is likely to be most suitable for the measure.

2. Very short paybacks for the measure (2-4 years) are only to be observed where other characteristics of the dwelling require action (c.f. low boiler efficiency, very high internal temperature, heating on 24hours)

To illustrate the second point, the average modelled payback of internal 50mm PIR solid wall insulation for all possible measures in the borough is **7.7 years**. However, if all gas boilers were upgraded to condensing, if all homes had an internal temperature of 18ºC, and no homes were heated 24 hours per day the average modelled payback rises to **10.1 years**.

<u>Geographical Distribution</u>

This section provides information about how potential for solid wall insulation is distributed around the borough. As solid wall insulation provides both a larger saving and a faster payback on semi detached and detached homes, information about these measures is also provided. As the measure is closely linked to distribution of dwellings built before about 1930-1935, the distribution pattern is similar to patterns noted in section 4.

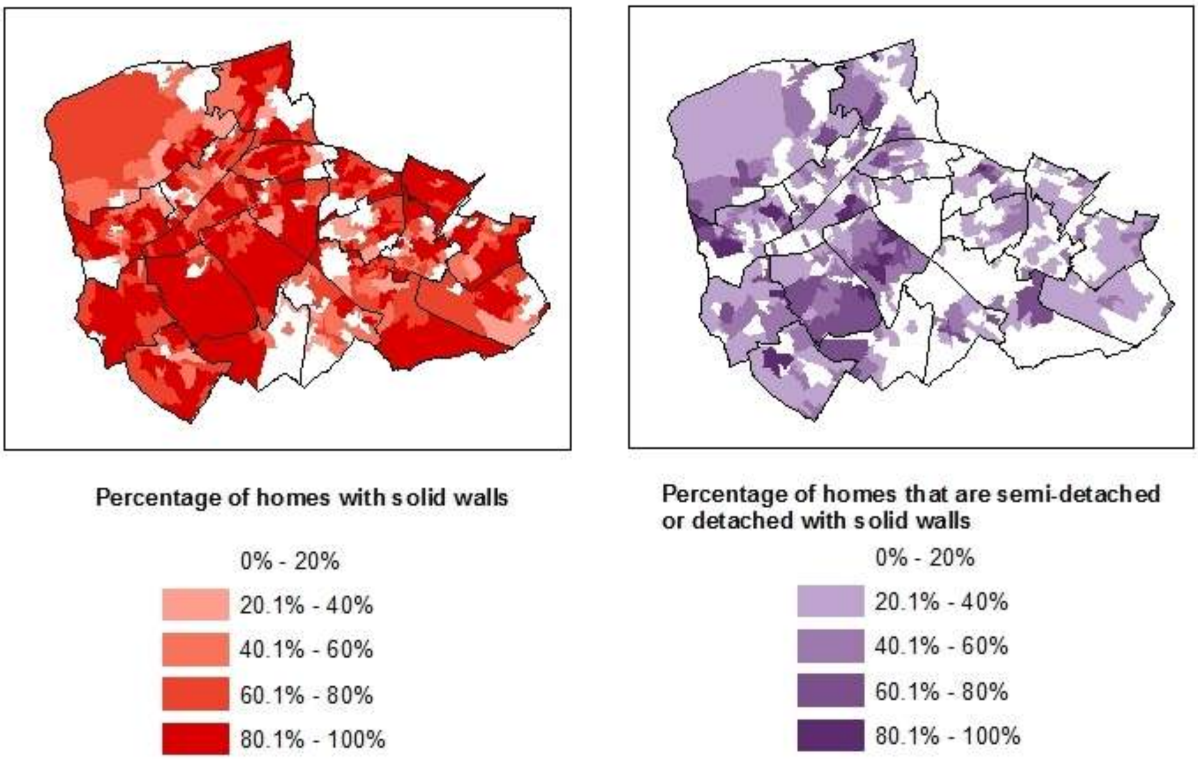


Figure 19: Geographical distribution of solid walls in Merton all homes with solid walls, and detached and semi-detached houses with solid walls

Ward	Percentage of homes that have solid walls	Percentage of homes that are detached or semi-detached houses with solid walls
Cannon Hill	90.4%	47.6%
Graveney	88.6%	18.4%
West Barnes	80.3%	34.2%
Merton Park	79.1%	38.3%
Lower Morden	74.6%	32.7%
Dundonald	69.9%	21.7%
Abbey	67.0%	7.2%
Wimbledon Park	64.0%	20.3%
Longthornton	63.7%	22.8%
Colliers Wood	60.7%	20.1%
Trinity	57.1%	17.8%
Raynes Park	56.2%	27.1%
Pollards Hill	51.1%	20.7%
Cricket Green	48.4%	10.7%
Figges Marsh	47.2%	14.9%
Village	44.2%	25.2%
Hillside	44.1%	19.5%
Lavender Fields	39.1%	13.5%
Ravensbury	30.5%	16.4%
St Helier	27.5%	10.1%

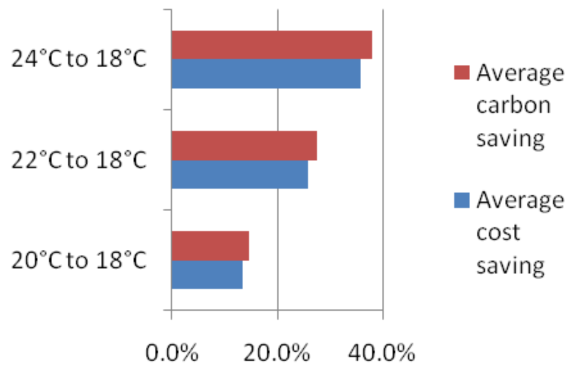
Table 5: Solid walls in Merton by ward, descending order of percentage of solid walls

4.2.2 Behavioural Measures

As information about resident behaviour could not be collected from the street survey we made assumptions about how each home was heated and occupied based on data from our database of previous surveys and allotted representative proportions of typical heating patterns and internal heating temperatures to the Merton addresses for modelling. Our model allowed us to estimate such amounts as hot water usage per property based on dwelling size.

For this reason the analysis results for behavioural measures should be regarded as useful mainly to indicate the scale of savings possible. We thought it was worth including the information in the model firstly to allow the scale of savings to be compared with other measures, and secondarily to allow real data for specific houses to be added to the model in future. Figures Figure 20 and Figure 21 show the remarkable levels of savings that can be achieved through reducing internal temperatures.

Figure 20: Average percentage carbon savings per home for reduction of internal temperatures



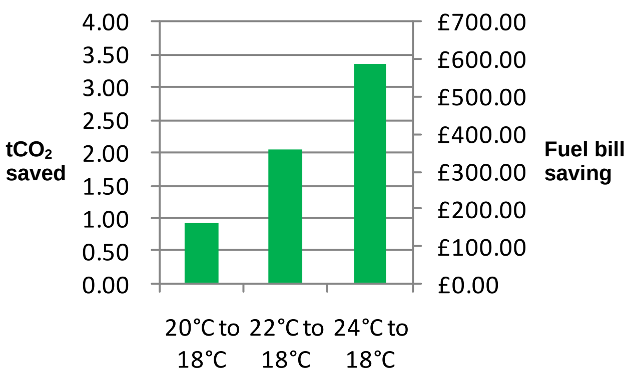


Figure 21: Average carbon and cost savings per home for reduction of internal temperatures

Similar levels of savings can be achieved by reducing the number of hours the heating is on as shown in Table 6: Average savings resulting from shorter heating periods. With the heating times, based on our database of previous surveys we have assumed that only 5% of homes are heated 24 hours, and that 55% of homes are heated only morning and evening during the week. As stated before, these measures are included to demonstrate the level of potential saving.

	Fuel bill saving		Carbon saving	
Measure	**Total**	**Percentage**	**Total (tCO_2)**	**Percentage**
Change from 24 hour heating to 6-8am and 5-9pm	£1,123.50	52.1%	6.52	54.5%
Change from 7am-9pm heating to 6-8am and 5-9pm	£329.10	24.5%	£1.91	26.3%

Table 6: Average savings resulting from shorter heating periods

RESULTS

How can these savings be identified and monitored?

There are a number of perennial issues with implementation of behavioural measures:

1. How can the potential measures be easily identified?
2. How can it be known whether measures have been implemented?
3. How can people be persuaded to change their behaviour?

Point 3 is outside the scope of this report, but we suggest that monitoring and control solutions might be considered. Such solutions fall into three categories: low tech, medium tech, and high tech.

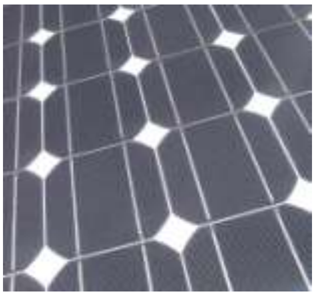
'Low tech' describes the range of solutions from meter reading schemes to face-to-face advice. Within the context of the Parity survey of Merton borough, it would be relatively straightforward to produce estimated annual energy usage estimates for every home in the borough for various scenarios such as 'very high use', 'typical', 'best practise'. This type of data could be used in parallel with information from meter readings (for example) to identify households for energy advice.

'Medium tech' describes solutions to do with existing control systems. There are probably cases where homes are not well heated because of controls which are not easy to use, or are not present.

'High tech' is smart metering, intelligent control systems, and so on. These allow measures to be identified and implementation to be monitored.

Parity Projects is able to advise on their application in more detail if required.

4.2.3 Solar PV



The upcoming Feed In Tariff (FIT) makes a very large difference to the financial viability of solar PV panels as a carbon saving measure. We have made the assumption that 75% of homes with roofs in the borough are able to install $4m^2$ solar PV panels.

There is a dilemma with PV with FIT: the FIT subsidy means that although the payback is relatively low, it is an expensive way of saving carbon. The following example illustrates this. A payback in the region of 10 years is comparable with other 'medium' payback measures such as:

- upgrading a 15 year old boiler
  8.9 year payback *£1.07 per kg CO_2 saved annually*
- installing 100mm PIR internal wall insulation
  10.1 year payback, *£1.20 per kg CO_2 saved annually*
- Upgrading a 10/15 year old cold appliance
  7.6/7.1 year payback *£1.67/£1.56 per kg CO_2 saved annually*
- Draughtproofing
  11.2 year payback *£1.34 per kg CO_2 saved annually*
- External Solid Wall Insulation
  26 year payback *£3.12 per kg CO_2 saved annually*

The dilemma is that PV with FIT costs £13.81 per kg CO_2 saved annually. This was illustrated in Figure 15 (page 21).

A related issue is the lifetime of the proposed FIT; even with a payback as short as 10 years residents need to have confidence that the FIT would continue for the duration of the period required to generate full payback on investment.

In terms of capacity for Solar PV across the borough, it is an attractive measure: requiring only a roof for installation (subject to planning restrictions) there is the potential for in the region of 50,000 installations across the borough, which could reduce Merton's carbon footprint by almost 4%.

4.2.4 Lighting, Appliances, Heating System Upgrade

As with some previous sections specific information for individual dwellings was not available for these measures. For this reason we had to use assumptions based on sample data to assign characteristics to randomly selected individual dwellings in representative proportions based on the sample data. The sample data used came from EST Home Energy Checks (lighting and heating) or Parity's catalogue of home surveys (cold appliances).

4.2.5 Minor measures

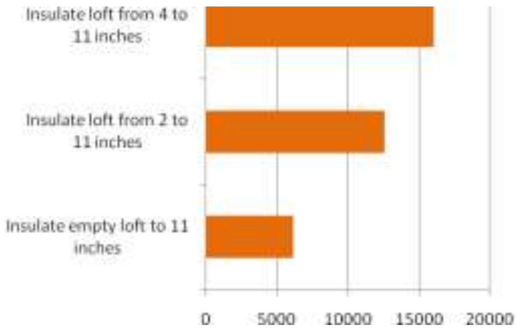
Loft and flat roof insulation

Loft insulation is a measure that has been central to energy efficiency for many years. The modelling provides two important insights into the measure.

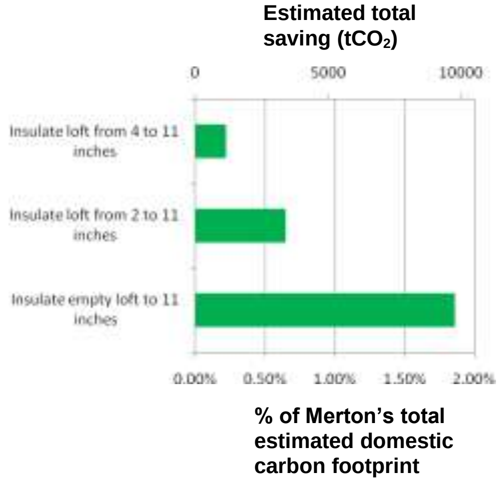
The first is that while insulation of empty lofts is very cost effective, there is relatively small benefit for an individual house of top up loft insulation. Figure 22 shows that for an individual household with an uninsulated loft, insulation results in significant savings and very fast paybacks. However, topping up from 2" or 4" existing insulation has much longer paybacks and rather small average fuel bill savings.

The second is that from the point of view of the borough's total carbon emissions, loft insulation appears not to be a very important measure. This is largely because most lofts appear already to have some insulation[6], so the potential per measure multiplied by the number of possible measures gives a relatively small number as illustrated in Figure 22.

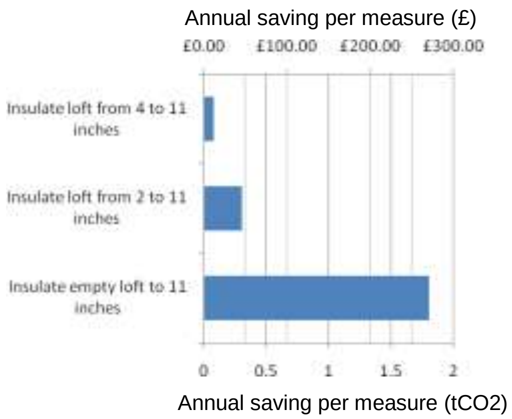
22.1 Estimated number of potential measures in Merton



22.3 Estimated total carbon saving potential of loft insulation in Merton



22.2 Average calculated saving per measure



[6] Although a key ambiguity in the EST's data should be noted: there is no distinction between 'no loft' and 'don't know' on the EST HEC. Based on EST 'loft - no insulation' category we assumed that only about 10% of homes with lofts had no loft insulation, but we would suggest that further work might find this figure to be higher.

Figure 22: Individual and aggregate savings modelled for loft insulation measures in Merton

Although insulating empty lofts will result in relatively small borough savings, it remains an extremely cost effective measure for individual houses. As shown by Figure 15: Cost spent in measures installation per unit of CO_2 saved annually for all measures considered (£/kg CO_2).Figure 15 (p 20) it is second only to CFLs in terms of cost effective carbon saving, and with CFLs and cavity wall insulation it falls into an exclusive groups of 'super measures'.

Solar Hot Water

The modelled performance of Solar Hot Water is fairly poor, with an average modelled payback of 136 years and average annual carbon saving per measure of 0.16 tonnes CO_2. The cost effect of solar hot water as a carbon saving measure is estimated as being in the same order as glazing and external flat roof insulation (see Figure 15 in previous section). Although solar hot water is often regarded as a relatively effective measure, this payback seems broadly in line with figures produced by the Energy Saving Trust[7].

The key issue is that Solar Hot Water can only assist with the hot water demand of a home. According to our modelling, 95% of householders in the borough spend less than £105 per year (and typically much less) to meet their hot water demands using gas as a fuel (based on £0.035 per unit of gas, and noting that the DREM model has calculated hot water energy demand based on home size).

Figure 23 shows the relationship between hot water demand and payback. The points are fairly few and fall on a distinct line: this is a reflection of the method used for modelling the hot water demand per house. However, it is fairly clear that the homes that might benefit most are those with highest hot water use, or those with no option at this time but to use on peak electricity for water heating.

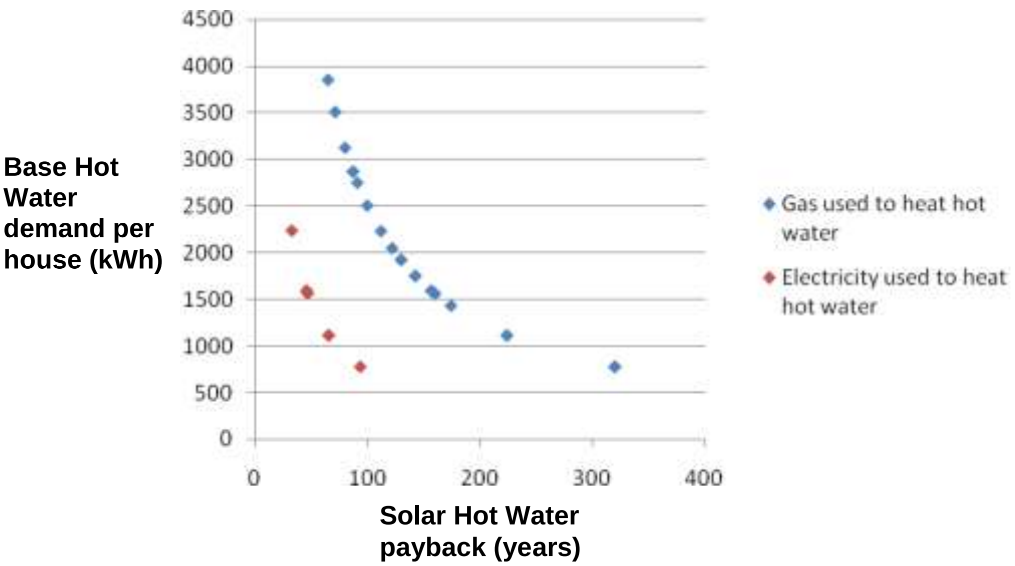


Figure 23: Merton model solar hot water heating results summary: modelled payback time for solar hot water plotted against total hot water demand per house

RESULTS

[7] 35-100 year paybacks typical based on figures from http://www.energysavingtrust.org.uk/Generate-your-own-energy/Solar-water-heating: "Costs for a typical solar water heating system range from £3,000 to £5,000. Savings are moderate - a solar water heating system can provide about a third of your hot water needs, reducing your water heating bill by between £50 and £85 per year".

Cavity Wall Insulation

From a strategic point of view cavity wall insulation is rather like insulation of empty lofts: it is a 'super measure' in terms of cost effect in reducing carbon emissions and fuel bills. However, the saving per measure combined with total potential in Merton results in its total carbon saving potential in the borough being only about 2% of the borough's total estimated domestic carbon footprint.

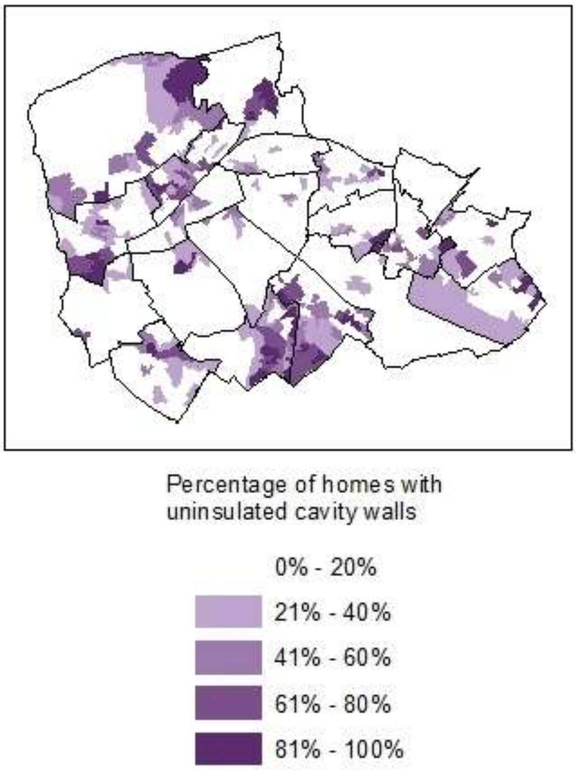
Compared with measures like solid wall insulation and behavioural change the measure might be expected to have relatively few barriers to installation, especially as it can be installed very cheaply (or free) in less than a day from the outside of a home.

Based on this we would suggest that the remaining cavity walls in the borough should be insulated in the next few years while the preparations are made to roll out the installation of more difficult measures with greater total potential.

Uninsulated cavity walls in the borough are found in homes built from about 1880 onwards, although they are rare in homes built before 1930 and only become the norm in homes built after 1935. Cavities as recent as 1981 can have extra insulation added although cavity walls built from the late 1970s will probably have some insulation already in place. Some cavities cannot be insulated due to cold bridging difficulties, narrow cavities, or construction methods that impede installation, but we have made the assumption that the numbers of such properties are negligible in Merton (although the model can be updated appropriately should appropriate data become available).

Based on our survey we believe that of the 16,500 or so homes in the borough of suitable wall construction, only about 3,500 have been insulated. It seems that similar proportions of houses and flats have been insulated. However, the geographical distribution of the installations made to date is very interesting, and is shown as a map in Figure 24 below, and by ward in Table 7 below.

It seems that the houses with walls of cavity construction suitable for post-insulation are distributed broadly as might be expected from the age of the housing stock (see section 4), but there has only been significant post-insulation in the South of the borough. This may be a result of the patterns of social housing in the borough (which may have had access to attractive grant funding for cavity wall insulation for the last several years), or linked to patterns of promotion of the measure in the past, by installers or other organisations.



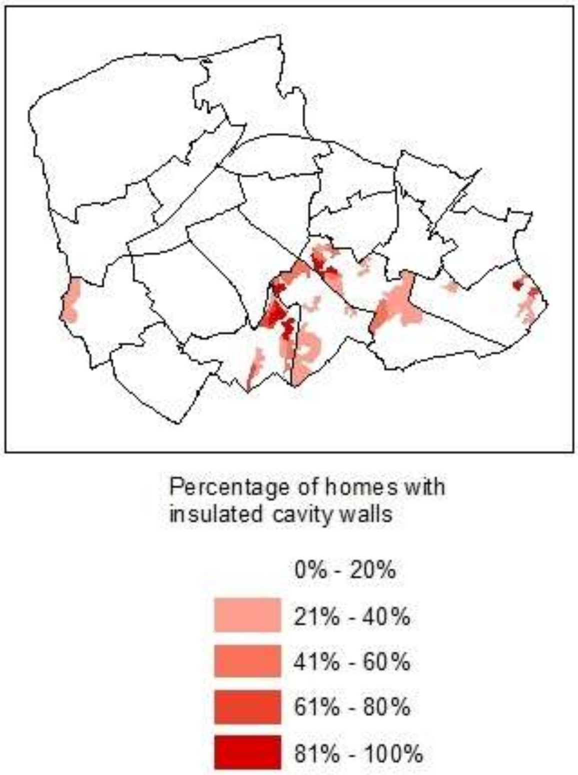


Figure 24: Percentage of the housing stock mapped by Census Output Area with insulated and uninsulated cavity walls built before 1982

Ward	Percentage of homes with uninsulated pre-1982 cavity walls	Percentage of homes with post-insulated pre-1982 cavity walls
Ravensbury	45%	17%
St Helier	45%	24%
Hillside	41%	1%
Figges Marsh	40%	1%
Village	35%	1%
Pollards Hill	30%	11%
Raynes Park	24%	0%
Lower Morden	22%	0%
Lavender Fields	17%	0%
Longthornton	17%	1%
Colliers Wood	13%	1%
Wimbledon Park	13%	0%
Abbey	11%	1%
Merton Park	10%	0%
Dundonald	9%	0%
West Barnes	9%	4%
Trinity	8%	0%
Cannon Hill	7%	0%
Cricket Green	3%	28%
Graveney	2%	0%

Table 7: Percentage of the housing stock with insulated and uninsulated cavities by ward in Merton

Draughtproofing

Draughtproofing of windows and doors might be regarded as a relatively minor measure: we estimate that it has the potential to reduce Merton's domestic footprint by just under 0.5% with a typical payback to the householder of about 10 years.

Glazing

Glazing is an expensive measure compared with the cost and carbon associated with the heat lost through windows. With a typical payback well over 100 years and a typical cost well over £10 per kg CO_2 saved we would not recommend that it be promoted as a major energy saving measure until other options have been explored.

However, there may be other reasons for upgrading glazing, and given that there is potential to reduce Merton's domestic footprint by as much as 4% if all homes in the borough were upgraded to modern double-glazing there may be value in monitoring glazing installation levels in Merton.

4.3 INSTALLATION OF GROUPS OF MEASURES IN INDIVIDUAL DWELLINGS

In this section we have sought to investigate the levels of likely investment required by householders for installation of packages of measures chosen based on payback period. We have used the measures considered in previous sections of the report with the exception of:

- Behavioral measures (which are free!)
- More expensive solid wall insulation options: we have assumed that all householders will go for the more cost effective option of 50mm PIR internally

The sections in this report below summarise and quantify the levels of potential for such packages of measures.

4.3.1 Loan Size and Benefit per House for different durations

This section considers the level of investment likely to be possible, and the level of return that would be expected for various packages of measures defined by maximum payback period. Figure 25 below shows the variation in maximum investment that would be required for various types of measure package defined by maximum payback time. Note that the paybacks used for this analysis are calculated for the individual householder: this means for example that a householder with a high heating temperature and long heating periods might be able to achieve relatively shorter paybacks for heating or insulation measures compared with the average for those measures.

Table 8: overleaf shows the average investment, annual carbon savings and annual fuel bill savings for a number of packages defined by varying maximum payback times for component measures.

It is clear from the table and the figure that most homes in the borough will be able to access some measures, and that the low payback measures (such as light bulbs and loft insulation) make the total payback of the packages generally much more attractive than their threshold payback.

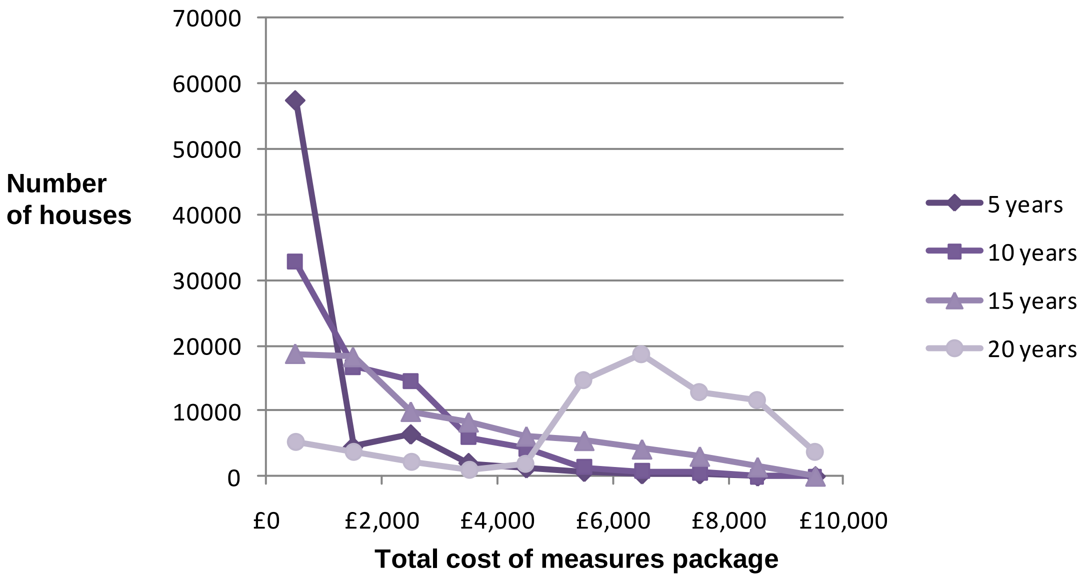


Figure 25: Numbers of homes against estimated package cost for various cut-off payback times for measure selection

Maximum payback for measures	Count of homes where measures are possible	Average cost of installing measures	Average annual fuel bill saving per home	Average annual carbon saving per home (tCO_2)	Potential reduction in borough's domestic carbon footprint
5	73008	£638.35	£290	1.5	23.00%
7	75360	£1,137.95	£350	1.8	28.50%
10	76743	£1,512.59	£380	2	30.70%
12	77765	£1,972.69	£660	2.5	33.70%
15	77905	£2,184.98	£680	2.5	34.60%
17	77917	£2,306.11	£690	2.5	34.90%
20	77926	£5,928.08	£700	2.4	38.50%

Table 8: Average investment, annual carbon savings and annual fuel bill savings for a number of packages defined by varying maximum payback times for component measures

4.3.2 What measures will be recommended?

Figure 26 below shows what measures are likely to be included in packages based on various maximum payback times
Figure 26.

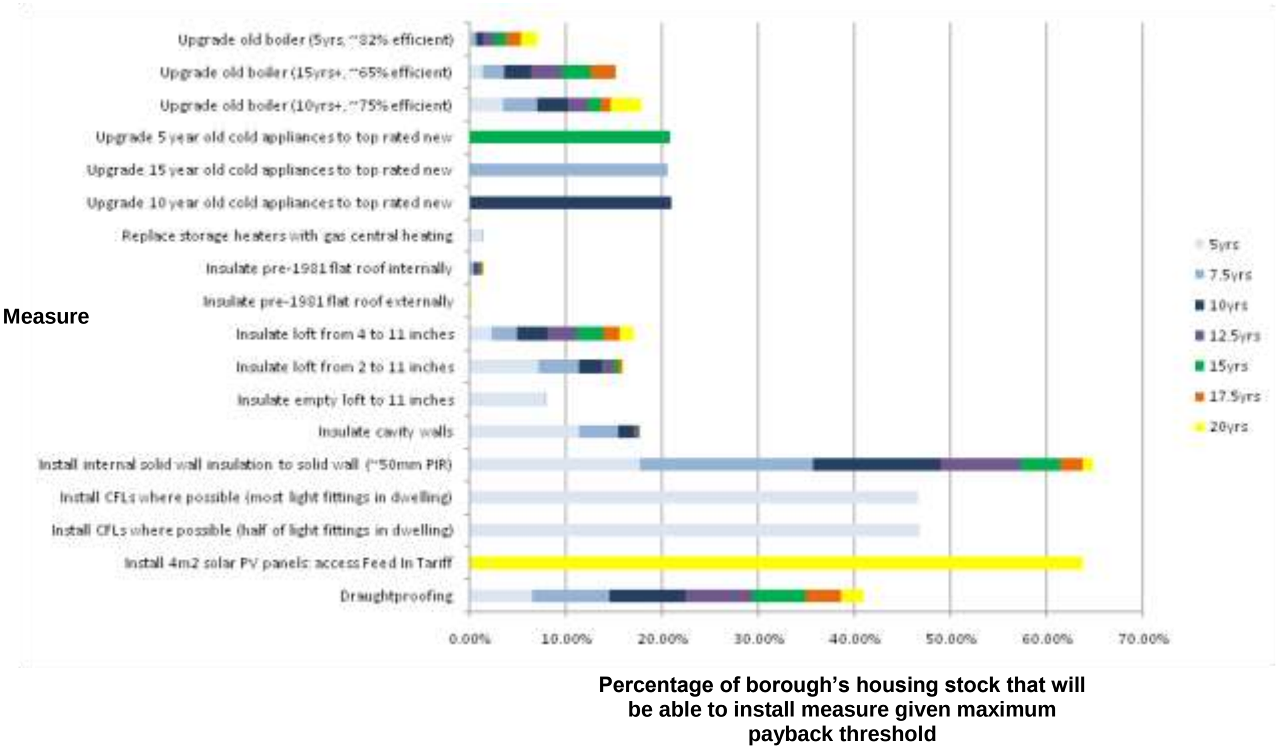


Figure 26: Proportions of houses in the borough that will be recommended a particular measure for different PAYS payback periods

RESULTS

5 Future Steps

This section looks at areas of potential for building on the data collection and analysis work described in this report. It does not include recommendations for strategic or tactical approaches to reducing the carbon use of housing stock in LB Merton, which would be outside the scope of this report.

The approach we have taken has been designed with scalability in mind. In line with this philosophy:

- the data that has been collected is linked to specific properties so that future work can build on and refine this data rather than having to re-collect a sample of data.
- the analysis made assumptions about various property characteristics (such as heating pattern), but assumptions are clearly marked as such so that they can be clearly distinguished from actual data points.

As a result we expect that any future potential estimation or progress-monitoring work by Parity or other consultants will be able to link new data collected through the course of the project or through subsequent surveys with the dataset collected during the exercise described by this report.

In particular:

- information about measures installed might be incorporated into a model to allow progressive estimation of savings achieved.
- improved data (especially about energy related characteristics not visible to a street surveyor) might be incorporated in order to allow the baseline (and current progress estimates) to be retrospectively re-calculated to a greater level of accuracy.
- Parity has used figures about 'typical' dwellings of each type in the modeling. Detailed assessments of additional individual dwelling types common in the area (such as the Wimpey homes already assessed) would allow more accurate savings to be calculated for more unusual measures, or more unusual dwelling types.

In line with this we might recommend that ongoing project activities be designed with these considerations in mind so that outreach activities (for example) cost-effectively incorporate data collection that will improve the data integrity of the baseline estimation and progress monitoring.

6 Conclusions

The main conclusion from this report is that to reduce the domestic carbon footprint of Merton, behavioral measures and solid wall insulation look to be the most important measures if savings in the order of 60 - 70% are to be achieved most cost-effectively. Both measures present challenges, but have the potential to be important for making large carbon savings in the timescale of the next decade or so. Other important measures include solar PV (if a Feed In Tariff becomes available), efficient lighting, and boiler replacement.

Cavity wall insulation and loft insulation (of empty lofts) are both very cost effective, but only have potential to save about 4% of the borough’s total domestic carbon footprint. Therefore, while they are measures that should not be ignored over the next few years, they are not especially strategically important measures for longer term achievement of serious carbon savings for the borough. Loft top-up insulation has lower total carbon saving potential (less than 1%) and a cost effect comparable to boiler replacement in terms of payback (about 6-15 years).

A future “pay as you save” (PAYS) scheme could address non-behavioral measures. A scheme that offered up to £10,000 per home for measures with individual estimated paybacks less than 15 years might be expected to deliver average carbon savings per home of about 2.5 tonnes (~38%) for an average investment of about £2,200 per house and a typical combined payback of just under 10 years. However, savings larger than about 35% would probably be difficult without behavioral measures, and it should be noted that the spend per house would vary significantly from the average figure.

Appendix A: Parity Domestic Retrofit Energy Model (DREM)

Parity's Domestic Renovation Energy Model uses data about building characteristics and resident behaviour to derive an accurate estimate of the annual energy and carbon usage of a dwelling. It then applies an initiative algorithm to derive the cost, savings and payback of a very wide variety of possible carbon saving measures tailored specifically based on their applicability to the individual dwelling and to the preferences and requirements of the resident (or client). Costs can be based on dwelling characteristics (e.g. wall insulation can be based on the sum of a flat rate and a per m^2 wall area) and so are realistically applied to each building in turn. The cost rates are derived from our experience of carrying out the work, but can be revised for any situation, for instance where a social landlord framework contractor is in place or a local authority has negotiated a local contract.

In addition, it allows custom initiatives to be applied: this functionality allows any realistic change to the building to be model, and affords a great deal of flexibility in allowing for future scenarios such as extensions or emerging innovative measures.

The calculations used by the model is based on BREDEM8, but uses with supplementary information from sources including CIBSE Guide A and MTP to cover aspects of energy use outside the current scope of BREDEM such as floor heat losses and appliances. The model differs particularly from other available models mainly by its completeness, applicability to existing buildings, and by inclusion of building data specific to the resident such as appliance usage, lighting, heating pattern and temperature: these features allow it to evaluate retrofit recommendations fully and in context for the individual resident.

The model is used for stock assessment by deriving assumptions about individual dwelling details (such as wall area, window area, etc) from basic house characteristics (such as number of bedrooms, number of storeys, etc) from the English House Condition Survey. Where details are unknown (e.g. loft insulation, heating pattern, heating temperature) assumptions are made based on expected proportions of houses with a particular characteristic. Where possible, this is done based on data from the area, such as EST Home Energy Checks. Where this is not possible assumptions can be made using other data sources, or based on sensible estimates. The assumptions made for the analysis of Merton are stated in the report.

DREM used for stock assessment produces estimated current fuel use for every dwelling considered in an area, in parallel with estimated fuel use and typical installation cost for every energy/carbon saving measure that can be applied to each dwelling. The model outputs can be used to derive cost savings, carbon savings, paybacks and so on. It should be understood that as the model outputs are based on assumptions, they should be used primarily as a strategic tool: outputs for individual dwellings will have limited applicability. However, we believe that the model has good strategic applicability over wider areas. This report is based on analysis of such an output for the London Borough of Merton.

Appendix B: pricing framework used to generate estimated costs for each measure

Initiative	Cost
Draughtproofing	£90 (flat rate)
Install 4m2 solar PV panels	£3,500 (flat rate)
Install CFLs	£4 per CFL needed (lamps per house estimated based on dwelling type/size)
Install external solid wall insulation to …	£90 per m^2 wall area (Wall area estimate based on dwelling type/size)
Install internal solid wall insulation to … (~100mm PIR)	£36 per m^2 wall area
Install internal solid wall insulation to … (~50mm PIR)	£25 per m^2 wall area
Insulate cavity walls	£300 (flat rate)
Insulate empty loft to 11 inches	£250 (flat rate)
Insulate loft from 2 to 11 inches	£300 (flat rate)
Insulate loft from 4 to 11 inches	£300 (flat rate)
Insulate pre-1981 flat roof externally	£160 per m^2 roof area (Roof area estimate based on dwelling type/size)
Insulate pre-1981 flat roof internally	£31 per m^2 roof area
Solar hot water (4m2 flat plate)	£3,500 (flat rate)
Upgrade … old cold appliances to top rated new	£350 (flat rate)
Upgrade old boiler	£1,600 (flat rate)
Upgrade … to new double glazing	£500 per m^2 window area (Window area estimate based on dwelling type/size)

Appendix C: payback adjustments for various assumed fuel inflation scenarios

If cost of fuel increases faster than inflation, the actual effective paybacks might be lower than those provided in the report above (where it is assumed that fuel prices will stay steady in real terms).

This appendix provides a tabular guide for how paybacks might be expected to vary in various scenarios where fuel prices rise faster than inflation. For simplicity we have rounded payback periods to the nearest year.

Annual fuel tariff increase (above inflation)	Payback (years)																
0%	1	2	3	4	5	6	7	8	9	10	15	20	30	40	50	75	100
1%	1	2	3	4	5	6	7	8	9	10	14	18	26	34	41	56	69
2%	1	2	3	4	5	6	7	7	8	9	13	17	24	29	35	46	55
3%	1	2	3	4	5	6	6	7	8	9	12	16	21	26	31	40	47

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