

Dwelling Energy Assessment Procedure (DEAP) 2006

Procedure for Energy Rating of Irish dwellings

Version 1.0

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Contents

SUMMARY	2
INTRODUCTION	3
SCOPE OF THE DEAP PROCEDURE	3
GENERAL PRINCIPLES	3
CALCULATION PROCEDURE AND CONVENTIONS	5
1 Dwelling dimensions	5
2 Ventilation rate	7
2.1 Chimneys and flues	7
2.2 Fans and passive vents	7
2.3 Pressurisation test	8
2.4 Main entrance	8
2.5 Sheltered Sides	8
2.6 Mechanical ventilation	9
3 Heat losses	9
3.1 U-values of opaque elements	9
3.2 Window U-values	10
3.3 U-values of elements adjacent to an unheated space	10
3.4 Thermal bridging	14
3.5 Dwellings that are part of larger premises	14
4 Domestic hot water	14
5 Internal gains	15
6 Solar gains	16
6.1 Solar gains for openings	16
6.2 Openings for which solar gain is included	16
6.3 More than one glazing type	16
7 Mean internal temperature	16
7.1 Heating schedule	16
7.2 Living area fraction	17
7.3 Internal heat capacity	17
7.4 Mean internal temperature with ideal heating system	17
8 Heat use	18
9 Space heating requirements	18
9.1 Heating systems	18
9.2 Heating system efficiency	18
9.3 Heating controls	20
10 Total energy use and fuel costs	22
10.1 Energy use	22
10.2 Factors and costs	22
10.3 Main fuel types	23
10.4 Secondary fuel types	24
10.5 Water heating fuel types	24
10.6 Electricity for pumps and fans	24
10.7 Electricity for lighting	24
11 Energy emissions and costs	24
12 DEAP rating	24
13 Building regulations	25
REFERENCES	26

LIST OF STANDARDS REFERRED TO IN THIS DOCUMENT	27
Appendix A: Primary and secondary heating systems	28
Appendix B: Gas and oil boiler systems, boilers with a thermal store, and range cooker boilers	30
Appendix C: Community heating, including schemes with Combined Heat and Power (CHP) and schemes that recover heat from power stations.	33
Appendix D: Method of determining seasonal efficiency values for gas and oil boilers	35
Appendix E: Method of determining seasonal efficiency for gas or oil room heaters	42
Appendix F: Electric CPSUs	44
Appendix G: Heat pumps	45
Appendix H: Solar water heating	47
Appendix J: Seasonal efficiency for solid fuel boilers from test data	51
Appendix K: Thermal bridging	52
Appendix L: Energy for lighting	53
Appendix M: Energy from Photovoltaic (PV) technology	54
Appendix N: Micro-cogeneration (also known as micro-CHP)	55
Appendix P: Assessment of internal temperature in summer	59
Appendix Q: Special features and specific data	64
Appendix R: Reference values	65
Appendix S : Reduced Data DEAP for existing dwellings	67
Appendix T : DEAP Calculation Procedure (Version 1)	80

Acknowledgement:

The UK Standard Assessment Procedure (SAP) 2005. Its documentation provided the basis for this document, and many of the calculation procedures in DEAP and much of the accompanying tabulated data are drawn from SAP.

SUMMARY

This manual describes the Government's Dwelling Energy Assessment Procedure (DEAP) for assessing the energy performance of dwellings. The procedure takes account of the energy used for space heating, water heating, ventilation and lighting, less cost savings from energy generation technologies. For standardised occupancy, it calculates annual values of delivered energy consumption, primary energy consumption, carbon dioxide emissions and costs, both totals and per square metre of floor area.

The procedure will produce a DEAP rating, for display on advisory reports. At the time of writing, the basis of the DEAP rating has not yet been decided.

The procedure also calculates the Carbon Dioxide Emission Rate (CDER) of the dwelling, and the corresponding Maximum Permitted Carbon Dioxide Emission rate (MPCDER), used in assessing compliance of new dwellings with the Building Regulations Technical Guidance Document L.

The method of calculating the energy performance and the ratings is set out in the form of an Excel workbook, accompanied by a series of tables. The methodology is compliant with the Energy Performance of Buildings Directive. It is expected that SEI will make available computer software implementing the procedure.

INTRODUCTION

The Dwelling Energy Assessment Procedure (DEAP) is adopted by Government as the Irish methodology for calculating the energy performance of dwellings.

The calculation is based on the energy balance taking into account a range of factors that contribute to energy efficiency:

- materials used for construction of the dwelling
- thermal insulation of the building fabric
- ventilation characteristics of the dwelling and ventilation equipment
- efficiency and control of the heating system(s)
- solar gains through openings of the dwelling
- thermal capacity of the building
- the fuel used to provide space and water heating, ventilation and lighting
- renewable energy technologies

The calculation is independent of factors related to the individual characteristics of the household occupying the dwelling when the rating is calculated, for example:

- household size and composition;
- ownership and efficiency of particular domestic electrical appliances;
- individual heating patterns and temperatures.

Ratings are not affected by the geographical location, so that a given dwelling has the same rating in all parts of Ireland.

The procedure used for the calculation is based on the European Standard I.S. EN 13790: 2004, and draws heavily on the UK's Standard Assessment Procedure (SAP 2005).

SCOPE OF THE DEAP PROCEDURE

The procedure is applicable to self-contained dwellings of total floor area (as defined in Section 1, Dwelling Dimensions) not exceeding 450 m².

For flats, it applies to the individual flat and does not include common areas such as access corridors.

Note: Dwellings of floor area greater than 450 m², common areas of blocks of flats such as access corridors, and other buildings (even though used for residential purposes, e.g. nursing homes) are assessed using procedures for non-domestic buildings.

Where part of an accommodation unit is used for commercial purposes (e.g. as an office or shop), this part should be included as part of the dwelling if the commercial part could revert to domestic use on a change of occupancy. That would be applicable where:

- there is direct access between the commercial part and the remainder of the accommodation, and
- all is contained within the same thermal envelope, and
- the living accommodation occupies a substantial proportion of the whole accommodation unit.

Where a self-contained dwelling is part of a substantially larger building, where the remainder of the building would not be expected to revert to domestic use, the dwelling is assessed by DEAP and the remainder by procedures for non-domestic buildings.

GENERAL PRINCIPLES

Input precision and rounding

Data should be entered as accurately as possible, although it is unnecessary to go beyond 3 significant figures (and some product data may only be available to lesser precision).

Input data

Various tables of performance data are provided as part of this document. The tables are used when specific performance information on the product or system is not available. However, when specific

performance information is available for the following items, it should be used in preference to data from the tables, particularly in the new build context.

U-values – walls, floors, roofs

For new build, U-values should be calculated on the basis of the actual construction.

Linear thermal transmittance (Ψ -values)

There are three possibilities.

- a) The use of a global factor, which is multiplied by the total exposed surface area, as described in Appendix K.
- b) On the basis of the length of each junction and the default Ψ -values in Table K1.
- c) On the basis of the length of each junction and user-supplied Ψ -values. It is not necessary to supply Ψ -value for each junction type – values from Table K1 can be mixed with user-supplied values.

Window data

Window U-values and g-values (total solar energy transmittance) can be from a certified window energy rating or manufacturers' declaration. Both U-values and g-values are needed. For light transmittance, only the values in Table 6b are to be used.

Normally the frame factors in Table 6c are used. However, manufacturer's values are permitted provided they are representative of the actual windows.

Boiler efficiency – gas and oil

Boiler efficiency can be from the Home-Heating Appliance Register of Performance (preferably) or from a manufacturer's declaration given in the terms stated in D3.

Boiler efficiency – solid fuel

Boiler efficiency can be from the Home-Heating Appliance Register of Performance (preferably) or from a manufacturer's declaration.

Efficiency of gas/oil/solid fuel fires and room heaters

Efficiency can be from a manufacturer's declaration as specified in E2 in Appendix E (gas and oil) or in terms to be published separately (solid fuel).

Standing loss – cylinders, thermal stores and CPSUs (includes both gas and electric CPSUs)

The manufacturer's declared loss obtained in terms of an applicable Irish or British standard and expressed in kWh/day, can be used instead of the calculated storage loss factor.

Pressure test result

The result of a pressure test can be used instead of the default calculations of infiltration. In the case of a dwelling not yet built, a design value of air permeability can be used, subject to verification once the dwelling is built.

Solar collector performance

The zero-loss collector efficiency and the collector's linear heat loss coefficient can be used if obtained from test results.

Specific fan power

Specific fan power for these mechanical ventilation systems:

- positive input ventilation from outside (not loft)
- mechanical extract
- balanced

can be used in place of the default values in Table 4g, subject to conditions for acceptance of manufacturer's values of specific fan power that are issued in terms of Q2 in Appendix Q.

Existing properties

The DEAP calculation procedure for existing properties follows that for new dwellings. However, some of the data items are usually defaulted or inferred. For further details see Appendix S.

The calculation is concerned with the assessment of the dwelling itself, as used by standard or typical occupants, and not affected by the way current occupants might use it. Thus, for example, the living room fraction is based on the original design concept and not on the rooms the current occupants heat.

CALCULATION PROCEDURE AND CONVENTIONS

The method of calculating the energy performance is set out in the form of an Excel workbook, accompanied by a series of tables. The following notes on calculations and conventions should be read in conjunction with the workbook.

The workbook specifies the calculation procedure. It is expected that the calculation procedure will be implemented in a computer software application in due course. In the meantime, the workbook may be used for DEAP calculations.

1 DWELLING DIMENSIONS

The boundary of the heated space consists of all the building elements separating it from external environment or from adjacent dwellings or unheated spaces. Any internal elements (internal partition walls or intermediate floors within the dwelling) are disregarded for the purposes of establishing the floor area.

Dimensions refer to the inner surfaces of the elements bounding the dwelling. Thus floor dimensions are obtained by measuring between the inner surfaces of the external or party walls, disregarding the presence of any internal walls.

Storey height is the total height between the ceiling surface of a given storey and the ceiling surface of the storey below. For a single storey dwelling, or the lowest floor of a dwelling with more than one storey, the measurement should be from floor surface to ceiling surface.

Floor area should be measured as the actual floor area, i.e. if the height of a room extends to two storeys or more only the actual accessible floor area should be entered. However, as an exception to this rule in the case of stairs, the floor area should be measured as if there were no stairs but a floor in their place at each level.

In general, rooms and other spaces, such as built-in cupboards, should be included in the calculation of the floor area where these are directly accessible from the occupied area of the dwelling. However unheated spaces clearly divided from the dwelling should not be included. The following provides specific guidance:

Porches:

- *should be included* if they are heated by fixed heating devices;
- *should be included* if there is direct access into the dwelling but no separating door, whether heated or not;
- *should not be included* if they are unheated and there is a separating door into the dwelling. In this context 'porch' means an addition protruding from the line of the external wall of the dwelling; an entrance lobby that is within such line *should be included*.

Conservatories:

- *should not be included* if they are separated from the dwelling according to the definition in 3.3.3
- *should be included* as part of the dwelling if they are not separated.

Store rooms and utility rooms:

- *should be included* if they are directly accessible from the occupied area of the dwelling, whether heated or not;
- *should not be included* if they are unheated and accessible only via a separate external door.

Basements:

- *should be included* only if consisting of heated and habitable rooms.

Garages:

- *should be included* if heating is provided within the garage from the main central heating system;
- *should not be included* where the garage is thermally separated from the dwelling and is not heated by the central heating system

Attics:

- *should be included* if they are habitable rooms, accessed by a fixed staircase.
- roof spaces (even though within the insulated envelope, i.e. where the roof insulation is provided at rafter level) *should not be included* unless they are habitable rooms accessed by a fixed staircase.

When porches or garages are not included in floor area, the door and part of the wall between the dwelling and these structures are adjacent to an unheated space and their U-values should be calculated accordingly (see section 3.3).

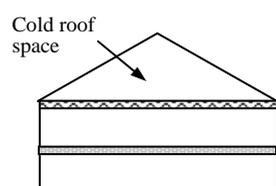
In flats, if corridors and stairwells are heated, treat walls between the flat and heated corridors/stairwells as non-heat loss walls (i.e. assuming the same temperature on either side of the walls). Otherwise these walls are treated as elements adjacent to an unheated space and their U-values should be calculated accordingly (see section 3.3).

No special treatment should be given in cases where a central heating boiler is located in an unheated garage (i.e. the floor area used for the assessment should be the same as if the boiler were in the kitchen or a utility room).

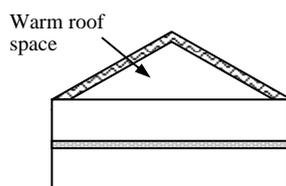
Pitched roofs

There are three main types of pitched roof construction:

1. pitched roof with insulation at ceiling level, insulated between (and perhaps also above) joists;
2. pitched roof insulated at rafter level (no insulation at ceiling level), insulated between and/or above rafters ("warm roof"), with a non-ventilated loft space but with a ventilated space between the insulation and the roof covering;
3. pitched roof insulated either at ceiling level or at rafter level, with roof space converted into habitable space.

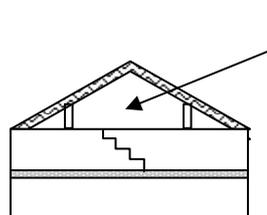


a) Insulation at ceiling level

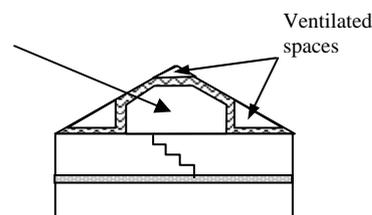


b) Insulation at rafter level

In the cases of a) and b) the roof space should **not** be entered as a separate storey.



c) Room in roof built into a pitched roof insulated at rafter level



d) Room in roof built into a pitched roof insulated at ceiling level

In the cases of c) and d) the floor area of the roof space that is converted into habitable space should be entered as a separate storey.

2 VENTILATION RATE

The ventilation air change rate is the rate at which outside air enters/leaves a building.

DEAP requires a reasonable estimate of the air change rate in order to calculate the overall heating requirement. The actual ventilation rate depends on a large number of factors, many of which may not be known precisely (e.g. permeability of materials and inadvertent gaps and openings in the structure) and in most cases cannot be assessed from a site survey or from plans.

The infiltration rate can be assessed either from pressurisation test or, in the absence of pressure test, using the DEAP ventilation algorithm.

Whether or not a pressurisation test has been carried out, the ventilation algorithm requires the information on chimneys, fans, open flues and passive vents. The numbers of chimneys, fans, open flues and passive vents (blocked off during a pressurisation test but open in practice) should be entered in the 'Vent' worksheet.

Ventilation rates for chimneys, flues, fans and passive vents and flueless gas fires are given in Table 2.1 below.

Table 2.1 Ventilation rates

Item	Ventilation rate m ³ /hour
Chimney	40
Open flue	20
Fan	10
Passive vent	10
Flueless gas fire	40

2.1 Chimneys and flues

Ventilation rates for chimneys and flues should be entered only when they are unrestricted and suitable for use. The specified ventilation rate includes an allowance for the associated permanent vent for air supply, so this vent should not be entered separately.

For the purposes of the DEAP a chimney is defined as a vertical duct for combustion gases of diameter 200 mm or more (or a rectangular duct of equivalent size). Vertical ducts with diameter less than 200 mm should be counted as flues. The following are also counted as flues:

- a chimney for solid fuel appliances with controlled flow of the air supply;
- a flexible flue liner sealed into a chimney;
- a chimney fitted with a damper;
- a chimney fitted with an open-flue gas fire where the flue products outlet is sealed to the chimney;
- a blocked up fireplace fitted with ventilators (if ventilator area does not exceed 30 000 mm²)

Ventilation rates should be entered only for open flues; they should not be included for room-sealed boilers or room heaters. Ventilation rates for specific closed appliances may be introduced (see Appendix Q).

2.2 Fans and passive vents

Extract fans which exhaust air (typically from the kitchen and bathroom), including cooker hoods and other independent extractor fans, should be included in the 'number of fans' category, but those that form part of a whole-dwelling mechanical ventilation system are treated separately (see section 2.6) and are not included here.

Passive stack ventilators are an alternative to extract fans, and are included under 'fans and passive vents' in the worksheet. Such systems comprise extract grilles connected to ridge terminals by ducts. Such systems should be supplied with air bricks or trickle vents for air ingress. It is the number of extract grilles that should be entered into the worksheet.

Trickle vents or air bricks alone do not count as passive vents and should not be included in the calculation (provided their open area is less than 4000 mm²).

Permanent vents of open area 4000 mm² or greater (e.g. vents required in habitable rooms in dwellings built according to TGD F (Ventilation) 1991) should be counted as passive vents. Permanent vents of smaller area should not be included in the calculation. For permanent vents associated with chimneys/flues, see above.

2.3 Pressurisation test

A pressurisation test of a dwelling is carried out by installing a fan in the doorway of the principal entrance to the dwelling, sealing all flues and chimneys, and determining the air flow rate required to maintain an excess pressure of 50 pascals (Pa). The pressurisation test should be carried out in accordance with I.S. EN 13829. The air permeability measured in this way, q_{50} , expressed in cubic metres per hour per square metre of envelope area is divided by 20 for use in the worksheet (to give an estimate of the air change rate at typical pressure differences). In this case the structural infiltration cells of the 'Vent' worksheet (number of storeys, structure type, suspended wooden floor, draught-stripping of windows) are not used.

2.4 Main entrance

If a dwelling's main entrance is accessed from outdoors, as opposed to an indoor common area, an allowance is made for ventilation heat loss via the main door. The main entrance should be specified as opening to the outside even if it has a privately-owned porch. An indoor main entrance should be specified only for apartments accessed from an indoor common area, for example, an access corridor or covered atrium. This input applies to the main entrance, not to a back door or balcony door.

2.5 Sheltered Sides

A side of a building is sheltered if there are adjacent buildings or tree-height hedges which effectively obstruct the wind on that side of the building. A side should be considered sheltered if all the following apply:

- the obstacle providing the shelter is at least as high as the ceiling of the uppermost storey of the dwelling;
- the distance between the obstacle and the dwelling is less than five times the height of the obstacle;
- the width of the obstacle (or the combined width of several obstacles) is such that it subtends an angle of at least 60° within the central 90° when viewed from the middle of the wall of the dwelling that faces the obstacle - see Figure 1

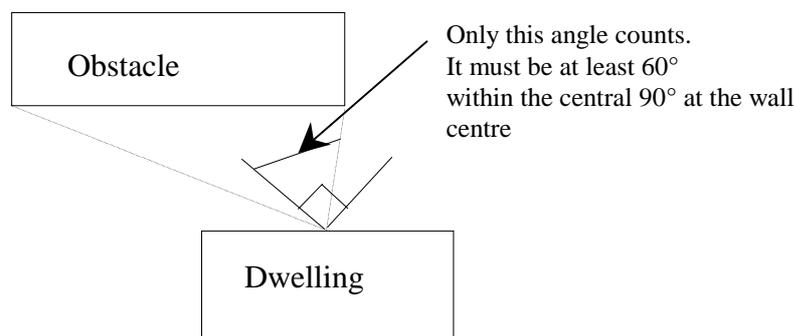


Figure 1 Shelter angle

Two partially sheltered sides should be counted as one sheltered side. Architectural planting does not count as shelter unless it actually exists (even though shown as mature trees on drawings).

Any party wall should be counted as a sheltered side.

For new dwellings it will often be appropriate to assume that two sides of the dwelling are sheltered.

2.6 Mechanical ventilation

Balanced whole house mechanical ventilation is a fan driven ventilation system, which provides fresh air to the rooms in the dwelling and also extracts exhaust air from the dwelling. The system may or may not be fitted with a heat recovery unit. The DEAP calculation is based on a throughput of 0.5 air changes per hour through the mechanical system, plus infiltration.

For buildings with heat recovery from exhaust to inlet air, the heat loss by mechanical ventilation is reduced by the factor η_v where $\eta_v = 0.66$ is the efficiency of heat recovery system.

Positive input ventilation is a fan driven ventilation system, which often provides ventilation to the dwelling from the loft space. The DEAP calculation procedure for systems which use the loft to pre-heat the ventilation air is the same as for natural ventilation, including 20 m³/h ventilation rate equivalent to two extract fans or passive vents. (The energy used by the fan is taken as counterbalancing the effect of using slightly warmer air from the loft space compared with outside). Some positive input ventilation systems supply the air directly from the outside and the procedure for these systems is the same as for mechanical extract ventilation.

Mechanical extract ventilation refers to a fan driven ventilation system, which only extracts air from the dwelling. The DEAP calculation is based on a throughput of 0.5 air changes per hour through the mechanical system, plus infiltration.

The calculation requires information on specific fan power (SFP) of mechanical ventilation fans. Default data are provided in Table 4g. Alternatively values based on tests may be used subject to conditions for acceptance of manufacturer's values of specific fan power that are issued in terms of Q2 in Appendix Q. SFP should account for any transformers.

3 HEAT LOSSES

The areas of building elements are based on the internal dimensions of surfaces bounding the dwelling.

Window and door area refers to the total area of the openings, including frames. Wall area is the net area of walls after subtracting the area of windows and doors. Roof area is also net of any rooflights or windows set in the roof. Losses or gains through party walls to spaces in other dwellings or premises that are normally expected to be heated are assumed to be zero.

The calculation should allow for different types of element where their U-values differ (e.g. some windows single glazed and some double glazed, masonry main wall and timber framed wall in an extension, main roof pitched and extension roof flat).

3.1 U-values of opaque elements

When the details of the construction are known, the U-values should be calculated for the floor, walls and roof. This should always be the case for new dwellings being assessed from building plans. For existing dwellings see Appendix S.

U-values for walls and roofs containing repeating thermal bridges, such as timber joists between insulation, etc, should be calculated using methods based on the upper and lower resistance of elements, given in I.S. EN ISO 6946.

I.S. EN ISO 6946 gives the calculation that applies to components and elements consisting of thermally homogenous layers (which can include air layer) and is based in the appropriate design thermal conductivity or design thermal resistances of materials and products involved. The standard also gives an approximate method that can be used for inhomogeneous layers, except cases where an insulating layer is bridged by metal.

Thermal conductivity values for common building materials can be obtained from TGD L, I.S. EN 12524 or the CIBSE Guide Section A3^[6]. For specific insulation products, data should be obtained from manufacturers.

U-values for ground floors and basements should be calculated using the procedure described in I.S. EN ISO 13370, in section A3 of the CIBSE Guide A.

The thickness of loft insulation should be determined by inspection if the loft is accessible. The thickness should be measured at least as accurately as in the following list: 0, 12, 25, 50, 100, 150, 200, 250, 300 mm.

3.2 Window U-values

The U-value for a window should be that for the whole window opening, including the window frame.

Measurements of thermal transmittance in the case of doors and windows should be made according to I.S. EN ISO 12567-1. Alternatively, U-values of windows and doors may be calculated using I.S. EN ISO 10077-1 or I.S. EN ISO 10077-2.

Table 6a gives values that can be used in the absence of test data or calculated values. Use a value from Table 6a, which corresponds most closely to the description of the actual window; interpolation should not be used in this table.

For the purposes of the DEAP, rooflights are treated as roof windows.

3.3 U-values of elements adjacent to an unheated space

The procedure for treatment of U-values of elements adjacent to unheated space is described in I.S. EN ISO 6946 and I.S. EN ISO 13789.

The following procedure may be used for typical structures (no measurements are needed of the construction providing an unheated space, just select the appropriate R_u from Tables 3.1 to 3.3 below).

$$U = \frac{1}{\frac{1}{U_o} + R_u}$$

where: U = resultant U-value of element adjacent to unheated space, W/m^2K ;
 U_o = U-value of the element between heated and unheated spaces calculated as if there were no unheated space adjacent to the element, W/m^2K ;
 R_u = effective thermal resistance of unheated space from the appropriate table below.

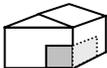
R_u for typical unheated structures (including garages, access corridors to flats and rooms in roof) with typical U-values of their elements are given below. These can be used when the precise details on the structure providing an unheated space are not available, or not crucial.

The effect of unheated spaces, however, need not be included if the area of the element covered by the unheated space is small (i.e. less than 10% of the total exposed area of the dwelling). Consequently a door in an element abutting an unheated space would not need to have its U-value changed (unless it is part of a very small flat where the U-value of the door might make a significant contribution to the result).

3.3.1 Garages

The U-value of elements between the dwelling and an integral garage should be adjusted using R_u from Table 3.1 or Table 3.2. Attached garages (not integral) should be disregarded.

Table 3.1 R_u for integral single garages (single garage is a garage for one car)

Garage type	Elements between garage and dwelling	R_u for a single garage	
		Inside ¹	Outside ²
Single fully integral	 Side wall, end wall and floor	0.68	0.33

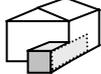
Single fully integral		One wall and floor	0.54	0.25
Single, partially integral displaced forward		Side wall, end wall and floor	0.56	0.26

Table 3.2 R_u for integral double garages (double garage is a garage for two cars)

Garage type	Element between garage and dwelling	R_u for a double garage	
		Inside ¹	Outside ²
Double garage fully integral	Side wall, end wall and floor	0.59	0.28
Double, half integral	Side wall, halves of the garage end wall and floor	0.34	n/a
Double, partially integral displaced forward	Part of the garage side wall, end wall and some floor	0.28	n/a

¹inside garage – when the insulated envelope of the dwelling goes round the outside of the garage

²outside garage – when the walls separating the garage from the dwelling are the external walls

3.3.2 Stairwells and access corridors in flats

Stairwells and access corridors are not regarded as parts of the dwelling. If they are heated they are not included in the calculation. If unheated, the U-value of walls between the dwelling and the unheated space should be modified using the following data for R_u .

Figure 3.1 shows examples of access corridors in flats.

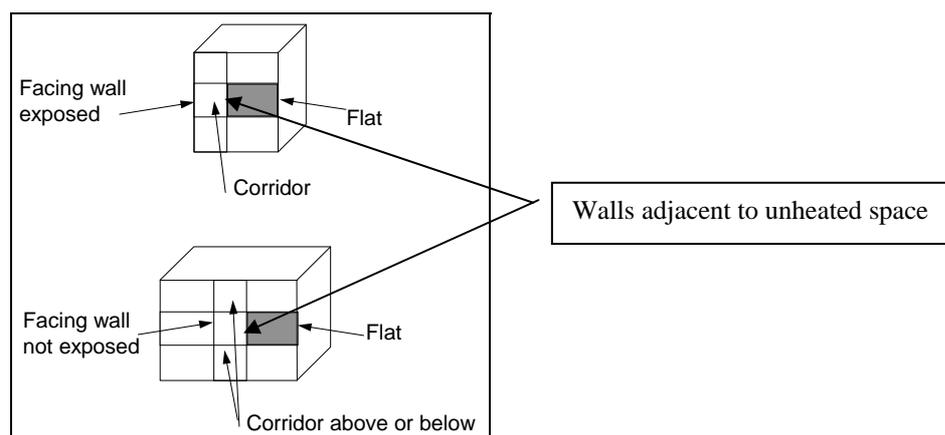


Figure 3.1 Access corridors

The following table gives recommended values of R_u for common configurations of access corridors and stairwells.

Table 3.3 R_u for common configurations of stairwells and access corridors.

Elements between stairwell/corridor and dwelling	Heat loss from corridor through:	R_u
Stairwells:		
Facing wall exposed		0.82
Facing wall not exposed		0.90
Access corridors:		
Facing wall exposed, corridors above and below	facing wall, floor and ceiling	0.28
Facing wall exposed, corridor above or below	facing wall, floor or ceiling	0.31
Facing wall not exposed, corridor above and below	floor and ceiling	0.40
Facing wall not exposed, corridor above or below	floor or ceiling	0.43

3.3.3 Conservatories

In this document, a conservatory is defined as an extension attached to a dwelling which has not less than three-quarters of the area of its roof and one half of the area of its external walls made of translucent material.

An attached conservatory should generally be treated as an integral part of the dwelling to which it is attached. However, it may be treated as an unheated space if it is thermally separated from the main dwelling. To be considered thermally separated, it must fulfill both of the following:

- i) The walls, floors, windows and doors between it and the main dwelling must have U-values not more than 10% greater than corresponding exposed elements, and,
- ii) It must be unheated or, if provided with a heating facility, must have provision for automatic temperature and on-off control independent of the heating provision in the main building.

3.3.4 Other large glazed areas

Any structure attached to a dwelling that is not a thermally separated conservatory according to the definitions in 3.3.3 should be treated as an integral part of the dwelling. This means that the glazed parts of the structure should be input as if they were any other glazed component (both in the heat loss calculation, and in the solar gain calculation according to orientation).

3.3.5 Room in roof

In the case of room-in-roof construction where the insulation follows the shape of the room, the U-value of roof of the room-in-roof construction is calculated using the procedure described in paragraph 3.3 using thermal resistance R_u from Table 3.4. The same applies to the ceiling of the room below.

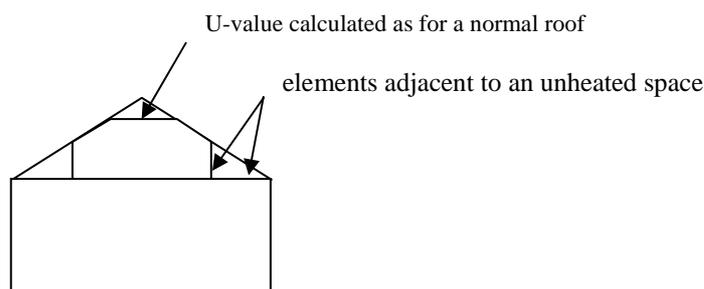


Figure 3.2 Room in roof

Table 3.4 R_u for room in roof adjacent to unheated loft space

Area (figure 3.2)	Element between dwelling and unheated loft space	R_u for elements
Room in roof built into a pitched roof insulated at ceiling level	insulated wall of room in roof	0.50
	or insulated ceiling of room below	0.50

If the insulation follows the slope of the roof, the U-value should be calculated in the plane of the slope. For existing dwellings see Appendix S.

3.3.6 Other cases

In other cases R_u should be calculated using the following formula

$$R_u = \frac{A_i}{\sum (A_e \times U_e) + 0.33nV}$$

A_i ; A_e = areas of internal and external elements (m^2), excluding any ground floor

U_e = U-values of external walls (W/m^2K)

V = volume of unheated space (m^3)

n = air change rate of unheated space (ach)

3.4 Thermal bridging

The DEAP calculation takes account of thermal bridging, at junctions between elements and around openings. If linear thermal transmittance values are available for these junctions, they can be multiplied by the length of the junction concerned, and the total added to the transmission heat transfer coefficient.

Usually, however, specific values for thermal bridges are not known, and the calculation can be done by including an allowance based on the total exposed surface area. Further details are in Appendix K.

3.5 Dwellings that are part of larger premises

In the case of a dwelling that is part of a larger building where the remainder of the building is used for non-domestic purposes, the elements between the dwelling and the remainder of the building are considered:

- a) to have zero heat loss if the spaces adjacent to the dwelling are normally heated to similar levels as a dwelling, or
- b) as heat loss elements to an unheated space if the spaces are unheated, heated only intermittently or heated only to a low level.

4 DOMESTIC HOT WATER

The demand for hot water is derived from the floor area of the dwelling and is calculated in the workbook. The energy required to produce that amount of hot water is then calculated, taking account of losses in heating, storage and distribution. Heat to the dwelling from storage cylinders and distribution pipe work is also estimated, so that it can be taken into account in the calculation of space heating requirements.

A distinction is made between instantaneous water heating, which heats water when it is required, and water heating that relies on storage of hot water in a cylinder, tank or thermal store. 'Primary' and 'cylinder' losses are not used in the calculation for instantaneous heaters.

'Single-point' heaters, which are located at the point of use and serve only one outlet, do not have distribution losses either. Gas multipoint water heaters and instantaneous combi boilers are also instantaneous types but, as they normally serve several outlets, they are assumed to have distribution losses.

Stored hot water systems can either be served by an electric immersion heater or obtain heat from a boiler or a heat pump through a primary circuit. In both cases, water storage losses are incurred to an extent that depends on how well the water storage is insulated. These losses apply for:

- hot water cylinders;
- the store volume of storage combination boilers (where the boiler efficiency is derived from test data);
- thermal stores;
- combined primary storage units (CPSUs);
- community heating schemes.

Water storage losses are set to zero for other combi boilers and instantaneous water heaters.

For cylinders the preferred way of establishing cylinder losses is from measured data on the cylinder concerned, according to BS 1566.

For thermal stores and CPSUs (including electric CPSUs) the preferred way of establishing heat losses is from measured data on the thermal store or CPSU concerned.

If measured data is not available, a default value is used; this is calculated on the 'Wh' worksheet based on insulation type and thickness and cylinder volume.

In all cases, the loss rate is to be multiplied by a temperature factor from Table 2. This factor accounts for the average temperature of the cylinder or thermal store under typical operating conditions, compared to its temperature under test.

For combi boilers the storage loss factor is zero if the efficiency is taken from Table 4b. The loss is to be included for a storage combination boiler if its efficiency is the manufacturer's declared value or is obtained from the Home-Heating Appliance Register of Performance (the HARP database), using the calculated hot water storage loss factor and volume factor on the 'Wh' worksheet and the temperature factor from Table 2 (its insulation thickness and volume are also to be provided by the manufacturer or obtained from the database).

For boiler systems with separate hot water storage, primary losses are incurred in transferring heat from the boiler to the storage; values for primary losses are obtained from Table 3. For combi boilers the additional losses in Table 3a are included to allow for the draw-off of water until an adequate temperature at the taps is attained. The data in Table 3a are provisional pending the availability of test results based on relevant EN standards (currently under development on basis of EU Mandate to CEN).

The efficiency for both space and water heating is reduced by 5% if the boiler is not interlocked for both space and water heating (see section 9.3.9).

For hot water provided from community heating, if there is a hot water cylinder within the dwelling, its size and the appropriate loss factor should be used. If there is not a hot water cylinder within the dwelling the calculation should assume a storage loss corresponding to a cylinder volume of 110 litres with factory-applied insulation of thickness 50 mm. Primary circuit loss for insulated pipework and cylinderstat should be included (Table 3).

A solar collector coupled with solar water storage reduces the fuel needed for domestic hot water (see Appendix H). The solar water storage can be either as the lower part of a multi heat source cylinder, or as a separate solar cylinder.

In most cases the system specified for water heating should be that intended to heat the bulk of the hot water during the course of the year. For example, an immersion heater should be disregarded if provided only for backup where the principal water heating system is from a central heating boiler, as should other devices intended for or capable of heating only limited amounts of hot water. Exceptions are (a) heat pump systems where an immersion is provided to operate in conjunction with the heat pump as described in Appendix G, and (b) solid fuel room heaters with a back boiler, and other heaters incapable of providing water heating without space heating, where an immersion heater is used to heat water in the summer (see section 10.3.3).

5 INTERNAL GAINS

Internal gains from appliances, cooking and from the occupants of the dwelling (metabolic gains) are estimated from floor area within the workbook.

Lighting electricity consumption is calculated on the 'Light' worksheet as described in Appendix L. Savings due to low energy lights are estimated. Heat gains from lighting are calculated and added to the other gains.

Heat loss to the cold water network is estimated based on floor area, and subtracted from the above gains.

Gains from ventilation system fans are also accounted for here. No useful gains are assumed from individual extractor fans. Gains from heating system fans and pumps are accounted for later, in the heating system part of the procedure.

6 SOLAR GAINS

6.1 Solar gains for openings

Solar gains and heat use are calculated on a monthly basis. The average daily heat gain through windows and glazed doors is calculated for each month from

$$G_{\text{solar}} = 0.9 \times A_w \times S \times g_{\perp} \times FF \times Z$$

where:

G_{solar} is the average solar gain in kWh/m² day

0.9 is a factor representing the ratio of typical average transmittance to that at normal incidence

A_w is the area of an opening (a window or a glazed door), m²

S is the solar radiation on a surface from Table 1b, kWh/m² day

g_{\perp} is the total solar energy transmittance factor of the glazing at normal incidence (see Table 6b)

FF is the frame factor for windows and doors (fraction of opening that is glazed) (see Table 6c)

Z is the solar access factor from Table 6d

Solar gains should be calculated separately for each orientation and for rooflights, and then totalled for use in the calculation. E/W orientation of windows may be assumed if the actual orientation is not known. The solar access factor describes the extent to which radiation is prevented from entering the building by nearby obstacles. The over-shading categories are dependent on how much the view of the sky through the windows is blocked. The categories are defined in Table 6d in terms of the percentage of sky obscured by obstacles (the 'average' category applies in many cases, and can be used for DEAP calculations if the over-shading is not known).

6.2 Openings for which solar gain is included

Openings should be classified as windows, glazed doors or solid doors according to the percentage of glazed area (the percentage of total area of opening that is glass, i.e. excluding framing, mullions, transoms, solid panels etc.). For DEAP calculations the following definitions apply:

Category	Description	Glazing area	Solar gain included
1	Solid door	< 30 %	No
2	Glazed door	30% - 60%	No
3	Window	> 60 %	Yes

Patio doors which have large glazing areas, generally 70% or more, should be treated as windows and so should take account of solar gain. No allowance should be made for solar gain via doors in categories 1 and 2 even though they have some glazing. French windows often have high frame factors (around 50%) and are thus classified as glazed doors for which no solar gain is included.

6.3 More than one glazing type

Sometimes a dwelling has more than one type of glazing (e.g. some double glazing and some single glazing). In these cases the gains should be calculated separately for each glazing type, and added in the same manner as that shown in the 'Win' worksheet.

7 MEAN INTERNAL TEMPERATURE

7.1 Heating schedule

The heating hours and required internal temperatures in DEAP are based on the requirements of a typical household. The schedule is as follows.

Weekdays: 07.00 to 09.00 and 16.00 to 23.00

Weekends: 07.00 to 23.00

The required (set-point) internal temperatures during heating periods are:

Living area: 20°C
Rest of dwelling: 17°C

During heating hours, the mean internal temperature of the dwelling is the average of set-point temperatures in the living area and rest of dwelling, weighted by floor area.

7.2 Living area fraction

The living area is the room marked on a plan as the lounge or living room, or the largest public room (irrespective of usage by particular occupants), together with any rooms not separated from the lounge or living room by doors, and including any cupboards directly accessed from the lounge or living room. Living area does not, however, extend over more than one storey, even when stairs enter the living area directly.

The living area fraction is the floor area of the living area divided by the total floor area.

7.3 Internal heat capacity

DEAP takes account of the dwelling's internal heat capacity, using a procedure based on that described in I.S. EN 13790: 2004.

The position of insulation affects the internal heat capacity of a construction. For example, if a concrete wall is insulated internally, the concrete will not contribute internal heat capacity, but if insulated externally, it will. The internal heat capacity of a building element is determined primarily by the properties of the layers adjacent to the room. Thermal capacity deep with an element (e.g. 10 cm or more) contributes little to heat storage under a daily internal temperature cycle.

The heat capacity input required by DEAP is the thermal mass category of the dwelling: low, medium-low, medium, medium-high or high. The category is determined using the following procedure:

- (1) First, each opaque element type of the dwelling (walls, ceilings, floors, both exposed and internal) should be classed as either 'thermally light' or 'thermally massive', by selecting the class of the construction in Table 11a most closely matching the construction in question.
- (2) The ratio of total area of thermally massive elements to total floor area, 'AmAf', is then determined (e.g. if a bungalow has a concrete floor with all other elements 'thermally light', the ratio is '1'). Where internal elements (intermediate floors or internal partitions) are thermally massive on both sides, both sides should be included.
- (3) The thermal mass category of the dwelling is then obtained by locating the 'AmAf' ratio in Table 11 closest to the calculated one.

Further notes on the procedure:

- Thermally massive wall areas should be net of windows and doors.
- If, from the guidance given in Table 11a, an element appears borderline between thermally light and thermally massive, it may be assumed that half its area is light and half massive.

As an alternative way of determining whether an element is thermally light or massive, the internal thermal admittance of the element may be calculated as described in I.S. EN 13786 using a time period of 24 hours and a surface resistance of 0.13 W/m² K. A result of 2.3 W/m² K or greater is considered 'massive'; a lower result light.

7.4 Mean internal temperature with ideal heating system

The mean internal temperature of the dwelling during periods when heating is required is calculated based on a floor-area-weighted average of set-point temperatures in the living area and the rest of the dwelling.

The effect of intermittent heating on the mean internal temperature is calculated using a procedure which takes account of the dwelling's internal heat capacity. An ideal heating system is assumed, i.e. one which emits just enough heat to maintain required temperatures during heating hours. An ideal heating system has perfect control and responsiveness, and infinite heating capacity. (The effect of imperfect control and heating system responsiveness is dealt with later in the procedure). The mean internal temperature is calculated for each month, taking account of monthly mean external temperatures.

8 HEAT USE

The heat use is defined in I.S. EN 13790 as the heat to be delivered to the heated space by an ideal heating system to maintain the set-point temperature during a given period of time. The calculation of heat use is done on a monthly basis based on the procedure described in I.S. EN 13790. A single-zone calculation is used (as a single value of mean internal temperature is used).

For each month, the average rate of heat loss is calculated by multiplying the dwelling's heat loss coefficient by the mean internal-external temperature difference. The solar gains are added to the internal gains to give total heat gains. A utilisation factor is then applied to the gains, in order to include only the proportion of gains that contribute to meeting required internal temperatures. The utilisation factor calculation takes account of the dwelling's internal heat capacity. Useful gains are then subtracted from heat loss to give the heat use for each month.

The utilisation factor calculation does not account for the responsiveness of the heating system. A slow-response heating system can significantly reduce the usefulness of fluctuating heat gains.

In DEAP, the heating season is defined as running from October to May inclusive. The annual heat use is the sum of monthly values for these months.

9 SPACE HEATING REQUIREMENTS

The energy required from the heating system is calculated, taking account not only of heat use, but also imperfect control and responsiveness of the heating system, and additional heat loss associated with underfloor heating where applicable. Electricity consumption and heat gains associated with heating-system pumps and fans are also addressed. The quantity of fuel or electric energy required to meet that demand is then calculated, taking account of the efficiency of the space heating system (obtained from Home-Heating Appliance Register of Performance or from Table 4a or 4b).

9.1 Heating systems

It is assumed that the dwelling has heating systems capable of heating the entire dwelling. Calculations are on the basis of a main heating system and secondary heaters as described in Appendix A; this appendix also covers whether secondary heating is to be specified or not. The proportion of heat from the main and secondary systems is as given in Table 7.

For a new dwelling that has no heating system specified, it should be assumed that the dwelling will be heated by direct acting electric heaters (at standard tariff).

For group/community heating schemes and combined heat and power, see Appendix C. A heating system supplying more than one dwelling should be regarded as a community scheme. This includes schemes for blocks of flats as well as more extended district schemes.

For an electric CPSU, see Appendix F.

For heat pumps, see Appendix G.

9.2 Heating system efficiency

9.2.1 Heating systems based on a gas or oil boiler

Boiler efficiency may be obtained from:

- a) The HARP database;
- b) Certified manufacturer's data;
- c) Table 4b.

The preferred source of boiler efficiency is the Home-Heating Appliance Register of Performance (the HARP database), under construction at the time of writing, which will contain boiler efficiency figures intended for use in DEAP. If a new boiler is not included in the database, manufacturer's data certified as explained in paragraph D3 (Appendix D) should be used if available. If there is no entry in the database

and certified manufacturer's data is not available an indicative seasonal efficiency should be taken from Table 4b.

In the HARP database, boilers that are currently in production will normally be shown with DEAP seasonal efficiency calculated from test results by the HARP procedure. Most other (old/obsolete) boilers have estimated values from Table 4b. The database may be viewed or downloaded from the Internet website www.sei.ie/harp. It will be updated at the start of every month. DEAP calculations should always use the most up to date version of the database.

9.2.2 Heating systems based on a gas or oil range cooker boiler

For definitions see paragraph B4 (Appendix B). Boiler efficiency may be obtained from:

- a) The HARP database;
- b) Certified manufacturer's data;
- c) Table 4b.

For twin burner models the preferred source of efficiency is from the database, which contains the boiler seasonal efficiency figure and case heat emission figure intended for use in DEAP. If a new range cooker boiler is not included in the database, manufacturer's data certified as explained in paragraph D6 (Appendix D) may be used. If there is no entry in the database or certified manufacturer's data is not available or it is not of the twin burner type, an indicative seasonal efficiency should be taken from Table 4b.

9.2.3 Heating systems based on a solid fuel boiler

This applies to independent solid fuel boilers, open fires with a back boiler and roomheaters with a boiler.

Boiler efficiency may be obtained from:

- a) The HARP database;
- b) Certified manufacturer's data;
- c) Table 4a.

The preferred source of boiler efficiency is the HARP database. If a new boiler is not included in the database, manufacturer's certified data should be used if available. Appendix J defines how the efficiency for calculations is determined from test data. If there is no entry in the database and certified manufacturer's data is not available an indicative seasonal efficiency should be taken from Table 4a.

Solid fuel boiler efficiencies for open fires and closed roomheaters with boilers are the sum of the heat to water and heat directly to room. It is the designer's responsibility to ensure that the ratio of these figures is appropriate to the property being modelled. These systems are assigned a lower responsiveness to allow for limitations on the controllability of heat output to the room.

9.2.4 Room heaters

Where available, manufacturer's declared values should be used for the efficiency of gas or oil room heaters, certified as explained in Appendix E.

Otherwise, and for other types of room heaters, the efficiency should be taken from Table 4a.

Gas fires

The following notes provide guidance for identifying the appropriate entry from the room heater section of Table 4a, for gas fires already installed in a dwelling. (They are not intended to classify gas fires for testing purposes.)

Gas fires can be "open" or "closed" fronted. Open fronted means the fuel bed and combustion gases are not "sealed" from the room in which the gas fire is fitted. Such a fire may or may not have a glass panel in front of the fuel bed, but the glass panel will not be sealed to the front of the fire. Closed fronted means the fuel bed and combustion gases are "sealed" (generally with a glass panel sealed to the front of the fire) from the room in which the gas fire is fitted.

Fuel effect gas fires can be "live fuel effect" (LFE), "inset live fuel effect" (ILFE) or "decorative fuel effect" (DFE). The products of combustion from a DFE pass unrestricted from the fire-bed to the chimney or

flue; for the LFE/ILFE the products of combustion are restricted before passing into the chimney or flue. For further clarification of LFE/ILFE/DFE see clauses 3.1.2, 3.1.3 and 3.1.4 and Figure 1 of BS 7977-1:2002.

Room heaters with boilers

Gas, oil and solid fuel room heaters can have a boiler, which may provide either domestic hot water only or both space heating and domestic hot water.

For gas back boilers, separate efficiencies apply to the boiler and to the associated room heater. This means that:

- if the back boiler provides space heating, it should be defined as the main heating system, and the gas fire should be indicated as the secondary heater;
- if the back boiler provides domestic hot water only, the boiler efficiency is used for water heating and the gas fire efficiency for space heating (gas fire as main or as secondary heater).

For oil and solid fuel room heaters with boilers, the efficiency is an overall value (i.e. sum of heat to water and heat to room). This means that:

- if the boiler provides space heating, the combination of boiler and room heater should be defined as the main heating system;
- if the boiler provides domestic hot water only, the overall efficiency should be used as the efficiency both for water heating and for the room heater (room heater as main or as secondary heater).

9.2.5 Other heating systems

For other systems the seasonal efficiency should be taken from Table 4a. For systems not covered by the table guidance should be sought from SEI.

9.3 Heating controls

The type of controls incorporated into the heating system influences the DEAP rating. This section gives specifications of the types of controls mentioned in Table 4e.

9.3.1 Room thermostat

A sensing device to measure the air temperature within the building and switch on and off the space heating. A single target temperature may be set by the user.

9.3.2 Time switch

A switch operated by a clock to control either space heating or hot water, but not both. The user chooses one or more "on" periods, usually in a daily or weekly cycle.

9.3.3 Programmer

Two switches operated by a clock to control both space heating and hot water. The user chooses one or more "on" periods, usually in a daily or weekly cycle. A mini-programmer allows space heating and hot water to be on together, or hot water alone, but not heating alone. A standard programmer uses the same time settings for space heating and hot water. A full programmer allows the time settings for space heating and hot water to be fully independent.

9.3.4 Programmable room thermostat

A combined time switch and room thermostat which allows the user to set different periods with different target temperatures for space heating, usually in a daily or weekly cycle.

9.3.5 Delayed start thermostat

A device or feature within a device, to delay the chosen starting time for space heating according to the temperature measured inside or outside the building.

9.3.6 Thermostatic radiator valve (TRV)

A radiator valve with an air temperature sensor, used to control the heat output from the radiator by adjusting water flow.

9.3.7 Cylinder thermostat

A sensing device to measure the temperature of the hot water cylinder and switch on and off the water heating. A single target temperature may be set by the user.

9.3.8 Flow switch

A flow switch is a device, which detects when there is no water flow through the system because the TRVs on all radiators are closed.

9.3.9 Boiler interlock

This is not a physical device but an arrangement of the system controls so as to ensure that the boiler does not fire when there is no demand for heat. In a system with a combi boiler it can be achieved by fitting a room thermostat. In a system with a regular boiler it can be achieved by correct wiring interconnections between the room thermostat, cylinder thermostat, and motorised valve(s). It may also be achieved by a suitable boiler energy manager.

In systems without an interlock the boiler is kept cycling even though no water is being circulated through the main radiators or to the hot water cylinder. This results in a reduction in operating efficiency and for this reason Table 4e specifies that a seasonal efficiency reduction of 5% should be made for such systems. For the purposes of the DEAP, an interlocked system is one in which both the space and water heating are interlocked. If either is not, the 5% seasonal efficiency reduction is applied to both space and water heating; if both are interlocked no reductions are made.

It is also necessary in the DEAP to specify whether a hot water cylinder has a thermostat or not. A cylinder thermostat normally shuts down the primary circuit pump once the demand temperature in the cylinder is met. The cylinder thermostat itself may not switch off the boiler; this is only done if the pump and boiler are interlocked and so the presence of a cylinder thermostat does not in itself signify the presence of an interlock for water heating. If there is no cylinder thermostat, however, there can be no interlock since the system does not know when the demand temperature is reached. A boiler system with no cylinder thermostat must therefore be considered as having no interlock.

A boiler system with no room thermostat - even if there is a cylinder thermostat - must be considered as having no interlock.

For solid fuel boilers and dry core electric boilers the boiler interlock question is not relevant and the efficiency values in Table 4a allow for normal operation of these appliances. For such systems there is no efficiency reduction for the absence of interlock, except where the system has "No thermostatic control", for which the efficiency reduction of 5% is made to the space and water heating efficiencies.

Note: TRVs alone do not perform the boiler interlock function and require the addition of a separate room thermostat in one room.

9.3.10 Bypass

A fixed bypass is an arrangement of pipes that ensures a minimum flow rate is maintained through the boiler. This is achieved either by ensuring that one radiator stays open or by adding a short pipe with a valve between the flow and return pipe. A radiator without a TRV or hand valve is a common form of fixed bypass.

The control type 'TRVs + programmer + bypass' is a non-interlocked system in the absence of other arrangements to provide the interlock function.

9.3.11 Boiler energy manager

Typically a device intended to improve boiler control using a selection of features such as weather compensation, load compensation, start control, night setback, frost protection, anti-cycling control and hot water over-ride. For the purposes of the DEAP it is an equivalent to a hard-wired interlock, and if present, weather compensation or load compensation.

9.3.12 Time and temperature zone controls

In order for a system to be specified with time and temperature zone control, it must be possible to program the *heating times* of at least two zones independently, as well as having independent

temperature controls. It is not necessary for these zones to correspond exactly with the zone division that defines the living area fraction.

In the case of wet systems this involves separate plumbing circuits, either with its own programmer, or separate channels in the same programmer. (By contrast, TRVs provide only independent temperature control.)

Time and temperature zone control can be obtained for electric systems, including underfloor heating, by providing separate temperature and time controls for different rooms.

9.3.13 Weather compensator

A device, or feature within a device, which adjusts the temperature of the water circulating through the heating system according to the temperature measured outside the building.

9.3.14 Load compensator

A device, or feature within a device, which adjusts the temperature of the water circulating through the heating system according to the temperature measured inside the building.

9.3.15 Controls for electric storage heaters

There are three types of control that can be used with electric storage heaters - manual charge control, automatic charge control and CELECT-type control.

Automatic charge control can be achieved using internal thermostat(s) or an external temperature sensor to control the extent of charging of the heaters. Availability of electricity to the heaters may be controlled by the electricity supplier on the basis of daily weather predictions (see 24-hour tariff, 10.3.2).

A CELECT-type controller has electronic sensors throughout the dwelling linked to a central control device. It monitors the individual room sensors and optimises the charging of all the storage heaters individually (and may select direct acting heaters in preference to storage heaters).

10 TOTAL ENERGY USE AND FUEL COSTS

10.1 Energy use

The annual energy use is calculated for the following items:

- main space heating system;
- secondary space heating;
- domestic hot water heating;
- electricity for pumps and fans (including mechanical ventilation if present);
- electricity for lighting.

10.2 Factors and costs

Primary energy factors, CO₂ emission factors and costs associated with different fuels are calculated using the data given in Table 8. Other primary energy or CO₂ factors must not be used for the purpose of this calculation.

Since fuels have to relate to realistic heating systems it is important that practical combinations of fuel types are used.

The primary energy and carbon dioxide emission factors in Table 8 account for energy used and emissions released at the dwelling, and also take some account of energy used and emissions released in bringing the fuel or other energy carrier to the dwelling. For example, in the case of electricity they account for energy loss and emissions at power stations.

10.3 Main fuel types

The choice of fuel type from Table 12 should be appropriate for the particular heating system. Specifying the main heating fuel is usually straightforward but the following points should be borne in mind.

10.3.1 Gas systems

The choices are mains gas, bulk LPG and bottled gas. Bottled gas is normally used only with gas room heaters. In dwellings where the main heating system uses mains gas or bulk LPG, any gas-fired secondary system should use the same fuel as the main system.

10.3.2 Electric systems

When the main system is an electrical storage system on a night-rate tariff using off-peak electricity, any systems that use electricity outside the low tariff times are charged at the on-peak rate (i.e. pumps and fans, electric secondary heating and a percentage of the water heating). Standard rate electricity should not generally be specified in dwellings making use of a night-rate tariff. For proportions of electricity used at the on-peak and off-peak rates see Table 10a.

Integrated storage/direct systems comprise:

- a) electric storage heaters with reduced storage capacity but incorporating a direct-acting radiant heater, designed to provide about 80% of the heat output from storage and about 20% from direct-acting;
- b) underfloor heating designed to take about 80% of the heating needs at off-peak times and about 20% at on-peak times. This heating can be controlled by a "low (off-peak) tariff control" which optimises the timing and extent of the off-peak charge according to outside temperature and the quantity of stored heat. Low tariff control optimises the storage of heat in the floor during the off-peak period, and is modelled by a higher system responsiveness.

A secondary system is always to be specified when the main system is electric storage heaters or off-peak electric underfloor heating.

10.3.3 Solid fuel systems

Independent boilers can be fuelled by coal, anthracite, peat or wood; some models are 'multi-fuel' able to use more than one fuel type. Some pellet boilers and stoves may be room sealed, in which case the flue ventilation loss (see section 2) does not apply.

For solid fuel boilers and heaters, the fuel type to be entered should be chosen as follows, proceeding from points 1 towards 4 until a choice is made.

1. If the heating appliance is designed to burn only a wood fuel, i.e. if its design is such as to prohibit the use of any other fuel type, then the appropriate wood fuel type should be selected. Otherwise a wood fuel should not be selected.
2. If the appliance is designed to burn a particular coal-based or peat-based fuel type, then that should be chosen as the fuel.
3. If the appliance can burn more than one fuel type (open fires and many closed room heaters are in this category), the most likely non-wood fuel type should be selected based on (a) the appliance design, and (b) the dwelling location (taking account of smoke control areas and fuels common in the area).
4. If the fuel type is still unresolved, "multi-fuel" should be selected.

Independent boilers that provide domestic hot water usually do so throughout the year. With open fire back boilers or closed room heaters with boilers, an alternative system (electric immersion) may be provided for heating water in the summer. In that case a fraction 0.33 of the annual water heating is provided by the electric immersion. Supplementary electric water heating should be specified where the main water heater is incapable of providing water heating without space heating.

10.4 Secondary fuel types

Secondary heating systems are taken from the room heaters section of Table 4a and the fuel options will in practice be determined by the fuel used for the main heating system. For solid fuel heaters, the fuel type should be selected as described in section 10.3.3 above for main fuel types.

10.5 Water heating fuel types

Water heating may be provided by the main heating system or it may be supplied using an independent water heating system.

Whenever water heating is supplied by a system using off-peak electricity it is assumed that a proportion of the water heating will, nevertheless, take place at on-peak times (and so be charged at on-peak rates). This proportion is calculated within the workbook.

10.6 Electricity for pumps and fans

An allowance for the electricity used has to be made for systems that include any of the following:

- central heating pump;
- boiler with fan assisted flue;
- warm air heating system fans;
- whole house mechanical ventilation;
- keep-hot facility (electric) for gas combi boilers

The tariff at which this electricity is charged is the on-peak rate if the heating and/or hot water uses an off-peak tariff, otherwise it is the standard tariff. Note that the allowance in this section for fan assisted flues only applies for boilers - fan assisted flues for gas fires should not be counted. Data are given in Table 4f.

10.7 Electricity for lighting

The electricity used for lighting is calculated according to the procedure in Appendix L. The calculation allows for low-energy lighting provided by fixed outlets (both dedicated fittings and compact fluorescent lamps) on the basis of the proportion of the fixed outlets that have low-energy fittings. The tariff at which electricity for lighting is charged is the on-peak rate if the heating and/or hot water uses an off-peak tariff, otherwise it is the standard tariff.

11 ENERGY, EMISSIONS AND COSTS

The DEAP procedure calculates the following results, both total and per m² of floor area. All of these relate to the assumed standard occupancy; the energy consumption patterns of real occupants vary widely.

Delivered energy, in kWh/year: This corresponds to the energy consumption that would normally appear on the energy bills of the dwelling for the assumed standardised occupancy.

Primary energy, in kWh/year: This includes delivered energy, plus an allowance for the energy used in extracting, processing and transporting a fuel or other energy carrier to the dwelling. For example, in the case of electricity it takes account of generation efficiency at power stations.

Carbon dioxide emissions, in kg CO₂ per year: Emissions are calculated on the basis of primary energy consumption, e.g. emissions at power stations associated with the dwelling's electricity use are accounted for.

Costs: Fuel costs are estimated average values for a recent period. It is expected that updates will be made available periodically.

12 DEAP RATING

At the time of writing, the basis of the DEAP rating to be displayed on advisory reports has not yet been decided.

13 BUILDING REGULATIONS

Part L of the Building Regulations requires that, for new dwellings, the CO₂ emissions associated with energy use for space heating, water heating, ventilation and lighting are limited insofar as is reasonably practicable. TGD L specifies that the DEAP methodology be used to show that the Carbon Dioxide Emission Rating (CDER) of the dwelling being assessed does not exceed that of a Reference dwelling, the details of which are specified in the TGD.

REFERENCES

Main references

I.S. EN ISO 13790:2004: Thermal performance of buildings – calculation of energy use for space heating.

UK Standard Assessment Procedure (SAP) 2005, published on behalf of DEFRA by BRE.

Other references

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5. Anderson B R, *Energy assessment for dwellings using BREDEM worksheets*, BRE Information Paper IP 13/88, BRE, Garston, 1988.
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7. Basements for dwellings. Approved Document, British Cement Association, BCA, Crowthorne, 1997. ISBN 0-7210-1508-5

LIST OF STANDARDS REFERRED TO IN THIS DOCUMENT

Reference	Title	Content
I.S. EN ISO 6946*	Building components and building elements - Thermal resistance and thermal transmittance - Calculation method	Calculation of U-values for walls and roofs.
I.S. EN ISO 13789*	Thermal performance of buildings - transmission heat loss coefficient - Calculation method	Heat loss rate from whole building
I.S. EN 12524**	Building materials and products - Hydrothermal properties - Tabulated design values	List of thermal conductivity values
I.S. EN ISO 10077-1*	Thermal performance of windows, doors and shutters - Calculation of thermal transmittance Part 1: General	U-values for windows and doors
I.S. EN ISO 10077-2	Thermal performance of windows, doors and shutters - Calculation of thermal transmittance Part 2: Numerical method for frames	U-values for window frames
I.S. EN ISO 12567	Thermal performance of windows and doors- Determination of thermal transmittance by hot box method	U-value measurement for windows and doors
I.S. EN ISO 13370*	Thermal performance of buildings - Heat transfer via the ground - Calculation methods	U-values for floors

* under review

** being subsumed into ISO 10456

Appendix A: Primary and secondary heating systems

A1 General principles

The primary heating system is that which heats the largest proportion of dwelling. It is a heating system which is not usually based on individual room heaters (although it can be), and often provides hot water as well as space heating. Main heating systems are categorised on the basis of generic types in Tables 4a and 4b. Occasionally there may be two central heating systems, for example two separate boilers used to heat different parts of the property. In this case the calculation should be undertaken using the system that heats the largest part of the property.

The secondary heating system is based upon a room heater. Secondary heating systems are taken from the room heaters section of Table 4a and the fuel options will in practice usually be determined by the fuel used for the main heating system.

A secondary heating system is to be specified if:

- a) the main system is not sufficient in itself to heat the dwelling to the temperatures on which the DEAP is based
- or
- b) fixed secondary heaters are present (e.g. a gas fire or a chimney and hearth capable of supporting an open fire).

In case a), assume direct-acting electric heaters if no actual secondary heaters are present. A secondary system is always specified when the main system is electric storage heaters or off-peak electric underfloor heating. If none of the above conditions apply, secondary heating is not specified, i.e. in the workbook the secondary fraction is set to zero.

Note that building regulations or other regulations may make additional specifications in relation to secondary heaters, which should be followed in the case of compliance calculations.

The DEAP calculation is based on the characteristics of the dwelling and the systems installed and not on the heating practices of the occupying household. That does not preclude further estimates of energy consumption being made to take account of actual usage. Such estimates are not part of DEAP but could form the basis of advice given to the occupying household on how to make best use of the systems at their disposal.

Table 7 gives the fraction of the heating that is assumed to be supplied by the secondary system. The treatment of secondary systems is not affected by any control options for the secondary system.

In some cases it may not be immediately clear which of two systems present should be classified as the main system and which as the secondary. In these cases the system which is cheapest to use should be taken as the primary, and if there is still doubt, i.e. if they are both equally cheap to use, select the system that heats the living room. The other system can still be input as a secondary system but it needs to be input as a room heater. A room heater system should be chosen so that its efficiency closely reflects (but does not exceed) that of the actual system (as defined by Table 4a). The chosen room heater should also use the same fuel/tariff as the actual system.

If two types of secondary heater are present, that which heats the greater number of rooms should be specified as the secondary system (and the other secondary heaters ignored). If that condition does not resolve the choice, the system which is the cheapest to run should be specified.

A2 Procedure for determining the heating systems

- (1) Identify the main heating system. If there is a central system that provides both space and water heating and it is capable of heating at least 30% of the dwelling, select that system as the main heating system. If there is no system that provides both space and water heating, then select the system that has the capability of heating the greatest part of the dwelling.

- (2) If there is still doubt about which system should be selected as the main system, select the system that supplies useful heat to the dwelling at lowest cost (obtained by dividing fuel cost by conversion efficiency).

A3 Dwellings with inadequate heating systems

A3.1 New dwellings

The DEAP assumes that a good standard of heating will be achieved throughout the dwelling. For dwellings in which the heating system is not capable of providing the standard, it should be assumed that the additional heating is provided by electric heaters, using the fraction given in Table 7 (but see also A3.3). For new dwellings that have no heating system specified, it should be assumed that all heat will be provided by electric heaters using electricity at the standard domestic tariff.

A3.2 Existing dwellings

Some existing dwellings have heaters only in a limited number of rooms, generally gas or electric fires. In these cases the usual basis of calculation, that the dwelling is fully heated, still applies. Rooms without heaters are assumed to be heated by electric room heaters. The choice between primary and secondary heating is decided as follows.

- (1) Count the number of habitable rooms as defined in S9 in Appendix S.
- (2) If 25% or less of the habitable rooms are actually heated, and are heated by a fuel other than electricity, the (assumed) electric system is the primary and the other fuel is the secondary. A heated room means one with a heat emitter in the room.
- (3) If the number of habitable rooms actually heated is more than 25% but not exceeding 50%, the heaters in these rooms are the primary and the (assumed) electric heaters are the secondary.
- (4) If more than 50% of rooms are heated, the normal rules apply.

Examples. A house with 6 habitable rooms with one gas fire would be treated as being electrically heated with a gas secondary heater (1 room out of 6). If there were two gas fires (2 rooms out of 6), the gas fires are the primary heating and electricity the secondary. If there were 4 habitable rooms, and one gas fire (1 out of 4), the primary heating would be electric and the gas fire the secondary.

A3.3 Highly insulated small dwellings

In the case of highly insulated small dwellings, item (2) in A3.2 may not be realistic, for example a 3 kW gas fire could suffice to provide most of the heating needs. Accordingly, if the design heat loss (DHL) is less than 3 kW, the heating in the main room is the primary system irrespective of the number of rooms heated. For this purpose, DHL is the heat loss coefficient of the dwelling multiplied by a design temperature difference of 20 K.

A3.4 Broken heating systems

DEAP assumes that the installed heating systems are operational and takes no account of whether they are working or not. However, in the case where the main heating unit (e.g. boiler) is missing and thus the dwelling has no installed primary heating system, the rules in A3.2 should be followed.

Appendix B: Gas and oil boiler systems, boilers with a thermal store, and range cooker boilers

B1 Boilers in the database

The Home-Heating Appliance Register of Performance (HARP database) (see section 9.2.1) contains, in addition to efficiency, all the boiler parameters relevant to DEAP calculations.

B2 Gas and oil boiler systems in Table 4b

General definitions of the various modern boiler types are given in Appendix D. Table 4b gives efficiency values for use when the HARP value is not available. The following notes give guidance for the categories in Table 2 and Table 4b.

B2.1 Combination boilers

Table 4b does not distinguish between the sub-types of combination boiler, and the values given for 'combi' apply to all sub-types (on/off or modulating, instantaneous or storage).

For definitions of storage combination boilers see D1.10 to D1.12 in Appendix D.

A combination boiler with an internal hot water store may be either:

- primary a primary water store contains mainly water which is common with the space heating circuit.
- secondary a secondary water store contains mainly water which is directly usable as domestic hot water.

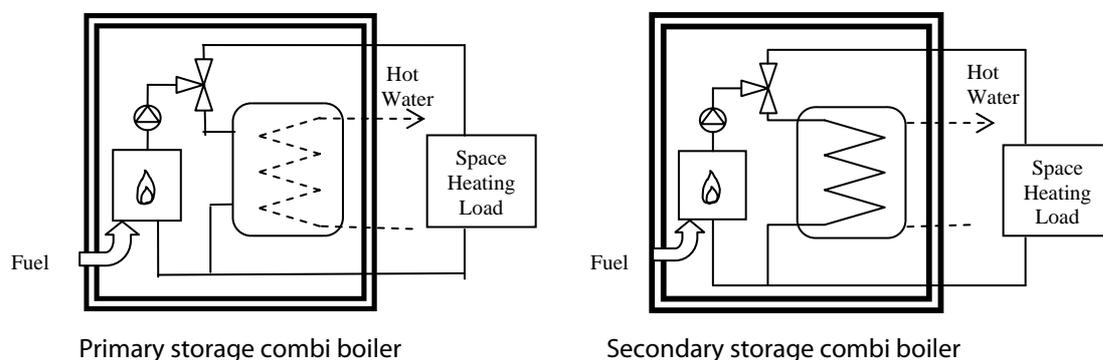


Figure B1 Primary and secondary storage combi boilers

The essential difference between a CPSU (see section B2.5) and a storage combination boiler with a larger primary store is that in the case of a CPSU the feed to the space heating circuit is taken from the store, while in the case of a storage combi with a larger primary store, the store does not feed the space heating circuit.

B2.2 Boilers 1998 or later

If the ignition type is not known, a boiler with a fan-assisted flue may be assumed to have automatic ignition, and one with an open flue to have a permanent pilot light.

B2.3 Boilers with fan-assisted flue

'Low thermal capacity' means a boiler either having a copper heat exchanger or having an internal water content not exceeding 5 litres. If the position is uncertain the category of 'high thermal capacity' should be used.

B2.4 Boiler selected by date

The date refers to the year of manufacture of the boiler. If this is uncertain the older category should be used.

B2.5 Combined Primary Storage Unit (CPSU)

A CPSU is defined in D 1.13. The store must be at least 70 litres - if the store is less than 70 litres, the appliance should be treated as a storage combination boiler. A schematic illustration of a CPSU is shown in Figure B2.

Note: If the store is a different appliance from the boiler (ie contained within a separate overall casing) the system should be treated as a boiler with a thermal store as described in B3.

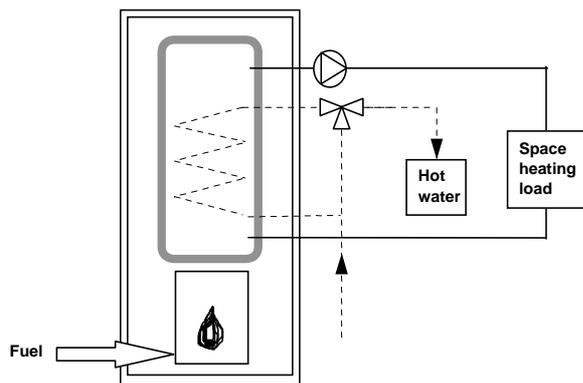


Figure B2 Combined primary storage unit (CPSU)

B3 Boilers with a thermal store

All systems described in this section have hot water stores as a separate appliance from the boiler.

B3.1 Integrated thermal store

An integrated thermal store is designed to store primary hot water, which can be used directly for space heating and indirectly for domestic hot water. The heated primary water is circulated to the space heating (e.g. radiators). The domestic hot water is heated instantaneously by transferring the heat from the stored primary water to the domestic hot water flowing through the heat exchanger. A schematic illustration of an integrated thermal store is shown in Figure B3.

For an appliance to qualify as an integrated thermal store, at least 70 litres of the store volume must be available to act as a buffer to the space heating demand.

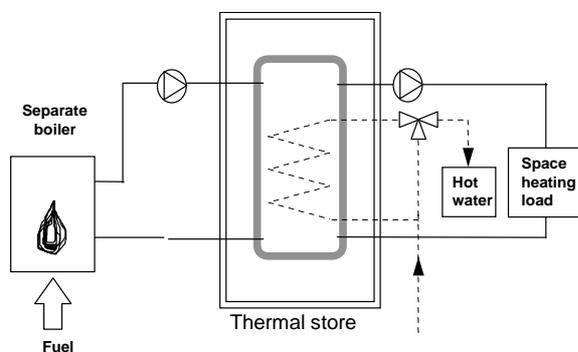


Figure B3 Integrated thermal store

B3.2 Hot water only thermal store

A hot water only thermal store is designed to provide domestic hot water only and is heated by a boiler. The domestic hot water is heated by transferring the heat from the primary stored water to the domestic hot water flowing through the heat exchanger, the space heating demand being met directly by the boiler. A schematic illustration of a hot water only thermal store is shown in Figure B4.

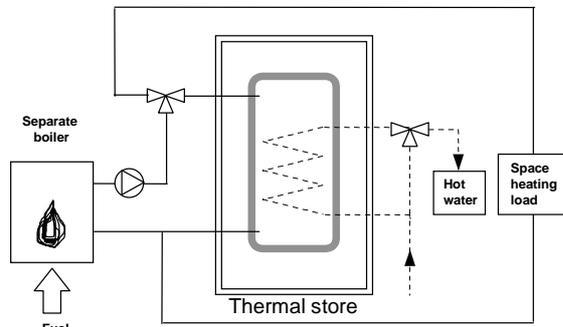


Figure B4 Hot water only thermal store

B4 Range cookers

Range cookers are flued cooking appliances predominantly constructed of cast iron designed to provide some heat from their case into the space in which they are located. There are three types.

B4.1 Range cooker with boiler for space heating

This type provides an independent water heating function for space heating in addition to the cooking function. There are two design variations:

- (i) **Twin burner range cooker/boiler** – an appliance with two independently controlled burners, one for the cooking function, one for the water heating function for space heating,
- (ii) **Single burner range cooker/boiler** – an appliance with a single burner that provides a cooking function and a water heating function for space heating

For the twin burner type, the efficiency can be from the HARP database, manufacturer's declaration or Table 4b, as explained in section 9.2.2 of this document.

For the single burner type, the efficiency should be obtained from Table 4b.

B4.2 Single burner range cooker/water heater

This type provides a cooking function and some heating of domestic hot water. For DEAP calculations all heating of domestic hot water should be based on an electric immersion heater.

B4.3 Single burner dry heat range cooker

This type is an appliance with a single burner that provides a cooking function. It is not included in DEAP calculations.

Appendix C: Community heating, including schemes with Combined Heat and Power (CHP) and schemes that recover heat from power stations.

C1 Community heating where heat is produced by centralised unit by dedicated plant

In community schemes, also known as group or district schemes, heat produced centrally serves a number of dwellings or communal areas.

CHP (Combined heat and Power) is defined as the simultaneous generation of heat and power in a single process.

There are essentially two ways of producing heat for community heating by a dedicated plant:

- heat produced by boilers only (Figure C1);
- heat produced by a combination of boilers and CHP units (Figure C2).

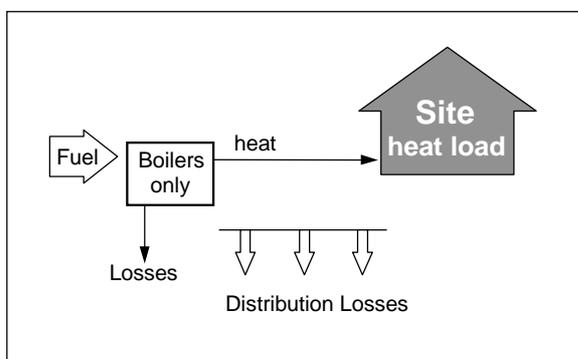


Figure C1 Community heating with heat supplied by boilers only

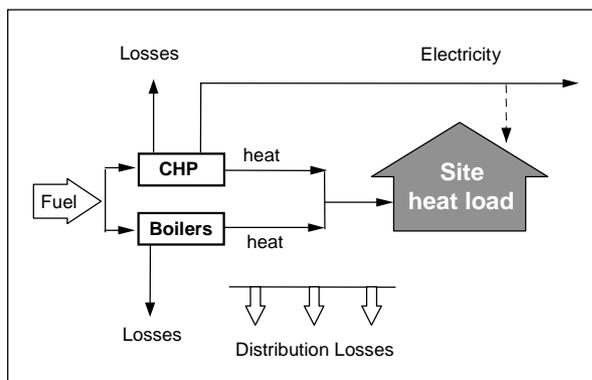


Figure C2 Community heating with heat supplied by a combination of boilers and CHP

For community heating with CHP Schemes, the CHP unit is the primary heat source, and back-up boilers of conventional design are used when the heat output of the CHP plant is insufficient to meet the instantaneous demand. The proportion of heat from CHP and from boilers varies from installation to installation.

The proportions of heat from the CHP and from conventional boilers, and the heat and electrical efficiencies of the CHP for the calculation of CO₂ emissions, should be estimated, either on the basis of operational records or in the case of a new scheme on the basis of its design specification. Heat efficiency is defined as the annual useful heat supplied from a CHP scheme divided by the total annual fuel input. The power efficiency is the total annual power output divided by the total annual fuel input. The heat efficiency of the CHP should be based on the useful heat supplied by the CHP to the community heating, excluding any dumped heat (see Figure C3).

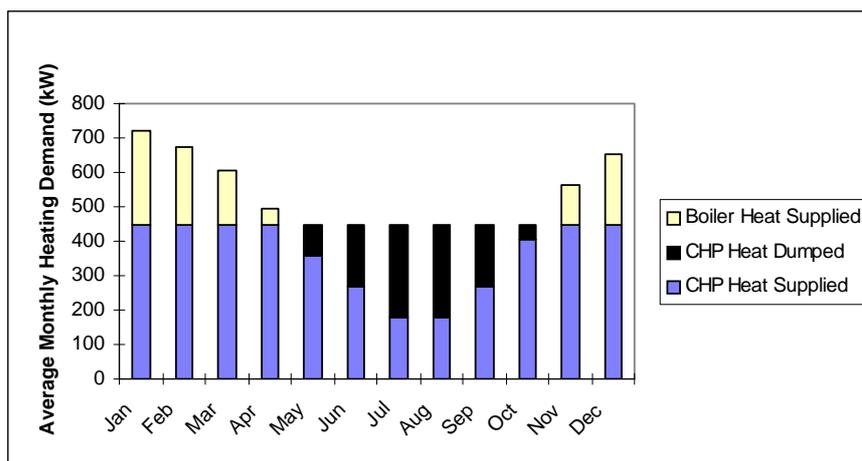


Figure C3 An example of a heat profile chart

The energy required for space and water heating is calculated using an alternative worksheet, designed for calculating DEAP when space and water heating is provided by community heating (with or without CHP). The CO₂ emission and primary energy factors and the heat price for community heating are taken from Table 8. These relate to delivered heat, e.g. the emission factor is given in units of kilograms of CO₂ emitted at the generating plant per kWh of heat delivered to the dwelling.

For community boilers, a default figure for the efficiency is given in Table 4a but, if known, the actual efficiency of the boilers should be used instead. For CHP plant, the efficiency is specified as the heat efficiency and the electrical efficiency; these may be determined from the overall efficiency and the heat-to-power ratio if these are the figures available.

The price incorporates bulk rates for buying the fuel used in the plant, operating costs, energy used in pumping the hot water and, in the case of CHP, receipts from the sale of the electricity generated.

Note: In the case of community heating with CHP, both heat and electricity are produced and the CO₂ emissions associated with the fuel burnt have to be apportioned to the two forms of energy. In the DEAP calculation the emissions saved by the CHP in displacing electricity from the national grid are subtracted from the total emissions associated with the community heating plant, and the remaining emissions are assigned fully to the heat produced.

C2 Community heating schemes that recover waste heat from power stations

This includes waste heat from power stations rated at more than 10 MW electrical output and with a power efficiency greater than 35%. (Otherwise the system should be considered as CHP.)

For community schemes that recover heat from power stations, the waste heat is the primary heat source, and secondary boilers of conventional design are used when the available waste heat is insufficient to meet the instantaneous demand. The proportions of heat from the power station and from the conventional boilers should be estimated, either on the basis of operational records or in the case of a new scheme on the basis of its design specification.

The emission and primary energy factors should be taken from Table 8.

Note: 0.018 kg CO₂/kWh in Table 8 reflects emissions associated with the electricity used for pumping the water from the power station to the dwelling.

Appendix D: Method of determining seasonal efficiency values for gas and oil boilers

Note: The data and equations in this appendix are not to be used by DEAP assessors.

This appendix sets out, in D2 and D4, the method to be used by manufacturers to determine the seasonal efficiency of domestic boilers in Ireland for inclusion in the HARP database, for particular gas and oil boilers when test data have been obtained to establish conformity with Council Directive 92/42/EEC*. The procedure is referred to as the HARP procedure.

Manufacturers' declarations of seasonal efficiency values so calculated should be accompanied by the form of words in D3, and DEAP assessors should look for the same form of words in order to ascertain that the efficiency value referred to is appropriate for DEAP calculations. The SEDBUK efficiency for SAP calculations in the UK is equally acceptable.

Range cooker boilers with twin burners are covered by D5 and D6.

D1 Definitions

D1.1 Boiler

A gas or liquid fuelled appliance designed to provide hot water for space heating. It may (but need not) be designed to provide domestic hot water as well.

D1.2 Condensing boiler

A boiler designed to make use of the latent heat released by the condensation of water vapour in the combustion flue products. The boiler must allow the condensate to leave the heat exchanger in liquid form by way of a condensate drain. 'Condensing' may only be applied to the definitions D1.3 to D1.14 inclusive. Boilers not so designed, or without the means to remove the condensate in liquid form, are called 'non-condensing'.

D1.3 Regular boiler

A boiler which does not have the capability to provide domestic hot water directly (ie not a combination boiler). It may nevertheless provide domestic hot water indirectly via a separate hot water storage cylinder.

D1.4 On/off regular boiler

A regular boiler without the capability to vary the fuel burning rate whilst maintaining continuous burner firing. This includes those with alternative burning rates set once only at time of installation, referred to as range rating.

D1.5 Modulating regular boiler

A regular boiler with the capability to vary the fuel burning rate whilst maintaining continuous burner firing.

D1.6 Combination boiler

A boiler with the capability to provide domestic hot water directly, in some cases containing an internal hot water store.

D1.7 Instantaneous combination boiler

A combination boiler without an internal hot water store, or with an internal hot water store of capacity less than 15 litres.

* Council Directive 92/42/EEC on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels. Official Journal of the European Communities No L/167/17. 21 May 1992, p. 92

D1.8 On/off instantaneous combination boiler

An instantaneous combination boiler that only has a single fuel burning rate for space heating. This includes appliances with alternative burning rates set once only at time of installation, referred to as range rating.

D1.9 Modulating instantaneous combination boiler

An instantaneous combination boiler with the capability to vary the fuel burning rate whilst maintaining continuous burner firing.

D1.10 Storage combination boiler

A combination boiler with an internal hot water store of capacity at least 15 litres but less than 70 litres, OR

a combination boiler with an internal hot water store of capacity at least 70 litres, in which the feed to the space heating circuit is not taken directly from the store. If the store is at least 70 litres and the feed to the space heating circuit is taken directly from the store, treat as a CPSU (D1.13 or D1.14).

D1.11 On/off storage combination boiler

A storage combination boiler that only has a single fuel burning rate for space heating. This includes appliances with alternative burning rates set once only at time of installation, referred to as range rating.

D1.12 Modulating storage combination boiler

A storage combination boiler with the capability to vary the fuel burning rate whilst maintaining continuous burner firing.

D1.13 On/off combined primary storage unit (CPSU)

A single appliance designed to provide both space heating and the production of domestic hot water, in which there is a burner that heats a thermal store which contains mainly primary water which is in common with the space heating circuit. The store must have a capacity of at least 70 litres and the feed to the space heating circuit must be taken directly from the store. The appliance does not have the capability to vary the fuel burning rate whilst maintaining continuous burner firing. This includes those with alternative burning rates set once only at time of installation, referred to as range rating.

D1.14 Modulating combined primary storage unit (CPSU)

A single appliance designed to provide both space heating and the production of domestic hot water, in which there is a burner that heats a thermal store which contains mainly primary water which is in common with the space heating circuit. The store must have a capacity of at least 70 litres and the feed to the space heating circuit must be taken directly from the store. The appliance has the capability to vary the fuel burning rate whilst maintaining continuous burner firing.

D1.15 Low temperature boiler

A non-condensing boiler designed as a low temperature boiler and tested as a low temperature boiler as prescribed by the Boiler Efficiency Directive (ie; the part load test was carried out at average boiler temperature of 40°C).

D1.16 Keep-hot facility

A facility within an instantaneous combination boiler whereby water within the boiler may be kept hot while there is no demand. The water is kept hot either (i) solely by burning fuel, or (ii) by electricity, or (iii) both by burning fuel and by electricity, though not necessarily simultaneously.

D2 Method for calculating the seasonal efficiency of domestic boilers in Ireland

The method of calculation is applicable only to boilers for which the full load and the 30% part load efficiency values, obtained by the methods deemed to satisfy Council Directive 92/42/EEC, are available. These are net efficiency values. It is essential that both test results are available and that the tests are appropriate to the type of boiler as defined in Council Directive, otherwise the calculation cannot proceed.

In the calculation method the data are first converted to gross efficiency under test conditions, and then converted to a seasonal efficiency value that applies under typical conditions of use in a dwelling, allowing for standing losses.

In this Appendix, efficiencies are expressed in percent. Intermediate calculations should be done to at least four places of decimals of a percentage, and the final result rounded to one decimal place.

The procedure to be adopted by manufacturers is as follows:

1. Determine fuel for boiler type.

The fuel for boiler type must be one of natural gas, LPG (butane or propane), or oil (kerosene or gas oil). The HARP seasonal efficiency cannot be calculated for other fuels.

2. Obtain test data.

Retrieve the *full-load net efficiency* and *30% part-load net efficiency* test results. Tests must have been carried out using the same fuel as the fuel for boiler type, except as provided in D4.

3. Reduce to maximum net efficiency values.

Table D2.1 gives the maximum values of net efficiency for each fuel that may be used for the purposes of the DEAP. Reduce any greater test value to the appropriate value given in Table D2.1.

Table D2.1 : Maximum net efficiency values (in %)

Condensing boilers		Non-condensing boilers	
Full load	30% part load	Full load	30% part load
101.0	107.0	92.0	91.0

4. Convert the full and 30% part load efficiencies from net values to gross.

Use the following equation with the appropriate factor from Table D2.2.

$$E_{\text{gross}} = f \times E_{\text{net}}$$

Table D2.2 : Efficiency conversion factors

Fuel	Net-to-gross conversion factor, f
Natural gas	0.901
LPG (propane or butane)	0.921
Oil (kerosene or gas oil)	0.937

5. Categorise the boiler.

- Select the appropriate category for the boiler according to the definitions given in D1.
- If a gas or LPG boiler, determine whether it has a permanent pilot light:
 - if it has a permanent pilot light, set $p = 1$
 - if not, set $p = 0$.
- In the case of a storage combination boiler (either on/off or modulating) determine from the test report whether the losses from the store were included in the values reported (this depends on whether the store was connected to the boiler during the tests):
 - if the store loss is included, set $b = 1$
 - if not, set $b = 0$.
- In the case of a storage combination boiler or a CPSU, obtain the store volume, V_{cs} , in litres from the specification of the device and the standby loss factor, L , using the following equation:

$$\text{if } t < 10 \text{ mm: } L = 0.0945 - 0.0055t$$

if $t \geq 10$ mm: $L = 0.394/t$
 where t is the thickness of the insulation of the store in mm.

6. Calculate seasonal efficiency

- Use the boiler category and other characteristics as defined in D1 (non-condensing or condensing; gas or LPG or oil; on/off or modulating) to look up the appropriate HARP equation number in Table D2.3. If no equation number is given the calculation cannot proceed. Otherwise, select the appropriate equation from Table D2.4 or Table D2.5.
- Substitute the gross full and part load efficiencies (found in step 4) and p , b , V and L (found in step 5). Round the result to one decimal place; ie, to nearest 0.1%. Note the result as $[x]$ for the purpose of the declaration in D3.

Table D2.3 : Boiler category table

HARP Equation numbers for different boiler types	non-condensing (see D1.2)				low-temperature (see D1.15)	condensing (see D1.2)			
	Gas or LPG		Oil			Gas or LPG		Oil	
	on/off (see D1.4, D1.8, D1.11, D1.13)	modulating (see D1.5, D1.9, D1.12, D1.14)	on/off (see D1.4, D1.8, D1.11)	modulating (see D1.5, D1.9, D1.12)		on/off (see D1.4, D1.8, D1.11, D1.13)	modulating (see D1.5, D1.9, D1.12, D1.14)	on/off (see D1.4, D1.8, D1.11)	modulating (see D1.5, D1.9, D1.12)
regular boiler (see D1.4, D1.5)	101	102	201	X	X	101	102	201	X
instantaneous combi boiler (see D1.7, D1.8, D1.9)	103	104	202	X	X	103	104	202	X
storage combi boiler (see D1.10, D1.11, D1.12)	105	106	203	X	X	105	106	203	X
combined primary storage unit (see D1.13, D1.14)	107	107	X	X	X	107	107	X	X

Table D2.4 : Seasonal efficiency, E , for natural gas and LPG boilers

Gas or LPG boiler type	Eq. no.	Equation
D1.4 : On/off regular	101	$E = 0.5(E_{full} + E_{part}) - 2.5 - 4p$
D1.5 : Modulating regular	102	$E = 0.5(E_{full} + E_{part}) - 2.0 - 4p$
D1.8 : On/off instantaneous combination	103	$E = 0.5(E_{full} + E_{part}) - 2.8 - 4p$
D1.9 : Modulating instantaneous combination	104	$E = 0.5(E_{full} + E_{part}) - 2.1 - 4p$
D1.11 : On/off storage combination	105	$E = 0.5(E_{full} + E_{part}) - 2.8 + (0.209 \times b \times L \times V_{cs}) - 4p$
D1.12 : Modulating storage combination	106	$E = 0.5(E_{full} + E_{part}) - 1.7 + (0.209 \times b \times L \times V_{cs}) - 4p$
D1.13 : On/ off combined primary storage unit (condensing and non-condensing) D1.14 : Modulating combined primary storage unit (condensing and non-condensing)	107	$E = 0.5(E_{full} + E_{part}) - (0.539 \times L \times V_{cs}) - 4p$

Table D2.5 : Seasonal efficiency, E , for oil boilers

Oil boiler type	Eq. No.	Equation
D1.3 : Regular	201	$E = 0.5(E_{full} + E_{part})$
D1.7 : Instantaneous combination	202	$E = 0.5(E_{full} + E_{part}) - 2.8$
D1.10 : Storage combination	203	$E = 0.5(E_{full} + E_{part}) - 2.8 + (0.209 \times b \times L \times V_{cs})$

D3 Declaring values of seasonal efficiency

Manufacturers wishing to declare their products' seasonal efficiencies for the specific purposes of calculating DEAP ratings can do so provided that:

- a) they use the HARP calculation procedure given in D2 above; and
- b) the necessary boiler test data and the calculations are certified by a Notified Body accredited for the testing of boilers by an EU national accreditation service. The Notified Body must certify that: 'the full load and part load efficiency test results detailed in *[insert reference to report on the efficiency tests]* have been obtained by methods deemed to satisfy the Boiler Efficiency Directive'.

Where a manufacturer declares the HARP seasonal efficiency, it shall be expressed as:

"Seasonal Efficiency (HARP) = [x]%
The value is used in the Irish Government's Dwelling Energy Assessment Procedure (DEAP) for energy rating of dwellings. The test data from which it has been calculated have been certified by *[insert name and/or identification of Notified Body]*."

Data for several products may be presented in tabulated form, in which case the second paragraph of the declaration should be incorporated as a note to the table.

D4 Method for calculating the HARP seasonal efficiency for boilers fuelled by LPG but tested with natural gas

If the fuel for boiler type is LPG but the fuel used to obtain efficiency test results is natural gas then seasonal efficiency may be calculated subject to certain conditions using the procedure given below. The value of seasonal efficiency will be lower than if the fuel used to obtain the test results had been LPG.

1. Note the restrictions set out at the start of D2, which still apply.
2. Any differences between the boiler fuelled by natural gas (used to obtain full-load and 30% part-load efficiency test results) and the boiler fuelled by LPG (for which the seasonal efficiency is required) must be minor. Examples of minor differences are a change of gas injector or adjustment by a single screw on the gas valve.
3. Determine the net heat input on a net calorific value basis for both the natural gas boiler and the LPG boiler. The LPG figure must lie within $\pm 5\%$ of the natural gas figure.
4. Determine by measurement the percentage dry CO₂ by volume at the maximum heat input for both the natural gas boiler and the LPG boiler. From the results calculate the excess air fractions for both boilers. The calculated excess air fraction for the LPG boiler must not exceed that for the natural gas boiler by more than 5% (of the natural gas excess air fraction).
5. Retrieve the *full-load net efficiency* and *30% part-load net efficiency* test results. If the boiler is a condensing boiler then deduct 2.2 percentage points from the *30% part-load net efficiency* test result.
6. Follow the calculation procedure in D2 from step 3 onwards, taking the fuel for boiler type as LPG.

D5 Method for calculating Seasonal Efficiency and Case Emission value of a non-condensing twin-burner range cooker boiler

1. The method of calculation of the Seasonal Efficiency is applicable only to cooker boilers for which the full load and the 30% part load efficiency values for the boiler function, obtained by the methods deemed to satisfy Council Directive 92/42/EEC, are available.

Note: A non-condensing range cooker boiler which does not have the capability to provide domestic hot water directly (i.e. is not a combination boiler), but which may nevertheless provide domestic hot water indirectly via a separate hot water storage cylinder exactly matches the definition D1.3 for a Regular Boiler. Consequently the methods deemed to satisfy 92/42/EEC for a Regular Boiler will equally satisfy this requirement for the equivalent type of range cooker boiler.

These efficiencies are for the heat transferred to water and are carried out with the cooker burner turned off,

When undertaking the efficiency test, record

- input power (net) at full load conditions, $\Phi_{\text{input,net}}$ in kW.
- heat transfer to the water under full load conditions, Φ_{water} in kW
- flue loss (net) under full load conditions, $\Phi_{\text{flue,net}}$ in kW according to the method given in I.S. EN 304 or other method assured by the independent test laboratory as providing comparable results for the product under test.

Note: Independent test laboratory is qualified in D6 b).

2. Calculate the seasonal efficiency according to D2 using the appropriate equation for a regular boiler.
3. Calculate the case heat emission at full load from

$$\Phi_{\text{case}} = \Phi_{\text{input,net}} - \Phi_{\text{water}} - \Phi_{\text{flue,net}}$$

where Φ_{water} is the heat transferred to water under full load conditions;
 $\Phi_{\text{flue,net}}$ is the flue gas loss measured according to I.S. EN 304.

4. If Φ_{case} exceeds either of $0.05 \times \Phi_{\text{water}}$ or 1 kW, reduce Φ_{case} to $0.05 \times \Phi_{\text{water}}$ or 1 kW (whichever is the smaller).
5. Provide the values of Φ_{case} and Φ_{water} in kW as part of the test report.

D6 Declaring values of seasonal efficiency and heat emission from the case for twin-burner range cooker boilers

Manufacturers wishing to declare their products' seasonal efficiencies and case emission values for the specific purposes of calculating DEAP ratings can do so provided that:

- a) They use the calculation procedure given in D5 above; and
- b) The necessary boiler test data and calculations are certified by an independent Test Laboratory notified under the Council Directive 92/42/EEC on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels (known as a "Notified Body").

Where a manufacturer declares the seasonal efficiency and the case emission value, it shall be expressed as:

Seasonal Efficiency (HARP) = [x]%
 Case heat emission at full load = [y] kW
 Heat transfer to water at full load = [z] kW
 The values are used in the Irish Government's Dwelling Energy Assessment Procedure (DEAP) for the energy rating of dwellings. The test data from which they have been calculated has been certified by [insert name and/or identification of Notified Body].

Data for several products may be presented in tabulated form, in which case the last paragraph of the declaration should be incorporated as a note to the table.

Appendix E: Method of determining seasonal efficiency for gas or oil room heaters

Note: The data and equations in this appendix are not to be used by DEAP assessors.

This appendix sets out the method to be used by manufacturers to determine the declared efficiency for gas or oil room heaters. Declared efficiencies acceptable for UK SAP calculations are also acceptable for DEAP calculations.

E1 Efficiency determination

Only test results obtained by one of the recognised methods given in Table E1 and Table E2 may be used to establish a seasonal efficiency for DEAP calculations. The methods give comparable results.

Table E1 : Recognised efficiency test methods for gas heaters

I.S. EN 613:2001	Independent gas-fired convection heaters
I.S. EN 13278:2003	Open-fronted gas-fired independent space heaters
I.S. EN 1266:2002	Independent gas-fired convection heaters incorporating a fan to assist transportation of combustion air and/or flue gases
BS 7977-1:2002	Specification for safety and rational use of energy of gas domestic appliances. Part 1: Radiant/Convectors
BS 7977-2:2003	Specification for safety and rational use of energy of gas domestic appliances. Part 2: Combined appliances: Gas fire/back boiler

Table E2 : Recognised efficiency test method for oil heaters

OFS A102:1999	Oil fired room heaters with atomising or vaporising burners with or without boilers, heat output up to 25 kW
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Efficiency test results are normally calculated using the net calorific value of fuel. Before a declaration can be made, conversion to gross must be carried out by multiplying the efficiency by the appropriate conversion factor given in Table E3.

Table E3: Efficiency conversion factors

Fuel	Net-to-gross conversion factor
Natural gas	0.901
LPG (propane or butane)	0.921
Oil (kerosene or gas oil)	0.937

E2 Declaring the efficiency of gas and oil room heaters

Manufacturers' declarations so calculated should be accompanied by the following form of words:

"The efficiency of this appliance has been measured as specified in [*insert appropriate entry from Table E1 or Table E2*] and the result is [*x*]%. The gross calorific value of the fuel has been used for this efficiency calculation. The test data from which it has been calculated has been certified by [*insert name and/or identification of Notified Body*]. The efficiency value may be used in the Irish Government's Dwelling Energy Assessment Procedure (DEAP) for energy rating of dwellings."

Appendix F: Electric CPSUs

An electric CPSU is a central heating system providing space and domestic water heating. A thermal store containing primary water is heated mainly during off-peak times to approximately 75°C in summer and between 85 and 95°C in winter. The space heating circuit operates in the same way as a wet central heating system, with controls appropriate for "wet" systems. For domestic hot water, secondary water flows directly from the cold mains into a heat exchanger, where it is heated by the hot water in the store before being delivered to the taps.

The CPSU volume should be sufficiently large to meet most of the space and water heating demand during on-peak times from heat stored during off-peak times, otherwise the on-peak fraction will be high. For a 10-hour off-peak tariff providing 3 off-peak periods per day, available in some other countries, a volume of at least about 270 litres may be appropriate. For the night-rate tariff available in Ireland, providing one off-peak period each night, a larger volume would be appropriate.

For DEAP calculations, the on-peak fraction should be taken from Table 7. It is assumed that the CPSU volume is adequately sized to achieve this fraction.

The heat losses from the CPSU are calculated, as for other hot water storage vessels, on the 'Water heating' worksheet, using data from Table 2.

Note: In the DEAP workbook box, the input cell 'Fraction of heat use from secondary system' is normally used for entry of a fraction from a separate heating appliance, but for the purpose of electric CPSU only, this box is used for CPSU on-peak fraction.

Appendix G: Heat pumps

A heat pump is a device which takes heat energy from a low temperature source and upgrades it to a higher temperature at which it can be usefully employed for heating. There are a number of heat pump techniques by which this can be achieved. The ratio of heat energy released to the energy consumed can be significantly greater than one. Heat pump systems operate most efficiently when the source temperature is as high as possible and the heat distribution temperature is as low as possible.

Heat pump systems are categorised by the low temperature heat source used (e.g. air, water, ground) and the seasonal performance factors (SPF) given in Table 4a under "Efficiency" are assumed to apply for all systems using that source. This is a simplified approach especially for ground source heat pumps where energy may be collected from the ground in a variety of ways, e.g. using surface water from lakes or ponds, using ground water from wells, using fluid (either refrigerant or a water/antifreeze mixture) circulated in closed pipe loops buried horizontally in shallow trenches or vertically in boreholes.

At the time of publication, the SPF to be used for DEAP calculations is the appropriate entry in Table 4a. A system of appliance-specific performance factors may be introduced (see Appendix Q).

Heat pumps can also be used in community schemes. In this case, the appropriate SPF should be entered to the 'System efficiency of the heat generating plant' input cell in the 'Boilers' section of the 'Ener2' worksheet.

G1 Domestic hot water (DHW)

G1.1 DHW heated by heat pump with immersion heater

The heat pump raises the water temperature to a maximum of about 40°C, and an immersion heater is then used to raise the water temperature to the required delivery temperature. For the purpose of the DEAP calculation it is assumed that 50% of domestic hot water heating is by the heat pump and 50% by the immersion heater using off-peak electricity.

The average efficiency for water heating, to be entered to the 'Efficiency of main water heater' input cell of the 'Ener1' worksheet, is:

$$\frac{100}{[50 \div \text{SPF}] + 0.5} \quad (\text{G1})$$

where SPF is the seasonal performance factor for the heat pump, %, given under "Efficiency" in Table 4a. (The SPF is an overall figure, taking account of all the energy required to operate the heat pump, including primary circulation pumps and an auxiliary heater if present). In the case of a ground or water source heat pump the fraction of electricity at the on-peak rate is given in Table 10a with the remainder charged at the off-peak rate.

G1.2 DHW heated by heat pump without immersion heater

The heat pump supplies all domestic hot water without supplementary immersion heater. In the case of a ground or water source heat pump, the on-peak fraction is given in Table 10a. The SPF of the heat pump for water heating is to be multiplied by the factor given in Table 4c.

G1.3 DHW heated by immersion only

An immersion heater is used, either standard or off-peak electric tariff.

G2 Space heating requirement

G2.1 Space heating from ground or water source heat pump

A ground source heat pump system (when the main heating system) may consist of either a ground source heat pump sized to meet all space heating requirements, or a combination of a ground source heat pump and a direct acting electric heater (auxiliary heater). A ground source heat pump system

which includes an auxiliary heater to help meet the maximum demands has a lower SPF than one without an auxiliary heater.

Use the appropriate SPF given in Table 4a under "Efficiency".

For ground and water source heat pumps using an off-peak tariff, the fraction of the electricity used for space heating at the on-peak rate is given in Table 10a with the remainder charged at off-peak rate.

If the heat pump supplies heat to radiators (as opposed to underfloor heating) the heat pump efficiency for space heating is to be multiplied by the appropriate factor given in Table 4c.

G2.2 Direct acting air source heat pump

A heat pump using ambient air as the source is subject to frost build up on the external coil and is very likely to have an integral electric heater to provide space heating while the external coil is being defrosted. The use of this heater is allowed for in the SPF. Air source heat pumps use standard electricity tariff.

G2.3 Heating controls

Control options for heat pumps are given in Group 2 of Table 4e. Note that a bypass arrangement is usually necessary with TRVs to ensure sufficient circulating thermal mass while the heat pump is operating. Zoning arrangements or TRVs may not be appropriate for small domestic installations for this reason.

Appendix H: Solar water heating

The working principle of solar hot water systems is shown in Figure H1: examples of arrangements are given in Figure H2.

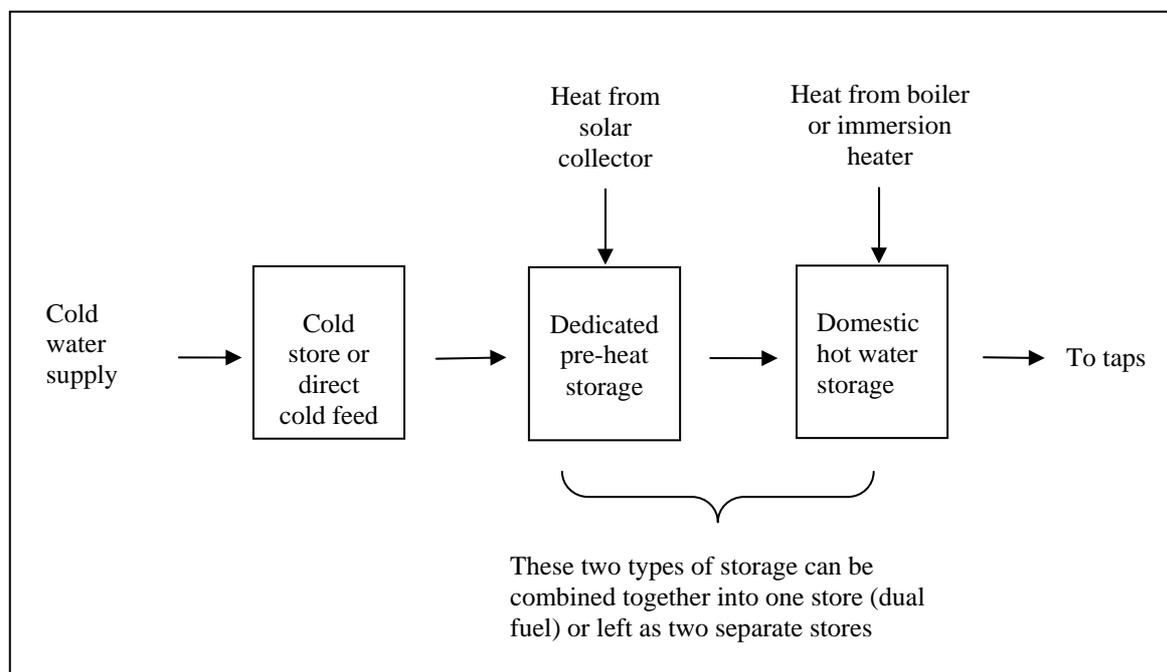
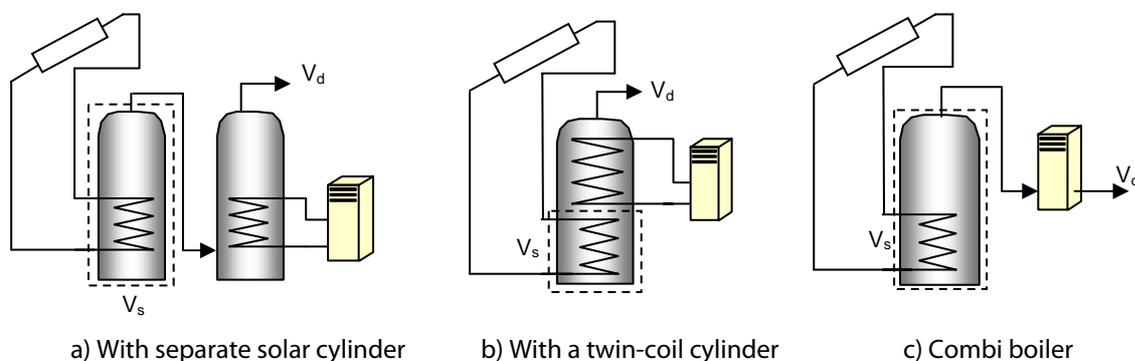


Figure H1: Working principle of solar water heating.



V_s (indicated by the dashed line) is the dedicated solar storage volume. See text below concerning the effective solar volume. V_d is the daily hot water demand.

Figure H2: Schematic examples of arrangements for solar pre-heating

Water from the cold supply is either fed (directly or via a cold feed cistern) to the preheat zone where it is heated by solar energy. Then the water passes to the domestic hot storage (separate hot water cylinder or upper part of combined cylinder) which is heated to the required temperature by a boiler or an electric immersion.

There are three main types of solar collector:

- unglazed: the overall performance of unglazed collectors is limited by high thermal losses;
- glazed flat plate: a flat plate absorber (which often has a selective coating) is fixed in a frame between a single or double layer of glass and an insulation panel at the back;
- evacuated tube: an absorber with a selective coating is enclosed in a sealed glass vacuum tube.

The performance of a solar collector is represented by its zero-loss efficiency (proportion of incident solar radiation absorbed in the absence of thermal loss) and its heat loss coefficient (heat loss from collector to the environment per unit area and unit temperature difference).

The solar contribution to domestic hot water is given by

$$Q_s = S \times Z_{\text{panel}} \times A_{\text{ap}} \times \eta_0 \times UF \times f(a_1/\eta_0) \times f(V_{\text{eff}}/V_d) \quad (\text{H1})$$

where

Q_s = solar input, kWh/year

S = total solar radiation on collector, kWh/m²/year

Z_{panel} = overshadowing factor for the solar panel

A_{ap} = aperture area of collector, m²

η_0 = zero-loss collector efficiency

UF = utilisation factor

a_1 = linear heat loss coefficient of collector, W/m²K

$f(a_1/\eta_0)$ = collector performance factor = $0.87 - 0.034 (a_1/\eta_0) + 0.0006 (a_1/\eta_0)^2$

V_{eff} = effective solar volume, litres

V_d = daily hot water demand, litres

$f(V_{\text{eff}}/V_d)$ = solar storage volume factor = $1.0 + 0.2 \ln(V_{\text{eff}}/V_d)$ subject to $f(V_{\text{eff}}/V_d) \leq 1.0$

The collector's gross area is the projected area of complete collector (excluding any integral means of mounting and pipework). The aperture area is the opening through which solar radiation is admitted.

The preferred source of performance data for solar collectors is from a test on the collector concerned according to I.S. EN 12975-2, *Thermal solar systems and components – Solar collectors – Part 2: Test methods*. The aperture area, and the performance characteristics η_0 and a_1 related to aperture area, are obtained from the test certificate. If test data are not available (e.g. for existing installations), the values in Table H1 may be used.

The effective solar volume is:

- in the case of a separate pre-heat tank (such as arrangements a) or c) in Figure H2), the volume of the pre-heat tank;
- in the case of a combined cylinder (such as arrangement b) in Figure H2), the volume of the dedicated solar storage plus 0.3 times the volume of the remainder of the cylinder;
- in the case of a thermal store (hot-water-only or integrated as defined in Appendix B) where the solar coil is within the thermal store, the volume of the dedicated thermal storage.

Calculation of solar input for solar water heating

Aperture area of solar collector, m ² <i>If only the gross area can be established reliably, multiply it by ratio in Table H1</i>		<input type="text"/>	(H1)
Zero-loss collector efficiency, η_0 , from test certificate or Table H1		<input type="text"/>	(H2)
Collector heat loss coefficient, a_1 , from test certificate or Table H1		<input type="text"/>	(H3)
Collector performance ratio a_1/η_0	(H3) ÷ (H2) =	<input type="text"/>	(H4)
Annual solar radiation per m ² from Table H2		<input type="text"/>	(H5)
Overshading factor from Table H3		<input type="text"/>	(H6)
Solar energy available	(H1) × (H2) × (H5) × (H6) =	<input type="text"/>	(H7)
Solar-to-load ratio	(H7) ÷ [EnerUsage + DistLoss] =	<input type="text"/>	(H8)
Utilisation factor if (H8) > 0, $1 - \exp[-1/(H8)]$, otherwise enter "0" in box (H9) <i>if the cylinder is heated by a boiler and there is no cylinderstat, reduce the utilisation factor by 10%</i>		<input type="text"/>	(H9)
Collector performance factor	$0.87 - 0.034 \times (H4) + 0.0006 \times (H4)^2 =$	<input type="text"/>	(H10)
Dedicated solar storage volume, V_s , litres <i>volume of pre-heat store, or dedicated solar volume of a combined cylinder</i>		<input type="text"/>	(H11)
If combined cylinder, total volume of cylinder, litres		<input type="text"/>	(H12)
Effective solar volume, V_{eff} <i>if separate pre-heat solar storage or a thermal store, (H13) = (H11)</i> <i>if combined cylinder, (H13) = (H11) + 0.3 × [(H12) – (H11)]</i>		<input type="text"/>	(H13)
Daily hot water demand, V_d , (litres) from Table 1		<input type="text"/>	(H14)
Volume ratio V_{eff}/V_d	(H13) ÷ (H14) =	<input type="text"/>	(H15)
Solar storage volume factor $f(V_{eff}/V_d)$	$1 + 0.2 \times \ln(H15) =$	<input type="text"/>	(H16)
Solar input Q_s	(H7) × (H9) × (H10) × (H16) =	<input type="text"/>	(H17)

Note: 'HwReq_t' and 'DistLoss' are values in the main worksheets. HwReq_t is the 'Hot water energy requirement' and DistLoss is the 'Distribution loss', both on the 'Wh' worksheet.

Enter (H17) to the 'Solar DHW input, Q_s ' input cell of the 'Wh' worksheet. If separate figures for solar input are required for the heating season (8 months) and summer (4 months) take 50% of Q_s as applying during the heating season and 50% during the summer.

Table H1 : Default collector parameters

Collector type	η_0	a_1	Ratio of aperture area to gross area
Evacuated tube	0.6	3	0.72
Flat plate, glazed	0.75	6	0.90
Unglazed	0.9	20	1.00

Table H2 : Annual solar radiation, kWh/m²

Tilt of collector	Orientation of collector				
	South	SE/SW	E/W	NE/NW	North
Horizontal	963				
15°	1036	1005	929	848	813

30°	1074	1021	886	736	676
45°	1072	1005	837	644	556
60°	1027	956	778	574	463
75°	942	879	708	515	416
Vertical	822	773	628	461	380

Table H3 : Overshading factor

Overshading	% of sky blocked by obstacles.	Overshading factor
Heavy	> 80%	0.5
Significant	> 60% - 80%	0.65
Modest	20% - 60%	0.8
None or very little	< 20%	1.0

Note: Overshading must be assessed separately for solar panels, taking account of the tilt of the collector. Usually there is less overshading of a solar collector compared to overshading of windows for solar gain (Table 6d)

Appendix J: Seasonal efficiency for solid fuel boilers from test data

This appendix specifies how to obtain a seasonal efficiency from test data on a solid fuel boiler that is provided in the Home-Heating Appliance Register of Performance (HARP). A HARP database record for a solid fuel boiler includes:

- DEAP seasonal efficiency, %
- Fuel input, heat to water and heat to room from test at full load, kW
- Fuel input, heat to water and heat to room from test at part load, kW

J1 DEAP seasonal efficiency is given

If the DEAP seasonal efficiency is given, that value is used for both space and water heating, and the other data is disregarded.

J2 DEAP seasonal efficiency is not given

If the DEAP seasonal efficiency is blank, the appropriate efficiency for use in the calculations is obtained as follows.

J2.1 Part load data is available

The efficiency at full load is obtained from:

$$E_{\text{full}} = 100 \times \frac{(\text{heat to water at full load}) + (\text{heat to room at full load})}{\text{fuel input at full load}} \quad (\text{J1})$$

and the efficiency at part load from:

$$E_{\text{part}} = 100 \times \frac{(\text{heat to water at part load}) + (\text{heat to room at part load})}{\text{fuel input at part load}} \quad (\text{J2})$$

If the boiler is outside the boundary of the dwelling as defined in section 1, "Dwelling dimensions", the heat to room is omitted from (J1) and (J2).

The seasonal efficiency is then:

$$\text{Seasonal efficiency} = 0.5 (E_{\text{full}} + E_{\text{part}}) \quad (\text{J3})$$

J2.2 Part load data is not available

If the data for the part load test is blank, the part load efficiency is taken as 95% of the full load efficiency, so that:

$$\text{Seasonal efficiency} = 0.975 E_{\text{full}} \quad (\text{J4})$$

J2.3 Rounding

The seasonal efficiency should be rounded to one decimal place before using it in calculations.

J3 Heating type and responsiveness

The heating type and responsiveness is that for the applicable type of appliance given in Table 4a.

Appendix K: Thermal bridging

Thermal bridges that occur at junctions between building elements are now included in the calculation of transmission heat losses.

The quantity which describes the heat loss associated with a thermal bridge is its linear thermal transmittance, Ψ . This is a property of a thermal bridge and is the rate of heat flow per degree per unit length of the bridge, that is not accounted for in the U-values of the plane building elements containing the thermal bridge.

The transmission heat loss coefficient associated with non-repeating thermal bridges is calculated as:

$$H_{TB} = \sum (L \times \Psi)$$

where L is the length of the thermal bridge over which Ψ applies.

If details of the thermal bridges are not known, use

$$H_{TB} = y \sum A_{exp}$$

where A_{exp} is the total area of exposed elements, m^2 .

$y = 0.11$ for new dwellings whose details conform with guidance given in TGD L (including references) or are shown to be equivalent. A default value of $y = 0.15$ applies otherwise.

Alternatively values of Ψ can be determined from the results of numerical modelling, or they can be derived from measurement. If the junction detail is as recommended in the UK Government's *Accredited Construction Details*, the Ψ -value associated with that junction can be taken from Table K1. These *Accredited Construction Details* are published in "Limiting thermal bridging and air leakage: Robust construction details for dwellings and similar buildings, Amendment 1, TSO, 2002.

Table K1 Maximum values of Ψ from UK Accredited Construction Details for different types of junctions.

Junction detail in external wall	Ψ (W/m·K)
Steel lintel with perforated steel base plate	0.50
Other lintels (including other steel lintels)	0.30
Sill	0.04
Jamb	0.05
Ground floor	0.16
Intermediate floor within a dwelling	0.07
Intermediate floor between dwellings ^{a)}	0.14
Balcony within a dwelling ^{b)}	0.00
Balcony between dwellings ^{a) b)}	0.04
Eaves (insulation at ceiling level)	0.06
Eaves (insulation at rafter level)	0.04
Gable (insulation at ceiling level)	0.24
Gable (insulation at rafter level)	0.04
Corner (normal)	0.09
Corner (inverted)	-0.09
Party wall between dwellings ^{a)}	0.06

^{a)} For these junctions, half the value of Ψ is applied to each dwelling

^{b)} This is an externally supported balcony (the balcony slab is not a continuation of the floor slab) where the wall insulation is continuous and not bridged by the balcony slab.

Appendix L: Energy for lighting

The calculation of lighting use is based on the proportion of fixed low energy lighting outlets installed, and on the contribution of daylight.

Allowing for fixed low-energy outlets

In Irish houses, the average annual energy consumption for lighting is taken to be as follows if no low-energy lighting is used.

$$E_B = 270 + 6.5 \times \text{TFA} \text{ [kWh/year]} \quad (\text{L1})$$

where TFA (total floor area) is in m². This gives about 9.3 kWh/m² yr for a typical floor area of 96 m².

The DEAP calculation takes account of fixed lighting outlets with low-energy lamps, by including a correction factor C₁:

$$C_1 = 1 - 0.6 \times N_{LE}/N \quad (\text{L2})$$

where N_{LE} is the number of fixed low energy lighting outlets (including sockets or complete luminaires capable of taking only low-energy lamps, and also compact fluorescent lamps that fitted into ordinary lighting sockets) and N is the total number of fixed lighting outlets (only the ratio N_{LE}/N is needed).

Note: In Equation (L2), only fixed lighting outlets are included in N_{LE} and N. Movable lamps, which plug into a mains socket, are disregarded. The equation is based on 80% of the lighting energy consumption being via fixed lighting points, and each fixed low energy lighting point achieving a saving of 75% over a point with a non low energy lamp (0.8 × 0.75 = 0.6).

Daylighting

Analysis of typical house types gives the following approximate correction factor, C₂, for lighting energy use depending on the ratio of glass area to floor area, glass transmittance and light access factor.

$$C_2 = 52.2 G_L^2 - 9.94 G_L + 1.433 \quad \text{if } G_L \leq 0.095 \quad (\text{L3})$$

$$C_2 = 0.96 \quad \text{if } G_L > 0.095 \quad (\text{L4})$$

$$G_L = \frac{\sum 0.9 \times A_w \times g_L \times \text{FF} \times Z_L}{\text{TFA}} \quad (\text{L5})$$

where: FF is the frame factor from Table 6c
 A_w is the area of a window, m²
 TFA is the total floor area, m²
 g_L is the light transmittance factor from Table 6b
 Z_L is the light access factor from Table 6d

The summation allows for different window and rooflight types (the light access factor is different for windows and rooflights).

The annual energy used for lighting in the house, E_L, is then

$$E_L = E_B \times C_1 \times C_2 \text{ [kWh/year]} \quad (\text{L6})$$

where C₁ and C₂ are defined above.

Gains from lighting

To calculate the heat gains due to lighting, it is assumed that 85% of the annual lighting electricity consumption occurs during the heating season (Oct – May). Of this, it is assumed that 90% contributes to internal gains, the remainder being accounted for by e.g. external lighting or lighting of unheated spaces. The average rate of heat gain from lighting is thus

$$G_L = E_L \times 0.77 \times (1000 / (24 \times \text{HsDays})) \text{ [W]} \quad (\text{L7})$$

where HsDays is the duration of the heating season in Days (243 days)

Appendix M: Energy from Photovoltaic (PV) technology

Photovoltaic technology converts sunlight directly into electricity. It works during daylight hours but more electricity is produced when the sunshine is more intense (a sunny day) and is striking the PV modules directly. Unlike solar systems for heating water, PV technology does not produce heat. Instead, PV produces electricity as a result of interaction of sunlight with semi-conductor materials in the PV cells.

For DEAP calculations, the energy produced per year depends on the installed peak power (kWp) of the PV module (the peak power corresponds to the rate of electricity generation in bright sunlight, formally defined as the output of the module under radiation of 1 kW/m² at 25°C). PV modules are available in a range of types and some produce more electricity per square metre than others (the range for currently available types is from about 30 to 120 watts peak per m²), and the peak power depends on the type of module as well as its effective area. In the UK climate, an installation with 1 kWp produces about 750 kWh of electricity per year (at favourable orientation and not overshadowed).

The procedure for PV is as follows.

- 1) Establish the installed peak power of the PV unit (kWp).
- 2) The electricity produced by the PV module in kWh/year is

$$0.75 \times \text{kWp} \times S \times Z_{PV}$$
 where S is the annual solar radiation from Table H2 (depending on orientation and pitch), and Z_{PV} is the overshadowing factor from Table H3.
 In the worksheet enter the calculated energy produced by PV in the 'Energy produced or saved' input cell in the 'Results by end use' section of the 'Ener1' worksheet.
- 3) For calculation of CO₂ emissions and primary energy savings, the factors for grid-displaced electricity from Table 8 are used. The same factor is used for all electricity generated, whether used within the dwelling or exported.
- 4) The cost saving associated with the generated electricity depends on whether it is used directly within the dwelling or whether it is exported. Electricity used directly within the dwelling is valued at the unit cost for purchased electricity (usually the standard tariff, or the day rate in the case of an off-peak tariff). Electricity exported is valued at the price in Table 8 for electricity sold to the grid. The effective price depends on a factor β, which is in the range 0.0 to 1.0 and is defined as the proportion of the generated electricity that is used directly within the dwelling. The value of β depends on the coincidence of electricity generation and electricity demand. At present the value of β = 0.30 should be used for DEAP calculations: this will be reviewed in future if relevant data becomes available.

The fuel price used in the calculation of box (95a) is:

$$\beta \times \text{normal electricity price} + (1 - \beta) \times \text{exported electricity price.}$$

Appendix N: Micro-cogeneration (also known as micro-CHP)

N1 Overview

Micro-cogeneration provides both heat and electricity. It is assumed to be heat-led, meaning that it is allowed to operate only when there is a demand for space heating or hot water. The domestic application of micro-cogeneration is treated as an alternative to a conventional domestic boiler, using mains gas, LPG, oil or solid fuel. It is also assumed that it is connected to the public electricity supply in such a way that all surplus generated electricity is exported. It provides space heating throughout the heating season, and hot water service for either (a) the whole of the year, or (b) none of the year.

The characteristics of micro-cogeneration are described by data derived from laboratory tests. The test data is used to calculate parameters related to the annual energy performance of the micro-cogeneration package. Results (known as "intermediate results") from the annual energy performance method are used for DEAP as described in N2.

Any space heating requirements not met by the micro-cogeneration package are assumed to be provided by secondary heating appliances (if provided) or by electric room heaters. If the package provides domestic hot water it is assumed to provide all water heating needs.

The heat produced by the package and the electrical energy consumed/generated are based on operation during an average year, taking account of the output rating of the appliance and the design heat loss for the dwelling into which it is installed. The amount of auxiliary heating is determined by the plant size ratio (full output power of the micro-cogeneration package divided by the design heat loss). If the plant size ratio is less than 0.5 then the package cannot be regarded as the primary heating system, and the performance data are not valid for DEAP.

The electricity consumed will normally be negative, and then represents the net electricity provided by the micro-cogeneration package that is available to offset electricity that would otherwise be taken from the public electricity supply grid or, to the extent that instantaneous generation exceeds instantaneous electricity demand, is exported to the grid.

The thermal efficiency of the micro-cogeneration package is used in the normal way for the calculation of energy requirements for space heating and, if supplied by the micro-cogeneration package, water heating. The electricity consumed (or the net electricity generation) is scaled according to the net energy use as obtained in the DEAP calculation.

N2 Interpolation of result sets

The intermediate results from the annual energy performance method are produced in sets, with each set calculated for a different plant size ratio (e.g. 0.5, 1.0, 1.5 and 4.0). The plant size ratio is defined as the maximum heat output of the micro-cogeneration package divided by the design heat loss of the dwelling. Each set of results contains the data in Table N1. The data to be used for DEAP calculations are provided by way of the HARP database, each database record for a micro-cogeneration package containing the output power of the package and a number of sets of intermediate results.

Table N1: Set of intermediate results from the annual energy performance method

Data item	Symbol	Unit
Plant size ratio for which data apply	PSR	-
Annual heat generated for space heating	Q_{sp}	kWh
Annual heat generated for domestic hot water, if any	Q_{hw}	kWh
Annual auxiliary heating requirement	Q_{aux}	kWh
Heating season ¹ thermal efficiency	η_{hs}	-
Summer season thermal efficiency	η_{sum}	-
The electricity consumed or, if negative, net electricity generated, during the heating season	$E_{mc,hs}$	kWh
The electricity consumed or, if negative, net electricity generated, during the summer season	$E_{mc,sum}$	kWh
Number of days operating for 16 hours instead of 9	$N_{16,9}$	days
Number of days operating for 24 hours instead of 9	$N_{24,9}$	days
Number of days operating for 24 hours instead of 16	$N_{24,16}$	days

The plant size ratio (PSR) for the dwelling is calculated using the maximum output of the micro-cogeneration package and the design heat loss of the dwelling taken as the heat loss coefficient from the 'Fabric' worksheet, multiplied by a temperature difference of 20 K. In the case of a range-rated package, the PSR for the dwelling is calculated assuming that it is set to the top of the range. The intermediate results applicable to the dwelling are then obtained by linear interpolation between the intermediate results² for the two sets of data whose PSRs enclose that of the actual dwelling. The dwelling-specific result sets are used in equations (N1) to (N4) to calculate the parameters used in the DEAP calculation.

N3 Calculation of space and water heating, and electricity produced

The electricity used by any fans within the package is included in $E_{mc,hs}$ and $E_{mc,sum}$ and is not included separately in the DEAP calculation, thus no allowance is made for it in the 'Pumps/fans' section of the 'Ener1' worksheet.

If the micro-cogeneration package includes a central heating system pump to circulate water through the heat emitters the electricity for it is included in $E_{mc,hs}$ and the heat gain from it is allowed for in η_{sp} . In that case no allowance for a central heating pump is included in 'Pumps/fans' section of the 'Ener1' worksheet. If the package does not include a central heating pump, it is provided separately outside the package, and should then be accounted for in the 'Pumps/fans' section of the 'Ener1' worksheet.

Mean internal temperature

The micro-cogeneration package, when undersized in relation to the dwelling's design heat loss, can provide space heating needs on more days of the heating season if it operates for 16 hours per day or continuously. The seasonal thermal efficiency and electricity generated in the intermediate results are based on the hours of operation indicated by the parameters $N_{16,9}$, $N_{24,9}$ and $N_{24,16}$ for a total heating

¹ The heating season and summer season together comprise a whole year.

² For the efficiency values, the interpolated efficiency is the reciprocal of linear interpolation between the reciprocals of the efficiencies. Round $N_{16,9}$, $N_{24,9}$ and $N_{24,16}$ to the nearest integer.

season length of 238 days (34 weeks). For the normal DEAP heating schedule, this heating season would comprise 68 weekend days each with one no-heating period and 170 weekdays each with two no-heating periods – a total of 408 no-heating periods. All no-heating periods are approximately the same length (8 or 7 hours).

In DEAP, less-than-ideal heating system responsiveness is modelled as heat emission outside heating hours, and operating the micro-cogeneration system outside heating hours for the reason given above is modelled in a similar manner. The responsiveness “category” is given by

$$R = [(N_{24,16} + 2 * N_{24,9} + N_{16,9}) / 408] * 5 + 1$$

The result (to one decimal place) is entered to the ‘Responsiveness category’ input cell in the ‘Sh’ worksheet.

By way of background information to the above, the heat emitted by slow-response heaters outside heating hours is considered to be a percentage of that emitted during heating hours. The percentage for responsiveness categories 1, 2 and 5 are 0%, 20% and 80% respectively. It follows that a responsiveness category of 6 would effectively amount to continuous heating.

Efficiency

Use the heat efficiency η_{hs} as the efficiency of the main space heating system on the ‘Sh’ worksheet.

If the micro-cogeneration package provides both space and hot water heating, use the heat efficiency η_{hs} for water heating in the heating season (238 days) and η_{sum} for water heating in summer (127 days).

If the package only provides space heating specify a separate hot water system such as an electric immersion heater.

If the package is a condensing type, the efficiency adjustments in Table 4c(1) apply where relevant to efficiency in the heating season.

Hot water storage losses

If the micro-cogeneration package contains within it a storage vessel for domestic hot water that was included in the energy performance tests, heat losses associated with hot water storage are included in the intermediate results and zero is entered for the storage (cylinder) loss and the primary circuit loss on the ‘Wh’ worksheet. The distribution loss is included as normal.

If the package does not contain a storage vessel for domestic hot water, a cylinder is specified separately and the cylinder loss and primary loss are included in the DEAP calculation.

Secondary heating

The auxiliary heating requirement Q_{aux} is provided by a secondary heating system (any system from the room heater section of Table 4a). The secondary fraction is calculated from

$$SF = \frac{Q_{aux}}{Q_{sp} + Q_{aux}} \quad (N2)$$

Electricity

If the package provides both space and hot water heating, the electricity consumed or generated is scaled to the actual heat requirement of the dwelling for both heating and hot water:

$$E^* = \frac{[ShReqt] \times (1 - SF) + [0.66 \times WhReqt]}{Q_{sp} + 0.66 \times Q_{hw}} \times E_{mc,hs} + \frac{WhReqt}{Q_{hw}} \times E_{mc,sum} \quad (N3)$$

where

ShReqt = Space heating requirement from ‘Sh’ worksheet

WhReqt = Water heating requirement (output from main water heater) from ‘Wh’ worksheet (0.66 is the heating season as a fraction of a year).

If the package provides space heating only, the electricity consumed or generated is scaled to the actual space heating requirement of the dwelling:

$$E^* = \frac{Sh\ Re\ qt \times (1 - SF)}{Q_{sp}} \times E_{mc,hs} \quad (N4)$$

If E^* is positive, it is entered to the 'Energy consumed by the technology' input cell in the 'Results by end use' section of the 'Ener1' worksheet. If it is negative, it is entered to the 'Energy produced or saved' cell.

If E^* is positive, the primary energy and emission factors entered to the 'Energy consumed by the technology' input cells of the 'Fuel data' section of the 'Ener1' worksheet are those for grid-supplied electricity from Table 8.

If E^* is negative, the factors entered to the 'Energy produced or saved' input cells are those for grid-displaced electricity from Table 8.

If E^* is positive, use the unit price for standard tariff electricity as the price of electricity consumed.

If E^* is negative, the cost saving associated with the net generated electricity depends on whether it is used directly within the dwelling or whether it is exported. Electricity used directly within the dwelling is valued at the unit cost for purchased electricity (usually the standard tariff, or the day rate in the case of an off-peak tariff). Electricity exported is valued at the price in Table 8 for electricity sold to the grid.

The effective price depends on a factor β , which is in the range 0.0 to 1.0 and is defined as the proportion of the generated electricity that is used directly within the dwelling. The value of β depends on the coincidence of electricity generation and electricity demand within the dwelling. At present the value of $\beta = 0.40$ should be used for DEAP calculations: this will be reviewed in future if relevant data become available. The fuel price used is then:

$\beta \times \text{normal electricity price} + (1 - \beta) \times \text{exported electricity price}.$

Appendix P: Assessment of internal temperature in summer

This appendix provides a method for assessing the propensity of a dwelling to have high internal temperature in hot weather. It does not provide an estimate of cooling needs. The procedure is not integral to DEAP and does not affect the calculated DEAP results or CDER.

The calculation is related to the factors that contribute to internal temperature: solar gain (taking account of orientation, shading and glazing transmission); ventilation (taking account of window opening in hot weather), thermal capacity and mean summer temperature for the location of the dwelling.

P1 Assessment procedure

1. Obtain a value for the effective air change rate during hot weather. Indicative values are given in Table P1.

Table P1: Effective air change rate

Window opening	Effective air change rate in ach		
	Trickle vents only	Windows slightly open (50 mm)	Windows fully open
Single storey dwelling (bungalow, flat) Cross ventilation possible	0.1	0.8	6
Single storey dwelling (bungalow, flat) Cross ventilation not possible	0.1	0.5	4
Two storey dwelling windows open upstairs and downstairs Cross ventilation possible	0.2	1	8
Two storey dwelling windows open upstairs and downstairs Cross ventilation not possible	0.1	0.6	5

If there is a mechanical ventilation system providing a specified air change rate, that rate can be used instead.

2. Calculate the ventilation heat loss, H_v^{summer} , using the formula:

$$H_v^{\text{summer}} = 0.33 \times n \times V \quad (\text{P1})$$

where:

n = air change rate during hot weather, ach

V = volume of the heated space of the dwelling, m^3

3. Calculate the heat loss coefficient under summer conditions:

$$H = \text{total fabric heat loss} + H_v^{\text{summer}} \quad (\text{P2})$$

The total fabric heat loss is the same as for the heating season (box (35) of the worksheet).

4. Calculate the total solar gains for the summer period, $G_{\text{solar}}^{\text{summer}}$, using the solar flux for the summer period from Table 1c.

$$G_{\text{solar}}^{\text{summer}} = \sum (0.9 \times A_w \times S \times g_{\perp} \times \text{FF} \times Z_{\text{summer}}) \quad (\text{P3})$$

where:

0.9 is a factor representing the ratio of typical average transmittance to that at normal incidence

A_w is the area of an opening (a window or a glazed door), m^2

S is the solar flux on a surface during the summer period from Table 1c, W/m^2

g_{\perp} is the total solar energy transmittance factor of the glazing at normal incidence from Table 6b

FF is the frame factor for windows and doors (fraction of opening that is glazed) from Table 6c

Z_{summer} is the summer solar access factor

Solar gains should be calculated separately for each orientation and for rooflights, and totalled according to equation (P3).

For data to calculate Z_{summer} see section P3.

Assume that the summer internal gains (G_i) are equal to the winter 'net internal gains' (these are calculated in the 'Internal gains' section of the DEAP workbook), so that the total gains are:

$$G = G_{solar}^{summer} + G_i \quad (P5)$$

- Calculate the temperature increment due to gains in summer, from the following, where H is the heat loss coefficient of the dwelling:

$$\text{Temperature increment} = \frac{G}{H} \quad (P6)$$

- Obtain the summer mean external temperature, T_e^{summer} , from Table P2. Alternatively, the mean for the months June – August for the dwelling location may be used if available.

Table P2: Summer mean external temperature

Region	Mean external temperature, T_e^{summer} , used for estimating mean internal temperature in summer [°C]
Ireland	15

- Obtain the threshold internal temperature which is used to estimate likelihood of high internal temperature. This is the mean internal temperature during the summer period plus an increment related to the thermal mass.

$$T_{threshold} = T_e^{summer} + \frac{G}{H} + \Delta T_{mass} \quad (P7)$$

where

$$\Delta T_{mass} = 2.0 - 7 \times HCP \quad \text{if } HCP < 0.28$$

$$\Delta T_{mass} = 0 \quad \text{if } HCP \geq 0.28$$

HCP (heat capacity parameter) is the internal heat capacity of the dwelling divided by the total floor area, as entered to the DEAP calculation workbook.

- Use Table P3 to estimate tendency to high internal temperature in hot weather.

Table P3: Levels of threshold temperature corresponding to likelihood of high internal temperature during hot weather

$T_{threshold}$	Likelihood of high internal temperature during hot weather
< 20.5°C	Not significant

$\geq 20.5^{\circ}\text{C}$ and $< 22.0^{\circ}\text{C}$	Slight
$\geq 22.0^{\circ}\text{C}$ and $< 23.5^{\circ}\text{C}$	Medium
$\geq 23.5^{\circ}\text{C}$	High

P2 Reporting of results

Results should include:

- details of the house design including its heat capacity parameter and specification of any overhangs, together with its orientation and the climatic region assumed;
- for one or more scenarios, the category from Table P3 for stated assumptions on occupant-determined factors (usage of blinds/curtains and window opening).

If the orientation of the dwelling is not known, the assessment should be for the orientation giving the greatest tendency to high internal temperature.

P3 Solar shading

Z_{summer} is given by

$$Z_{\text{summer}} = Z_{\text{blinds}} (Z + Z_{\text{overhangs}} - 1) \quad (\text{P8})$$

subject to

$$Z_{\text{summer}} \geq 0.1 Z_{\text{blinds}} \quad (\text{P9})$$

where

Z_{blinds} is a shading factor for blinds or curtains

Z is the solar access factor from Table 6d

$Z_{\text{overhangs}}$ is a shading factor for overhangs

Table P4 gives values for Z_{blinds} , and Tables P5 and P6 give values for $Z_{\text{overhangs}}$. If there are no overhangs, $Z_{\text{overhangs}} = 1$.

P3.1 Curtains and blinds

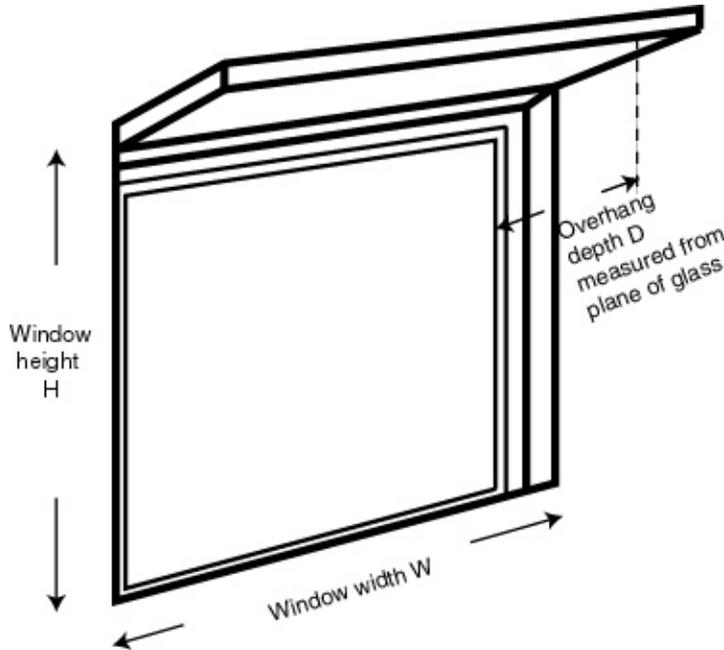
Table P4 : Shading factors for blinds, curtains or external shutters

Blind or curtain type	Z_{blind}
Net curtain (covering whole window)	0.80
Net curtain (covering half window)	0.90
Dark-coloured curtain or roller blind (note 1)	0.85
Light-coloured curtain or roller blind (note 1)	0.60
Dark-coloured venetian blind (note 2)	0.88
Light-coloured venetian blind (note 2)	0.70
Dark-coloured external shutter, window closed	0.24
White external shutter, window closed	0.27
Dark-coloured external shutter, window fully open	0.85
White external shutter, window fully open	0.65

Notes to Table P4

1. Factor applies when fully closed. If closed only for a fraction f of the daylight hours use $f \times Z_{\text{blind}} + (1 - f)$.
2. Factor applies for venetian blind with slats at 45° against the sun. The same factor can be used if the blind is fully closed. If closed only for a fraction f of the daylight hours use $f \times Z_{\text{blind}} + (1 - f)$.

P3.2 Overhangs



Where the overhang is at least twice as wide as the window (e.g. balconies on blocks of flats) use Table P5. In other cases use Table P6. Interpolation may be used between rows of these tables. Usually the same value of $Z_{\text{overhangs}}$ can be applied to all the windows on a given façade on the basis of an average depth-to-height ratio.

Table P5: $Z_{\text{overhangs}}$ for wide overhangs

Depth/H	Orientation of window				
	N	NE/NW	E/W	SE/SW	S
0.0	1.00	1.00	1.00	1.00	1.00
0.2	0.92	0.89	0.88	0.83	0.77
0.4	0.85	0.80	0.76	0.67	0.55
0.6	0.79	0.72	0.66	0.54	0.38
0.8	0.73	0.65	0.58	0.43	0.32
1	0.69	0.59	0.51	0.36	0.30
1.2 or more	0.66	0.55	0.46	0.31	0.29

This table is to be used where the overhang is at least twice as wide as the window

Table P6: $Z_{\text{overhangs}}$ for normal overhangs

Depth/H	Orientation of window				
	N	NE/NW	E/W	SE/SW	S
0.0	1.00	1.00	1.00	1.00	1.00
0.2	0.94	0.91	0.89	0.84	0.79
0.4	0.90	0.85	0.79	0.72	0.64
0.6	0.88	0.81	0.72	0.62	0.53

0.8	0.86	0.79	0.66	0.55	0.50
1	0.85	0.77	0.61	0.52	0.49
1.2 or more	0.84	0.76	0.57	0.50	0.48
This table is to be used where the overhang is less than twice as wide as the window					

Appendix Q: Special features and specific data

Q1 Special features

This section provides a method to allow for the benefits of new energy-saving technologies that are not included in the published DEAP specification.

This procedure may only be used for technologies whose characteristics have been independently assessed and which are recognised as part of DEAP by being described on the web page www.sei.ie/deap2006 (or a web page linked to it). For recognised systems, this web page will contain details for calculating the data to be entered into the worksheet.

In general, a technology may use one form of energy to achieve savings in another form of energy.

Example. If whole-house mechanical ventilation with heat recovery were to be assessed in this way for an oil-heated house:

- *the web page would contain the routine for calculating the heat recovered (and so the energy saved), together with a routine to calculate the energy used by fans;*
- *the energy saved would be applied with the primary and CO₂ emission factors and cost for oil;*
- *the electricity used for fans would be applied with the primary and CO₂ factors and cost for electricity.*

In the workbook, in the 'Ener1' or 'Ener2' worksheet as appropriate, go to the 'Results by end use' section, 'Renewable and energy-saving technologies' sub-section, and enter the delivered energy produced or saved, and the delivered energy consumed by the technology, to the appropriate input cells. Then go to the 'Fuel data' section, 'Renewable and energy-saving technologies' sub-section, and enter the primary and CO₂ factors and cost data for the energy produced or saved, and the energy consumed, to the appropriate input cells.

Q2 Specific data

A similar mechanism will be used, if appropriate, to permit the use of data specific to a technology instead of the data provided in the DEAP tables. For recognised data types, the web page mentioned above will give details of the conditions for accepting the data and its applicability within the DEAP calculation.

Appendix R: Reference values

This appendix provides a set of reference values for the parameters of a DEAP calculation, which are used to establish a datum against which the performance of the actual dwelling can be compared. Table R1 is used to define a notional dwelling of the same size and shape as the actual dwelling. The notional or "reference" dwelling represents a dwelling built to current energy-efficiency standards as specified in TGD L 2006, and with a gas-fired central heating system.

Note that this reference dwelling is not identical to that used to determine compliance with the MPCDER requirement of TGD L 2006, details of which are specified in the TGD L document itself.

Table R1 : Reference values

Element or system	Value
Size and shape	Same as actual dwelling
Opening areas (windows and doors)	25% of total floor area (or, if total exposed façade area is less than 25% of the total floor area, the total exposed façade area) The above includes one opaque door of area 1.85 m ² , any other doors are fully glazed
Walls	U = 0.27 W/m ² K
Floors	U = 0.25 W/m ² K
Roofs	U = 0.16 W/m ² K
Opaque door	U = 3.0 W/m ² K
Windows and glazed doors	U = 2.2 W/m ² K Double glazed, low-E hard coat Frame factor 0.7 Solar energy transmittance 0.72 Light transmittance 0.80
Living area fraction	Same as actual dwelling
Shading and orientation	All glazing orientated E/W; average overshadowing
Number of sheltered sides	2
Allowance for thermal bridging	0.11 x total exposed surface area (W/K)
Internal heat capacity	0.17 MJ/m ² K
Ventilation system	Natural ventilation with intermittent extract fans
Air permeability	Infiltration due to structure = 0.5 ac/h
Chimneys	One
Open flues	None
Extract fans	3 for dwellings with floor area greater than 100 m ² , 2 for smaller dwellings
Primary heating fuel (space and water)	Mains gas
Heating system	Boiler and radiators water pump in heated space
Boiler	Seasonal efficiency 78% room-sealed fanned flue
Heating system controls	Programmer + room thermostat + TRVs boiler interlock

Hot water system	Stored hot water, heated by boiler separate time control for space and water heating
Hot water cylinder	120 litre cylinder insulated with 35 mm of factory applied foam
Primary water heating losses	Primary pipework not insulated cylinder temperature controlled by thermostat
Secondary space heating	10% electric
Low energy light fittings	30% of fixed outlets

Appendix S : Reduced Data DEAP for existing dwellings

Reduced Data DEAP has been developed by government for use in existing dwellings based on a site survey of the property, when the complete data set for a DEAP calculation is not available. It consists of a system of data collection (defined in Table S17) together with defaults and inference procedures, as defined by the rules given in this Appendix, that generate a complete set of input data for the DEAP calculation. For any item not mentioned in this Appendix, the procedures and data given elsewhere in this document apply.

This Appendix forms part of DEAP 2005 and provides a methodology for existing dwellings that is compliant with the Energy Performance of Buildings Directive. It is not appropriate for new dwellings for which all data for the calculation should be acquired related to the dwelling concerned.

S1 Dwelling types

Dwellings are classified as one of

- house
- bungalow
- flat
- maisonette

and one of

- detached
- semi-detached
- mid-terrace
- end-terrace
- enclosed mid-terrace
- enclosed end-terrace

A house or bungalow has a completely exposed ground floor and a completely exposed roof. A flat or maisonette does not have both.

"Enclosed" is typically applicable for "back-to-back" terraces and has the following meaning:

- mid-terrace has external walls on two opposite sides;
- enclosed mid terrace has an external wall on one side only;
- end-terrace has three external walls;
- enclosed end-terrace has two adjacent external walls.

Many dwellings have an extension either added onto the main part, or built at the same time but of different construction or insulation. In these cases, dimensions and constructional details of the main part of the dwelling and the extension are recorded separately, to allow the assignment of different U-values to the original and to the extension. Occasionally there may be two extensions whose details need each to be recorded separately. In addition, dwellings can have a different construction for some parts of the walls (for example, a timber framed bay window in otherwise masonry construction). These are recorded as a separate constructional element, termed "alternative wall".

S2 Age bands

A set of age bands is defined according to Table S1 for the purposes of assigning U-values and other data.

Table S1 : Age bands

Age band	Years of construction
A	before 1900
B	1900-1929
C	1930-1949
D	1950-1966
E	1967-1977
F	1978-1982
G	1983-1992
H	1993-1998
I	1999-2003
J	2004 onwards

Note. From the mid-1970s, constructional changes have been caused primarily by amendments to draft or actual building regulations for the conservation of fuel and power, which have called for increasing levels of thermal insulation. The dates in Table S1 are generally two years after a change in regulations, to allow for completion of dwellings approved under the previous regulations.

S3 Heat loss areas

Heat loss areas are determined separately for the main part of the dwelling and any extension.

S3.1 Conversion to internal dimensions

If horizontal dimensions are measured externally, they are converted to overall internal dimensions for use in DEAP calculations by application of the appropriate equations in Table S2, using the appropriate wall thickness from Table S3. External dimensions should be measured to the mid-point of party walls dividing two dwellings. The equations are applied on a storey-by-storey basis, for the whole dwelling (i.e. inclusive of any extension).

Table S2 : Conversion of dimensions

Dwelling type	Equations
Detached	$P_{int} = P_{ext} - 8 w$ $A_{int} = A_{ext} - w (P_{int} - 4 w^2)$
Semi-detached or End-terrace	$P_{int} = P_{ext} - 5 w$ $a = 0.25 \left(P_{ext} + \sqrt{P_{ext}^2 - 8 A_{ext}} \right)$ $A_{int} = A_{ext} - w (P_{int} + 0.5 A_{ext}/a) - 2 w^2$
Mid-terrace	$P_{int} = P_{ext} - 2 w$ $A_{int} = A_{ext} - w (P_{ext} + 2 A_{ext}/P_{ext}) + 2 w^2$
Enclosed end-terrace	$P_{int} = P_{ext} - 3 w$ $A_{int} = A_{ext} - 1.5 w P_{ext} + 2.25 w^2$

Enclosed mid-terrace	$P_{int} = P_{ext} - w$ $A_{int} = A_{ext} - w (A_{ext}/P_{ext} + 1.5 P_{ext}) + 1.5 w^2$
All types	Perimeter ratio = P_{int}/P_{ext} Area ratio = A_{int}/A_{ext}
P_{ext} and A_{ext} are the measured external perimeter and area (of whole dwelling) P_{int} and A_{int} are the calculated internal perimeter and area w is the wall thickness After obtaining the perimeter ratio and area ratio for the whole dwelling, multiply separately the measured perimeters and areas of (a) the main part of the dwelling and (b) any extension, by these ratios.	

Table S3 : Wall thickness (m)

Age band	A	B	C	D	E	F	G	H	I, J
Wall type									
Stone as built	0.50	0.50	0.50	0.50	0.45	0.42	0.42	0.42	0.45
Stone + internal or external insulation	0.57	0.57	0.57	0.57	0.52	0.49	0.49	0.49	0.52
Solid brick / solid concrete / hollow-block, as built	0.22	0.22	0.22	0.22	0.24	0.25	0.27	0.27	0.30
Solid brick / solid concrete / hollow-block + internal or external insulation	0.29	0.29	0.29	0.29	0.31	0.32	0.34	0.34	0.37
Cavity	0.25	0.25	0.25	0.25	0.25	0.26	0.27	0.27	0.30
Timber Frame	0.15	0.15	0.15	0.25	0.27	0.27	0.27	0.27	0.30
System Build	0.25	0.25	0.25	0.25	0.25	0.30	0.30	0.30	0.30
System build + internal or external insulation	0.32	0.32	0.32	0.32	0.32	0.37	0.37	0.37	0.37

S3.2 Heights and exposed wall areas

Heights are measured internally within each room, and 0.25 m is added to each room height except for the lowest storey of the dwelling, to obtain the storey height. Façade areas are obtained from the product of heat loss perimeter (after conversion to internal dimensions if relevant) and storey height, summed over all storeys. For the main house and any extension(s), window and door areas are deducted from the façade areas to obtain the net wall areas for the heat loss calculations. If an alternative wall is present, the area of the alternative wall is recorded net of any openings in it and identified as part of the main wall or extension wall, so that it may be subtracted from that wall area prior to the calculation of wall heat losses.

S3.3 Door and window areas

The area of external doors is taken as 1.85 m². The number of external doors is:

- flat/maisonette with heated corridor: 0
- flat/maisonette with unheated corridor or no corridor: 1
- house/bungalow: 2

Window areas are obtained by application of the appropriate equation from Table S4. The equation used is the same for all age bands.

Table S4 : Window area (m²)

Age band	House or Bungalow	Flat or Maisonette
All	WA = 0.127 * TFA + 4.6	WA = 0.091 * TFA + 3.6
WA = window area for main part or extension TFA = total floor area of main part or extension		

The window areas calculated using Table S4 should be reduced by 25% if it is assessed as being less than typical, and increased by 25% if assessed as being more than typical.

If assessed as much greater than typical, or for an atypical property e.g. a dwelling created by a change of use, the total window area should be obtained from measurements of each individual window. In this case the window areas in the main part of the dwelling and in any extension are recorded separately, along with whether single glazed or double glazed, and if double glazed, whether it was installed before or after the start of 2004, and Table S4 is not used.

S3.4 Roof area

Roof area is the greatest of the floor areas on each level.

S3.5 Room in roof

If there are roof rooms, with a total floor area of F_{rr} (measured internally), then:

- (1) Area F_{rr} is deducted from the roof area determined at S3.4.
- (2) A separate heat-loss roof area A_{rr} is defined, where

$$A_{rr} = F_{rr} + 11.0\sqrt{F_{rr}} / 1.5$$

A_{rr} has a U-value for the appropriate age band for the construction of the roof rooms (see Table S8). The formula is based on a rectangular room-in-roof area of average height 2.2 m, and A_{rr} includes the walls of the roof rooms as well as their roof.

S3.6 Heat loss floor area

The lowest floor of a dwelling can be a basement, a ground floor, an exposed floor (e.g. over a passageway) or a semi-exposed floor (e.g. over an integral garage) or not a heat loss floor (flats/maisonettes).

If it is a basement it is treated as if it were a ground floor for heat loss purposes.

S3.7 Heat loss floor area for houses and bungalows

The area of the lowest occupied floor is a ground floor. If the area of an upper floor is greater than that of the floor below, the difference in these areas is an exposed or semi-exposed floor. Semi exposed floors are treated as if they were fully exposed.

The ground floor area of the main dwelling and that of any extension are treated separately as they can have different U-values.

S3.8 Heat loss floor area for flats and maisonettes

There is no heat loss through the floor if below it there is another dwelling or other premises that are normally heated. The floor area of the flat, or the lower floor of the maisonette, is an exposed or semi-exposed floor if there is an open space or unheated premises below it. Semi exposed floors are treated as if they were fully exposed.

S3.9 Semi-exposed walls for flats and maisonettes

If the flat or maisonette is adjacent to an unheated corridor or stairwell, the area of wall between the dwelling and the corridor or stairwell is treated as a semi-exposed wall. Semi exposed walls in houses and bungalows are treated as if they were fully exposed.

S4 Parameters for ventilation rate

The parameters for calculation of the ventilation rate are obtained from Table S5.

Table S5 : Ventilation parameters

Parameter	Value
Chimneys	Number of open fireplaces
Flues	Number of open flues (main and secondary heating systems)
Ventilation system	Natural with intermittent extract fans, unless mechanical system clearly identified
Extract fans	Age bands A to E all cases 0
	Age bands F to G all cases 1
	Age bands H to J up to 2 rooms 1
	" 3 to 5 rooms 2
	" 6 to 8 rooms 3
" more than 8 rooms 4	
Wall infiltration	According to wall type, system build treated as masonry
Floor infiltration (suspended timber floor only)	Age bands A to E: unsealed Age bands F to J: sealed
Draught lobby	House or bungalow: no Flat or maisonette: yes if heated or unheated corridor
Percent of doors and windows draughtstripped	Percentage of double glazing (Doors not draughtstripped)
Number of storeys	Greater of the number of storeys in the main part of the dwelling and in any extension
Sheltered sides	4 for flat/maisonette up to third storey above ground level 2 in other cases
Age bands in this table relate to the age of the main dwelling and not to any extension The number of rooms is as defined in S9	

S5 Constructional types and U-values

U-values of construction elements are determined from the constructional type and date of construction. U-values are assessed separately for the main part of the dwelling and for any extension. If the insulation status is unknown, the relevant value for "as built" is used.

S5.1 U-values of walls

Table S6 : Wall U-values

Age band	A	B	C	D	E	F	G	H	I	J
Wall type										
Solid (1) (as built)	2.1	2.1	2.1	2.1	1.7	1.0	0.60	0.45	0.45	0.28
Stone/solid brick (external insulation)	0.60	0.60	0.60	0.60	0.55	0.45*	0.35*	0.30*	0.30*	0.21*
Stone/solid brick (internal insulation)	0.60	0.60	0.60	0.60	0.55	0.45*	0.35*	0.30*	0.30*	0.21*
Cavity (as built)	2.1	1.6	1.6	1.6	1.5	1.0	0.60	0.45	0.45	0.28
Filled cavity	0.50	0.50	0.50	0.50	0.50	0.40	0.35	0.45 [†]	0.45 [†]	0.28 [†]
Timber frame (as built)	2.5	1.9	1.9	1.0	0.80	0.45	0.40	0.40	0.40	0.28
System build (as built)	2.0	2.0	2.0	2.0	1.7	1.0	0.60	0.45	0.45	0.28
System build (external insulation)	0.60	0.60	0.60	0.60	0.55	0.45	0.35*	0.30*	0.30*	0.21*

System build (internal insulation)	0.60	0.60	0.60	0.60	0.55	0.45	0.35*	0.30*	0.30*	0.21*
---------------------------------------	------	------	------	------	------	------	-------	-------	-------	-------

(1) "Solid" includes solid stone, solid concrete, solid brick and hollowblock

* wall may have had internal or external insulation when originally built; this applies only if insulation is known to have been increased subsequently (otherwise "as built" applies)

† assumed as built

S5.2 U-values of semi-exposed walls

For semi-exposed walls of flats and maisonettes, the U-value for the applicable wall area is taken as that of the external walls of the dwelling adjusted as described in Section 3.3 using $R_u = 0.4 \text{ m}^2\text{K/W}$.

S5.3 U-values of roofs

The U-value assumed for a pitched roof with an insulated ceiling should, where possible, be based on the observed thickness of the loft insulation according to Table S7.

Table S7 : Roof U-values when loft insulation thickness is known

Insulation thickness (mm)	Assumed roof U-value (W/m ² K)
None	2.3
12	1.5
25	1.0
50	0.68
75	0.50
100	0.40
150	0.29
200	0.20
250	0.16
>= 300	0.13

Note: These U-values take account of joists. The insulation is taken as being between joists only up to 150 mm, and between and over joists for 200 mm or more.

If the insulation thickness is not known, the U-value should be taken from Table S8.

Table S8 : Assumed U-values when the roof insulation thickness is unknown

Age band	Assumed Roof U-value (W/m ² K)			
	Pitched, insulation between joists	Pitched, insulation between rafters	Flat roof	Room-in-roof
A, B, C, D, E	2.3 (none)	2.3	2.3	2.3
E	1.5 (12 mm)	1.5	1.5	1.5
F	0.68 (50 mm)	0.68	0.68	0.80
G	0.40 (100 mm)	0.40	0.40	0.50
H	0.29 (150 mm)	0.35	0.35	0.35
I	0.26 (150 mm)	0.35	0.35	0.35
J	0.16 (250 mm)	0.20	0.22	0.22

Note: These U-values take account of joists. They may differ from Elemental U-values in regulations applicable at the time of construction, where the Elemental U-values were set on the basis of ignoring joists in U-value calculations.

S5.4 U-values of floors next to the ground

The floor U-value is calculated according to I.S. EN ISO 13370 using its area and exposed perimeter, and rounded to two decimal places. The following parameters are used:

- wall thickness from Table S3
- soil type: default (thermal conductivity 2.0 W/m·K)
- $R_{si} = 0.17 \text{ m}^2\text{K/W}$
- $R_{se} = 0.04 \text{ m}^2\text{K/W}$
- floor type from Table S9
- all-over floor insulation of thickness from Table S9 with thermal conductivity 0.035 W/m·K

For suspended floors:

- height above external ground level 0.3 m
- average wind speed at 10 m height 5 m/s
- wind shielding factor 0.05
- ventilation openings per m exposed perimeter 0.003 m²/m
- U-value of walls to underfloor space 1.5 W/m²K

A non-separated conservatory has an uninsulated solid ground floor.

Table S9 : Basis for floor U-value calculation

Age band	Floor type	All-over floor insulation
A, B	suspended, unsealed	none
C to E	solid	none
F or G	solid	12 mm
H or I	solid	50 mm
J	solid	100 mm

S5.5 U-values of exposed and semi-exposed upper floors

To simplify data collection no distinction is made in terms of U-value between an exposed floor (to outside air below) and a semi-exposed floor (to an enclosed but unheated space below) and the U-values in Table S10 are used.

Table S10 : Exposed/Semi-exposed floor U-values

Age band	U-value (W/m ² K)
A to E	1.20
F or G	0.80
H	0.55
I	0.45
J	0.25

S5.6 U-value of floor above a partially heated space

The U-value of a floor above partially heated premises is taken as 1.0 W/m²K. This applies typically for a flat above non-domestic premises that are not heated to the same extent or duration as the flat.

S5.7 Allowance for thermal bridging

The thermal bridging factor, y , as defined in Appendix K is taken from Table S11.

Table S11 : Thermal bridging

Age band	Thermal bridging factor y (W/m ² K)
A to I	0.15
J	0.11

S6 Non-separated conservatory

The floor area and volume of a non-separated conservatory are added to the total floor area and volume of the dwelling. Its roof area is taken as the same as its floor area, and wall area is taken as the product of its exposed perimeter and its height. Its height can be estimated from the equivalent number of storey heights of the dwelling to the nearest half storey. The conservatory walls and roof are taken as fully glazed (and this glazed area applied in addition to that from Table S4). Glazed walls are taken as windows, glazed roof as rooflight.

S7 Solar gains

Solar gains are calculated for average overshadowing (Table 6d) and for East/West orientation of all windows. A conservatory roof is taken as horizontal for the purposes of Table 6a.

S8 Window U-values and g-values

The U-value of windows and the solar transmittance of glazing is taken from Table S12.

Table S12 : Window characteristics

Glazing	Installed	Frame (for Table 6c)	U-value	g-value
Single	any	wood frame	4.8	0.85
Double	Before 2004	PVC frame	3.1	0.76
Double	2004 or later	PVC frame	2.0	0.72

Table S13 applies to a non-separated conservatory.

Table S13 : Non-separated conservatory

Glazing	Age band	Frame (for Table 6c)	Window U-value	Roof U-value	g-value
Single	any	wood frame	4.8	5.1	0.85
Double	any	PVC frame	3.1	3.3	0.76

S9 Living area fraction and heat capacity

The room count is based on the number of habitable rooms, which include any living room, sitting room, dining room, bedroom, study and similar; and also a non-separated conservatory.

Excluded from the room count are any kitchen, utility room, bathroom, cloakroom, en-suite accommodation and similar; any hallway, stairs or landing; and also any room not having a window.

For open plan dwellings count all spaces thermally connected to the main living area (e.g. a living/dining room) as one room.

The living area fraction is determined from the number of habitable rooms.

Table S14 : Living area fraction

Number of rooms:	1	2	3	4	5	6	7	8
Living area fraction:	0.75	0.50	0.30	0.25	0.21	0.18	0.16	0.14
Number of rooms:	9	10	11	12	13	14	15+	
Living area fraction:	0.13	0.12	0.11	0.10	0.10	0.09	0.09	

The default value of internal heat capacity is "Medium". However, if it can be seen that the heat capacity of the dwelling is significantly different from this, the category may be determined as in a full DEAP calculation.

S10 Space and water heating

Space and water heating systems and their controls are those defined in Tables 4a, 4b and 4e (less some specific systems which will be defined separately). Parameters not included in the data collection (Table S17) are defined in Table S15 and Table S16.

Table S15 : Cylinder size

Descriptor	Indicative size range	Size to be used in DEAP calculation
Inaccessible		Off-peak electric dual immersion: 210 litres From solid fuel boiler: 160 litres Otherwise: 110 litres
Normal	90 – 130 litres	110 litres
Medium	131 – 170 litres	160 litres
Large	> 170 litres	210 litres

Table S16 : Heating and hot water parameters

Note: If improvement measures related to any of the following parameters are to be recommended, actual details for the dwelling being assessed should be determined, and used in preference to the tabulated details below.

Parameter	Value
Hot water cylinder insulation if not accessible	Age bands A to G: none Age band H: 25 mm foam Age bands I or J: 35 mm foam
Insulation of primary pipework	No
Space heating circulation pump for wet systems	Within heated space
Hot water separately timed	Age bands A to I: no Age band J: yes
Hot water cylinder in heated space	Yes
Boiler interlock	Assumed present if there is a room thermostat and (for stored hot water systems) a cylinder thermostat. Otherwise not present

Solar panel	<p>If present, the parameters for the calculation are:</p> <ul style="list-style-type: none"> - panel aperture area 3 m² - flat panel, $\eta_0 = 0.75$, $a_1 = 6.0$ - facing South, pitch 30°, modest overshadowing - combined cylinder, solar part one-third of total, or if a combi boiler the cylinder identified is a dedicated solar cylinder - pump is not solar powered
Photovoltaics	<p>If present, the parameters for the calculation are:</p> <ul style="list-style-type: none"> - PV area is roof area for heat loss, times percent of roof area covered by PVs, and if pitched roof divided by $\cos(35^\circ)$ - kWp is 0.06 x PV area. - facing South, pitch 30°, modest overshadowing
Community heating scheme	<p>If details cannot be ascertained they are defaulted to: system based on mains gas-fired boiler, efficiency 80% piping installed before 1990, pre-insulated flat-rate charging</p> <p>If CHP and details cannot be ascertained they are defaulted to:</p> <ul style="list-style-type: none"> fraction of heat from CHP = 0.30 CHP overall efficiency 75% heat to power ratio = 2.0

S11 Improvement measures

The effect of improvement measures can be assessed by amending the data for the existing dwelling according to the improvement measure being considered. When a number of measures are being considered, the effect of any one of them on the DEAP results depends, in general, on the order in which they are introduced. A standard list of improvement measures and how their effect on energy performance is to be assessed will be published separately.

In most cases, an improvement measure is assessed by adjusting the values within the reduced data set. For increased loft insulation, for example, the calculation would be re-done with a different roof U-value taken from Table S7 according to the proposed new thickness of the loft insulation. For some cases involving new technology, appropriate data may be added in future via the Appendix Q procedure.

S12 Minimum data to be collected

Table S17 : Data to be collected

Item	Data	Comment
Built form and detachment	Classification according to S1.	
Age band	According to S2.	Identify age band separately for: – main property – any extension – any rooms in roof
Number of rooms	Number of habitable rooms If half or more of those rooms are not heated, the number of heated habitable rooms	Total as defined in S9, inclusive of main property and any extension. A heated room is one with a heat emitter in the room.

Item	Data	Comment
Dimension type	Measured internally or externally	Applies to areas and perimeters. Room heights always measured internally within the room. See S3.
Dimensions	Area, average room height and exposed perimeter for each floor	Measured separately for main property and any extension For rooms-in-roof, measure floor area only, inside the dwelling
Non-separated conservatory.	Floor area Glazed perimeter Double glazed (yes/no) Height (number of half storeys of main dwelling)	See section 3.3.3. A separated conservatory is to be disregarded.
Flats and maisonettes	Corridor, one of: - no corridor - heated corridor - unheated corridor	Refers to entrance to the flat
	If unheated corridor, length of sheltered wall	The length of wall between flat and corridor
	Floor level (0 for ground floor) and number of floors in block	The lowest floor level of a maisonette
	Floor is one of: - above heated space - above partially heated space - above unheated space or fully exposed	A heated space below applies when it is above another flat. A partially heated space below applies when it is above non-domestic premises. An unheated space below applies when it is above a space not used for habitation. Where the flat is above more than one type, it is classified according to the largest floor area concerned.
Wall construction	One of: - solid (brick, concrete, stone, or hollowblock) - cavity - timber frame - system build (i.e. any other)	Recorded separately for main dwelling and any extension.
Wall insulation	One of: - external - filled cavity - internal - as built - unknown	Recorded separately for main dwelling and any extension. External, cavity or internal insulation to be indicated only if added subsequent to original construction. If it has only the insulation that was part of the original construction it is "as built".

Item	Data	Comment
Alternative wall construction (if present)	<ul style="list-style-type: none"> - Location - construction (as preceding item) - insulation (as preceding item) - net area of alternative wall 	Location identifies whether part of main wall or an extension wall
Roof construction	One of: <ul style="list-style-type: none"> - pitched - flat - another dwelling above 	Recorded separately for main dwelling and any extension
Roof insulation (if not another dwelling above)	One of: <ul style="list-style-type: none"> - rafters - joists - no access 	Recorded separately for main dwelling and any extension
Roof insulation thickness	One of: <ul style="list-style-type: none"> - none, 12, 25, 50, 75, 100, 150, 200, 250, ≥ 300 mm, don't know 	For roof insulation at joist level and where can be accessed. Recorded separately for main dwelling and any extension
Windows (of the dwelling only, not including any conservatory)	Area: one of <ul style="list-style-type: none"> - typical - less than typical - more than typical - much more than typical 	"Typical" refers to normal construction for the property type. If assessed as much more than typical the area of each window should be measured.
	Proportion double glazed	As percentage
	Double glazing installed, one of: <ul style="list-style-type: none"> - pre year xxxx - during or post year xxxx - don't know 	xxxx is: <ul style="list-style-type: none"> - 2002 in England & Wales - 2003 in Scotland - 2006 in Northern Ireland
Fireplaces	Number of open fireplaces	
Main heating system	Fuel for main heating	
	Boiler identification if possible, otherwise system according to Table 4a/4b ^(a)	If boiler can be identified, its characteristics are obtained via the HARP database
	Heat emitter type, one of <ul style="list-style-type: none"> - radiators - underfloor - other 	If underfloor, is the floor a heat loss element?
Main heating controls	Item from Table 4e ^(a) according to main system type	
Secondary heating system	Fuel for secondary heating, and system from room heater section of Table 4a ^(a)	"None" if no secondary heating system
Water heating	Either <ul style="list-style-type: none"> - from main heating system, or - from secondary system, or - item from hot-water-only section of Table 4a ^(a) 	

Item	Data	Comment
	Cylinder size, one of: - no cylinder - no access - normal (90-130 litres) - medium (131-170 litres) - large (> 170 litres)	
	Cylinder insulation type, one of - no access - none - jacket - spray foam	
	Cylinder insulation thickness, one of: 0, 12, 25, 38, 50, 80, 100, 150 mm	
	If immersion, whether single or dual	
	Cylinderstat (yes/no)	
Mechanical ventilation	yes/no, and if yes whether heat recovery	Applies to whole house balanced ventilation system only. Otherwise natural ventilation is assumed. Intermittent extract fans (kitchen and bathrooms) are not a mechanical ventilation system for DEAP calculations.
Mains gas available	yes/no	Can be relevant to improvement recommendations
Solar water heating	Solar panel (yes/no)	
Photovoltaic array	yes/no, and if yes the % of external roof area with PVs	
Low energy lighting	Percentage of fixed outlets	
^(a) A few heating systems and controls will be omitted, this will be published separately		

Appendix T: DEAP Calculation Procedure (Version 1)

Introduction

The DEAP calculation procedure is described below. It refers to the set of DEAP tables (Ref. Appendix E2 of the Invitation to Tender). It does not state how input values should be determined; this is described in the main DEAP document. The procedure is implemented in the 'Deap.xls' workbook (Reference Appendix E1 of the Invitation to Tender).

In this document, units are shown within square brackets, e.g. [m²]. A dimensionless number is indicated by [-].

Symbols (including abbreviations) used in equations are explained as they arise in the procedure. The explanation of a symbol used in an equation will be found either

- (a) immediately following the equation, or if not here,
- (b) previously in that section, or if not here,
- (c) previously in this document.

Dwelling dimensions

The total floor area, Tfa, is calculated from

$$Tfa = \sum_s A_s$$

where A_s = floor area on storey s.

The dwelling volume, Vol, is calculated from

$$Vol = \sum_s (A_s * h_s)$$

where ' h_s ' = average room height on storey s.

Ventilation

The infiltration due to openings, 'InfiltOpe', in air changes per hour [ac/h], is calculated from

$$InfiltOpe = (NumChim * 40 + NumFlue * 20 + NumFan * 10 + NumFire * 40) / Vol + VentDoor$$

where

NumChim is the number of chimneys;

NumFlue is the number of flues;

NumFan is the number of fans and passive vents;

NumFire is the number of flueless gas fires;

VentDoor is the ventilation associated with the main entrance to the dwelling [ac/h]: 0 if it opens to an indoor common area, 0.05 otherwise;

Vol is in m³.

If a pressurisation test has been done, the infiltration due to the structure, InfilStruct [ac/h], is given by

$$InfilStruct = Q50 / 20 \text{ [ac/h]}$$

where

Q50 = measured leakage rate at a pressure difference of 50 Pa [ac/h].

Otherwise, the infiltration due to the structure is given by

$$InfilStruct = (NumStoreys - 1) * 0.1 + InfStruc + InfFloor + (0.25 - 0.2 * Dsp)$$

where

NumStoreys = number of storeys

InfStruc = infiltration due to the structure type: 0.35 for masonry, 0.30 for timber- or steel-frame [ac/h]

InfFloor = infiltration due to the ground floor type: 0.2 for suspended timber unsealed, 0.1 for suspended timber sealed, 0 otherwise [ac/h]
 Dsp = proportion of windows and doors draughtstripped [-].

The overall infiltration rate, Infiltration, is then given by

$$\text{InfiltrationRate} = (\text{InfiltrationOpen} + \text{InfiltrationStruct}) * (1 - \text{NumShelt} * 0.075)$$

where
 NumShelt = number of sides sheltered

The ventilation rate, VentRate [ac/h], is then determined as follows, depending on the ventilation method.

(a) Natural ventilation

If InfiltrationRate > 1 ac/h,

$$\text{VentRate} = \text{InfiltrationRate}$$

Otherwise

$$\text{VentRate} = 0.5 * (1 + \text{InfiltrationRate}^2)$$

(b) Positive input ventilation from loft

$$\text{VentRate} = \text{InfiltrationRate} + 20 / \text{Vol}$$

(c) Positive input ventilation from outside

$$\text{VentRate} = \text{Max}(\text{InfiltrationRate} + 0.25, 0.5)$$

(d) Whole-house extract ventilation

Same as positive input ventilation from outside.

(e) Balanced whole-house mechanical ventilation, no heat recovery

$$\text{VentRate} = \text{InfiltrationRate} + 0.5$$

(f) Balanced whole-house mechanical ventilation with heat recovery

$$\text{VentRate} = \text{InfiltrationRate} + 0.17$$

For the mechanical ventilation methods above, the annual electricity consumption of fans, VentElec [kWh/y], is determined from Table 4f, and the average heat gains from fans (if any) is determined from Table 5.

Fabric heat loss

The heat loss through plane elements of the building fabric, Hplane [W/K], is determined by summing the product of U-value and area over all heat loss elements (roofs, external walls, ground and exposed floors, windows and doors).

$$H_{\text{plane}} = \sum (U * A)$$

For windows, the U-value adjustments given in the notes following Table 6 should be applied.

The additional heat loss due to thermal bridging, Htb [W/K], is determined as described in Appendix K of the main DEAP document. The fabric heat loss coefficient, Hfab [W/K], is then given by

$$H_{\text{fab}} = H_{\text{plane}} + H_{\text{tb}}$$

The ventilation heat loss coefficient, Hvent [W/K] is given by

$$H_{\text{vent}} = 0.33 * \text{VentRate} * \text{Vol}$$

where VentRate and Vol are as defined above.

The dwelling's heat loss coefficient, Hlc [W/K] is then given by

$$H_{\text{lc}} = H_{\text{fab}} + H_{\text{vent}}$$

Solar gains

For DEAP calculations, the heating season runs from October to May inclusive (8 months). Passive solar heat gain via glazed openings is calculated for each month of the heating season.

The effective collecting area of a glazed opening, A_s , is

$$A_s = A * F_s * F_f * g_{\perp} * 0.9$$

where

A is the overall area of the glazed element (e.g. window area) including frame;

F_s is the shading correction factor;

F_f is the frame factor (ratio of transparent area to overall area);

g_{\perp} is the total solar energy transmittance factor of the glazing at normal incidence (see Table 6b);

0.9 is a factor representing the ratio of typical average transmittance to that at normal incidence.

For a given month, solar gains for the dwelling are calculated from

$$Q_S = \sum_j \left[I_{sj} \sum_n A_{snj} \right]$$

where

I_{sj} is the solar radiation on an unshaded surface of orientation j , from Table 1.

The first sum is over all orientations, j , and the second sum is over all glazed openings, n , with orientation j .

Lighting

The lighting calculation is specified in Appendix L of the main DEAP document, and is not repeated here. The main outputs are the annual electricity use for lighting in the dwelling, EnerLight [kWh/y], and the average rate of internal heat gain from lighting during the heating season, GainLight [W].

Water heating

The standardised number of occupants in the dwelling, N , is given by

$$N = 0.033 * Tfa - 0.000036 * Tfa^2, \text{ if } Tfa \leq 333$$

$$N = 7 \text{ if } Tfa > 333$$

where Tfa is the total floor area [m²]

The daily hot water usage, V_d [litres/day] is

$$V_d = 26 * N + 28$$

This represents the volume of water leaving the cylinder at 60°C (i.e. it includes distribution loss), and its energy content, E_d [kWh/y] is given by

$$E_d = V_d * 21.3$$

The energy content of hot water usage, $WhUsage$ [kWh/y], is

$$WhUsage = E_d * 0.85$$

1 DISTRIBUTION LOSS

If distribution loss is applicable, the distribution loss, $DistLoss$ [kWh/y], is

$$DistLoss = E_d * 0.15$$

2 STORAGE LOSS

If hot water storage loss, $StorLoss$ [kWh/y], is applicable, it may be determined based on either (a) a manufacturer's declared loss factor, or (b) a calculated value.

(a)

$$StorLoss = L_m * F_t * 365$$

where

Lm is manufacturer's declared loss factor [kWh/day];
 Ft is a Temperature Factor, from Table 2.

(b)

$$\text{StorLoss} = Vc * Lc * Fv * Ft * 365$$

where

Vc is the cylinder volume [litres], including any solar storage within same cylinder;

Lc is the calculated cylinder loss factor [kWh/(litre day)] (see below);

Fv is a Volume Factor, given by

$$Fv = (120 / Vc)^{1/3}$$

Ft is as above.

If the cylinder is insulated with a loose jacket,

$$Lc = 0.005 + 1.76 / (t + 12.8)$$

If the cylinder has factory-applied insulation,

$$Lc = 0.005 + 0.55 / (t + 4.0)$$

where

t is the insulation thickness [mm]

3 SOLAR WATER HEATING

If there is a solar water heating system, the calculation of solar input, WhSolar [kWh/y], to the domestic hot water requirement is specified in Appendix H of the main DEAP document, and is not repeated here.

If the hot water cylinder contains dedicated solar storage, the storage loss calculated above is adjusted as follows.

$$\text{Storloss_adjusted} = \text{Storloss_unadjusted} * (Vc - Vs) / Vc$$

where Vs is the dedicated solar storage volume within the cylinder.

The resulting storage loss, unadjusted or adjusted as applicable, is referred to simply as 'StorLoss' below.

4 PRIMARY CIRCUIT LOSS

The primary circuit loss is obtained from Table 3. This is adjusted for occupancy as follows.

$$\text{PrimLoss} = \text{PrimLossTab} * 0.5 * (1 + N / 4)$$

where

PrimLossTab is the value obtained from the table [kWh/y];

PrimLoss is the adjusted value [kWh/y].

5 COMBI LOSS

If the hot water is heated by a combi boiler, the additional loss, CombiLoss [kWh/y] is obtained from Table 3a.

6 WATER HEATING REQUIREMENT

With some solid fuel water heaters, electric immersion heating must be specified for the summer months.

Case (a): No supplementary electric water heating

The output from the water heater is

$$\text{WhReq} = \text{WhUsage} + \text{DistLoss} + \text{StorLoss} + \text{PrimLoss} + \text{CombiLoss} - \text{WhSolar}$$

Case (b) Supplementary electric water heating in summer

If supplementary electric heating is required, it is assumed that it is required for the summer season – 33% of the year. If there is a solar system, it is assumed that 50% of the solar input occurs during this summer season, and the remainder during the heating season. Hence the heating requirement from the main heater is

$$\text{WhReq} = 0.67 * (\text{WhUsage} + \text{DistLoss} + \text{StorLoss} + \text{PrimLoss} + \text{CombiLoss}) - 0.5 * \text{WhSolar}$$

The supplementary electric heating required is given by

$$\text{WhReqtSup} = 0.33 * (\text{WhUsage} + \text{DistLoss} + \text{StorLoss}) - 0.5 * \text{WhSolar}$$

If this result is negative, it is set equal to zero.

7 GAINS

The use of supplementary electric heating in summer will not affect heat gains during the heating season. The heat gains to the dwelling during the heating season, GainWh [W], are

$$\text{GainWh} = \{0.9 * \text{StorLoss} + 0.8 * (\text{DistLoss} + \text{PrimiLoss}) + 0.15 * (\text{WhUsage} + \text{CombiLoss})\} / 8.76$$

where division by 8.76 converts from kWh/y to W.

Internal gains

The average rate of heat gain from internal sources during the heating season, Qi [W], is calculated as follows:

$$Q_i = \text{GainLight} + \text{GainWh} + \text{GainMetab} + \text{GainApp} + \text{GainVent} - \text{LossCw}$$

where

GainLight is the average rate of heat gain from lighting, referenced above;

GainWh is the heat gain from water heating, calculated above;

GainMetab is the sensible heat gain from people (metabolism), given by

$$\text{GainMetab} = 50 * N \text{ [W]}$$

GainApp is the heat gain from appliances and cooking, given by

$$\text{GainApp} = 37 + 1.2 * T_{fa} + 19 * N \text{ [W]}$$

GainVent is the heat gain from mechanical ventilation fans, as specified above;

LossCw is the heat loss to the cold water network, given by

$$\text{LossCw} = 14 + 9 * N \text{ [W]}$$

Qi is assumed to be constant for all months of the heating season.

Heat use

Intermittent heating with the following schedule is used.

Weekdays (Mon – Fri): 07.00 to 09.00 and 17.00 to 23.00

Weekends (Sat – Sun): 07.00 to 23.00

The required (set-point) internal temperatures during heating periods are:

Living area: 20°C

Rest of dwelling: 17°C

The mean internal temperature of the dwelling during heating hours, Tih, is determined as follows.

$$T_{ih} = F * T_1 + (1 - F) * T_2$$

where

F is the living area fraction;

T1 is the temperature in living area during heating hours;

T2 is the temperature in rest of dwelling during heating hours.

1 UTILISATION FACTOR CALCULATION

The internal heat capacity of the dwelling for the utilisation factor calculation, C, is determined by multiplying the value per unit floor area from Table 11 by the floor area. The time constant of the dwelling, τ , is then given by

$$\tau = C / H_{lc}$$

where

Hlc is the dwelling's heat loss coefficient calculated previously.

Parameter 'a' [-] for the utilisation factor calculation is then given by

$$a = a_0 + \tau / \tau_0$$

where

a_0 is a constant equal to 1;

τ_0 is a constant equal to 25.

Parameter 'a' is used in the heat use calculation below to calculate monthly utilisation factors.

2 INTERMITTENT HEATING CALCULATION

The mean internal temperature for the dwelling, in the absence of gains, is calculated as follows.

The internal heat capacity of the dwelling for the intermittent heating calculation, C , is determined by multiplying the value per unit floor area from Table 11 by the floor area. The time constant of the dwelling is then given by

$$\tau = C / Hlc$$

Note that the value of C for the intermittent heating calculation, and the consequent value of τ , are different to those for the utilisation factor calculation.

The heat loss from the dwelling during one unheated period, Q_1 , is given by

$$Q_1 = C * (T_{ih} - T_e) * (1 - \exp(-t / \tau))$$

where

T_e is the mean external temperature for the month under consideration, from Table 1.

t is the duration of the unheated period.

The constant value of mean internal temperature during an unheated period, T_{m1} , that would give this heat loss is calculated from

$$T_{m1} = T_e + Q_1 * (hlc * t)$$

The mean internal temperature for the dwelling across the full weekly heating schedule, T_m , is obtained by calculating the time-weighted average of mean internal temperatures during heated and unheated periods as follows.

$$T_m = (T_{m1} * 8 * Num + T_{ih} * (168 - 8 * Num)) / 168$$

where

8 is the duration of one unheated period in hours;

Num is the number of such unheated periods per week;

168 is the number of hours per week.

A temperature factor F_t is then calculated as follows.

$$F_t = (T_m - T_e) / (T_{ih} - T_e)$$

F_t must be between 0 and 1. In subsequent parts of the procedure, F_t will be used to conveniently calculate the value of T_m from known values of T_{ih} and T_e .

3 MONTHLY HEAT USE

For each month, the following calculations are performed.

The average rate of heat gains, Q_g [W] are calculated from

$$Q_g = Q_i + Q_s$$

where Q_i and Q_s are the average rates of internal and solar heat gain as calculated above.

The adjusted internal temperature (adjusted for intermittency) is determined from

$$T_i = T_e + F_t * (T_{ih} - T_e)$$

where T_e , F_t and T_{ih} are as specified above.

The average rate of heat loss from the dwelling, Q_L [W], is given by

$$Q_L = Hlc * (T_i - T_e)$$

If Q_L is negative, it is set to zero, and subsequent steps are adjusted accordingly to give a heat use of zero for this month.

The gain/loss ratio, γ [-], is given by

$$\gamma = Q_g / Q_L$$

The utilisation factor, η [-] is given by

$$\text{If } \gamma \neq 1, \eta = (1 - \gamma^a) / (1 - \gamma^{a+1})$$

$$\text{If } \gamma = 1, \eta = a / (a + 1)$$

where parameter 'a' is as calculated above.

The average rate of heat use is then given by

$$Q_h = Q_L - \eta * Q_g$$

The annual heat use is then obtained by converting Q_h from units of power to units of energy, i.e. from watts to kilowatt-hours per month, and summing across all months between October and May inclusive (the standardised heating season).

$$\text{HeatUse} = \sum_{m=\text{Oct}}^{\text{May}} [(Q_h / 1000) * 24 * N_d]$$

where N_d is the number of days in the month; (28 days are used for February).

Space heating system

1 CONTROL AND RESPONSIVENESS

The adjusted internal temperature is re-calculated, this time taking account of the responsiveness and control characteristics of the real heating system. Quantities referring to the real, as opposed to ideal, heating system are distinguished where required with a prime (e.g. T_{ih} and T_{ih}').

The mean internal temperature of the dwelling during heating hours, T_{ih}' , is determined as follows.

$$T_{ih}' = F * (T_1 + \Delta T_1) + (1 - F) * (T_2 + \Delta T_2)$$

where

F , T_1 and T_2 are as specified in the heat use section above;

ΔT_1 is a temperature adjustment to the living-area temperature from Table 4e

ΔT_2 is a temperature adjustment to the rest-of-dwelling-area temperature as follows, dependent on control category from Table 4e

Control category	ΔT_2 [°C]
1	1.2
2	0.5
3	0

The responsiveness category of the heating system, RespCat (a number between 1 and 5) is taken from Table 4a or 4d (or determined using Appendix N for micro-CHP). The responsiveness factor, R [-], is determined from

$$R = (\text{RespCat} - 1) * 0.2$$

The background temperature, T_b , is given by

$$T_b = T_e + (T_{ih}' - T_e) * R$$

The value of T_e (mean external temperature) used here is the average for the heating season from Table 1. The value of F_t used here is the same as that in the heat use section).

The adjusted internal temperature of the dwelling with the real heating system is then given by

$$T_{i'} = T_b + F_t * (T_{ih}' - T_b)$$

The additional heat emission to the heated space due to less-than-perfect responsiveness and control, ΔE_c [kWh/y] is then given by

$$\Delta E_c = (T_{i'} - T_{ih}) * H_{lc} * (24 * H_s \text{Days} / 1000)$$

where $H_s \text{Days}$ is the heating season length in days (243 days)

The gross heat emission to the heated space, E_g , is then given by

$$E_{gross} = Heat_{use} + \Delta E_c$$

2 HEATING SYSTEM PUMPS/FANS

The heat gains from heating system pumps/fans, $Gain_{Pf}$ [W], where applicable are taken from Table 5a.

The net heat emission to the heated space, E_{net} [kWh/y] (net of useful gains from pumps/fans) is given by

$$E_{net} = E_{gross} - \eta * (Gain_{Pf} * (24 * H_sDays / 1000))$$

where η is the average utilisation factor for gains – the straight average of monthly values across the heating season as calculated in the heat use section above.

3 EMISSION EFFICIENCY

If the main heat emission system is within an envelope element (e.g. underfloor heating in ground floor), the additional heat loss via the envelope element is given by

$$\Delta E_e = (R_i / (1 / U_e)) * E_{net}$$

where

R_i represents the thermal resistance between the heating element and the internal environment, here taken as 0.1 m² K/W;

U_e is the U-value of the envelope element.

The space heat requirement, Sh_{Req} [kWh/y], e.g. the heat required from the boiler, is then given by

$$Sh_{Req} = E_{net} + \Delta E_e$$

Energy requirement – individual heating system

If the dwelling has its own individual heating system, the calculations described in this section are carried out. If it is heated by a group/community heating scheme, the calculations in the next section are carried out instead.

The efficiency of the main space heating system, η_{sh} [-], is taken from the Irish Boiler Database or Table 4a or 4b, and adjusted as specified in Table 4c if required.

The fraction of heat supplied by the secondary heater, $SecFrac$ [-], is taken from Table 7 or 10 or Appendix F; (the fraction will be zero if no such system is specified). If a secondary heater is specified, its efficiency, η_{shsec} [-], is taken from Table 4a or Appendix E.

The main and secondary space heating fuel requirements are then given by

$$Sh_{FuelMain} = (1 - SecFrac) * Sh_{Req} / \eta_{sh}$$

$$Sh_{FuelSec} = SecFrac * E_{gross} / \eta_{shsec}$$

(Note: the use of 'E_{gross}' in the 'Sh_{FuelSup}' formula comes from the assumption that the effect of control and responsiveness of the secondary heater is the same as that of the main system).

The efficiency of the main water heating system, η_{wh} [-], is taken from the Irish Boiler Database or Table 4a or 4b, and adjusted as specified in Table 4c if required.

The main and supplementary water heating fuel requirements are then given by

$$Wh_{Fuel} = Wh_{Req} / \eta_{wh}$$

$$Wh_{FuelSup} = Wh_{ReqSup}$$

where Wh_{Req} and Wh_{ReqSup} come from the water heating section above.

Note: for supplementary water heating, the efficiency of electric immersion heating is always 100%.

1 PUMPS/FANS

The electricity for pumps and fans and electric keep-hot facility, EnerPumpFan [kWh/y], where applicable, is obtained from Table 4f.

2 RENEWABLE AND ENERGY-SAVING TECHNOLOGIES

If applicable, the contribution of such technologies, RestProd [kWh/y], and the energy they consume, RestCons [kWh/y], are calculated as referenced in Appendix Q of the main DEAP document.

3 FUELS

The annual energy delivered to the dwelling for the end-uses considered, EnerDeliv [kWh/y] is given by

$$\text{EnerDeliv} = \text{ShFuelMain} + \text{ShFuelSec} + \text{WhFuel} + \text{WhFuelSup} + \text{EnerPumpFan} + \text{EnerLight} + \text{RestProd} - \text{RestCons}$$

where the quantities are as specified in preceding sections of this document.

For each of the applicable end-uses, the fuel is specified by the user, and the primary energy factor, CO2 emission factor, per-unit cost and standing charge for each fuel are taken from Table 8. For electric space and water heating on a night-rate tariff, the fraction of heat supplied at the on-peak tariff, and hence the average per-unit cost, is obtained from Table 10a or 10b.

The primary energy consumption, CO2 emissions and annual cost for each end-use, are then calculated as follows.

$$\text{PrimaryEnergy} = \text{DeliveredEnergy} * \text{PrimaryEnergyFactor}$$

$$\text{Emissions} = \text{DeliveredEnergy} * \text{EmissionFactor}$$

$$\text{Cost} = \text{DeliveredEnergy} * \text{PerUnitCost} + \text{StandingCharge}$$

In calculating fuel costs, particular standing charges should not be double-counted. They are assigned to one end-use only.

The total primary energy consumption, CO2 emissions and cost are obtained by summing across end-uses as with delivered energy above. The totals are normalized by dividing by the dwelling's total floor area. These totals, both absolute and per unit floor area, are the main energy performance indicators for the dwelling output by DEAP.

Energy requirement – group heating scheme

1 SECONDARY SPACE HEATING

The secondary space heating fuel requirement, ShFuelSec [kWh/y], is calculated as described above for individual heating systems.

2 DELIVERED ENERGY FOR MAIN SPACE HEATING

The heat delivered to the dwelling from the group heating scheme, ShFuelMain [kWh/y], is given by

$$\text{ShFuelMain} = (1 - \text{SecFrac}) * \text{ShReqt} / \text{EffCh}$$

where

SecFrac and ShReqt are as specified above;

EffCh is the efficiency factor associated with the charging method: 1 for charging based on heat consumed, 0.9 for flat-rate charging.

3 PRIMARY ENERGY AND CO2 EMISSION FACTORS

The distribution loss factor is taken from Table 9. The distribution efficiency, η_d [-], is its inverse.

Heat from the group heating scheme may come from either boilers producing heat only or CHP plant producing both heat and electricity; the fraction from CHP, $ChpFrac$ [-], is entered by the user. The procedure also covers waste heat from power stations as defined in Appendix C2.

(a) Boilers

The boiler efficiency, η_b [-], is entered by the user. The primary energy and emission factors for the boiler fuel are taken from Table 8. The factors for heat delivered to the dwelling are then given by:

$$F_d = F_f / (\eta_b * \eta_d)$$

where

F_d is the factor for heat delivered to the dwelling;

F_f is the factor for the boiler fuel;

F_d and F_f may represent either primary energy or emission factors.

(b) CHP

The electrical and heat efficiencies of the CHP plant, η_e and η_h respectively [-], are entered by the user. The primary energy and CO₂ emission factors for the CHP plant fuel are taken from Table 8, as are the factors for electricity displaced from the grid. The factors for heat delivered to the dwelling are then given by

$$F_d = (F_f - \eta_e * F_e) / (\eta_h * \eta_d)$$

where

F_e is the factor for electricity displaced from the grid.

(c) Waste heat from power stations

The factors for waste heat from power stations, F_w [-] (representing either primary energy or CO₂ emission factor), are taken from Table 8. The factors for heat delivered to the dwelling are then given by

$$F_d = F_w / \eta_d$$

Where heat delivered to the dwelling comes from a combination of community heating boilers and CHP, the factors for heat delivered to the dwelling are calculated as a weighted average:

$$F_d = F_{d,chp} * ChpFrac + F_{d,b} * (1 - ChpFrac)$$

where

$F_{d,chp}$ is the factor for delivered heat from CHP (or waste heat from power stations);

$F_{d,b}$ is the factor for delivered heat from boilers.

4 WATER HEATING

The model assumes that the group heating scheme supplies water heating throughout the year as well as space heating, hence the factors for water heating are the same as those for space heating, and supplementary electric water heating in summer is not required.

5 FUELS

The remainder of the procedure for group heating schemes proceeds in a similar manner to that for individual heating systems, but using the appropriate factors/costs from Table 8 or calculated above. The delivered energy, primary energy, CO₂ emissions and cost is determined for each end-use, then summed across end-uses and normalised by floor area.