Solar Thermal
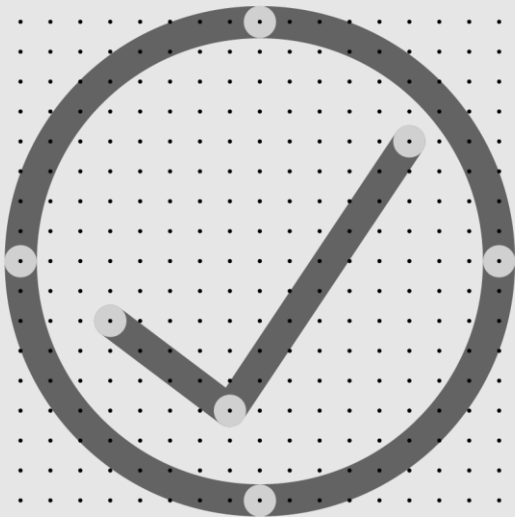# Domestic Hot Water Energy Calculator

To be used in conjunction with MIS 3001

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

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ABOUT MCS

Giving you confidence in home-grown energy

With energy costs constantly rising and climate change affecting us all, low-carbon technology has an ever increasing role to play in the future of UK energy.

We're here to ensure it's a positive one.

Working with industry we define, maintain and improve quality – certifying products and installers so people can have confidence in the low-carbon technology they invest in. From solar and wind, to heat pumps, biomass and battery storage, we want to inspire a new generation of home-grown energy, fit for the needs of every UK home and community.

About

The Microgeneration Certification Scheme Service Company Ltd (MCSSCo Ltd) trades as MCS and is wholly owned by the non-profit MCS Charitable Foundation. Since 2007, MCS has become the recognised Standard for UK products and their installation in the small-scale renewables sector.

We create and maintain standards that allow for the certification of products, installers and their installations. Associated with these standards is the certification scheme, run on behalf of MCS by Certification Bodies who hold UKAS accreditation to ISO 17065.

MCS certifies low-carbon products and installations used to produce electricity and heat from renewable sources. It is a mark of quality. Membership of MCS demonstrates adherence to these recognised industry standards; highlighting quality, competency and compliance.

Vision

To see MCS certified products and installations in every UK home and community.

Mission

To give people confidence in low-carbon energy technology by defining, maintaining and improving quality.

Values

1. We are expert – ensuring quality through robust technical knowledge
2. We are inspiring – helping to reshape energy in UK homes and communities
3. We are collaborative – working with industry and government to create positive change
4. We are principled – operating in a way that's clear, open and fair
5. We are determined – supporting the UK's drive towards a clean energy future

CHANGES TO STANDARDS

When MCS Standards are revised, the issue number is also revised to indicate the nature of the changes. This can either be a whole new issue or an amendment to the current issue. Details will be posted online, www.mcscertified.com

Technical or other significant 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 is given on the left of the decimal point, and the amendment number on the right. For example, issue 3.2 indicates that it is the third significant version of the document which has had two sets of minor amendments.

Users of this Standard should ensure that they are using the latest issue.

Issue No.	Amendment Details	Date
1.0	First Publication	01/10/2013
1.1	Addition of IAM for evacuated tube collectors	16/12/2013
2.0	Rebrand, inclusion of other corporate elements and adaptation for systems certified to EN 12976	01/12/2021

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1 SCOPE

This MCS 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 The Solar Thermal Standard.

A copy of this calculation shall be retained by the contractor for the minimum period defined within MCS001 and made available for audit.

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×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 × $V_{d,average}$ × 365 × 37 / 3600).

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

Modified solar to Load Ratio = (H7) ÷ { [H × $\Sigma(45)_m$]+ 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

h2 is the water efficient dwelling adjustment factor,

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

h3 =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

(f) Where the solar collector has been tested according to EN12975 or BS EN ISO 9806 performance values shall be taken from the test results. Where the solar hot water system has only been tested according to EN12976/1 and EN12976/2, SAP Table H1 default values as below may be used.

	TSPEC line reference			
	1.4	**1.5**	**1.6**	**1.7**
Collector type	Total aperture area = Gross collector area x ratio below	Zero loss collector efficiency (No)	Heat loss coefficient (a1)	Second order heat loss coefficient (a2)
Evacuated tube	0.72	0.60	3.0	0.008
Flat plate glazed	0.90	0.75	6.0	0.016
Flat plate unglazed	1.00	0.90	20.0	n/a

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 = $K\theta(50T)$ x $K\theta(50L)$ 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 – 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.