The Certification Mark for Onsite
Sustainable Energy Technologies

## Microgeneration Installation Standard : MCS 024

# SOLAR DOMESTIC HOT WATER ENERGY CALCULATION

## to be used in conjunction with MIS 3001:

## REQUIREMENTS FOR CONTRACTORS UNDERTAKING THE SUPPLY, DESIGN, INSTALLATION, SET TO WORK, COMMISSIONING AND HANDOVER OF SOLAR HEATING MICROGENERATION SYSTEMS

## Issue 1.1

This standard has been approved by the Steering Group of the Microgeneration Certification Scheme (MCS).

This standard was prepared by the MCS Working Group 1 'Solar Heating Systems'.

**REVISION OF MICROGENERATION INSTALLATION STANDARDS**

Microgeneration Installation Standards will be revised by issue of revised editions or amendments. Details will be posted on the website at www.microgenerationcertification.org.

Technical or other changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments.

The issue number will be given in decimal format with the integer part giving the issue number and the fractional part giving the number of amendments (e.g. Issue 3.2 indicates that the document is at Issue 3 with 2 amendments).

Users of this Standard should ensure that they possess the latest issue and all amendments.

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# 1 SCOPE

This Microgeneration Installation Standard describes the method for calculating the renewable energy produced by and the fuel energy saving from a solar heating microgeneration system designed to provide domestic hot water only. It is to be used in conjunction with MIS 3001 Microgeneration Installation Standard "Requirements for contractors undertaking the supply, design, installation, set to work, commissioning and handover of Solar Heating Microgeneration Systems".

# 2 METHOD

Calculate the annual solar energy input to the cylinder, using Appendix H of the Standard Assessment Procedure (SAP 2012) with the following modifications:

(a) If the occupation of the building is known, determine the number of full time equivalent occupants, N, of the dwelling by completing the table below and applying an upper limit of 6.

| Question | Count | Answer | Multiply by | Full time equivalent |
|---|---|---|---|---|
| How many people live in this dwelling as full time residents? | People | | 1.0 | |
| How many people live in this dwelling as part time residents (for example because the dwelling is their second home, or because they are students living there only outside term time)? | People | | 0 | |
| For each of the part time residents, estimate how many days per year they live in the dwelling. | Days/year | | 1/365 | |
| Total full time equivalent | | | | |
| N (equal to the total full time equivalent or 6, whichever is the lower) | | | | |

(b) If the occupation is not known (for example in many new-build situations) N shall be taken from box 42 of a SAP 2012 assessment of the building, and subject to an upper limit of 6.

(c) Calculate the daily hot water demand, $V_{d,average}$, as $(25 \times N + 36)$ litres/day. This represents (43) where referred to in SAP Appendix H, and is used in (H14) and (H8).

(d) Calculate the energy content of hot water used, representing $\Sigma(45)_m$ where referred to in SAP Appendix H, as $(4.190 \times V_{d,average} \times 365 \times 37 / 3600)$.

(e) Calculate the modified solar-to-load ratio (H8) as:

Modified solar to Load Ratio = $(H7) \div \{ [H \times \Sigma(45)_m] + C \}$

Where

- H is an adjustment factor for hot water use:
  $H = h_1 \times h_2 \times h_3$

  Where $h_1$ is the electric showers adjustment factor taken from the following table:

  | Showers present in the property | $h_1$ |
  |---|---|
  | Non-electric shower(s) only | 1.29 |
  | Electric shower(s) only | 0.64 |
  | Both electric and non-electric showers | 1.00 |
  | No shower, bath only | 1.09 |

  $h_2$ is the water efficient dwelling adjustment factor,

  | | $h_2$ |
  |---|---|
  | Water efficient dwelling (compliant approved doc G) | 0.95 |
  | Other dwellings | 1.00 |

  and $h_3$ is the Waste Water Heat Recovery System (WWHRS) adjustment factor, currently set to 1.0

$h_3 = 1.0$

- C is the annual cylinder heat loss, taken from the following table:

| Total Hot Water Storage Volume | litres | 150 | 180 | 200 | 250 | 300 | 500 |
|---|---|---|---|---|---|---|---|
| C | kWh/year | 417 | 471 | 505 | 586 | 662 | 930 |

(Interpolate linearly for intermediate volumes)

(f) The solar collector performance figures shall be taken from EN 12975 test results and not the SAP default values. (H1) (H2) (H3) (H3a)

Perform the calculation as specified in Appendix H of SAP 2012 using the above amended box inputs.

The resulting annual solar energy input to the cylinder (kWh/year) calculated at (H17) is the deemed renewable heat for the purposes of the domestic RHI. This is the figure to be added into the MCS Installation Database (MID).

The additional fuel energy saving (based on the backup heater efficiency) is calculated using the solar efficiency factor, $A_1$, for the type of back-up heater in the building (see Appendix A).

Additional Fuel Energy Saving (kWh/year) = solar energy input to cylinder x { (1/$A_1$) – 1}

**For evacuated tube collectors only:**

a) calculate the Incidence Angle Modifier Factor (IAM Factor) as the product of transverse and longitudinal IAM at 50 degrees from the product test report:
IAM factor = KƟ(50T) x KƟ (50L) or 1.0 whichever is the higher

b) Solar Energy Available, line (H7) becomes (H1) x (H2) x (H5) x (H6) x IAM factor

# APPENDIX A: BOILER EFFICIENCY

The annual energy performance calculation (derived from SAP Appendix H) above predicts the solar output to the hot water cylinder, but takes no account of boiler efficiency. The fuel saved by the customer may be considerably greater, due to poorer boiler efficiency when heating hot water only, such as in the summer months.

Contractors shall assess the existing boiler system and categorise it according to Table C1 below. The calculated annual energy performance (from SAP Appendix H calculation) shall be divided by the appropriate factor to determine the estimated annual fuel saving from the solar system.

The predicted solar output (from SAP) and the estimated fuel saving shall both be presented to the client at quotation stage.

*Notes:*
*(1) Attention is drawn to Section 4.4 of MIS3001 whereby existing boiler controls must be upgraded wherever possible (e.g. fitting of cylinder thermostats and appropriate control valves etc to prevent excessive cylinder heating by gravity circulation).*
*(2) A "best fit" approach should be used. For range cookers, use floor mounted boiler figures.*

Table A1 Seasonal efficiency for backup heating used with solar systems.

| **Regular or system boilers** | Solar efficiency factor ($A_1$) |
|---|---|
| Gas, post 1998, condensing with automatic ignition | 0.768 |
| Gas, post 1998, non-condensing with automatic ignition | 0.668 |
| Gas, pre 1998, fan flue | 0.618 |
| Gas, 1979 - 1997, open or balanced flue, floor mounted | 0.588 |
| Gas, pre 1979, open or balanced flue, floor mounted | 0.488 |
| Oil, condensing | 0.754 |
| Oil, standard, post 1998 | 0.714 |
| Oil, standard, 1985 - 1997 | 0.624 |

| | |
|---|---|
| Oil, standard, pre 1985 | 0.574 |
| **Combi boilers** | |
| Gas, post 1998, condensing with automatic ignition | 0.775 |
| Gas, post 1998, non-condensing with automatic ignition | 0.675 |
| Gas, pre 1998, fan flue | 0.645 |
| Oil, pre 1998 | 0.645 |
| Oil, post 1998 | 0.705 |
| **Other backup heaters** | |
| Wood chip/pellet independent boiler | 0.63 |
| Closed room heater with boiler to radiators | 0.65 |
| Manual feed independent boiler | 0.55 |
| Immersion heater within DHW tank back up heating zone | 1.00 |
| Electric boiler separate from DHW tank | 0.85 |
| Ground to water heat pump | 1.50 |
| Air to water heat pump | 1.43 |

**Worked examples**

SAP appendix H calculated solar input [Qs] of 1600 kWh, condensing gas boiler, post 1998

Condensing gas boiler, from Table 1, solar efficiency = 76.8%. Predicted Qs solar yield = 1600 kWh

Fuel saved = solar yield (Qs) divided by 0.768 = 2083 kWh annual fuel saving.


Calculated solar input Qs of 1600 kWh, pre-1979 floor mounted gas boiler

Pre 1979 floor mounted boiler, from Table 1, solar efficiency = 48.8%.

Fuel saved = solar yield (Qs) divided by 0.488 = 3279 kWh annual fuel saving.


Calculated solar input Qs of 1600 kWh, ground to water heat pump

Ground to water heat pump, from Table 1, solar efficiency = 150%.

Fuel saved = solar yield (Qs) divided by 1.50 = 1067 kWh annual fuel saving.


**Background to the Solar Efficiency Factor**

The table presents a simplified list of the more common boilers listed in Table 4b of SAP 2009. The solar efficiency factor is derived from the SAP summer and winter efficiencies in the ratio 28% winter and 72% summer. This ratio is taken from the monthly solar gain in SAP 2009 Table H3 for a collector tilt angle of 30°:

Table C2 Simplified list of the more common boilers listed in Table 4b of SAP 2009.

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.35 | 0.63 | 0.92 | 1.3 | 1.58 | 1.68 | 1.62 | 1.39 | 1.08 | 0.74 | 0.43 | 0.29 |
| 3% | 5% | 8% | 11% | 13% | 14% | 13% | 12% | 9% | 6% | 4% | 2% |
| Heating season | | | Non- heating season | | | | | | Heating season | | |

The blue coloured bars (row 4) represent when the household is almost certain to have a space heating demand so the winter boiler efficiency should be used without doubt. The orange bar represents when the space heating demand is likely to be small or zero (depending on the user, location and the building insulation qualities etc) so the boiler is likely to operate closer to the summer efficiency. Adding the monthly percentages for heating and non-heating seasons gives 72% non-heating and 28% heating season.

Hence, the boiler efficiency used in the "displaced fuel" calculation is weighted 72% summer, 28% winter. If preferred, independent laboratory results may be used if they are available.

*Note: Solid fuel boilers*
*Two efficiency columns are presented in SAP2009, column A for HETAS approved appliances and column B for others. Section 9.2.4, p.21, states "Values from column (B) should be used for appliances, particularly those already installed in dwellings, for which efficiency data are not available" and efficiency values for summer and winter efficiency are not provided. Hence if manufacturer summer/winter efficiency data is not available, the column B efficiency should be used as the solar efficiency factor. For manual feed boilers, the assumed value is that of a boiler in an unheated space (since the case losses are not useful for heating water).*

*Note: Heat pumps*
*SAP section 9.2.7 states "If the heat pump provides domestic hot water heating an electric immersion should be assumed to operate in conjunction with the heat pump unless it is known that the heat pump can provide*
*100% of the water heating requirement, using an efficiency for water heating given by {equation 9}.*

*The calculated water heating efficiencies are 152% ground to water, 150% ground to water with auxiliary heater and 143% for air to water.*

*Note: Electric boilers and immersion heaters*

*For Immersion heaters within the hot water store assume 100% efficiency. Direct acting electric boilers (i.e. those fitted within a pumped heating circuit with primary pipe losses) should assume 85% efficiency as the pipe losses are not useful for water heating. The primary pipework must be insulated as far as practicable.*

# AMENDMENTS ISSUED SINCE PUBLICATION

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|---|---|---|
| 1.0 | First publication | 01/10/2013 |
| 1.1 | Addition of IAM for evacuated tube collectors | 16/12/2013 |