element energy

Green Deal Household Model Assumptions Document

for

DECC

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Contents

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Caveat

The outputs of the Green Deal model rely entirely on the inputs entered into it and results must always be carefully considered and challenged in the context of the model inputs, in order to confirm their validity. Element Energy does not accept any responsibility for the misuse of Green Deal model results or any subsequent losses which may arise.

Additionally, due to the innovative nature of the Green Deal policy and the lack of historical data for calibration, it has not been possible to validate the consumer choice coefficients used in the uptake model against real-world data. We therefore strongly recommend that further data are collected on real-world uptake of Green Deal measures, perhaps through the on-going trials by the energy companies, to allow calibration of the consumer behaviour within the Green Deal model. This work should be done periodically to ensure that the modelling reflects changing consumer attitudes, for example as they become more familiar with the Green Deal offer and the measures themselves.

The analysis involves a very high degree of segmentation within the English House Condition Survey, Scottish House Condition Survey and Living in Wales surveys, and assumptions on the treatment for ‘missing’ data. The user should not rely on the properties for individual segments with very low populations – in these cases sampling distortions may be material.

1 Introduction

DECC's Green Deal policy will allow consumers to have energy efficiency measures fitted to their home, without the need for a significant capital outlay. The capital cost of the measure(s) to be installed will be paid off through a charge attached to the property, with the charge payments covered by the fuel bill savings achieved (the up-front cost of the most expensive measures may be partially subsidised by either a consumer contribution, or a top-up from the new post-2012 Energy Company Obligation). Measures are only considered applicable for installation if the fuel savings can meet or exceed the charge payments – this is the 'golden rule' of the Green Deal.

In order to understand the implications of the Green Deal on UK domestic energy demand and the likelihood of success of this innovative policy on the uptake of energy efficiency measures, DECC has commissioned an extensive consumer survey to assess the attitudes of consumers to different Green Deal configurations and measures. Element Energy and Cambridge Architectural Research were subsequently commissioned to produce a model of consumer uptake under the Green Deal, based on the survey results.

The DECC Green Deal model is designed to predict the uptake of various energy efficiency measures in the UK domestic sector, under different Green Deal policy configurations. It allows the user to vary the offer to the consumer for different technologies, by modifying the upfront cost contribution, the audit contribution, the length of the Green Deal financing, the contribution from the Energy Company Obligation and the fuel bill savings retained.

As such, it allows users to model the effect of energy companies choosing to subsidise the cost of the installation, or customers paying varying amounts towards the remaining installation cost. There are a total of 9 measures on offer which consist of the following technologies and combinations thereof:

1. SWI internal
2. SWI external
3. CWI
4. Loft top up
5. Gas boiler

The model includes 1582 typical GB house types (determined from a breakdown of the GB Housing Condition Surveys) and outputs from the SAP 2005 energy model to predict a reduction in energy requirements from the application of Green Deal measures to individual homes. These can then be translated into annual fuel bill savings, social benefits, etc.

The model uses a Logit-based methodology to allow consumers in each house type to make a choice between measures which are suitable in a given house type and which meet the Green Deal 'golden rule' (i.e. fuel bill savings exceed the repayments). The consumer behaviour in the model is based on a choice experiment within the Green Deal survey. The outputs of the choice modelling are used to predict the uptake from competing technologies under a range of Green Deal configuration.

2 Assumptions

2.1 Energy demand and SAP rating

The annual heating and electricity demand for the GB housing stock is calculated using a SAP 2005 methodology. This also provides the SAP rating for all the house types. This is done for the baseline as well as with the installation of the measures in the suitable house types.

The U values for the baseline scenario are:

a) Solid wall – 1.97
b) Unfilled cavity pre 1980 – 1.52
c) Unfilled cavity post 1980 – 0.53
d) Filled cavity – 0.47
e) Loft < 150 mm – 0.75
f) Loft > 150 mm – 0.26
g) No loft – 0.

The U values after the application of measures are:

a) SWI (internal/external)– 0.33/0.33
b) CWI(pre 1980/ post 1980) – 0.44/0.29
c) Loft – 0.15.

The efficiency of the heating system when a boiler upgrade is installed is assumed to be 90%.

2.2 Logit coefficients

The logit coefficients used to predict the uptake of measures are based upon the consumer survey conducted by GfK. Based upon the responses, the attitude of consumers towards perceived costs of upfront installation cost, audit cost, fuel savings, Green Deal contract length, interest rate and measures was quantified using a statistical analysis.

2.3 Fuel calibration factor

The total fossil fuel and electricity use of the GB housing stock is calibrated based upon the DUKES 2007 data.

3 Analysis of consumer survey

This section provides further detail on the derivation of the consumer coefficients at the heart of the Green Deal uptake model. It describes the steps taken to process the choice experiment results from the Green Deal survey and investigate how the consumer attitudes vary across the population.

3.1 Outline of process

The following steps were used to derive the final set of consumer coefficients used in the model:

1. Estimate a global model based on the 'forced choice' responses of all respondents (i.e. where respondents were not allowed to select 'none' as one of the options).
2. Test the effects of demographic and attitudinal variables captured in other parts of the survey, such as income, super priority versus non-priority group, environmental awareness.
3. Investigate non-linear relationships between the survey attributes, for example a disproportionate reaction to repayment terms over 20 years. Confirm that inclusion of these non-linear terms in model improves the 'goodness of fit'.
4. Select the segmentation and which provides the best fit for the data, including the non-linear attributes from Step 3.
5. Use the free choice data (i.e. the questions that allowed respondents to select 'no purchase') to estimate a final model that correctly predicts the relative uptake of each measure and the 'none' choice.

This final set of coefficients is then implemented in the Green Deal model. These can be viewed in the model on the 'Advanced Settings' page, as well as in Section 7.1 of this document.

3.2 Selection of the 'base' model

The choice model was initially estimated assuming linear effects for all attributes, to provide a 'baseline' model against which more complex models can be compared. A linear effect for an attribute implies that doubling its value doubles the contribution that it makes to the overall 'utility' or attractiveness of a Green Deal package to consumers. In other words, a further implication is that an increase of, for example, £50 per year in energy bill savings always has the same effect on the attractiveness of the measure whether the increase is from £100 to £150 or from £300-350.

The interest rate policy (whether it is fixed or variable) was not coded in a linear way in the base model, since there is no reason to expect fixed interest rates to be twice as attractive as variable rates. Instead, we calculate the attractiveness of the variable rate relative to fixed rates.

3.3 Consumer segmentation

We tested a large number of demographic and attitudinal variables and their interaction with the choice data. These included:

- Environmental attitudes ("I'm environmentally friendly in most or all the things I do")
- Solid wall versus other measures
- Moving house within 3 years
- Owner occupier / private renters
- Household income

- ‘Likely to take up the Green Deal’
- Respondents who find home ‘hard to heat’
- Eligibility for Affordable Warmth support.

For several of these variables, such as ‘moving house’ or environmental attitudes, there was an insufficient number of respondents in one of the categories to allow estimation of coefficients for each of the Green Deal attributes. Other variables, such as the owner occupiers versus private tenants, did not show statistically significant differences in consumer response.

Of the variables tested, splitting the sample according to eligibility for Affordable Warmth (AW) support provides the largest improvement in the model fit while allowing the calculation of statistically significant coefficients for all the Green Deal attributes. Using this segmentation has a further advantage that it matches the segmentation of the housing stock within the Green Deal model, allowing the mapping of all house types to one of two sets of coefficients.

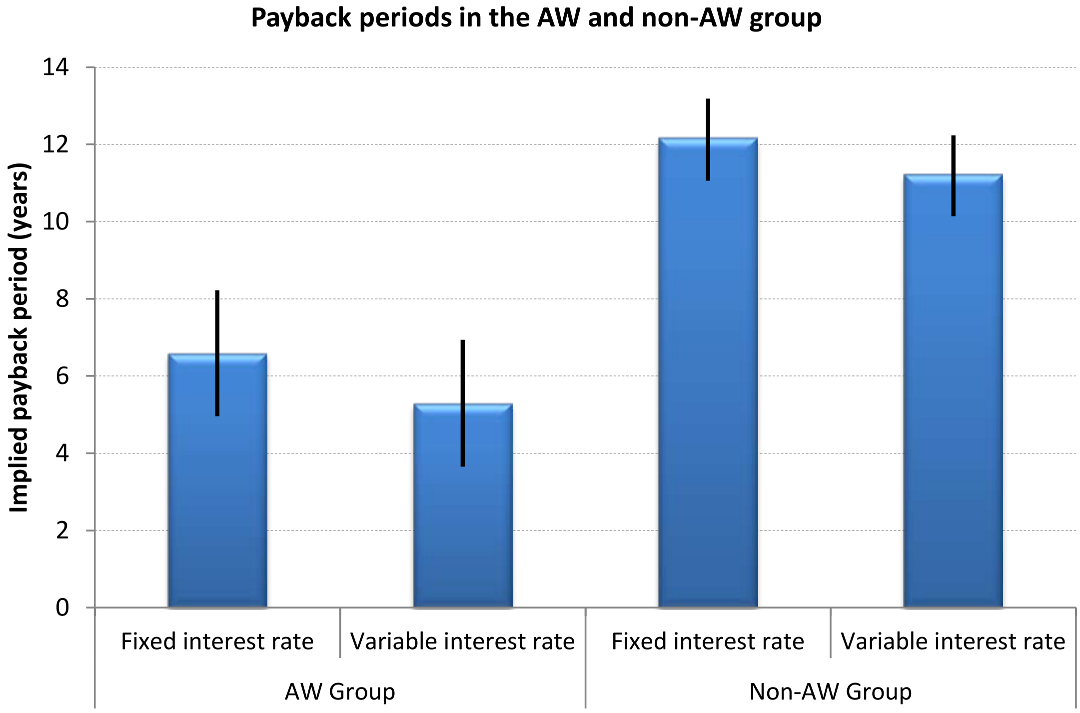
3.4 Consumer response to the Green Deal offer

While the main purpose of the choice experiment is to allow the prediction of market shares for each of the measures, it also provides insight into consumers’ responses to the underlying attributes in the Green Deal, such as the type of interest rate (fixed or variable), the level of upfront cost, the cost of the assessment, the payback period and the net bill savings.

3.4.1 Consumer time horizon

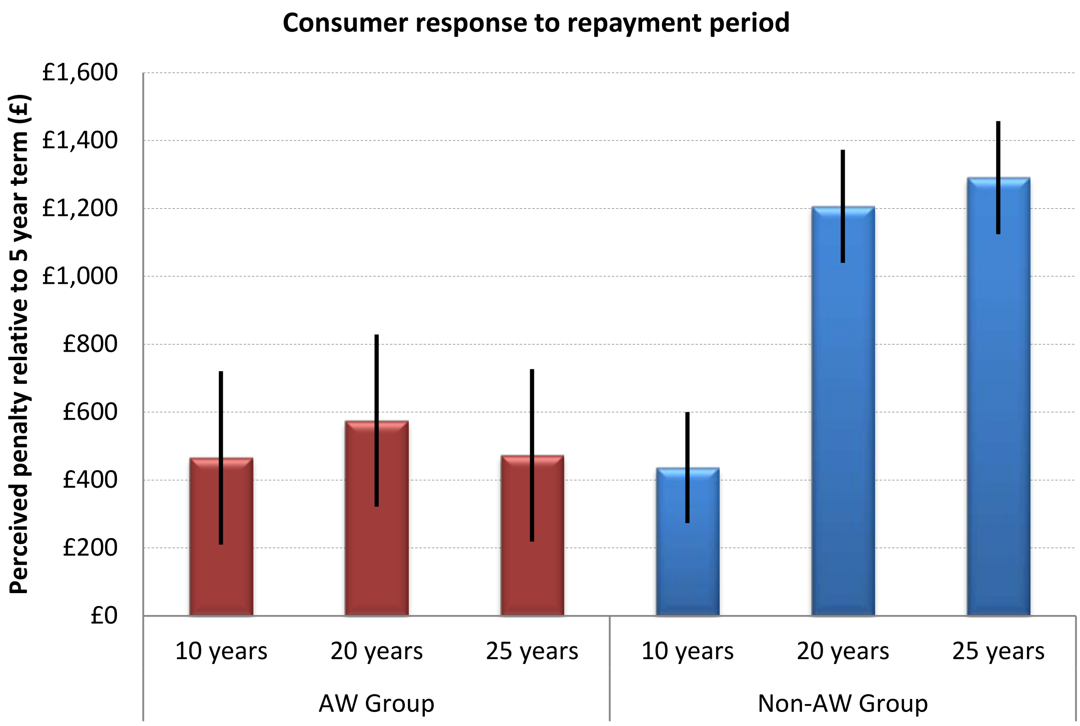
The first of these attributes is the ‘time horizon’ that consumers use when evaluating future energy bill savings. This is a critical factor in the perceived attractiveness of measures; if consumers value only, say, three years of energy savings, the package is unlikely to be attractive, especially if they are required to make an upfront contribution to the measures. On the other hand, if consumers value savings ten years or more into the future, this is likely to offset the cost or hassle of having measures installed.

The figure below shows the implied time horizons (or payback periods) for the non-AW and AW groups. The survey data suggest an interaction between the time horizon and the interest rate policy, with consumers showing a shorter time horizon when interest rates are variable. While this effect is relatively small (reducing the time horizon by approximately 1 year in both groups) it captures the risk of rising interest rates eroding future energy bill savings under a variable rate scenario, and is included in the Green Deal model.



3.4.2 Repayment term

The survey results show a highly non-linear response to the repayment term (the length over which the charge is applied to the property), as well as a large difference between the AW and non-AW group. In all cases, the 5 year term is the most attractive, with longer periods perceived as less attractive. The figure below shows the perceived 'penalty' of payment terms *relative to a 5 year term*.



In the AW group, there is no significant difference in the response to payment terms of 10, 20 or 25 years. This suggests that these respondents were willing to be tied into longer deals as long as they are making savings on their energy bills. In contrast, in the non-AW group there is a strong aversion to payment terms of 20 or 25 years. This suggests that non-AW group would be willing to use their own money (as upfront contributions) in order to reduce the repayment period, so that they could then benefit from the full energy bill savings after the end of the finance deal. This must be balanced with the fact that longer terms allow the expensive technologies (such as solid wall insulation) to meet the 'golden rule'. In other words, there is a trade-off between the consumer aversion to long payback periods and ensuring that the charge does not exceed the energy bill savings.

3.4.3 Interest rate policy

The interest rate coefficient (fixed or variable rates) was not statistically significant for either of the consumer groups when included in the model as a separate attribute. However, as shown above, there is an interaction between the interest rate policy and the energy bill saving attribute.

It is worth noting that although the consumer response to the interest rate policy itself is weak, the interest rates also influence the value of the repayment under the Green Deal and hence the net energy bill saving, to which consumers respond more strongly. In the limit, a high interest rate reduces the number of homes where the 'golden rule' is met (and hence where the Green Deal is applicable), so it remains an important variable in the model.

3.4.4 Response to the 'measure' attribute

In addition to aspects of the financial proposition, the choice experiment also tested the consumer response to the measures themselves. In other words, it quantified the relative attractiveness of cavity wall insulation versus loft insulation (all other things being equal). These responses reflect biases against certain technology, due to a lack of familiarity or the hassle of having them installed, for example for internal SWI.

As expected, internal solid wall insulation has the highest 'penalty', which is only slightly lower if fitted during a house refurbishment. Cavity wall insulation, boiler upgrades and loft top-up all have much lower penalties. Note that all measures have a penalty as this reflects their attractiveness *relative to no purchase*, before taking into account the benefit of the energy bill savings.

In the Green Deal model, the uptake module calculates the actual attractiveness of each measure, taking into account the measure-specific penalties as well as the financial attributes such as energy bill savings, audit cost, repayment term etc. However, it should be noted that the overall attractiveness of the package remains negative (even taking into account the energy savings) for most house types. This implies that the negative attitudes towards the measures as well as the Green Deal package are critically important in determining the attractiveness of the whole package. It is this component of consumer behaviour which could show significant change in the future as householders become more familiar with the measures and Green Deal policy.

3.5 Model calibration

Having calculated the consumer coefficients for each of the Green Deal attributes for the AW and non-AW group respondents, a final step is required to generate the correct market shares for each measure relative to the 'no purchase' option.

To do this, the values of all coefficients were fixed based on the 'forced choice' model, where respondents were forced to choose one of the measures on offer, and a new model was estimated using the 'free choice' dataset, where they were able to select 'no purchase'. This approach ensures the use of as much data as possible to understand the response to individual attributes (because choice questions where respondents pick 'no purchase' provide no information on how they traded off the various measures), while predicting the correct market shares of all measures and the no purchase option.

3.6 Caveat – the need for real-world uptake data

It is important to note that in the majority of choice models, stated preference data is combined with 'revealed preference' data on real-world uptake to create a final, calibrated model. This step removes the effect of survey biases, such as the fact that people are generally more willing to spend hypothetical money in surveys than their own money in the real-world. The Green Deal survey is a rare case where historical uptake data are not available, meaning that calibration based on revealed preference data is not possible.

In light of the above, we strongly recommend that further data are collected on real-world uptake of Green Deal measures, perhaps through the ongoing trials by the energy companies, to allow calibration of the consumer behaviour within the Green Deal model. This work should be done periodically to ensure that the modelling reflects changing consumer attitudes, for example as they become more familiar with the Green Deal offer and the measures themselves.

4 Housing Stock Segmentation

There are four physical parameters of primary significance for Green Deal domestic energy modelling purposes and one for consumer behaviour towards perceived costs, which include:

a) The type / size of dwelling
b) The primary central heating system / fuel used
c) The external wall properties
d) The level of loft insulation
e) Tenure / AW eligibility.

These parameters have been categorised into 10, 16, 4, 3 and 2 categories respectively. This gives a total 3,840 physical typologies that the 16,150 representative dwellings from the 2008 English Housing Survey (EHS) could be assigned to. The typologies were assigned as follows:

1. The type / size of dwelling - EHS data used:

a) Derived\physical\dwtype7x
b) Raw Physical\Services\finlopos
c) Derived\physical\floorx
d) Derived\general\aagpd78

“dwtype7x“ categorises dwelling as end terrace, mid terrace, semi-detached, detached, purpose built flat, converted flat or non-residential plus flat. The non-flat data was used to assign dwellings as (1) detached, (2) semi/end terrace, and (3) mid-terrace.

“finlopos” identifies the position of a flat within a property, therefore it was combined with “dwtype7x“ to identify (4) top-floor flats and (5) non-top-floor flats.

“floorx” gives total floor areas, whilst “aagpd78” provides the weighting for each of the 16,150 representative properties – such that the total weighting equates to the 22 million + dwellings in England. Combining “floorx” and “aagpd78”, and categorising each dwelling into one of the five types stated above enabled us to determine the median floor area for each type. Using “floorx” the dwellings were then assessed to determine whether the floor area was above or below the median point for each of the five types – thus the representative dwellings were assigned to one of the ten type/size (small or large) categories.

2. The primary central heating system / fuel used - EHS data used:

a) Derived\physical\mainfuel
b) Derived\physical\boiler
c) Derived\physical\heat7x
d) Raw Physical\Services\fingasms
e) Raw Physical\Services\fingaspr
f) Derived\physical\fuelx

“mainfuel” categorises the main fuel used for central heating; “boiler” categorises the type of boiler; “heat7x” categorises the type of heating system; “fingasms” identifies whether there is a mains gas supply; “fingaspr” identifies whether there is gas present in the dwelling; “fuelx” categorises the main fuel type.

This data is assessed to determine whether or not there is mains gas at the dwelling and to identify the main fuel used for heating, and the type of boiler or lack of a central heating system. This information was combined to assign each representative dwelling to one of the sixteen heating system categories: (1) Mains gas condensing with CH (2) Mains gas non-condensing with CH (3) Mains gas non-condensing without CH (4) Oil condensing no gas connection (5) Oil non-condensing with mains gas (6) Oil non-condensing no gas connection (7) Electric heating with mains gas connection and with CH (8) Electric heating with mains gas connection without CH (9) Electric heating with no gas connection (10) Solid fuel with mains gas connection with CH (11) Solid fuel with mains gas connection without CH (12) Solid fuel with no gas connection (13) LPG/bottled gas condensing with no gas connection with CH (14) LPG/bottled gas non-condensing with mains gas connection with CH (15) LPG/Bottled gas non-condensing no mains gas with CH (16) Community heating/

3. The external wall properties - EHS data used:

a) Derived\physical\wallinsx
b) Derived\physical\ dwage5x

“wallinsx” identifies whether a dwelling is a filled or unfilled cavity, or not a cavity wall; “dwage5x” categorises the age of the dwelling.

This data is combined to identify which wall category each dwelling should be assigned to: (1) filled cavity, (2) unfilled cavity pre 1980, (3) unfilled cavity post 1980, or (4) solid wall & other.

4. The level of loft insulation - EHS data used:

a) Derived\physical\ loftins4

“loftins4” identifies whether (1) there is loft insulation less than 150mm, (2) there is loft insulation greater than or equal to 150mm, or (3) there is no loft. These are our three loft insulation categories.

On this basis the 16,150 representative dwelling could be assigned to one of the 3,840 Green Deal physical typologies. We then have a new sample of representative dwellings, comprising up to 3,840 typologies each with a weighting, such that the total weighting still equates to the 25 million + dwellings in GB.

In addition, two attributes were defined relative to the occupancy of the stock, these were

- AW eligibility (two levels: eligible or not)
- Tenure (three levels: owner occupied, privately rented, or social landlord).

For details on the precise methodology used to undertake the breakdown of the English, Scottish and Welsh housing stocks, see the Appendices in Sections 14, 15 and 16 below.

5 Imputed House Parameters for SAP

The physical component of the SAP2005-based domestic energy model is populated with Green Deal representative dwellings as determined by the process outlined above. Although we know the physical properties for each of the GD dwellings for the four primary parameters, we further need to establish values for the remaining physical parameters required to run the domestic energy model – this is the imputation process.

The main approach used for the imputation process was the calculation of weighted averages for each Green Deal representative dwelling. For any given parameter we know the Green Deal typology for each of the 16,150 representative EHS dwellings and the associated EHS weighting. Therefore for any representative Green Deal dwelling we can assess the corresponding EHS dwellings and, for any given parameter, determine a weighted average for the value of that parameter. This value is then used as the value for this parameter, for this Green Deal dwelling, in the Green Deal domestic energy model. This approach was used to determine the following values:

Total floor area (m^2): A single Total Floor Area (TFA) is used for the TFA for each of the ten Green Deal dwelling type / sizes. These values are based on weighted average calculations using the 16,150 representative dwelling in the EHS derived physical dataset "floorx ", cross-referenced against our ten type / size types.

Living area fraction (0 to 1): Used the Raw Physical\Interior EHS dataset "finrooms" to identify the number of habitable rooms for each representative dwelling and cross-reference this with the SAP 2005 RdSAP Table S16 to determine the living area fraction. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

Draught lobby (0=absent,1=present): Used the Derived\physical EHS dataset "dwtype7x" to identify the EHS dwelling type and cross-reference this against SAP 2005 RdSAP Table S5 to identify whether or not there is a draught lobby. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

No. of chimneys: Summed the four pieces of Raw Physical\Chimney EHS data on chimney numbers – front and back datasets for both "fexcs1no" and "fexcs2no". We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

No. of open flues: Used the Raw Physical\Services EHS dataset "finchbcd" to identify the "Primary heating appliance code" and determined whether this primary heating type has an open flue. We also used Raw Physical\Services EHS dataset "finohtyp" to identify whether the "Other heating system type" is "Mains gas fires - open flue". We then summed the flues for main and secondary system to determine a number of flues for each EHS representative dwelling. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

Percentage of doors & windows draught stripped: Combined the information in the Derived\physical EHS datasets "dblglaz2" and "dblglaz4" to estimate the percentage of windows that are double glazed. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

Gross external wall area (m^2): The calculation of the geometric features of each representative dwelling is quite involved.

Used the four Raw Physical\Interior datasets “finlivcl”, which provide ceiling heights for the living room, kitchen, bedroom and bathroom. We took the average of these values to determine an average ceiling height. To calculate storey height 0.25m is added to this average ceiling height, except for the lowest storey of the dwelling - as per SAP 2005 RdSAP S3.3.

Façade Calculations: We calculated façade areas based on dwelling width multiplied by storey height, and dwelling depth multiplied by storey height. To ensure that widths and depths are consistent with the floor areas stated in “floorx” we assume that those floor areas are correct and that the **ratios** of width-to-depth in the EHS Raw Physical\Shape datasets “fdhmwid1” , “fdhmdep1” “fdhawid1 “, “fdhadep1 “, “fdhmwid2”, “fdhmdep2”, “fdhmwid3”, “fdhmdep3”, “ fdhawid2”, “fdhadep2”, “fdhawid3” and “fdhadep3” are correct. Took basement and ground floor areas calculated using “floorx”, and the number of storeys in the property from Derived\physical\ dataset “storeyx” and the Raw Physical\Flatdets dataset “fdffloor. Then using appropriate width-to-depth ratios we calculated the lengths of all four sides of the dwelling. Multiplying these perimeter values by the storey heights give us the gross external wall area for each EHS representative dwelling. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

Door area (external) (m^2): Used the six Raw Physical\Doors EHS datasets, three “fexdf1no” and three “fexdf2no”, to identify the total number of external doors, and multiplied this by a default SAP door area to calculate the total external door area for each EHS representative dwelling. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

Windows area (m^2): The Raw Physical\Elevate datasets “felfenfw”, “felfenfv”, “felfenfn”, “felfenlw”, “felfenlv”, “felfenln”, “felfenrw”, “felfenrv”, “felfenrn”, “felfenbw: “, “felfenbv: “ and “felfenbn” provide percentages of the four external façades that are classed as walls, windows or voids. Based on the previous calculation of the façade area above ground for each of the four sides, this surface area can then be apportioned as walls, windows and voids, thereby determining the window area for each EHS representative dwelling. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

Roof area (m^2): Used “floorx” to establish the “Usable floor area”; for non-flats used the Derived\physical EHS dataset “storey” to identify the “Number of floors above ground” and for flats used the Raw Physical\Flatdets EHS dataset “fdffloor” to identify the “Number of floors in flat”. Used the Derived\physical EHS dataset “basement” to determine whether there is a “Basement present in dwelling” and if so used the four Raw Physical\Shape EHS datasets “fdhmwid1”, “fdhmdep1” “fdhawid1” & “fdhadep1” to determine the width and depth of the basement, and then to calculate the basement area. For each EHS representative dwelling the roof area is then calculated as follows: for non-flats it is the useable floor area minus the basement area, divided by the number of storeys, whilst for flats it is just the useable floor area divided by the number of floors in the flat. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

Windows U-value: See “Percentage of doors & windows draught stripped” for the determination of the level of double glazing in the property. On this basis the proportions of single and double glazing in the property are assumed. Used the Derived\physical EHS dataset “typewin” to identify the “predominant window frame type” and the SAP table 6e for “Window U-values (W/m^2K)” to cross-reference the glazing type against the frame type (wood, UPVC or metal). This determines the window U-value for each EHS representative dwelling. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

Ground floor U-value: The floor type is determined by analysing the Raw Physical\Introoms EHS datasets “finflrsf”, and identifying whether the living room and kitchen have solid floors. SAP Table S3 provides wall thickness for given dwelling age/wall construction type, so using the Raw Physical\Firstimp EHS dataset “fodconst” to determine the dwelling age and the Derived\physical EHS dataset “typewstr” to determine the “Predominant type of wall structure”, the wall thickness can be determined. Floor U-value calculations are taken from Reduced SAP section S5.4 and require the floor type and wall thickness data, so on this basis the floor U-value is determined for each EHS representative dwelling. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

Walls U-value: Each of the 16,150 EHS representative dwellings is assigned one of our four Green Deal wall categories, and using wall U-values for each of the EHS representative dwellings a weighted average was calculated for each of the four Green Deal wall categories. Each Green Deal dwelling is then assigned one of these four values as appropriate. The wall U-values for each of the EHS representative dwellings was calculated as follows: SAP Table S6 provides wall U-values (W/m^2K) for given dwelling age/wall construction type so using the Raw Physical\Firstimp EHS dataset “fodconst” to determine the dwelling age and the Derived\physical EHS dataset “typewstr” to determine the “Predominant type of wall structure”, the wall U-value can be determined for each EHS representative dwelling.

Roof U-value: Each of the 16,150 EHS representative dwellings is assigned one of our three Green Deal loft insulation categories, and using roof details for each of the EHS representative dwellings a weighted average was calculated for each of the three Green Deal loft insulation categories. Each Green Deal dwelling is then assigned one of these three values as appropriate. The roof U-values for each of the EHS representative dwellings was calculated as follows: the Derived\Physical datasets “typercov” and “typerstr” provide data on the type of roof, the Raw Physical\Services dataset “flithick” provides details of the thickness/presence of loft insulation, and the Raw Physical\Firstimp dataset “fodconst” gives the age of the dwelling. SAP Tables S9 and S10 are then used to cross-reference these parameters and give a roof U-value for each EHS representative dwelling.

No. of sides on which sheltered: Used the four Raw Physical\Elevate EHS datasets “felexpff”, “felexplf”, “felexprf” and “felexpbf” which specify the “Wall part of face unattached” for the front, left, right and back respectively, and counted the number of sides which are NOT unattached. This is taken as the number of sides sheltered for each EHS representative dwelling. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

Gross daily HW demand (litres): Used the Derived\interview EHS datasets “hhsizex” and “NDEPCHILD” to identify the number of occupants in the EHS representative dwelling. if this is unknown used the default SAP calculation for the number of occupants, based on dwelling floor area. Calculated the average HW usage per day using the SAP equation of 36 litres + (25 litres x No of occupants) for each EHS representative dwelling. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

Total (combined) HW cylinder volume (litres): Used the Raw Physical\Services EHS dataset “finwhsiz”, which is the hot water cylinder volume, to identify the cylinder volume for each EHS representative dwelling. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

No. of low energy light fittings/No. of standard light fittings: Used the five Raw Physical\Introoms EHS datasets "finhtglg" describing whether there is low energy light in the living room, kitchen, bedroom, bathroom and "circulation". Used weighting factors obtained from BREDEM-8 Section 4.2 "Low energy lights" for the proportions of the dwelling that contain low energy lighting, relative to each of the five categories (living room, …) identified. Combined these two pieces of data to determine the proportion of low energy light fittings for each EHS representative dwelling. We then used a weighted average calculation across the EHS data and matched our typologies to the EHS representative dwellings.

In addition to the use of weighted average calculations a number of specific calculations and/or default assumptions were used to determine values for the remaining parameters necessary for the domestic energy modelling:

Ground floor area (m^2): If the dwelling is a flat assume that this is equal to the Total Floor Area (TFA); otherwise assume that this is equal to half the TFA.

First floor area (m^2): If the dwelling is a flat assume that this is equal to the zero; otherwise assume that this is equal to half the TFA.

Second floor area (m^2): Assume zero for all.

Area of third and other floors (m^2): Assume zero for all.

Structural infiltration (air changes/hour): Assume 0.3 for all.

Suspended wooden floor (0=absent,1=sealed,2=unsealed): If the dwelling is a flat, and has either an electric boiler or no boiler (Majority electric) then assume suspended sealed; otherwise if solid/other walls assumed not suspended ; otherwise assume suspended unsealed.

No. of intermittent fans / passive vents: Assume zero for all.

No. of flue-less gas fires: Assume zero for all.

No. of storeys: If the dwelling is a flat then assume single storey, otherwise assume two storeys.

Type of ventilation: Assume "Natural ventilation or whole house positive input ventilation from loft" for all.

Roof-lights area (m^2): Assume zero for all.

Ground floor area (m^2): Assume the same as "Ground floor area (m^2)" above.

Doors U-value: Assume a value of 3.0 for all.

Roof-lights U-value: We assume there are no roof-lights so assume zero for all.

Air permeability (q50): ($m^3/m^2/hr$): assumed zero since there are no new builds.

Thermal bridging 'y' value ($W/m^2.K$): Assume a value of 0.15 for all.

Fuel type - secondary system (individual): Assume that there is no secondary heating for all.

Electricity tariff: Assume "standard tariff" for all.

Percentage of space heating on peak (only for heat pumps with non-standard tariff else N/A): Assume the default “N/A”.

Percentage of DHW heating on peak (only for heat pumps with non-standard tariff else N/A): Assume the default “N/A”.

Electric water heating (0 = none, 1 = single immersion, 2 = dual immersion): If the main heating system is electric assume that there will be an immersion, otherwise there won’t; if the “Total (combined) HW cylinder volume (litres)” is greater than 150 litres then assume it is a dual immersion, otherwise assume it is single.

PV panel peak power (kW): Assumed to be zero.

Panel orientation: N/A.

Tilt: N/A.

Over-shading: N/A.

% PV electricity exported to grid: N/A.

% reduction in HW demand through low flow fittings N/A.

Energy content of gross HW (kWh/yr): Uses the default SAP value.

Gross HW distribution loss (kWh/yr): Uses the default SAP value.

Water storage loss: declared loss factor (kWh/day): Assumed to be 1.5 for all.

Area of SHW panel (m^2): N/A.

Internal gains (W): Uses the default SAP value.

Type of heating system (1): If the main fuel is Electricity then assume “Electric Immersion Heater”, otherwise assume “Boiler with insulated primary pipe-work and with cylinder thermostat”.

Type of heating system (2) (ignore if micro CHP is selected): Assume “Boiler with radiators” for all.

Combi boiler type: Assume the default “N/A”.

Combi boiler storage volume, Vc (litres): Assume zero for all.

Heating system controls: Assume “Programmer + room thermostat + TRVs” for all.

Fraction of heat from secondary system: Assume zero for all.

Efficiency of secondary heating system: Assume zero for all.

Gas boiler pump (if fan-assisted flue): Assume that there is a boiler pump if the main fuel is Gas, otherwise assume there is no boiler pump.

6 Appendix A – Dwelling classification for England

Dwelling classifications to understand Green Deal Relevance were prepared in steps using the SPSS software PASW18 (release 18.0.0). The following EHCS 2007/8 databases were available at the time of the study: Interview.sav, General.sav, Physical.sav, Flatdets.sav, Services.sav, Chimneys.sav , and Energydims.sav.

As a first step, the above databases were merged using aacode as the common variable, and then the dwelling weighting aapgd78 was applied. This corrects for oversampling of social landlord tenures and scales this to the overall population of English dwellings. After applying this weighting, the final dataset comprises 22,239,398 English dwellings.

6.1 Four wall levels

As a second step, a new variable was defined for wall type combining wallinsx and dwage5x. A comparison of walltsructure and wallinsx identified that the overwhelming majority of all non-cavity wall buildings were in the categories 9" solid wall, greater than 9" solid wall, or mixed construction (i.e. buildings which had been further developed since original construction, possibly through extensions). A significant difference in U-values is identified in for unfilled cavity walls in dwellings built pre- and post-1980. Assuming that mixed wall construction build would need to be treated as solid wall for the purpose of insulation measures, a new variable was computed with four levels:

Table 1 Wall type levels (England)

Level	Description	Algorithm	Number in level	%
1	Filled Cavity wall	Wallinsx = 1	7417,720	33.4
2	Cavity wall unfilled pre-1980	Wallinsx = 2 & Dwage5x<5	5863122	26.4
3	Cavity wall unfilled post-1980	Wallinsx = 2 & Dwage5x=5	2209989	9.9
4	Solid (includes other non-cavity, non-masonry and mixed) walls	Wallinsx =3	6748567	30.3
		Subtotal	22239398	100%

6.2 Ten dwelling type levels

A new variable was defined for dwelling type

Table 2 Dwelling type levels (England)

Level	Description	Algorithm	Number in level	%	Median floor area (m^2)
1	Detached	Dwtype7x= 4	4992676	22.4	117.03
2	Semi-detached or end-of-terrace	Dwtype7x=1 or 3	8798174	39.6	80.45
3	Mid-terrace	Dwtype7x=2	4305954	19.4	75.5
4	Top floor flat	Finlopos=2	1637682	7.4	54.79
5	Other flat	Finlopos =3,4 or 5	2504912	11.3	54
	Subtotal		22239398	100	

The median floor areas for these five dwelling types were then computed using the PASW "Explore" function with floorx as the dependent variable. Each of the five dwelling types were then divided into two further categories based on being above and below the median floor area.

Table 3 Dwelling/size levels (England)

Level	Description	Algorithm	Number in level	%
1	Large Detached	Dwtype7x=4 & floorx >=117.03	2494308	11.2
2	Small detached	Dwtype7x=4 & floorx <117.03	2498368	11.2
3	Large Semi-detached or end-of-terrace	(Dwtype7x=1 or 3) & floorx >=80.45	4400669	19.8
4	Small semi-detached or end-of terrace	(Dwtype7x=1 or 3) & floorx < 80.45	4397505	19.8
5	Large Mid-terrace	Dwtype7x=2	2158124	9.7

		&floorx >=75.5		
6	Small mid-terrace	Dwtype7x=2 &floorx< 75.5	2147830	9.7
7	Large Top floor flat	Finlopos =2 &floorx >=54.79	819869	3.7
8	Small top floor flat	Finlopos =2 &floorx < 54.79	817813	3.7
9	Large other flat	(Finlopos =3,4 or 5) &Floorx >=54	1253026	5.6
10	Small other flat	(Finlopos=3, 4 or 5) &Floorx <54	1251886	5.6

6.3 Sixteen heating systems

A third category was defined to identify as much information as possible on heating system to determine the relevance of boiler and central heating upgrades.

Table 4 Heating system levels (England)

Level	Description	Algorithm	Number	Percentage
1	Mains gas condensing	Mainfuel=1 & (boiler=4 or 5)	3655338	16.4
2	Mains gas non-condensing with CH	Mainfuel=1 & (boiler = 1,2 or 3) & heat7x =1	14403415	64.8
3	Mains gas non-condensing without CH	Mainfuel=1 & (boiler = 1,2 or 3) & heat7x • 1	201142	.9
4	Oil condensing no gas connection	fuelx=2& (boiler=4 or 5)& (either fingaspr=2 or fingasms=2)	47390	.2

5	Oil non-condensing with mains gas	fuelx=2 & fingasms=1	43942	.2
6	Oil non-condensing no gas connection	fuelx=2& (either boiler=1 or boiler=2 or boiler =3)& (either fingaspr=2 or fingasms=2)	784500	3.5
7	Electric heating with mains gas connection and with CH	Fuelx=4 & heat7x=1 & fingasms=1	10379	.0
8	Electric heating with mains gas connection without CH	Fuelx=4 & heat7x=1 & fingasms=1 All other systems	786599	3.5
9	Electric heating with no mains gas connection	fuelx=4 & (either fingaspr=2 or fingasms=2)	1618683	7.3
10	Solid fuel with mains gas connection with CH	Fuelx=3 & heat7x=1 & fingasms=1	48285	.2
11	Solid fuel with mains gas connection without CH	Fuelx=3 & heat7x• 1 & fingasms=1	8819	.0
12	Solid fuel with no mains gas connection	fuelx=3& (either fingaspr=2 or fingasms=2)	192032	.9
13	LPG/bottled gas condensing with no gas connection with CH	(Mainfuel = 2 or 3) & (boiler =4 or 5) & fingasms=2	12752	.1
14	LPG/bottled gas Mostly Non Condensing+ Mains Gas connection with CH	(mainfuel = 2 or 3) & (boiler =1,2,3,4 or 5) and fingasms=1	25555	.1

15	LPG/Bottled gas non-condensing no mains gas with CH	(Mainfuel =2 or 3)& (boiler = 1, 2, or 3)& fingasms=2	91819	.4
16	Community heating	Fuelx=-8	308748	1.4

6.4 Three loft insulation levels

A new variable describing three potential loft insulation levels was defined.

Table 5 Loft levels (England)

	Levels	Algorithm	No of groups in each	Percentage
1	0-149 mm loft insulation	Loftins4=1, 2 or 3	12294723	55.3
2	150 mm loft insulation or more	Loftins4=5	7443948	33.5
3	No loft	Loftins4=-9	2500727	11.2
	Subtotal		22239398	100%

6.5 Two AW group levels

A AW eligibility group variable was developed to capture where any of the following holds:

- Household in receipt of cold weather payment (variable CWP)
- Household in receipt of child tax credit AND household income less than £16,190 (variable CTCandincomecf16kb)

The AW Priority group was then computed by combining these two variables.

The cold weather payment variable compatible with the EHCS (CWPeligible) was supplied by DECC and is summarised below. As shown below, application of the dwelling weighting (aagpd78) results in 1016019 missing data. These missing responses were recoded as non-recipients of CWP for subsequent analysis.

Table 6 Supplied CWP data (England, Uncorrected)

CWPeligible	Levels	Algorithm	No of groups in each	Percentage
0	Do not receive CWP	Supplied by DECC	19552974	87.9%
1	Receive CWP	Supplied by DECC	1670405	7.5%
	Missing		1016019	4.6%
	Subtotal		22239398	100%

According to DECC, the CWP variable is made up of all households in receipt of pension credit, households in receipt of job seekers allowance AND (containing a child under 5 OR in receipt of any DLA), or households in receipt of income support AND (a child under 5 OR in receipt of any DLA).

Table 7 Calculated Receipt of Child Tax Credit and Household Income < £16,190 (England)

CTCandincomecf16kb	Levels	Algorithm	No of groups in each	Percentage
0	Other		21513954	96.7%
1	Receives Child tax credit and income less than £16,190	Hhincx<16190 & BnCTC=1	725444	3.3%
	Subtotal		22239398	100%

Table 8 Computed AW group levels (England, uncorrected)

SPGrev2	Levels	Algorithm	No of groups in each	Percentage
0	Not AW group (includes missing data)	CWP = 1 OR CTCandincomecf16kb=1	20039638	
1	AW group		2199760	
	Subtotal		22239398	100%

6.6 Three tenure levels

A new three level tenure 'tenure3' variable was computed using tenure4x. The levels "local authority" and "RSL" were merged to form a new variable "social landlord"

Table 9 Computed tenure levels (England)

3 tenures

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Owner occupier	15007451	67.5	67.5	67.5
	Privately rented	3296496	14.8	14.8	82.3
	Social landlord	3935451	17.7	17.7	100.0
	Total	22239398	100.0	100.0	

7 Appendix B – Dwelling classification for Scotland

The study had access to the Physical and Derived datasets from the Scottish House Condition Survey (2007-2009). Data were weighted using pwght0709, resulting in a maximum of 2,329,821 dwellings. The data in the SCHS were cut into the same groups as carried out for the EHCS. This resulted in 1290 non-zero groups. Around 60% of these overlap with the 920 non-zero groups identified for the EHCS. These overlapping groups were therefore reweighted to the full 2,329,821 and the Scottish data combined with the English data.

7.1 Ten dwelling types

A new variable for dwelling type was determined in four steps.

1) As a first stage, houses were categorised using D1. Mid-terrace, Mid-terrace dwellings with passages, and Corner properties were combined and coded as mid-terrace.Semi-detached and end-of-terrace were combined and coded as Semi-detached or end-of-terrace. Detached properties were coded as detached.
2) In a second stage, flats identified in D1 were categorised. Tenements, 4-in-a-block, tower or slab, flat from conversion and other were grouped as flats and then subdivided into those with flat-roof-exposure (top floor flat) and those without (other flats) using the variable D5.
3) In a third stage, the combined floor area was calculated using the sum of the floor areas from component floors (N1A, N2A, N3A, N4A, N5A).
4) Finally the five dwelling types were separated into two based on whether the floor area was above or below the median floor area for the equivalent category in the EHCS.

Table 10 Dwellings (Scotland)

		Frequency	Percent
Valid	Large detached (• 117.03 m^2)	303124	13.0
	Small detached (<117.03 m^2)	174805	7.5
	Large semi-detached or end-of-terrace (• 80.45 m^2)	489858	21.0
	Small semi-detached or end-of-terrace (< 80.45 m^2)	204032	8.8
	Large mid-terrace (• 75.5 m^2)	234961	10.1
	Small mid-terrace (< 75.5 m^2)	78621	3.4
	Large top-floor flat (• 54.79 m^2)	242610	10.4
	Small top-floor flat (<54.79 m^2)	67102	2.9
	Large other flat (• 54 m^2)	398801	17.1
	Small other flat (<54 m^2)	135673	5.8
	Total	2329586	100.0
Missing	System	235	.0

		Frequency	Percent
Valid	Large detached (• 117.03 m^2)	303124	13.0
	Small detached (<117.03 m^2)	174805	7.5
	Large semi-detached or end-of-terrace (• 80.45 m^2)	489858	21.0
	Small semi-detached or end-of-terrace (< 80.45 m^2)	204032	8.8
	Large mid-terrace (• 75.5 m^2)	234961	10.1
	Small mid-terrace (< 75.5 m^2)	78621	3.4
	Large top-floor flat (• 54.79 m^2)	242610	10.4
	Small top-floor flat (<54.79 m^2)	67102	2.9
	Large other flat (• 54 m^2)	398801	17.1
	Small other flat (<54 m^2)	135673	5.8
	Total	2329586	100.0
Missing	System	235	.0
Total		2329821	100.0

7.2 Sixteen heating system levels

A new heating system variable was calculated based on variables L1 (mains gas availability), M3 (extent of central heating), M4 (primary heating fuel), M5 (condensing vs. non-condensing gas boiler), and M6 (condensing vs. non-condensing oil boilers).

Table 11 Heating Systems (Scotland)

16-level split of heating systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mains gas condensing	217731	9.3	9.4	9.4
	Mains gas non-condensing with CH	1541906	66.2	66.3	75.7
	Mains gas non-condensing without CH	10447	.4	.4	76.1
	Oil condensing no gas connection	12092	.5	.5	76.6
	Oil non-condensing with mains gas	14944	.6	.6	77.3
	Oil non-condensing no gas connection	107764	4.6	4.6	81.9

	Electric heating with mains gas and CH	26555	1.1	1.1	83.0
	Electric heating with mains gas without CH	4577	.2	.2	83.2
	Electric heating with no mains gas	322177	13.8	13.9	97.1
	Solid fuel with mains gas with CH	3656	.2	.2	97.2
	Solid fuel with mains gas connection without CH	1438	.1	.1	97.3
	Solid fuel with no mains gas connection	28130	1.2	1.2	98.5
	LPG/bottled gas condensing with no gas connection with CH	914	.0	.0	98.6
	LPG/bottled gas with mains gas with CH	10122	.4	.4	99.0
	LPG/Bottled gas non-condensing no mains gas with CH	7380	.3	.3	99.3
	Community heating	16066	.7	.7	100.0
	Total	2325899	99.8	100.0	
Missing	System	3923	.2		
Total		2329821	100.0		

7.3 Three loft insulation levels

Variable loftins was supplied by the Scottish Government, which contains imputed estimates of loft insulation for dwellings for which the loft was inaccessible for survey. A new variable 'loftins3new' was then defined.

Table 12 Loft insulation (Scotland)

		Algorithm	Frequency	Percent
Valid	0-149 mm loft insulation	Loftins=0-4	981546	42.1
	150 mm loft insulation or more	Loftins=5-7	813101	34.9
	No loft	Loftins<0 OR >7	535175	23.0
	Total		2329821	100.0

7.4 Four wall levels

A new variable was created corresponding to four wall types using agedwell (age of dwelling), q2 (wall construction) and q6 (insulation). Note that in the EHCS split, the equivalent year-break is 1980 instead of 1982.

Table 13 Wall type (Scotland)

Four wall types (missing = insulated cavity)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Filled cavity (incl. cavity walls with external or internal insulation)	503770	21.6	21.6	21.6
	Cavity unfilled pre-1982	771624	33.1	33.1	54.7
	Cavity unfilled post-1982	464640	19.9	19.9	74.7
	Solid wall or other	589787	25.3	25.3	100.0
	Total	2329821	100.0	100.0	

7.5 Two AW eligibility levels

The variable for AW group SPGincB2 was supplied by the Scottish Government and used directly.

Table 14 AW Group (Scotland)

DECC AW Group 2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1892413	81.2	81.2	81.2
	Yes	437409	18.8	18.8	100.0
	Total	2329821	100.0	100.0	

According to the Scottish Government, households are flagged as being part of the SPG2 stock if any of below are true:

- in receipt of state pension credit.
- in receipt of child tax credit and has a relevant income below £16,190.
- in receipt of employment and support allowance, and either has a child under 5 or in receipt of a qualifying benefit (see below)
- in receipt of income based jobseekers allowance and either has a child under 5 or in receipt of a qualifying benefit (see below)
- in receipt of income support and either has a child under 5 or in receipt of a qualifying benefit (see below)

Qualifying benefits

1. CTC which includes a disability or severe disability element - have used CTC and disabled child under 16

2. a disabled child premium - have used disabled child 16 and under

3. a disability premium, enhanced disability premium or severe disability premium

4. a pensioner premium, higher pensioner premium or enhanced pensioner premium. Have used over 60s.

7.6 Three tenure levels

A new three-level variable for tenure ('Tenure3') was computed using the Tenure variable, merging the social landlord categories of local authority, housing authority, co-operative and other public.

Table 15 Three tenure classification (Scotland)

Three tenures

Tenure3		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Owner occupier	1468896	63.0	63.0	63.0
	Privately rented	219154	9.4	9.4	72.5
	Social landlord (incl. LA/HA/Co-op/other public)	641772	27.5	27.5	100.0
	Total	2329821	100.0	100.0	

8 Appendix C – Dwelling classifications for Wales

The study had access to the Living in Wales Survey data. Additional data on wall type and floor area were kindly provided by Mr. Darren Hatton, statistician in charge of disseminating the Living in Wales survey data. Data were weighted using GR2, resulting in a maximum of 1,268,420 dwellings. The data from the Living in Wales survey were cut into the same groups as carried out for the EHCS. This resulted in 838 non-zero classes. Around 90% of these overlapped with the 920 non-zero groups identified for the EHCS. These overlapping groups were therefore reweighted to the full 1,268,420 dwellings and combined with the English data.

Dwelling classes were derived using FODDTYPE (for houses) and FLIHOLFT (for top floor vs. other flats). These were further split using floor area (ngrofa) according to the median floor areas observed within the EHCS for these categories.

8.1 Ten dwelling levels

Table 16 Dwelling type (Wales)

10 dwellings with new floor area split

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Large detached house	213963	16.9	17.0	17.0
	Small detached house	143821	11.3	11.4	28.4
	Large semi-detached or end-of-terrace	357507	28.2	28.3	56.7
	Small semi-detached or end-of-terrace	165958	13.1	13.2	69.9
	Large mid-terrace	198737	15.7	15.8	85.6
	Small mid-terrace	76729	6.0	6.1	91.7
	Large top-floor flat	35638	2.8	2.8	94.5
	Small top-floor flat	12438	1.0	1.0	95.5
	Large other flat	32843	2.6	2.6	98.1
	Small other flat	23653	1.9	1.9	100.0
	Total	1261287	99.4	100.0	
Missing	System	7132	.6		
Total		1268419	100.0		

8.2 Sixteen heating levels

16 Heating categories were developed using FINGASMS (mains gas availability), FINCHTYP (main heating fuel), and FINCHPHT (condensing vs. non-condensing).

Table 17 Heating system (Wales)

16 heating categories

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mains gas condensing	233742	18.4	18.4	18.4
	Mains gas non-condensing with CH	748592	59.0	59.0	77.4
	Mains gas non-condensing without CH	3774	.3	.3	77.7
	Oil condensing	9201	.7	.7	78.5
	Oil non-condensing with mains gas	16554	1.3	1.3	79.8
	Oil non-condensing no gas connection	114218	9.0	9.0	88.8
	Electric heating with mains gas connection with CH	1124	.1	.1	88.9
	Electric heating with mains gas connection without CH	18935	1.5	1.5	90.4
	Electric heating with no mains gas connection	56826	4.5	4.5	94.8
	Solid fuel with mains gas connection with CH	2649	.2	.2	95.0
	Solid fuel with mains gas connection without CH	2774	.2	.2	95.3
	Solid fuel with no mains gas connection	31659	2.5	2.5	97.8
	LPG/bottled gas with mains gas with CH	21028	1.7	1.7	99.4
	LPG/bottled gas non-condensing no gas connection with CH	3504	.3	.3	99.7
	Community heating	3839	.3	.3	100.0
	Total	1268419	100.0	100.0	

8.3 Three loft insulation levels

The category FLITHICK was used to develop a new variable for loft insulation.

Table 18 Loft insulation (Wales)

Level of loft insulation for Green Deal

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-149 mm loft insulation	559400	44.1	44.1	44.1
	150 mm or more loft insulation	593928	46.8	46.8	90.9
	No loft	115091	9.1	9.1	100.0
	Total	1268419	100.0	100.0	

The categories Wall Type (cavity vs. other walls), h36 (cavity wall insulation present) and FODCONST (age of construction) were used to create a new variable wall classification with four levels.

8.4 Four wall levels

Table 19 Wall types (Wales)

Wall classification (solid,filled, unfilled pre80 unfilled post80)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Filled cavity	454554	35.8	35.8	35.8
	Unfilled pre-1980	280796	22.1	22.1	58.0
	Unfilled cavity post-1980	94005	7.4	7.4	65.4
	Solid wall (& other non-cavity & non-masonry)	439065	34.6	34.6	100.0
	Total	1268419	100.0	100.0	

8.5 Two AW group levels

The AW group was defined as

- Receipt of child tax credit and income less than £16190
- Receipt of cold weather payment

A proxy for receipt of cold weather payment, was determined using

- Any pension credit
- Disability premium
- Child under 5

Table 20 Pension credit receipt (Wales)

Any pension credit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No pension credit	759933	59.9	92.0	92.0
	Household receives pension credit	66404	5.2	8.0	100.0
	Total	826337	65.1	100.0	
Missing	System	442082	34.9		
Total		1268419	100.0		

Table 21 Disability premium (Wales)

Disability premium

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No disability premium	778220	61.4	99.1	99.1
	Receives disability premium	7170	.6	.9	100.0
	Total	785389	61.9	100.0	
Missing	System	483030	38.1		
Total		1268419	100.0		

Table 22 Child under 5 (Wales)

Child under 5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No children under 5	1127718	88.9	88.9	88.9
	At least one child under 5	140701	11.1	11.1	100.0
	Total	1268419	100.0	100.0	

A cold weather proxy variable was calculated based on Pension Credit, Disability premium, Child under 5.

Table 23 Cold weather payment proxy (Wales)

Cold weather payment proxy = pension credit, disability premium, and/or child under 5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CWP	212941	16.8	100.0	100.0

Missing	System	1055478	83.2		
Total		1268419	100.0		

A new variable for household income above or below a threshold of £16,190 was defined.

Table 24 Income relative to £16,190 (Wales)

Income relative to £16k

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Income less than or equal to £16190	497899	39.3	39.3	39.3
	Income greater than or equal to £16190.01	770520	60.7	60.7	100.0
	Total	1268419	100.0	100.0	

A new variable for child tax was defined for those households where either the HRP or partner received child tax credit. Missing data were assumed as non-recipients of CTC.

Table 25 Child tax credit (Wales)

Any child tax credit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neither HRP nor partner receive child tax credit	638280	50.3	75.1	75.1
	Either HRP or partner receives child tax credit	211610	16.7	24.9	100.0
	Total	849890	67.0	100.0	
Missing	System	418529	33.0		
Total		1268419	100.0		

A new variable was defined for those households receiving child tax credit AND income less than £16k.

Table 26 Household income less than £16k AND household receives CTC (Wales)

Household income is less than £16k and household receives child tax credit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Other	1196786	94.4	94.4	94.4
	Household receives child tax credit and net annual income is less than £16k	71633	5.6	5.6	100.0

Household income is less than £16k and household receives child tax credit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Other	1196786	94.4	94.4	94.4
	Household receives child tax credit and net annual income is less than £16k	71633	5.6	5.6	100.0
	Total	1268419	100.0	100.0	

A new variable for AW group was defined for those households (receiving child tax credit and income less than £16k) OR flagged with the CWP proxy.

Table 27 AW Group (Wales)

AW group - receive Cold Weather Payment or (household income <£16k & CTC)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not SPG	1019678	80.4	80.4	80.4
	SPG	248741	19.6	19.6	100.0
	Total	1268419	100.0	100.0	

8.6 Three tenure levels

Table 28 Three tenure groups (Wales)

Three tenure groups

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Owner occupier	930009	73.3	73.3	73.3
	Privately rented	114705	9.0	9.0	82.4
	Social landlord	223705	17.6	17.6	100.0
	Total	1268419	100.0	100.0	

9 Appendix D – Dwelling classifications for GB

The populations of Scottish and Welsh dwellings corresponding to each of the 1,582 non-zero English dwelling types were calculated and summed. Scottish dwellings built before or after 1982 were matched to English equivalents for 1980.

These populations were then re-weighted to give sub-total numbers of 2,329,821 for Scotland and 1,268,419 for Wales in dwellings corresponding to the 1,582 non-zero English dwelling categories.

The sub-totals for England, Wales and Scottish populations were then added to give total figures for GB for each of the 1,582 dwelling types. This approach represents the authors' view of the most pragmatic approach to aggregating GB data from multiple nation surveys for use in the Green Deal model.

Where necessary, the SPG estimates were corrected to DECC's estimate of 5.6 million SPG households as described earlier in this report.

Note that the very high degree of segmentation associated with the combination of tenure, SPG, wall type, loft insulation, heating system, house type results in some dwelling categories having very low (and therefore statistically challenging) numbers. Whilst the approach taken represents the authors' views of the best segmentation possible, the user should focus on aggregate results and avoid concentrating on individual segments, especially those with low populations.