Appendix V: Calculation of energy use and costs using actual occupancy parameters

This appendix describes modifications to the SAP procedures and data to take account of actual occupancy.

Generally in SAP calculations the energy use, and so outputs from the calculation such as ratings, running costs and emissions, is based on standard functions for parameters such as number of occupants, extent and duration of heating, use of appliances, cooking, etc. These parameters are defined in the SAP specification and include full house heating for specified hours, and other parameters that are typical of a household that would occupy a dwelling of its size.

In practice all of these parameters vary considerably from one household to another. In circumstances where the assessment is to relate to a particular household, the calculation is adjusted so far as possible to the actual occupancy parameters.

Furthermore, when fuel bill data covering a 12-month period is available, the calculated energy use can be reconciled with that from the fuel bills. To enable comparison of calculated energy with fuel bills the energy for all uses (e.g. cooking, electrical appliances) needs to be included in the calculation.

Except where amended by this Appendix, calculations follow the normal SAP procedures using regional weather.

Table V9 lists the data collected in an occupancy assessment.

Section V13 provides modifications to the SAP worksheet.

Section V14 describes the handling of improvement measures.

This appendix applies only in circumstances where occupancy factors for a specific household are to be taken into account (known as an Occupancy Assessment). It does not affect SAP calculations for any other purpose.

V1 Energy for water heating

At SAP worksheet (42) use the actual number of occupants (a whole number) instead of the formula. At worksheet (43) use the following formulation.

$$V_{d,average}\ (\text{litres/day}) = V_{d,shower} + V_{d,bath} + V_{d,other} \qquad (V1)$$

where

$V_{d,shower}$ (litres/day) = Showers per day × hot water per shower from Table V1
$V_{d,bath}$ (litres/day) = Baths per day × 50.8
$V_{d,other}$ (litres/day) = 9.8 N + 14
N is the actual number of occupants

Table V1 : Hot water used for showers

Shower type	Hot water used per shower (litres)
None	0
Mixer (not combi)*	28.8
Mixer (combi)*	44.4
Pumped	43.5
Electric	0
Unknown	18.7
* Combi applies when the water is heated by a combi boiler. Not combi applies in all other cases. Unknown based on shower ownership of 27.2% mixer (not combi), 9.8% mixer (combi), 15.1% pumped, 47.9% electric	

Where known, showers and baths per day is specific to the household. If showers per day is unknown then:

Showers per day = 0.45 N + 0.65

If the number of baths per day is unknown then:

Baths per day (no shower present, i.e. "None" selected in Table V1) = 0.35 N + 0.50
Baths per day (shower also present) = 0.13 N + 0.19
(A bath is assumed to be present when bathing data has not been provided.)

V2 Calculation of space heating

V2.1 Heating systems

A3 in SAP Appendix A, which is concerned with assigning heating to all rooms, does not apply. In an occupancy assessment, unheated rooms are treated as such and do not have heaters assigned to them.

If the occupancy assessment has identified that the main heating system(s) given in the RdSAP assessment is not used, use the room heaters defined in the occupancy assessment for calculation of the dwelling as-is. These heaters are selected from the list in Table V2. The same applies if a different secondary heater has been identified.

Table V2 : Room heaters

Fuel category	Fuel	Room heaters
Gas	Mains gas LPG Special condition 18 Bulk LPG Bottled LPG	601 Gas fire, open flue, pre-1980 603 Gas fire, open flue, 1980 or later 605 Flush fitting Live Fuel Effect gas fire 607 Flush fitting Live Fuel Effect gas fire, fan assisted 609 Gas fire or wall heater, balanced flue 610 Gas fire, closed fronted, fan assisted 611 Condensing gas fire 612 Decorative Fuel Effect gas fire, open to chimney 613 Flueless gas fire
Oil	Heating oil	621 Room heater, pre 2000 623 Room heater, 2000 or later
	Bioethanol	625 Bioethanol heater
Solid	House coal Smokeless	631 Open fire in grate 633 Closed room heater
	Anthracite	633 Closed room heater
	Dual fuel Wood logs	631 Open fire in grate 633 Closed room heater
	Wood pellets (bags)	635 Stove (pellet fired)
Electric	Electricity	691 Panel, convector or radiant heaters 694 Water- or oil-filled radiators 693 Portable electric heaters

Only room heaters can be substituted for other systems. The options for each heating are:
- main system 1: as RdSAP or a room heater
- main system 2: as RdSAP or a room heater or none
- secondary: as RdSAP or a different room heater or none

The following applies to room heater systems when they substitute for main heating:

- For heating control type, electric room heaters have appliance thermostats (control type 3) and all other types of room heater have no thermostatic control (control type 2).
- Solid fuel room heaters are not HETAS approved when choosing their efficiency from SAP Table 4a.

Do not adjust the number of chimneys and open flues to include those associated with substituted room heaters; use the number derived from the RdSAP assessment.

If the heating device that heats DHW is substituted for a room heater, water heating is still taken as being provided by the device identified in the RdSAP assessment.

V2.2 Proportion of heat from each system

The data collected during the occupancy assessment includes a list of the heating system(s) used in each habitable room and states whether rooms are partially heated or unheated. This data is processed to estimate what proportion of the heat required is provided by each heating system and the proportion of the dwelling that is heated.

There must be at least one room that is heated; that room is taken as the living room for this purpose.

The proportion from the secondary heating system is calculated first. The remainder is then split between the two main systems if there are two.

V2.2.1 Secondary heating

a) If secondary heating is used in the living room, include the secondary fraction from SAP Table 11.

b) If secondary heating is used in another room, disregard if the main heating also supplies the room.

c) If secondary heating is used in another room and there is no main heating in the room, use a secondary fraction of 0.25 divided by the total number of rooms other than living room.

d) The sum of the above fractions gives the proportion of heat provided by the secondary system.

V2.2.2 Two main systems

The proportion of heat provided by the main systems, p_{main}, is 1 minus the proportion provided by the secondary system. If there are two main systems, this is split as follows.

a) Add up the number of rooms served by main system 1, giving a weighting of 1.5 to the living room (because it is usually larger) and 1 to other rooms.

b) Multiply by 0.5 where a room is served by both main systems.

c) Multiply by 0.5 (again) where a room has been marked as partially heated.

d) Sum the individual room figures in the same way as a) to c) for the second main system.

e) Divide this by the total number of rooms heated by main-1 or main-2 (with weighting 1.5 for the living room) to get the fraction from main system 2.

f) The remainder (i.e. 1 minus the proportion from main-2) is assumed to come from main-1.

g) Multiply the proportions for main-1 and main-2 by p_{main} to calculate the overall fractions from main-1 and main-2.

V2.2.3 Rounding

Round the secondary fraction and main 1/main 2 fractions to two decimal places.

V3 Calculation of mean internal temperature

SAP Table 9 is adapted according to Table V3.

Table V3 : Heating periods and heating temperatures for occupancy assessment

Living area		Elsewhere		
Temperature T_{h1} (°C)	**Hours of heating off t_{off}**	**Heating control type (Table 4e)**	**Temperature T_{h2} °C**	**Hours of heating off t_{off}**
T_d from the occupancy assessment [a]	Up to 4 periods from the occupancy assessment	1	$T_{h1} - 0.5$ HLP	Same as living area
		2	$T_{h1} - HLP + 0.085\ HLP^2$	Same as living area
		3	$T_{h1} - HLP + 0.085\ HLP^2$	see [b] below

[a] If unknown use 21°C

[b] if the number of off periods for the living area is 1 and is less than 12 hours duration include it plus a second off period of duration 9 hours;
otherwise the shortest off period plus 2 hours and the other periods the same as the living area

If HLP > 6.0 use HLP = 6.0 for calculation of T_{h2}

Calculate $MIT_{h,m}$ for the heated rooms and applicable heating systems and controls (SAP Tables 9a, 9b and 9c) leading to worksheet (93). Suffix h denotes heated and m is the month number. In SAP Table 9c replace $T_{weekday}$ and $T_{weekend}$ by

$$T_{normal} = T_h - (u_1 + u_2 + u_3 + u_4) \quad (V2)$$

$$T_{alternative} = T_h - (u_1 + u_2 + u_3 + u_4) \quad (V3)$$

and

$$\text{Mean temperature} = (n_{normal}\ T_{normal} + n_{alternative}\ T_{alternative}) / 7 \quad (V4)$$

where u_1, u_2, u_3 and u_4 are related to the hours of heating off as defined in SAP Table 9b.

If all rooms are fully heated by the main system (or by one of them if there are two) set $MIT_m = MIT_{h,m}$ to calculate the space heating requirement for each month.

If there are any unheated rooms, partially heated rooms, or rooms heating by secondary heating only, proceed as follows.

a. Calculate the mean temperature $MIT_{u,m}$ in those rooms from

$$f_u = (n_u + 0.5\ n_p + 0.5\ n_{s\text{-}only}) / n_{total} \quad (V5)$$

$$H_{2,m} = H_m \times f_u \quad (V6)$$

$$G_{2,m} = G_{s,m} \times f_u \quad (V7)$$

$$MIT_{u,m} = \frac{MIT_{h,m} \times H_3 + T_{e,m} \times H_{2,m} + G_{2,m}}{H_3 + H_{2,m}} \quad (V8)$$

in which:

H_m is worksheet (39);
n_u is the number of unheated rooms;
n_p is the number of partially heated rooms;
$n_{s\text{-}only}$ is the number of rooms heated by secondary only;
n_{total} is the weighted total number of rooms (number of habitable rooms plus 0.5);
$G_{s,m}$ are the solar gains for month m;
H_3 is 100 W/K.

b. Set $MIT_m = (1 - f_u) \times MIT_{h,m} + f_u \times MIT_{u,m}$ (V9)

V4 Cooking, electrical appliances and electricity standing charge

The energy use for cooking and electrical appliances is estimated and included in the total energy for the purposes of comparing with fuel bills. The data given in this section replaces that in SAP Appendix L. There are also some modifications to internal heat gains for cooking and electrical appliances (see section V5).

V4.1 Cooking

The annual energy used for cooking, E_C (kWh/year), is a function of the actual number of occupants and the type of cooker and the fuel used. The following equations apply:

Normal cookers (4 hobs or less)

Gas:	$E_C = 481 + 96.3\ N$
Gas/electric:	$E_C = 138 + 27.5\ N$ (electric) plus $E_C = 241 + 48.2\ N$ (gas)
Electric:	$E_C = 275 + 55.0\ N$

Large cookers (more than 4 hobs, but not always hot)

Gas:	$E_C = 631 + 136\ N$
Gas/electric:	$E_C = 181 + 39\ N$ (electric) plus $E_C = 316 + 68\ N$ (gas)
Electric:	$E_C = 361 + 78\ N$

Always-hot ranges (8 or 12 months operation per year)

Gas, oil, or solid fuel:	$E_C = 631 + 136\ N$
Electric:	$E_C = 361 + 78\ N$

N is the actual number of occupants. Gas/electric means gas hobs and electric oven. For the calculation of gains (see section V5.1) divide E_C into monthly values using:

$$E_{C,m} = E_C \times n_m / 365$$

Where gas or gas/electric is selected, the gas is:
- mains gas if mains gas is available in the property (as defined in the RdSAP data);
- otherwise bulk LPG if bulk LPG is used for heating or hot water;
- otherwise bottled LPG.

Where oil is selected the fuel is heating oil.

Where solid fuel is selected, the fuel is the main heating fuel, if that is a solid fuel, or house coal if not.

V4.1.1 Additional energy for continuously operating ranges

Range cookers that stay hot all the time use additional fuel and produce additional heat. The energy they use for cooking is accounted for in V4.1 and the additional energy they use when not cooking, $E_{R,m}$ (kWh/month), is also included.

Range operating all year:

$$E_{R,m} = Q_R \times 0.024 \times n_m - E_{C,m} \quad \text{(V10)}$$

Range operating for 8 months per year:

$$\text{months October to May: } E_{R,m} = Q_R \times 0.024 \times n_m - E_{C,m} \quad \text{(V11)}$$

$$\text{months June to September: } E_{R,m} = 0 \quad \text{(V12)}$$

where Q_R is the average fuel consumption rate of the range cooker in watts. Use 2000 W for a range burning gas, oil or solid fuel or 1500 W for an electric range.

V4.2 Electrical appliances

L2 and L3 in SAP Appendix L do not apply and the following is used instead for electricity use by appliances and the resulting internal heat gains.

V4.2.1 Tumble dryer

Use the following equation to estimate the annual electricity requirement for tumble drying, E_{TD} (kWh/year).

$$E_{TD}\ (kWh/year) = (78.4\ N + 166) \times f_{TD} / 0.5 \quad (V13)$$

where f_{TD} is the fraction (percentage/100) of clothes drying done using a tumble dryer.

V4.2.2 Cold appliances

The electricity requirement for cold appliances, E_{cold} (kWh/year), is equal to product of the number of each appliance and the typical annual consumption per appliance as given in Table V4.

Table V4 : Electricity consumption of cold appliances

Cold appliance type	Typical consumption (kWh/year)
Fridge-freezer	500
Refrigerator	200
Freezer	300

V4.2.3 Other appliances

Use the following equation to estimate the annual energy consumption for other electrical appliances, E_{Aother}, in kWh/year:

$$E_{A,other} = 127.9 \times (TFA \times N)^{0.4714} \quad (V14)$$

V4.2.4 Total electricity for appliances

Add electrical consumption for cold appliances, tumble drying and other appliances to get the total electrical consumption for appliances, E_A (kWh/year):

$$E_A = E_{A,other} + E_{TD} + E_{cold} \quad (V15)$$

Monthly values, $E_{A,m}$ (kWh/month), are then calculated using:

$$E_{A,m} = E_A \times [1 + 0.157 \times \cos(2\pi(m - 1.78) / 12] \times n_m / 365 \quad (V16)$$

where m is the month number (1 = Jan, 12 = Dec) and n_m is the number of days in the month

Then re-calculate the annual total as the sum of the monthly values:

$$E_A = \sum_{m=1}^{12} E_{A.m} \quad (V17)$$

V4.2.5 Electric showers

Calculate the electricity used for showers:

$$E_{shower,m}\ (kWh/month) = \text{Showers per day} \times \text{electricity use per shower from Table V5} \times n_m \quad (V18)$$

where n_m is the number of days in the month.

Table V5 : Electric showers

Shower type	Electricity used per shower (kWh)
None	0
Pumped	0
Mixer	0
Electric	0.93
Unknown	0.45

V5 Internal gains

Internal heat gain is calculated as in SAP Table 5 column (A), except:
- the heat gain from appliances is based on the electricity used as calculated in V4.2.4;
- the heat gain from cooking is according to V5.1;
- additionally the heat gain from electric showers is included (V5.2).

V5.1 Gains from cooking appliances

Table V6 gives the proportion of cooking energy that is assumed to contribute to useful heat gains.

Table V6 : Utilisation factor for cooking gains

Cooker type	Cooking fuel	Utilisation factor, f_{cg}
Normal or large	Gas	0.75
	Gas/electric	0.75 / 0.9 *
	Electric	0.9
Always-hot range	Gas, Oil or Solid	0.6
	Electric	0.9
* apply 0.75 to the gas cooking energy use and 0.9 to the electric cooking energy use		

The gains from cooking, $G_{C,m}$ (W) for month m, are:

$$G_{C,m} = E_{C,m} \times f_{cg} / (0.024\ n_m) \qquad \text{(V19)}$$

where $E_{C,m}$ is obtained in V4.1.

In addition 75% of the (non-cooking related) heat output from continuously operating range cookers is assumed to be useful, and $G_{R,m}$ (W), is added to the cooking gains:

$$G_{R,m} = E_{R,m} \times f_r \times 0.75 / (0.024\ n_m) \qquad \text{(V20)}$$

where $E_{R,m}$ is obtained in V4.1.1 and f_r is the efficiency with which the range converts fuel into heat. Use 100% for electric ranges and 60% for gas, oil and solid fuel ranges.

V5.2 Gains from electric showers

For electric showers 25% of the electricity used is assumed to contribute usefully to the internal gains:

$$G_{shower,m}\ (W) = 0.25\ E_{shower,m} / (0.024\ n_m) \qquad \text{(V21)}$$

The above is included in addition to the items from SAP Table 5.

V6 Bill data reconciliation

Where data on energy used per year can be obtained from fuel bills, scaling factors are applied to the calculated energy for the fuel so that the calculated energy matches the actual energy used. The scaling factors are calculated for the dwelling as-is, and then the same factors are applied when evaluating improvement measures.

V6.1 Calculated fuel usage

Obtain the calculated total annual energy use by fuel. Include all end uses (those additional to a normal SAP calculation are shown in italics):

- Main space heating
- Second main space heating
- Secondary heating
- *Heat supplied by always-hot range*
- Main water heating
- Alternative water heating (i.e. summer immersion)
- *Fuel used by electric shower (always electricity)*
- Lighting (always electricity)
- *Appliances (incl. tumble dryer + cold appliances) (always electricity)*
- Pumps and fans for heating (always electricity)
- Pumps and fans for mechanical ventilation (always electricity)
- *Cooking*

V6.2 Energy used from fuel bills

Obtain the total number of units purchased and scale to one year. If renewable generation is present (e.g. PV), add the electricity generated per year[1] to the electricity purchased per year to estimate the total used in the dwelling (in the case of an off-peak electricity tariff using the fractions in SAP Table 12a to divide between high-rate and low-rate[2]).

Where the unit is other than kWh, convert using the calorific values in Table V7.

Table V7 : Calorific values

Fuel and unit	kWh per unit
bulk LPG, litres	7.11
bottled LPG, kg	13.89
bioethanol, litres	5.9
oil, litres (and other liquid fuels)	10.35
coal, kg (and the mineral part of dual fuel)	8.34
smokeless, kg	8.90
anthracite, kg	9.66
wood pellets, kg	4.7
wood chips, kg	3.5
wood logs, kg	4.1
wood logs, m³	1400

V6.3 Adjustment of calculated fuel usage

If the actual fuel usage is obtained from actual meter readings, estimated meter readings or receipts, for each fuel obtain a scaling factor which is the ratio of the energy used from the bill data (see V6.2) to calculated energy used.

[1] From the electricity bills if shown, otherwise as calculated by the SAP procedures.
[2] In the case of an electric continuously operating range cooker, 71% high rate if 7-hour tariff, 58% high rate if 10-hour tariff. The tariff is assigned following the rules in S12 of SAP Appendix S.

In the case of electricity, use the total calculated energy excluding any locally generated electricity. Apply a scaling factor to all fuels for which actual fuel usage is available. For example, if electricity use is 30% higher than predicted, and the household has an electric cooker and electric secondary heaters, increase the predicted energy use for appliances, lights, cooking, electric shower and secondary heating by 30% so that the total electricity use matches. Locally generated electricity is not scaled. The same scaling factors are to be applied when re-running the calculation to obtain the savings from improvement measures. Example:

Total calculated gas use = 25,000 kWh/year
Billed gas use = 20,000 kWh/year
Scaling factor = 20,000/25,000 = 0.8
The factor of 0.8 is to be applied to all calculated gas usage.

In other cases (fuels for which actual usage data is not available) do not adjust the calculated energy usage.

Also, the calculated energy usage is not adjusted for any fuel identified as being used for an unusual purpose.

If data for locally generated electricity is shown on the electricity bills, use the kWh from the electricity bills rather than that calculated by the SAP algorithms.

V7 Fuel tariffs

V7.1 Fuel tariffs available

Where tariff data is available, amend the fuel prices used to calculate annual costs and savings. In general there is an annual standing charge (£/year to nearest £) and a unit price (p/kWh). In the case of off-peak electricity there are high-rate and low-rate unit prices.

V7.1.1 VAT

If the fuel price data does not include VAT, first add 5% to each component of the tariff.

V7.1.2 Mains gas and electricity

- where a standing charge is applicable, scale it to one year:
  e.g. if given in p/day, multiply by 365 and divide by 100 to give £/year
  if given in £/quarter, multiply by 4
  and round to nearest £1.
- where two unit prices apply (initial units per period and follow-on units), obtain the difference in price between initial and follow-on units, scale to one year, round to nearest £1 and assign to standing charge:
  e.g. 600 kWh per quarter @ 8p, rest at 3p: standing charge = 0.01 × 600 × (8.0 – 3.0) × 4 = £120
  set the unit price to the follow-on unit price
  for off-peak tariffs set the standing charge and the high-rate unit price as above, and the low-rate unit price is as on the fuel bill

V7.1.3 Other fuels

- where a fixed cost applies and if the data is for other than 12 months, scale it to 12 months, round to nearest £1 and assign to standing charge (otherwise standing charge is 0)
- if unit price is given, convert to p/kWh (see Table V7)
- if only total cost is given, divide by number of units purchased to obtain unit price

V7.1.4 Community heating

- if the charging basis is fixed (not depending on the amount of heat used) no reconciliation can be done;
- if there is information on the charging basis per unit of heat, assign this (p/kWh) to the unit price for community heating and any fixed annual charge is the standing charge for community heating; in this case it does not depend on the community heat sources.

V7.2 Fuel tariff not available

For any fuel for which tariff data are not available use the tariff for SAP current prices. These prices include VAT. In the case of electricity tariff not available include an additional £52 standing charge since the SAP fuel price data omits the electricity standing charge for standard tariff.

V7.3 Calculation of energy costs

All standing charges are to be included in the calculation of total energy costs. These are taken from actual fuel tariff data where available.

V8 In-use factor for energy savings

In-use factors (<= 1.0) have been defined for each improvement measure and are applied to cost savings to reflect underperformance that has been found for some measures and to ensure that the savings are not over-estimated. Multiply the cost saving for each improvement measures by the in-use factor for the improvement measure concerned. A table of in-use factors is published separately[3].

V9 Improvement measures

The user interface offers improvement measures that are relevant to the property. These are defined in V14. Calculations of the effect of each selected improvement measure is done:

a) using the household's specific occupancy parameters, to estimate the saving for the measure for the particular household;
b) using the SAP standard occupancy parameters to obtain the Green Deal finance applicable to the measure.

V10 Fuel costs and savings for the Occupancy Assessment report

V10.1 Annual fuel costs

The household's total annual costs are calculated including all energy uses considered in the OA (see V6.1) using the occupancy parameters from the OA. Where available the energy scaling factors derived from fuel bill data are applied (see V6.3) and where available the particular fuel tariffs for the household are used.[4]

The corresponding figure for a typical household is calculated including all energy uses considered in the OA but using standard SAP occupancy parameters. There are no energy scaling factors (i.e. all factors set to 1). The same fuel tariffs as for the household's annual costs are used[5].

V10.2 Savings from improvement measures

Savings for improvement measures, applied sequentially one measure at a time, are obtained from the difference in total cost on application of the measure, multiplied by the in-use factor applicable to the measure then rounded to the nearest £.

The savings for the actual household are calculated on the basis of:
- all energy uses considered in the OA;
- occupancy parameters from the OA;
- energy scaling factors and actual fuel tariffs where known.

The savings for a typical household are calculated on the basis of:
- energy uses considered in RdSAP;
- standard SAP occupancy parameters;
- no energy scaling factors and SAP current fuel prices.

The savings for actual and typical are obtained (a) for the improvements selected in the OA and (b) for the improvements listed on the EPC. In the occupancy assessment, in-use factors are applied to all of these (so the savings shown for most of the EPC measures will differ from those on the EPC).

V10.3 Green Deal finance

Green Deal finance is indicated by a green or orange tick. If the measure is assessed as meeting the Golden Rule it has a green tick, if not it has an orange tick.

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[3] www.decc.gov.uk/assets/decc/11/tackling-climate-change/green-deal/5505-how-the-green-deal-will-reflect-the-insitu-perfor.pdf
[4] This means that, if the annual energy use for each fuel and the tariffs for each fuel are known, the total cost is equal to the sum of the fuel bills over one year. If the fuel information is incomplete it is completed by SAP data and/or fuel costs.
[5] If the fuel price has been worked out from total cost, it reverts to SAP current price for this calculation.

The Golden Rule says that the annual saving in energy cost from implementing the improvement measure must be at least equal to the annual repayments.

$$R = \frac{C \times r}{1-(1+r)^{-n}} \qquad \text{(V22)}$$

where:

R is the annual repayment
C is the cost of the measure (using the middle of the range where cost is given as a range)
r is the annual interest rate
n is the repayment term, taken as lifetime of the measure in years

Example. C = £500, r = 7%, n = 20 years:

$$R = \frac{500 \times 0.07}{1-(1+0.07)^{-20}} = £47$$

In this case the Golden Rule is met if the calculated annual saving for the measure is £47 or more. Round both R and the annual saving to nearest £ before comparing them. The saving used here is that calculated for a typical household (see V10.2).

As an exception to the above, solid wall insulation always gets a green tick. This is because a subsidy may be available via ECO (Energy Company Obligation) that reduces the cost to the householder to that available from GD finance.

Note. It might be changed to orange in some circumstances (when savings are small). Until such time as this is clarified, all solid wall insulation gets a green tick.

V11 Empty properties

If a property is unoccupied none of the data listed in Table V9 are available and the assessment is done with the following occupancy parameters.

Table V8 : Occupancy data for empty properties

Item	Data
Number of occupants	The value according to SAP Table 1b rounded to the nearest integer
Main heating 1	As RdSAP assessment
Main heating 2	As RdSAP assessment
Secondary heating	As RdSAP assessment; if there is no secondary heater and there are unheated rooms apply electric secondary heating using heater 693 if there is no secondary heater and main heating is one of 401, 402, 404, 421 apply electric secondary heating using heater 693
Heating by rooms	- if no main system 2, all rooms heated by main system 1 - if main system 2, assign heating to rooms alternately main system 1, main system 2 (starting with main system 1 for the living room). Note: No assignment of main system 2 to rooms if it does HW only according to the RdSAP data, otherwise at least one room with main system 2

	- if secondary heating present, assign it to the living room
Living room temperature	unknown
Heating pattern	07:00-09:00 and 16:00-23:00 five days per week and 07:00 to 23:00 two days per week
Showers and baths	- baths per day unknown - showers per day unknown - shower type unknown
Tumble drying	25% No outside drying space
Cold appliances	1 fridge 1 freezer No fridge-freezer
Cooking	Normal size cooker, electric
Fuel bills	No information for any fuel.
Energy scaling factors	1 for all fuels

V12 Occupancy data to be collected

Table V9 : Data to be collected

Item	**Data**	**Comment**
Number of occupants	whole number	This is a straight count of the number of people who sleep in this dwelling on at least half of the nights in a year, regardless of their age. Students living away from home during term time should be excluded.
Main heating 1	"as RdSAP assessment" or a room heater from Table V2, and the fuel used	Use "as RdSAP assessment" whenever relevant. Identification of particular room heaters is needed only where the main system(s) is not used, or where a different secondary heater is used
Main heating 2	"as RdSAP assessment" or a room heater from Table V2, and the fuel used	
Secondary heating	"as RdSAP assessment" or a room heater from Table V2, and the fuel used	

Heating by rooms (enter "1" in each applicable cell)					
Habitable rooms	**Heated by main system 1**	**Heating by main system 2**	**Heated by secondary heater**	**Partially heated**	**Not heated**
Living room	1			Assume L.R. fully heated	
Other room 1					
Other room 2					
Other room 3					
Other room 4					
(continue as necessary)					

The 'living room' for occupancy assessment is the room used most or best heated and is always taken as 'fully heated' (as the temperature and heating hours relate to it). Thus it is not necessarily the room that would be designated as the living room in a normal SAP assessment.

Enter data for habitable rooms only; omit other rooms (e.g. kitchen) and circulation spaces whether heated or not. Each room must be indicated as heated by at least one system or as unheated. A room can be heated by two systems (e.g. main and secondary). In the case of a partially heated room indicate also the system that provides heat to it.

Item	**Data**	**Comment**
Living room temperature	"unknown" or value	During heating periods, nearest 1°C
Heating pattern, normal day	On 1 Off 1 On 2 Off 2 On 3 Off 3 On 4 Off 4	Include times for the identified number of separate periods per day. Enter time in hours and quarter hours (24-hour clock), e.g. 08:30, 21:45
Heating pattern, alternative day	as above; also number of days per week using alternative pattern as a whole number between 0 and 3	
Showers and baths	Shower type: one of - none - mixer - pumped - electric - unknown Baths per day (if known) Showers per day (if known)	If more than one shower select value for the one used most often. If two types are stated to be used equally the selection order is (1) pumped, (2) mixer, (3) electric. Number per day is for the household as a whole and is a decimal number, e.g. 2.6
Tumble dryer	- percentage (0 to 100) - whether space is available for drying clothes outside	Tumble dryer can be combined with washing machine or separate. 0 if no tumble dryer. Otherwise householder's estimate of percentage of all clothes drying done in dryer.
Cold appliances	Number of each of: - stand-alone fridge - stand-alone freezer - fridge-freezer	"stand-alone" means it performs only one of the two functions (a small freezing compartment as is present in most fridges does not make it fridge-freezer, which is a unit with two separate compartments)

Item	Data	Comment
Cooking	Cooker type, one of - normal - large - always-hot range (all year) - always-hot range (winter) Cooking fuel: If normal or large, one of - gas - gas/electric - electric If always-hot range, one of - gas - oil - solid - electric	Normal is a standard cooker with 4 hobs or less; large has more than 4 hobs. Always-hot range stays hot all or most of the time, even when no cooking is taking place, regardless of the number of hobs. Note that many large cookers are commonly described as ranges, but these are not classified as range for present purposes unless they always stay hot. Winter assumes continuous operation for 8 months per year. gas/electric for a normal or large cooker has gas hobs and electric oven(s)
Fuel bills	Complete table below for each fuel currently used.	Includes annual usage of each fuel (where available) and fuel prices. User interface should indicate tariffs for SAP current prices, as a guide to the values expected.
Unusual energy-using item present	yes/no and if yes then short description and the fuel it affects. This can apply to any of the fuels currently being used.	e.g. heated swimming pool, pottery kiln, electric car.
Roof orientation(s)	S, SE, E, NE, N, NW, W, SW or horizontal	Possible roof orientations for solar water heating and PV improvements

Electricity tariff – standard domestic tariff		
Fuel bill information	One of - actual readings - estimated readings - not available	Select "actual" if that applies to the first and last reading of the total period
Energy used	- kWh supplied - period to which this relates.	period in months e.g. 12, 12.5, should be between 11 and 13 months. Where spread over more than one bill, add up and enter total
Electricity generated	- if renewable electricity generation is present, also the annual kWh generated	If shown on electricity bill, kWh generated during the same period as above.
Charging basis	One of - standing charge and unit price - two unit prices	
If standing charge and unit price	- amount (£ or p) and whether : £/year or £/quarter or £/month or p/day - p/kWh	
If two unit prices: initial unit price follow-on unit price	 - p/kWh - units at this price and whether per year, month or quarter - p/kWh	

Electricity tariff – standard domestic tariff		
Electricity generated	kWh/year	Where applicable
Price information includes VAT	- yes/no	

Electricity tariff – off-peak tariff		
Fuel bill information	One of - actual readings - estimated readings - not available	Select "actual" if that applies to the first and last reading of the total period. Must relate to current occupiers.
Energy used	- kWh supplied high rate - kWh supplied low rate - period to which this relates - if renewable electricity generation is present, also the annual kWh generated.	Period in months e.g. 12, 12.5, should be between 11 and 13 months. Where spread over more than one bill, add up and enter total.
Charging basis	One of - standing charge and unit price - two high-rate unit prices	
If standing charge	- amount (£ or p) and whether : £/year or £/quarter or £/month or p/day - high-rate p/kWh - low-rate p/kWh	
If two high-rate unit prices: initial high-rate unit price follow-on high-rate unit price low-rate unit price	 - p/kWh - units at this price and whether per year, month or quarter - p/kWh - p/kWh	Initial rate applies to high rate. Low rate has single p/kWh.
Electricity generated	kWh/year	Where applicable
Price information includes VAT	- yes/no	

Gas tariff		
Fuel bill information	One of - actual readings - estimated readings - not available	Select "actual" if that applies to the first and last reading of the total period
Energy used	- kWh - period to which this relates	period in months e.g. 12, 12.5, should be between 11 and 13 months. Where spread over more than one bill, add up and enter total
Charging basis	One of - standing charge and unit price - two unit prices	
If standing charge	- amount (£ or p) and whether : £/year or £/quarter or £/month or p/day - p/kWh	
If two unit prices: initial unit price follow-on unit price	 - p/kWh - units at this price and whether per year, month or quarter - p/kWh	
Price information includes VAT	- yes/no	

Community heating		
Fuel bill information	One of - invoices or receipts showing amount of heat used - not available	If charging basis does not depend on the amount of heat used, treat as not available; that includes cases where a fixed charge for heating is incorporated in rent. If not available omit the remainder of this table.
Energy used	If based on amount of heat used: - energy used in kWh - period to which this relates	period in months e.g. 12, 12.5, should be between 11 and 13 months. Where spread over more than one bill, add up and enter total
Fixed cost	- £/year	Any fixed cost, i.e. not related to number of units used
Unit price	p/kWh	
Price information includes VAT	- yes/no	

Other fuel (for each other fuel)		
Fuel bill information	One of - invoices or receipts - not available	
Fuel	One of - LPG - heating oil - coal - anthracite - smokeless fuel - wood logs - wood chips - wood pellets	If there is a dual fuel appliance complete this table separately for the mineral fuel and the wood fuel (logs).
Unit of supply	For wood logs, one of: - kg - cubic metres	For other fuels the unit of supply is as in Table V7
Units purchased	- number of units purchased - period to which this relates	Period in months e.g. 12, 12.5, should be between 11 and 13 months. Where spread over more than one bill, add up and enter total. If bills for more than one year are available a better estimate may be obtained from a total over 2 or 3 complete years. The householder's estimate of annual usage can be used.
Fixed cost	£/year	Any fixed cost on the bills, i.e. not related to number of units purchased (e.g. delivery charge, storage tank rental)
Unit cost	For wood logs, one of: - pence/kg - £/m³ - total cost in £/year For other fuels, one of: - pence per unit - total cost in £/year	Price per unit if known. If unit cost not known, the total cost (from which the cost per unit will be calculated from the units purchased).
Price information includes VAT	- yes/no	

V13 SAP WORKSHEET (Version 9.91 modifications for occupancy assessment)

1. Overall dwelling dimensions

As normal worksheet

2. Ventilation rate

As normal worksheet

3. Heat losses and heat loss parameter

As normal worksheet

4. Water heating energy requirement kWh/year

Actual occupancy, N (42)

Daily hot water requirement for:

Baths (litres/day) $V_{d,bath}$ = Baths per day × 50.8 (42a)

If the number of baths per day is unknown then:

(no shower present, i.e. "None" selected in Table V1) *(42a) = 0.35 × (42) + 0.50*

(shower also present) *(42a) = 0.13 × (42) + 0.19*

Showers (litres/day) $V_{d,shower}$ = Showers per day × hot water per shower from Table V1 (42b)

If showers per day is unknown then *(42b) = 0.45 × (42) + 0.65*

Other (litres/day) $V_{d,other}$ = 9.8 × (42) + 14 (42c)

Average daily water use (litres/day) $V_{d,average}$ = (42a) + (42b) + (42c) = (43)

Continue as normal to (65)

5. Internal gains (see Table 5 and 5a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), = 60 × (42)													
$(66)_m$ =	$(66)_1$	$(66)_2$	$(66)_3$	$(66)_4$	$(66)_5$	$(66)_6$	$(66)_7$	$(66)_8$	$(66)_9$	$(66)_{10}$	$(66)_{11}$	$(66a)_{12}$	(66)
Lighting gains (calculated in Appendix L, equation L9)													
$(67)_m$ =	$(67)_1$	$(67)_2$	$(67)_3$	$(67)_4$	$(67)_5$	$(67)_6$	$(67)_7$	$(67)_8$	$(67)_9$	$(67)_{10}$	$(67)_{11}$	$(67)_{12}$	(67)
Appliances gains (equation V14 and equation L13)													
$(68)_m$ =	$(68)_1$	$(68)_2$	$(68)_3$	$(68)_4$	$(68)_5$	$(68)_6$	$(68)_7$	$(68)_8$	$(68)_9$	$(68)_{10}$	$(68)_{11}$	$(68)_{12}$	(68)
Cooking gains, from equation V19 and, if continuously operating range, equation V20													
$(69)_m$ =	$(69)_1$	$(69)_2$	$(69)_3$	$(69)_4$	$(69)_5$	$(69)_6$	$(69)_7$	$(69)_8$	$(69)_9$	$(69)_{10}$	$(69)_{11}$	$(69)_{12}$	(69)
Pumps and fans gains (Table 5a)													
$(70)_m$ =	$(70)_1$	$(70)_2$	$(70)_3$	$(70)_4$	$(70)_5$	$(70)_6$	$(70)_7$	$(70)_8$	$(70)_9$	$(70)_{10}$	$(70)_{11}$	$(70)_{12}$	(70)
Losses e.g. evaporation (negative values) (Table 5)													
$(71)_m$ =	$(71)_1$	$(71)_2$	$(71)_3$	$(71)_4$	$(71)_5$	$(71)_6$	$(71)_7$	$(71)_8$	$(71)_9$	$(71)_{10}$	$(71)_{11}$	$(71)_{12}$	(71)
Water heating gains (Table 5)													
$(72)_m$ =	$(72)_1$	$(72)_2$	$(72)_3$	$(72)_4$	$(72)_5$	$(72)_6$	$(72)_7$	$(72)_8$	$(72)_9$	$(72)_{10}$	$(72)_{11}$	$(72)_{12}$	(72)
Electric shower, equation V21													
$(72a)_m$ =	$(72a)_1$	$(72a)_2$	$(72a)_3$	$(72a)_4$	$(72a)_5$	$(72a)_6$	$(72a)_7$	$(72a)_8$	$(72a)_9$	$(72a)_{10}$	$(72a)_{11}$	$(72a)_{12}$	(72a)
Total internal gains = $(66)_m$ + $(67)_m$ + $(68)_m$ + $(69)_m$ + $(70)_m$ + $(71)_m$ + $(72)_m$ + $(72a)_m$													
$(73)_m$ =	$(73)_1$	$(73)_2$	$(73)_3$	$(73)_4$	$(73)_5$	$(73)_6$	$(73)_7$	$(73)_8$	$(73)_9$	$(73)_{10}$	$(73)_{11}$	$(73)_{12}$	(73)

Continue as normal to (84)

7. Mean internal temperature (heating season)

Living room temperature during heating periods identified by occupancy survey, T_{h1} (°C), use 21°C if unknown [ ] (85)

Note: Use Table V3 instead of Table 9 and base the calculation on heaters identified in the occupancy survey as described in V2.1

Utilisation factor for gains for living area, $\eta_{1,m}$ (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
$(86)_m$ =	$(86)_1$	$(86)_2$	$(86)_3$	$(86)_4$	$(86)_5$	$(86)_6$	$(86)_7$	$(86)_8$	$(86)_9$	$(86)_{10}$	$(86)_{11}$	$(86)_{12}$	(86)

Mean internal temperature in living area T_1 *(follow steps 3 to 7 in Table 9c adapted for occupancy assessment in V3)*

$(87)_m$ =	$(87)_1$	$(87)_2$	$(87)_3$	$(87)_4$	$(87)_5$	$(87)_6$	$(87)_7$	$(87)_8$	$(87)_9$	$(87)_{10}$	$(87)_{11}$	$(87)_{12}$	(87)

Temperature during heating periods in rest of dwelling, T_{h2} (°C), from Table V3

$(88)_m$ =	$(88)_1$	$(88)_2$	$(88)_3$	$(88)_4$	$(88)_5$	$(88)_6$	$(88)_7$	$(88)_8$	$(88)_9$	$(88)_{10}$	$(88)_{11}$	$(88)_{12}$	(88)

Utilisation factor for gains for rest of dwelling, $\eta_{2,m}$ (see Table 9a)

$(89)_m$ =	$(89)_1$	$(89)_2$	$(89)_3$	$(89)_4$	$(89)_5$	$(89)_6$	$(89)_7$	$(89)_8$	$(89)_9$	$(89)_{10}$	$(89)_{11}$	$(89)_{12}$	(89)

Mean internal temperature in the rest of dwelling T_2
(follow steps 8 to 9 in Table 9c adapted for occupancy assessment in V3, if two main heating systems see further notes in Table 9c)

$(90)_m$ =	$(90)_1$	$(90)_2$	$(90)_3$	$(90)_4$	$(90)_5$	$(90)_6$	$(90)_7$	$(90)_8$	$(90)_9$	$(90)_{10}$	$(90)_{11}$	$(90)_{12}$	(90)

Living area fraction f_{LA} = Living area ÷ (4) = [ ] (91)

Mean internal temperature(for the whole dwelling if all rooms are heated)) $MIT_{h,m} = f_{LA} \times T_1 + (1 - f_{LA}) \times T_2$

$(92)_m$ =	$(92)_1$	$(92)_2$	$(92)_3$	$(92)_4$	$(92)_5$	$(92)_6$	$(92)_7$	$(92)_8$	$(92)_9$	$(82)_{10}$	$(92)_{11}$	$(92)_{12}$	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

$(93)_m$ =	$(93)_1$	$(93)_2$	$(93)_3$	$(93)_4$	$(93)_5$	$(93)_6$	$(93)_7$	$(93)_8$	$(93)_9$	$(93)_{10}$	$(93)_{11}$	$(93)_{12}$	(93)

If there are any unheated, partially heated or rooms with secondary heating only calculate MIT as described in V3

Mean internal temperature (for the unheated rooms, $MIT_{u,m}$)

$(93a)_1$	$(93a)_2$	$(93a)_3$	$(93a)_4$	$(93a)_5$	$(93a)_6$	$(93a)_7$	$(93a)_8$	$(93a)_9$	$(93a)_{10}$	$(93a)_{11}$	$(93a)_{12}$	(93a)

Unheated fraction, f_u: $f_u = (n_{unheated} + 0.5\, n_{partially\ heated} + 0.5\, n_{secondary\text{-}heating\text{-}only})/n_{total}$ [ ] (93b)

Note: assume living room fully heated and assign a factor of 1.5 for room count. [ ]

Mean internal temperature final, set $MIT_m = (1 - f_u) \times MIT_{h,m} + f_u \times MIT_{u,m}$ (see V3 for details)

$(93c)_1$	$(93c)_2$	$(93c)_3$	$(93c)_4$	$(93c)_5$	$(93c)_6$	$(93c)_7$	$(93c)_8$	$(93c)_9$	$(93c)_{10}$	$(93c)_{11}$	$(93c)_{12}$	(93c)

Continue as normal to (99)

9a. Energy requirements – Individual heating systems including micro-CHP

For any space heating or water heating provided by community heating use the alternative worksheet 9b.

Note: Base the calculation on heaters identified in the occupancy survey as described in V2.1

Space heating:

Fraction of space heat from secondary/supplementary system (from V2.2.1) *"0" if none*		(201)
Fraction of space heat from main system(s) (202) = 1 – (201) =		(202)
Fraction of main heating from main system 2 (fromV2.2.2)		(203)
Fraction of total space heat from main system 1 (204) = (202) × [1 – (203)] =		(204)
Fraction of total space heat from main system 2 (205) = (202) × (203) =		(205)
Efficiency of main space heating system 1 (in %) *(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c; for gas and oil boilers see 9.2.1)*		(206)
If there is a second main system complete (207)		
Efficiency of main space heating system 2 (in %) *(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c; for gas and oil boilers see 9.2.1)*		(207)
Efficiency of secondary/supplementary heating system, % *(from Table 4a)*		(208)

Continue as normal to (219)

Scaling factors apply to those fuels for which annual fuel use is available; set the factor to 1 for other fuels. The factors are calculated for the dwelling as-is and the same factors are used when evaluating improvement measures. Obtain the total of (211) to (232d) separately for each fuel, and divide into the annual fuel use for that fuel to obtain the scaling factor.

Scaling factors:

	Fuel bills, kWh/year	SAP calc, kWh/year	Scaling factor
Fuel bills – fuel 1			
Fuel bills – fuel 2			
Fuel bills – fuel 3			
Fuel bills – fuel N			

Annual totals:

	kWh/year	Scaling factor	kWh/year	
Space heating fuel used, main system 1				(211)
Space heating fuel used, main system 2				(213)
Space heating fuel used, secondary				(215)
Water heating fuel used				(219)
Electric shower (calculated in V4.2.5)				(219a)
Electricity for pumps, fans and electric keep-hot (Table 4f):				
§ mechanical ventilation fans - balanced, extract or positive input from outside				(230a)
§ warm air heating system fans				(230b)
§ central heating pump				(230c)
§ oil boiler pump				(230d)
§ boiler flue fan				(230e)
§ maintaining electric keep-hot facility for gas combi boiler				(230f)
§ pump for solar water heating				(230g)
Total electricity for the above, kWh/year sum of (230a)…(230g) =				(231)
Electricity for lighting (calculated in Appendix L)				(232)
Electricity for appliances (calculated in V4.2)				(232a)
Electricity for cooking (not range) (calculated in V4.1)				(232b)
Gas for cooking (not range) (calculated in V4.1)				(232c)
Energy for range cooker (V4.1 and V4.1.1)				(232d)

Energy saving/generation technologies (Appendices M ,N and Q)		
Electricity generated by PVs (Appendix M) (negative quantity)		(233)
Electricity generated by wind turbine (Appendix M) (negative quantity)		(234)
Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation)		(235)
Total delivered energy for all uses	(211) + ... + (235) =	(238)

10a. Fuel costs – Individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	(211)	×		× 0.01 =		(240)
Space heating - main system 2	(213)	×		× 0.01 =		(241)
Space heating - secondary	(215)	×		× 0.01 =		(242)
Water heating (electric off-peak tariff)						
High-rate fraction (Table 13, or Appendix F for electric CPSU)						(243)
Low-rate fraction	1.0 – (243) =					(244)
High-rate cost	(219) × (243) ×			× 0.01 =		(245)
Low-rate cost	(219) × (244) ×			× 0.01 =		(246)
Water heating cost (other fuel)	(219)	×		× 0.01 =		(247)
(for a DHW-only community scheme use (342a) or (342b) instead of (247)						
Electric shower	(219a)	×		× 0.01 =		(247a)
Pumps, fans and electric keep-hot	(231)	×		× 0.01 =		(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a						
Electricity for lighting	(232)	×		× 0.01 =		(250)
Electricity for appliances	(232a)	×		× 0.01 =		(250a)
Electricity for cooking (not range)	(232b)	×		× 0.01 =		(250b)
Gas for cooking (not range)	(232c)	×		× 0.01 =		(250c)
Energy for range cooker	(232d)	×		× 0.01 =		(250d)
Standing charges						(251)
Energy saving/generation technologies <description>	(233) to (235) as applicable, repeat line (252) as needed one of (233) to (235)	×		× 0.01 =		(252)
Total energy cost			(240)...(242) + (245)...(252) =			(255)

Community heating

9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Continue as normal to (306)

Scaling factors apply to those fuels for which annual fuel use is available; set the factor to 1 for other fuels. The factors are calculated for the dwelling as-is and the same factors are used when evaluating improvement measures. Obtain the total of (307a) to (332d) separately for each fuel, and divide into the annual fuel use for that fuel to obtain the scaling factor.

Scaling factors:

	Fuel bills, kWh/year	SAP calc, kWh/year	Scaling factor
Fuel bills – community heating			
Fuel bills – fuel 2			
Fuel bills – fuel 3			
Fuel bills – fuel N			

Space heating	kWh/year	Scaling factor	kWh/year	
Annual space heating requirement	(98)			
Space heat from CHP				(307a)
Space heat from heat source 2				(307b)
Space heat from heat source 3				(307c)
Space heat from heat source 4				(307d)
Space heat from heat source 5				(307e)
Efficiency of secondary/supplementary heating system in % *(from Table 4a or Appendix E)*				(308)
Space heating fuel for secondary/supplementary system				(309)

Water heating				
Annual water heating requirement	(64)			
If DHW from community scheme:				
Water heat from CHP				(310a)
Water heat from heat source 2				(310b)
Water heat from heat source 3				(310c)
Water heat from heat source 4				(310d)
Water heat from heat source 5				(310e)
If DHW by immersion or instantaneous heater within dwelling:				
Efficiency of water heater				(311)
Water heated by immersion or instantaneous heater				(312)
Electric shower (calculated in V4.2.5)				(312a)
Electricity used for heat distribution				(313)
Electricity for pumps and fans within dwelling (Table 4f):				
mechanical ventilation - balanced, extract or positive input from outside				(330a)
warm air heating system fans				(330b)
pump for solar water heating				(330g)
Total electricity for the above, kWh/year				(331)
Energy for lighting (calculated in Appendix L)				(332)
Electricity for appliances (calculated in V4.2)				(332a)
Electricity for cooking (not range) (calculated in V4.1)				(332b)
Gas for cooking (not range) (calculated in V4.1)				(332c)
Energy for range cooker (V4.1 and V4.1.1)				(332d)
Energy saving/generation technologies (Appendices M and Q)				
Electricity generated by PVs (Appendix M) (negative quantity)				(333)
Electricity generated by wind turbine (Appendix M) (negative quantity)				(334)

10b. Fuel costs – Community heating scheme

If price for community heat is known, the same price applies to all community heat sources

	Heat or fuel required kWh/year		Fuel price		Fuel cost £/year	
Space heating from CHP	(307a)	×		× 0.01 =		(340a)
Space heating from heat source 2	(307b)	×		× 0.01 =		(340b)
Space heating from heat source 3	(307c)	×		× 0.01 =		(340c)
Space heating from heat source 4	(307d)	×		× 0.01 =		(340d)
Space heating from heat source 5	(307e)	×		× 0.01 =		(340e)
Space heating (secondary)	(309)	×		× 0.01 =		(341)
Water heating from CHP	(310a)	×		× 0.01 =		(342a)
Water heating from heat source 2	(310b)	×		× 0.01 =		(342b)

Water heating from heat source 3	(310c)	×		× 0.01 =		(342c)
Water heating from heat source 4	(310d)	×		× 0.01 =		(342d)
Water heating from heat source 5	(310e)	×		× 0.01 =		(342e)

If water heated by immersion heater:

High-rate fraction (Table 13)			(343)
Low-rate fraction	1.0 - (343) =		(344)

			Fuel price			
High-rate cost, or cost for single immersion	(312) ×	(343) ×		× 0.01 =		(345)
Low-rate cost	(312) ×	(344) ×		× 0.01 =		(346)

If water heated by instantaneous water heater	(312)	×		× 0.01 =		(347)
Electric shower	(312a)			× 0.01 =		(347a)
Pumps and fans	(331)	×		× 0.01 =		(349)

(if off-peak tariff, list each of (330a) to (330g) separately as applicable and apply fuel price according to Table 12a

Electricity for lighting	(332)	×		× 0.01 =		(350)
Electricity for appliances	(332a)	×		× 0.01 =		(350a)
Electricity for cooking (not range)	(332b)	×		× 0.01 =		(350b)
Gas for cooking (not range)	(332c)	×		× 0.01 =		(350c)
Energy for range cooker	(332d)	×		× 0.01 =		(350d)

Standing charges						(351)
Energy saving/generation technologies	(333) to (334) as applicable, repeat line (352) as needed					
<description>	one of (333) to (334)	×		× 0.01 =		(352)
Appendix Q items: repeat lines (253) and (259) as needed						
<description>, energy saved	one of (336a) etc	×		× 0.01 =		(353)
<description>, energy used	one of (337a) etc	×		× 0.01 =		(354)
Total energy cost		=	(340a)...(342e) + (345)...(354) =			(355)

V14 Occupancy assessment : Improvement measures

On the user interface improvement measures relevant to the property concerned are shown in groups:

Insulation measures:	A, A2, A3, B, Q, Q1, Q2, W, D (B and Q2 are mutually exclusive, only one of them can be selected)
Heating and hot water:	C, F, G, H, J, K, L, M, I, R, S, T, T2, Z1, Z4, Z2, Z5, Z3, N, Y (I, J, K, L, M, R, S, T, Z1, Z4, Z2, Z5 and Z3 are mutually exclusive, only one of them can be selected) (T2 is available only in conjunction with I, S or T)
Windows and doors:	O, O2, P, X (O, O2 and P are mutually exclusive, only one of them can be selected)
Electricity generation:	U, V, V2 (V and V2 are mutually exclusive, only one of them can be selected)

If for any group there are no applicable measures write "No measures" otherwise indicate those that are (potentially) applicable with a tick-box to allow their selection and, where there are alternatives indicated in the table below such as different thicknesses of insulation or a choice between heating systems, provide a pick-list for one of the alternatives to be selected.

OA software calculates the effect of the selected improvement measures in the order shown in the table (this is similar although not identical to RdSAP).

The effect of each selected measure is shown whether or not it results in a cost saving. If the saving is negative this should be highlighted by showing it in red.

Unlike EPCs for which only one heating measure is considered, the OA offers a choice of all heating systems that could be installed.

There are a number of situations where precise details are not known, for example there was no access to the loft space to ascertain the existing thickness of loft insulation. Recommendations are not shown on EPCs for these cases but they are considered in the OA assessment, with a indication that additional information needs to be obtained. The cost saving is calculated on the basis of the existing dwelling having the default values assigned in RdSAP. The situations are:

Situation	Measure	Conditions and information required
Pitched roof, no access to loft	A	Access to the loft is needed to establish existing loft insulation.
Flat roof, insulation unknown	A2	Flat roof insulation improvement requires that the existing insulation is ascertained.
Roof rooms, insulation unknown for some or all	A3	Roof room insulation improvement requires that the existing insulation is ascertained.

Situation	Measure	Conditions and information required
Cavity wall, cavity fill unknown	B Q2	A borescope examination is needed to establish whether cavity insulation is already present.
Cavity wall, age band G or H, wall construction as built	B	A borescope examination is needed to establish whether cavity insulation is already present.
Cavity wall, fill selected but narrow cavities indicated in EPC addendum	B	The walls may have narrow cavities. This should be checked to establish a suitable type of cavity wall insulation.
Cavity wall, fill selected but access issues indicated in EPC addendum	B	Establish whether access to applicable walls can be arranged.
Cavity wall, fill selected but possible high exposure indicated in EPC addendum	B	Suitability for cavity fill should be checked in relation to local exposure conditions and wall construction
System build	B	Some of the walls are system built or of non-conventional construction. It needs to be established that these walls are suitable for cavity insulation
Stone walls not insulated	B	It should be established whether stone walls are of cavity construction and suitable for cavity fill.
Solid wall insulation unknown	Q, Q1	It needs to be established whether the solid walls are insulated.
Hot water cylinder present but inaccessible	C	The existing cylinder insulation is not known. Access to the cylinder is needed to establish this.
Hot water cylinder present but inaccessible	F	It is not known whether a cylinder thermostat is present. Access to the cylinder is needed to establish this.
Floor insulation unknown	W	Floor insulation improvement requires that the existing insulation is ascertained.
Mains gas not available	T T+T2 Z3	Assumes that mains gas can be made available to the property. The cost of providing the gas supply needs to be ascertained.

Where any of the above apply, this is to be indicated on the user interface (and is included in the OA report).

The effect of each improvement is calculated for:
1. With the standard occupancy parameters (as in RdSAP) for both existing dwelling and improved dwelling. The result sets the maximum Green Deal repayment.
2. With the occupancy parameters set in the occupancy assessment, for both existing dwelling and improved dwelling. This illustrates the effect of the measures for the current occupants' heating patterns.

Both of the above are shown on the Occupancy Assessment report.

Item	Measure	To be offered when existing dwelling is/has:	Improvement options:	Comment
INSULATION MEASURES				
For all insulation measures, change insulation only for those elements with less insulation than the selected option (e.g. loft insulation: main dwelling has 100 mm, extension 1 has 250 mm, selection is 200 mm: change main to 200 mm and leave extension 1 at 250 mm) U-values are for $\lambda = 0.044$ (loft insulation) or $\lambda = 0.04$ (others); assessors must be aware that different insulation materials give different U-values for a stated thickness.				
A	Loft insulation Note. This is assumed to include insulation of the loft hatch.	Pitched roof (slates or tiles, not thatched roof), accessible loft, insulation at ceiling level <= 150 mm or U > 0.30 or Pitched roof (slates or tiles), no access, unknown insulation, age band <= H	150 mm U = 0.30 200 mm U = 0.22 250 mm U = 0.18 270 mm U = 0.16 (default) 300 mm U = 0.15 350 mm U = 0.13 400 mm U = 0.11	
A2	Flat roof insulation	Flat roof including unknown insulation, U-value (entered or from RdSAP tables) > 0.35	100 mm U = 0.33 150 mm U = 0.24 200 mm U = 0.18 (default) 250 mm U = 0.15	
A3	Roof room insulation	Roof rooms including unknown insulation, not thatched roof, any part of roof rooms with U-value (entered or from RdSAP tables) > 0.35	100 mm U = 0.35 150 mm U = 0.25 (default) 200 mm U = 0.18 250 mm U = 0.15	Change U-value of any part of roof rooms with U > 0.35

Item	Measure	To be offered when existing dwelling is/has:	Improvement options:	Comment
B	Cavity wall insulation	Unfilled cavity wall as built or unknown, age band <= F or Unfilled cavity wall as built or unknown, age band G or H or System built or stone walls, as built or unknown insulation, age band <= F	Cavity filled wall, U-value from RdSAP tables according to age of wall. ditto U = 0.80	Where there is more than one applicable wall type the priority is: 1. cavity wall 2. system built wall 3. stone wall
Q2	External insulation with cavity wall insulation.	Cavity wall as B (not stone or system built) or Filled cavity and age band <= F	External insulation in addition to cavity fill: 50 mm (default) 100 mm 150 mm Improved U-value from Table S6/S7	If measure B is applicable offer Q2 as an alternative to B. If cavity wall already filled offer Q2
Q	Internal or external wall insulation	Solid wall, brick, as built or unknown insulation, age band A to D	Internal wall insulation: 50 mm 100 mm 150 mm or External wall insulation: 50 mm 100 mm (default) 150 mm Choice of percentage of wall to be improved, see note at end. Improved U-value from Table S6/S7	If percentage less than 100%, assign additional wall type for improved wall (each applicable building part)

Item	Measure	To be offered when existing dwelling is/has:	Improvement options:	Comment
Q1	Internal or external wall insulation	Solid wall, brick, as built or unknown insulation, age band E or F or Solid wall, stone or system build, as built or unknown insulation, age band <= F or Filled cavity wall, age band G to I	Internal wall insulation: 50 mm 100 mm 150 mm or External wall insulation: 50 mm 100 mm (default) 150 mm Choice of percentage of wall to be improved, see note at end. Improved U-value from Table S6/S7	Not if measure B selected for same wall(s) If percentage less than 100%, assign additional wall type for improved wall (each applicable building part)
W	Floor insulation	Below the building part there is: - ground, or - external air, or - unheated space and floor is as-built or unknown insulation or (has retro-fitted insulation <= 50 mm) or (has retro-fitted insulation with U > 0.5), and age band is <= J	Include floor insulation (ground floor) or retro-fit insulation (upper floor): 50 mm 100 mm (default) 150 mm 200 mm Ground floor: calculate U-value according to S5.4 Upper floor: calculate U-value by addition of selected insulation thickness with $\lambda = 0.04$	If floor type (solid or suspended) is unknown, calculate improvement for solid floor In the case of an exposed or semi-exposed floor deduced by RdSAP S3.10 rather than entered by the assessor, apply the values for an insulated floor in Table S12.
D	Draught proofing	Less than 100% draught proofing of windows and doors	100% draught proofing	

Item	Measure	To be offered when existing dwelling is/has:	Improvement options:	Comment
HEATING AND HOT WATER				
C	Hot water cylinder insulation	Cylinder present and accessible and (< 80 mm jacket or <= 25 mm factory-applied insulation) or Cylinder present and not accessible and age band of main dwelling <= H	If no insulation add 80 mm jacket If factory applied <= 25 mm add 80 mm jacket (see notes at end) If jacket < 80 mm add additional jacket (see notes at end) (If cylinder not accessible existing is per RdSAP)	
F	Cylinder thermostat	Cylinder present and no cylinderstat	Cylinderstat	Note: cylinderstat is assumed for electric immersions
G	Heating controls for wet central heating system This applies only if main heating system is used (not substituted by a room heater)	Main heating by boiler with radiators, heating control 2101, 2102, 2103, 2104, 2105 or 2111	If existing is 2105, Time and temperature zone control otherwise options: - Roomstat, programmer and TRVs - Time and temperature zone control	
		Main heating by boiler with underfloor heating and control not 2110	Time and temperature zone control	
		Main heating by heat pump with radiators or underfloor heating and control not 2207	Time and temperature zone control	
H	Heating controls for warm air system This applies only if main heating system is used (not substituted by a room heater)	Main heating by mains gas or LPG warm air, or by warm air heat pump, control 2501 or 2502	Programmer and roomstat	

Item	Measure	To be offered when existing dwelling is/has:	Improvement options:	Comment
For all heating measures (I to Z3 following), base possible upgrades on the heating system identified in the RdSAP assessment (main system 1 id there are two), not on any substituted room heater. Offer the user a choice of any of the applicable systems.				
I	Upgrade boiler, same fuel	Main heating by non-condensing mains gas boiler (including range cooker boiler) or CPSU or by non-condensing LPG or oil boiler (including range cooker boiler) Note. Not applicable to liquid biofuels.	If boiler (incl. range cooker boiler) and hot water cylinder in dwelling: condensing regular boiler, same fuel as original. See notes at end. If boiler (incl. range cooker boiler) and no hot water cylinder in dwelling: condensing combi boiler, same fuel as original. See notes at end. If CPSU: condensing CPSU. See notes at end.	Note. Although the calculation for the improvement is done with either a combi or a regular boiler according to the existing configuration, the results are very similar for both boiler types and can be taken as applicable to either boiler type.
S	Change heating to condensing gas condensing boiler (no fuel switch)	Main heating by: - mains gas fires or - mains gas warm air or - mains gas micro-CHP	If hot water cylinder in dwelling: condensing regular mains gas boiler, radiators. See notes at end. If no hot water cylinder in dwelling: condensing combi mains gas boiler, radiators. See notes at end.	
T	Change heating to condensing gas condensing boiler (fuel switch)	Any heating system (including no system present) other than: - community - mains gas boiler - mains gas fires - mains gas warm air - mains gas micro-CHP	If hot water cylinder in dwelling, condensing regular mains gas boiler, radiators. See notes at end. If no hot water cylinder in dwelling, condensing combi mains gas boiler, radiators. See notes at end.	

Item	Measure	To be offered when existing dwelling is/has:	Improvement options:	Comment
T2	Flue gas heat recovery	New or replacement gas boiler selected (I, S or T)	Add FGHRS (Replacement boiler provides DHW)	Offer as alternative, i.e. - gas boiler, or - gas boiler with flue gas heat rec. In this case the indicative cost is the sum of that for the boiler and the FGHRS, as is the annual repayment. The cost savings are calculated first for the boiler then for adding the FGHRS, the applicable in-use factor is applied to each of those and the costs saving is the sum.
R	Condensing oil boiler	Any heating system (including no system present) other than: - community - oil boiler (covered by measure I)	If hot water cylinder in dwelling: condensing regular oil boiler, radiators. See notes at end. If no hot water cylinder in dwelling: condensing combi oil boiler, radiators. See notes at end.	
J	Wood logs boiler	Any heating system (including no system present) other than: - community - biomass or dual fuel boiler	Manual feed biomass boiler in heated space (wood logs) with radiators. See notes at end.	Although the calculation is done for an independent boiler, the results are very similar for a wood-logs closed room heater with boiler and can be taken as applicable to either boiler type.
K	Wood pellets boiler	Any heating system (including no system present) other than: - community - biomass or dual fuel boiler	Wood pellet stove with radiators, summer immersion heater. See notes at end.	Although the calculation is done for a stove with boiler, the results are very similar for a wood-pellets independent boiler and can be taken as applicable to either boiler type.

Item	Measure	To be offered when existing dwelling is/has:	Improvement options:	Comment
L	New or replacement storage heaters	Any heating system (including no system present) other than: - community - fan-assisted storage heaters or integrated storage+direct-acting (i.e. 404, 408, 422)	Fan-assisted storage heaters with automatic charge control, secondary heating in living room (691 if no existing secondary heating) If meter is single change to dual. If water heating is from a main system, change to dual electric immersion and large cylinder with 50 mm factory-applied insulation; otherwise no change to DHW arrangements	
M	New or replacement warm-air unit	Any heating system (including no system present) other than: - community - warm air 502, 510, 511, 512 and mains gas available	Main gas warm-air unit, on-off control, fan-assisted flue (502). Heating controls 2504 (unless existing is 2505 or 2506 in which case leave unchanged)	
Z1	Air source heat pump with radiators	Any heating system (including no system present) other than: - community - heat pump - wet underfloor system	Electric air source heat pump and radiators (204)	
Z4	Ground source heat pump with radiators	House or bungalow with heating system (including no system present) other than: - community or - heat pump or - wet underfloor system	Electric ground source heat pump and radiators (201)	
Z2	Air source heat pump with underfloor heating	Any heating system (including no system present) other than: - community or - heat pump and wet underfloor system	Electric air source heat pump and underfloor heating (204)	

Item	Measure	To be offered when existing dwelling is/has:	Improvement options:	Comment
Z5	Ground source heat pump with underfloor heating	House or bungalow with any heating system (including no system present) other than: - community or - heat pump and wet underfloor system	Electric ground source heat pump and underfloor heating (201)	
Z3	Micro-CHP	Any heating system (including no system present) other than: - community - micro-CHP	Gas-fired micro-CHP. See notes at end.	
N	Solar water heating	any property, not thatched roof on main dwelling, no solar panel :	Solar panel with parameters per Table S18 but with options: - 3 m² panel (default) - 6 m² panel Increase cylinder size to: - 3 m² panel: medium; - 6 m² panel: large except that cylinder change not applicable to water heating by combi boiler or CPSU or heat pump or (micro-CHP with integral DHW vessel) or instantaneous water heater or community heating - in these cases add a separate solar cylinder of 75 litres.(3 m² panel) or 150 litres (6 m² panel) Cylinder has cylinderstat and 50 mm factory-applied insulation.	Also obtain orientation of roof (S, SE, E, etc or horizontal) and calculate effect of solar panel for that orientation
Y	Waste water heat recovery	Dwelling has a mixer shower and no WWHRS	Add WWHRS for each shower.	

Item	Measure	To be offered when existing dwelling is/has:	Improvement options:	Comment
WINDOWS AND DOORS				
O	Double glazing	Any single glazing present	If all windows measured, all single glazed windows replaced by double glazing with U = 1.5 and g = 0.63. Otherwise the windows with single glazing changed to double glazing with U = 1.5 and g = 0.63. Choice of percentage of windows to be improved, see note at end.	Included as OA option even if double glazing deselected in RdSAP assessment
O2	Triple glazing	Any single glazing present	If all windows measured, all single glazed windows replaced by triple glazing with U = 1.3 and g = 0.60. Otherwise the windows with single glazing changed to triple glazing with U = 1.3 and g = 0.60. Choice of percentage of windows to be improved, see note at end.	Included as OA option even if double glazing deselected in RdSAP assessment
P	Secondary glazing	Any single glazing present	If all windows measured apply secondary glazing to single glazed windows with U = 2.4 and g = 0.76. Otherwise the windows with single glazing changed to secondary glazing with U = 2.4 and g = 0.76. Choice of percentage of windows to be improved, see note at end.	

Item	Measure	To be offered when existing dwelling is/has:	Improvement options:	Comment
X	Insulated doors	House or bungalow or (flat or maisonette) and (no corridor or more than one door) i.e. door directly to outside and existing doors directly to outside not insulated	Change doors directly to outside to insulated doors with U = 1.5	
ELECTRICITY GENERATION				
U	Photovoltaics	House or bungalow, not thatched roof, no existing PV	Photovoltaics - 1.5 kWp (6-12 m²) - 2.5 kWp (10-20 m²) (default) - 3.5 kWp (14-28 m²)	Also obtain orientation of roof (S, SE, E, etc or horizontal) and calculate effect of PV for that orientation
V, V2	Wind turbine	House or bungalow, rural location, no wind turbine	(V) blade diameter 2.0 m, hub height 2.0 m (rooftop) (default) (V2) blade diameter 4.0 m, hub height 10 m (separate mast)	offer improvement measures V and V2 as alternatives

Note for improvement Q. Choice of percentage of wall to be improved from 100%.downwards in steps of 10% (i.e. 100% is shown first), default 100%.

Note for improvement C.
If existing is factory-applied improvement is modelled as an increase in factory-applied insulation: 12 mm improves to 38 mm, and 25 mm improves to 50 mm.
If existing is jacket, 12 or 25 mm improves to 80 mm, and 38 or 50 mm improves to 120 mm.

Note for improvements I, R, S, T.
For an existing CPSU, the upgrade is a condensing storage combi.

Controls are:
- for radiator systems, programmer, roomstat and TRVs (or time and temperature zone control if already present), interlocked system, separate timing of space and water heating (if regular boiler);
- for underfloor systems: time and temperature zone control.

Also:
- in the case of measure I, if existing cylinder leave cylinder as it is (but with cylinderstat and improved insulation if applied earlier in the sequence; if improvement N is also selected a larger cylinder may be substituted, see instructions in the table for N).

- in the case of measures R, S and T, if regular boiler, cylinder of at least normal size (no solar panel) or medium size (solar panel present) with 50 mm factory-applied insulation and cylinderstat (if improvement N is also selected a larger cylinder may be substituted, see instructions in the table for N).
- when there are two boilers, if main system 1 is being upgraded to a new boiler the new boiler does the water heating.

Note for improvements J, K. Heating controls are programmer, room thermostat and TRVs. Upgrade hot water cylinder to at least medium size with 50 mm factory-applied insulation and cylinderstat, separate timing of space and water heating.

Note for improvements Z1, Z2, Z4, Z5. Upgrade is generic heat pump from Table 4a. Heating controls are programmer and room thermostat. If no hot water cylinder add one of normal size. Cylinder has 50 mm factory-applied insulation and cylinderstat, separate timing of space and water heating.

Note for improvement Z3. Heating controls are programmer, room thermostat and TRVs. Upgrade hot water cylinder to at least normal size (no solar panel) or medium size (solar panel present) with 50 mm factory-applied insulation and cylinderstat, separate timing of space and water heating.

Note for improvements O, O2, P. Choice of percentage of existing single-glazed to be improved, from 100% downwards in steps of 10% (i.e. 100% is shown first), default 100%. The percentage is of those windows that are currently single glazed, Example: half the windows are double-glazed; to examine the effect of double glazing half the remainder enter 50% (the total double glazed percentage then becomes 75%).

To avoid complications of different specifications of existing windows, this is implemented applying the measure all of the single-glazed windows with U-value and g-value interpolated between the improved value (depends on whether O, O2 or P) and that for single glazing (U = 4.8, g = 0.85) according to the percentage to be improved.

Heating upgrades

In the case of a calculation using RdSAP occupancy parameters an improvement to a heating system by adoption of any of the following measures:

I, J, K, M, R, S, T, Z1, Z2, Z3, Z4, Z5

is taken as extending the main heating system to the whole dwelling where that is not the case in the existing dwelling. Thus when implementing any of the above measures, the number of heated habitable rooms is to be set equal to the number of habitable rooms. This rule affects the results where there are unheated habitable rooms and no identified secondary heater. If there is an identified secondary heater, the secondary heater remains throughout the sequence of calculations of improvement measures. Also, in the case of measure T upgrading storage heaters to a condensing gas boiler, if the secondary heating is portable electric heaters the secondary heating becomes none after the upgrade.

In the case of a calculation using occupancy parameters set in the occupancy assessment the allocation to heating systems to rooms (including unheated rooms) is not changed.

If there is an identified secondary heater, the secondary heater remains throughout the sequence of calculations of improvement measures.

In the case of measure T, if the existing heating is storage heaters or off-peak underfloor electric heating (401, 402, 404, 408, 421, 422) change the electric meter to single (unless storage heaters or off-peak underfloor electric heating remains as main system 2).

If the heating upgrade involves a change of fuel for main heating, or a change of tariff in the case of electric storage systems, the scaling factor for main heating is 1 (retain the scaling factor for other fuel uses if it has been defined). If the heating system concerned also supplies DHW also set the scaling factor for DHW to 1.

If the heating upgrade involves a fuel not currently in the property (a) the scaling factor for the new fuel is 1, (b) use SAP current fuel prices for its tariff.

Heating upgrades when there are two main systems

There are two alternatives:

a. Apply the improvement to system 1 only.
b. Apply the improvement to all heating. In this case cancel main system 2 so that main system 1 heats the whole dwelling and, when using occupancy assessment parameters, rooms assigned to system 2 are re-assigned to system 1.

Heating control upgrades when there are two main systems

Apply the improvement to the controls on system 1 only, except in the case of both systems being boilers in which case apply the improved controls to both (the trigger remains that on system 1). Any heating upgrade is accompanied by a controls upgrade (if not already applied) as described above for the heating measure concerned.