



Domestic heating sizing method



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This 'whole house' procedure provides the busy heating installer with a boiler sizing method that is fast and easy to use. It can also be used for other heat generators (such as micro-CHP or heat pumps) together with a heating system design method. Its purpose is to give a realistic estimate of the heating demand for a whole dwelling so that the boiler or other heat generator can be sized correctly. Good sizing leads to:

- Lower installed costs.
- Higher heating efficiencies.
- Lower fuel costs.
- Reduced CO₂ emissions to the environment.

The aims of this method

Replacement boilers are rarely sized correctly. Oversized boilers cost more to buy and generally operate less efficiently, leading to higher running costs and increased emissions to the atmosphere. This 'whole house' procedure provides the busy heating installer with a quick and easy but reasonably accurate way to size boilers.

This sizing method has been updated and can now deal with the improved levels of thermal insulation commonly used in both new and existing dwellings. Where possible, it follows the calculation principles used to produce Energy Performance Certificates.

It can be used for typical dwellings with gas, oil and LPG boilers. For combi boilers, the minimum size is often determined by hot water performance rather than space heating, but this method can still be used to check that a combi boiler can also meet the heating requirement. This method should not be used for a typical, very large, or unusually shaped dwellings, where more detailed methods should be used.

The method is based on a number of assumptions:

- A design internal temperature of 19.2°C (included in the location factor).
- Design external temperatures that depend on the location of the dwelling (included in the location factor).
- Losses to adjacent dwellings (party heat losses) are based on a room temperature difference of 10.6°C.
- Floor heat losses are based on both floor type and exposed perimeter of the dwelling.
- Window areas are inferred from floor area.
- An allowance of 10% for intermittent heating is included in the location factor.
- An allowance of 5% for distribution losses is included in the location factor.
- An average ventilation rate of 0.76 air changes per hour, with the facility to take account of extra heat losses due to open chimneys.
- An allowance of 2kW (3kW for larger hot water demands) for heating hot water in a separate cylinder.
- A minimum heat output of 8kW for boilers.

Sizing method update:

Where possible, this sizing guide follows the calculation principles used to produce Energy Performance Certificates. To replace the domestic heating sizing method worksheet please download sheets from energysavingtrust.org.uk/housing

Instructions

Complete sections 1 to 8 by filling in the shaded boxes from actual measurements and red-bordered boxes from the tables. The unshaded boxes should be filled by calculation. Assess the shape of the dwelling.

(i) For simple rectangular dwelling, use the worksheet alone.

(ii) For small extensions, conservatories or loft conversions heated by the boiler, use the worksheet and add on radiator outputs in section 8.

(iii) More complicated shapes should be divided into rectangular boxes and separate worksheets completed for each.

Section 1

Take internal measurements (in metres) of the overall length, width, and room height. The width is generally taken across the front of the dwelling and the length is a front-to-back measurement. Also note the type of dwelling, the number of floors (excluding any loft conversion), and the number of external walls along length and width. A 'top flat' means one where there is another flat below but not above; a 'mid flat' means one with another flat above and below; a 'bottom flat' means one with another flat above but not below.

For later use (in section 5), count the number of open fireplaces with a chimney (count 1 for each). In addition, count the number of closed but ventilated chimneys (count $\frac{1}{2}$ for each), open-fronted gas fires in a fireplace (count $\frac{1}{2}$ for each), and open-flue appliances (count $\frac{1}{2}$ for each).

Select the type of external wall by date of build, if known; otherwise by construction type (table 3).

Section 2

Calculate total external wall area (including windows) in square metres. Count the number of 'length' external walls along the length measurement and the number of 'width' walls along the width measurement; e.g. a semi-detached will have only one external wall along its length but two along its width. The wall is not regarded as external where any extensions join the main dwelling. Where there is a single-storey extension on a two-storey house then take half the wall area as external. The whole wall

is still regarded as external when it is attached to an unheated garage.

Note that the sum of the widths and lengths of external walls gives an 'exposed perimeter' value, which is used later in section 4.

Multiply the total floor area by 0.9 to give the 'maximum window area', which is used in section 3.

Section 3

First calculate the total floor area. Multiply the total floor area by the window factor for the type of property (taken from table 1) then add the window constant (taken from table 1). This gives an estimate of the window area without the need for extra measurements. If this window area is greater than the maximum window area (calculated in section 2),

use the maximum window area instead. Multiply the window area by the window U-value (taken from table 2) to calculate the window heat loss "A".

The wall heat loss "B" is calculated from the total external wall area (section 2) minus the window area, multiplied by the wall U-value taken from table 3.

Section 4

Multiply the area of the lowest floor (NOT the total floor area) by the roof U-value to calculate the roof heat loss "C". For a mid flat or bottom flat the roof heat loss will be zero.

The floor heat loss "D" depends on both the floor area and the exposed perimeter

(calculated in section 2). Divide the floor area by the exposed perimeter and use this value in table 6 to select a floor U-value depending on whether the floor is a suspended, solid, or insulated type. For a top flat or mid flat the floor heat loss will be zero.

Section 5

Using the total floor area, calculate the volume of the dwelling. Copy the number of open chimneys from section 1, counted as explained there.

Section 6

Add boxes "A", "B", "C", "D" and "E" to give a total "F". Multiply the total by the location factor from table 5 to give the overall external heat losses "G" in watts. The location factor includes an allowance for design temperatures,

intermittent heating, pipe losses, and a partial allowance for thermal bridging and inter-floor gaps.

Section 7

If adjacent properties are heated to the same standard, the heat loss through the shared building elements is usually small and can be ignored. However, there may be prolonged periods during which an adjacent property remains unheated. The party heat loss is calculated here so that it can be taken into account in the heating system design method, if required.

Detached dwellings have no party walls, so the party heat losses are zero. Semi-detached dwellings typically have one party wall, and mid-terraced dwellings normally have two

party walls. For a mid flat or bottom flat, there are also party losses through the ceiling. For a top flat or mid flat, there are also party losses through the floor.

To calculate the party heat losses, note the number of boundary walls of each length and width that are NOT external walls. Party wall, ceiling and floor U-values are given in table 7. Add boxes "H", "I", "J" and "K" to give a total then multiply by 10.6 to give the total party heat loss "L" in Watts.

Section 8

If the heat generator is a regular or system boiler (not a combi), copy the party loss from box "L" in section 7 into box "L" here and select a hot water allowance of 2000W (or 3000W if there is an unusually large hot water demand). If the heat generator is a combi boiler, copy the party loss from box "L" in section 7 into box "L" here and select a hot water allowance of zero in "M".

For any other type of heat generator (eg. micro-CHP or heat pump), refer to the relevant heating system design method to see whether party heat loss and hot water allowance should be included and fill boxes "L" and "M" accordingly. In some cases party losses may be omitted if there is a satisfactory auxiliary heating system. If no guidance is available from a relevant heating system design method then proceed as above for a regular boiler.

Copy the larger of box "L" and "M" into box "N". Copy box "G" from Section 6 into box "G" here. Copy the results from any separate worksheets for extensions, additional blocks, room-in-roof or conservatory into boxes "P" and "Q"; for other small extensions or loft conversions simply add the radiator output (in Watts) into box "P" or "Q".

Add box "N" plus "G" plus 400 (thermal bridging) plus "P" plus "Q", divide the total by 1000 and record the heat required in kW in box "T". For a boiler, a minimum size of 8kW is recommended, so enter the higher of box "T" or 8kW into box "V". This result includes all necessary factors and no further additions should be made. Choose the boiler that has a design output closest but above the calculated output; eg. if a heat output of 11.6kW is required install a 12kW unit. In the case of a combi boiler an output of at least 24kW will usually be required to provide satisfactory instantaneous water heating, so the worksheet result "V" should only be used if it is higher.

For other heat generators (eg. micro-CHP, heat pumps) the building fabric and ventilation heat loss in "G" can be used to derive a basic design heat loss (with no allowances for intermittent heating or pipe heat loss). This is useful as a starting point for heating system design procedures for other heat generators. To calculate the basic design heat loss, copy "G" and add "P", "Q", and 400 then divide the total by 1150. Record the result in box "U".

Property information

Name and address of property

Worksheet completed by

Date

1. Describe property and take three measurements (in metres)

Property type	Property location	External wall type (table 3)	Window type (table 2)
Length (m)	Room height (floor to ceiling) (m)	Roof type and insulation depth (table 4)	No. of open chimneys
Width (m)	Number of floors	Floor type and insulation depth (table 6)	

2. Calculate total external wall area (including windows) and exposed perimeter (see section 3 and section 4)

Length x No. of exterior walls = + = Exposed perimeter

Width x No. of exterior walls = Room height x No. of floors = Total external wall area

x 0.9 x = Maximum window area

3. Calculate the heat losses from windows and external walls

Length x Width = m² Area of lowest floor

Total floor area m² x No. of floors = m² Total floor area

Total floor area m² x Window factor (table 1) + and constant (table 1) = estimated window area

Total external wall area m² - Window area m² = Net wall area

x Window U-value (table 2) = Window heat loss (W/K)

x Wall U-value (table 3) = Wall heat loss (W/K)

+ = Roof heat loss (W/K)

+ = Floor heat loss (W/K)

+ = Ventilation heat loss (W/K)

4. Calculate the roof and floor heat losses

Area of lowest floor x Roof U-value table 4 = Roof heat loss (W/K)

Exposed perimeter ÷ (Use as look-up value in table 6) = Floor heat loss (W/K)

Floor U-value (table 6) x = Floor heat loss (W/K)

5. Calculate the ventilation heat loss

Total floor area x Height x 0.76 = Total flow rate

x 40 = Chimney air flow rate

+ = x 0.33 = Ventilation heat loss (W/K)

6. Sum the external surface and ventilation heat losses (see table 5)

A+B+C+D+E = F Total external loss (W/K)

x Location factor (see table 5) = G Total external loss (W)

7. Calculate any heat loss to adjacent properties (party heat losses), if required (see table 7)

Length x No. of party walls = Room height x No. of floors = Party wall heat loss (W/K)

Width x No. of party walls = Lowest floor area (section 3) x Party ceiling U-value (table 7) = Party ceiling heat loss (W/K)

Party ceiling losses are calculated for mid flats and bottom flats only. For other properties enter zero. x Party floor area (table 7) = Party floor heat loss (W/K)

Party floor losses are calculated for mid flats and top flats only. For other properties enter zero. x Party losses for extension (W/K) = Party floor heat loss (W/K)

x 10.6 = Total party losses (W)

8. Calculate required heat output (in kW) (see section 7)

Are party losses included? Party loss L

Enter yes or no Hot water allowance (2000, 3000, or 0) M

Larger of L or M Fabric and ventilation (W) + 400 + P + Q ÷ 1000 = T Heat required (KW)

Fabric and ventilation (W) G + P + Q + 400 ÷ 1150 = U Basic Design Heat Loss (WK)

Larger of T or 8 kW = V Boiler size (KW)

Table 1: Property type (window factor and constant)	Window factor	Window constant
Detached	0.127	8.2
Semi-detached	0.127	8.2
Mid terrace	0.127	8.2
Top flat	0.086	5.7
Mid flat	0.086	5.7
Bottom flat	0.086	5.7

Table 2: Window U-values

Double glazed fitted in 2002 or later	2.0
Double glazed wood/PVC fitted before 2002	3.1
Double glazed metal fitted before 2002	3.7
Single glazed wood/pvc	4.8
Single glazed metal	5.7

Table 3: Wall U-values. Select on year built, if known.
If not known select on construction type.

Built 2003 or later	0.35
Built 1983 - 2002	0.45
Solid wall 220mm	2.10
Unfilled cavity wall	1.60
Filled cavity wall	0.60

Table 4: Roof U-values. For a middle flat (another flat above and below) or bottom floor flat use a U-value of zero. Otherwise choose insulation thickness from below.

Pitched, none	2.30
Pitched, 50mm (2")	1.50
Pitched, 100mm (4")	0.40
Pitched, 150mm (6")	0.29
Pitched, 200mm (8") or more	0.20
Flat roof built 1983 or later	0.35
Flat roof, 25mm (1") or more	0.70
Flat roof, none	2.30

Table 5: Location factor

North England and the English Midlands	30.0
Northern Ireland	26.9
Scotland	29.4
South East England and Wales	27.5
South West England	25.0

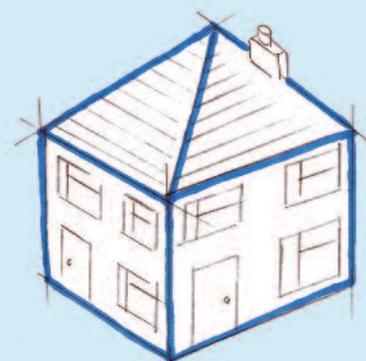
Table 6: Floor U-values. For a top flat or mid flat use a U-value of zero. Otherwise calculate floor area ÷ external perimeter and lookup the U-value by floor type and insulation thickness.

Floor type and insulation thickness	Suspended, 25mm (1") or less	Solid, 25mm (1") or less	Suspended or solid, more than 25mm (1")
Area ÷ exposed perimeter (m)	W/m ² /K	W/m ² /K	W/m ² /K
1 or less	1.41	1.87	0.63
Over 1 and up to 1.5	1.08	1.69	0.67
Over 1.5 and up to 2	0.98	1.52	0.67
Over 2 and up to 2.5	0.90	1.38	0.66
Over 2.5 and up to 3	0.84	1.27	0.64
Over 3 and up to 4	0.73	1.09	0.60
Over 4 and up to 5	0.66	0.96	0.56
Over 5 and up to 10	0.44	0.62	0.41
Over 10 and up to 20	0.27	0.38	0.27
Over 20	0.16	0.22	0.17

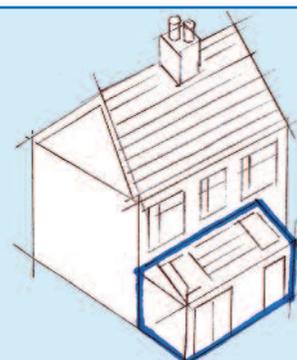
Table 7: Additional U-values for party loss

Party wall (brick 215mm)	1.33
Party ceiling	1.02
Party floor	1.02

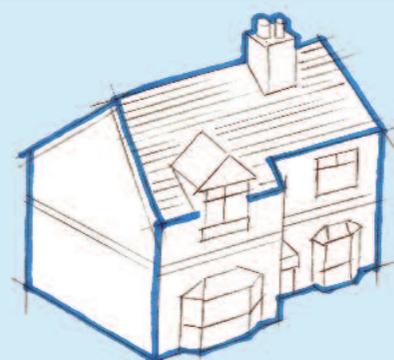
Assess the dwelling shape



A. Simple rectangular dwelling
Use worksheet alone



B. Extension and loft conversions
Use worksheet and add on radiators sizes in section 8



C. Non-rectangular dwelling
Divide into sections and repeat calculations.



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Further information

The Energy Saving Trust provides technical guidance and solutions to help UK housing professionals design, build and refurbish to high levels of energy efficiency in domestic newbuild and renovation. They are made available through the provision of training seminars, downloadable guides, online tools and a dedicated helpline.

For more information visit energysavingtrust.org.uk/housing

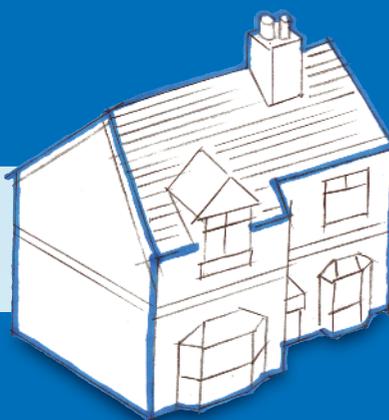
Further reading

A complete list of Energy Saving Trust housing professionals guidance can be found in 'Energy Efficiency is best practice' (CE279). To download this, and to browse all available Energy Saving Trust publications, visit energysavingtrust.org.uk/housing/publications

The following publications may also be of interest:

- Domestic heating by oil boiler systems (CE29)
- Domestic heating by gas boiler systems (CE30)
- Central heating system specifications (CHeSS) (CE31)

We have a new online boiler sizing tool called Domestic heating sizing wizard. See energysavingtrust.org.uk/housing for more information.



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