Solar Installers Note:
Guidance on Achieving Compliance with the Better Energy Homes Programme

February 2019

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1. Introduction

The launch of the Better Energy Homes programme in May 2011 saw the programme extended to include a grant for the installation of solar panels. One of the key objectives of the grant is the upgrading of the housing stock in Ireland. Therefore, the grants are based on an asset (house) upgrade to a specified performance standard as distinct from the aperture area of the solar collector as was applicable to the now closed Greener Homes Scheme.

The SEAI's Domestic Technical Standards and Specifications (DTSS) and the Better Energy Homes Contractor's Code of Practice provide information on the technical requirements of solar grants. The Homeowner's Guide to Solar Thermal for Hot Water is published on the SEAI website to assist homeowners with their selection of solar installation and with details of grant requirements.

This technical guidance note sets out the calculation methodology for achieving compliance with the solar grant programme requirements. In support of the SEAI's Domestic Technical Standards and Specifications, SEAI has prepared a Solar Hot Water Compliance Calculator to assist with the specification of works to meet the Better Energy Homes grant requirements. This Calculator is for the purpose of ensuring that the proposed installation meets the minimum performance requirements. The calculator is available for download on the SEAI website under Contractor Supports. It is a Microsoft Excel version of the solar contribution formula including DEAP. It is not a solar installation design tool or sizing calculator.

This note explains how to use the Solar Compliance Calculator and how to fill out the Declaration of Works forms for solar jobs. This note should be read in conjunction with the SEAI's Domestic Technical Standards and Specifications, the Better Energy Homes Contractor's Code of Practice and the Solar Hot Water Compliance Calculator.

2. Requirements of Solar Hot Water Installations in the Better Energy Homes Programme

The solar thermal installation must contribute a set portion of renewable energy output for domestic hot water heating. The method of calculating the solar output is set out in Appendix H of the DEAP manual and is summarised below.

The solar contribution to domestic hot water is given by:

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

Where:
Q_s = solar input, kWh/year
S = total solar radiation on collector, kWh/m^2/year
Z_{panel} = overshading factor for the solar panel
A_{ap} = aperture area of collector, m^2

η_o = zero-loss collector efficiency
UF = utilisation factor
a_1 = linear heat loss coefficient of collector, W/m^{2}K
$f(a_1/\eta_o)$ = collector performance factor = (see H10 below)
V_{eff} = effective solar volume, litres
V_d = daily hot water demand, litres
$f(V_{eff}/V_d)$ = solar storage volume factor = 1.0 + 0.2 In(V_{eff}/V_d)

The minimum required output of the solar hot water system depends on the total floor area (TFA) of the dwelling as detailed in the following table:

Total Floor Area (TFA) (m^2)	Required Energy Yield for Solar Panels Installed
TFA ≤ 170	10 kWh/m^2/year
170 < TFA ≤ 200	1,700 kWh/year
200 < TFA ≤ 250	1,850 kWh/year
TFA > 250	2,000 kWh/year

Properties with a floor area of up to 170 square meters require a renewable energy contribution by the solar installation of 10 kWh/m2/year. The requirements for properties over 170 square meters have been adjusted to enable systems in larger dwellings to achieve compliance while maintaining best practice regarding system-sizing.

Some examples are set out below for guidance:
For a house in the first category of this table: TFA ≤ 170m^2 – the Required Energy Yield depends on the TFA of the house as can be seen in Examples (i) and (ii):

(i) Total Floor Area – 100m^2: Required Energy Yield = 10 kWh/m^2/year.
This is the required output per square meter of floor area of the house. In terms of the total output from the solar panels,
Required Energy Yield = 100m^2 x 10 kWh/m^2/year = 1,000 kWh/year.

(ii) Total Floor Area = 155m^2: Required Energy Yield = 10 kWh/m^2/year.
This is the required output per square meter of floor area of the house. In terms of the total output from the solar panels,
Required Energy Yield = 155m^2 x 10 kWh/m^2/year = 1,550 kWh/year.

For houses in the other categories of the table: TFA > 170m^2 – the Required Energy Yield is the same for all houses in that particular range, as shown in Examples (iii) and (iv):

(iii) Total Floor Area = 175m^2: Minimum Energy Yield = 1,700 kWh/year.
(iv) Total Floor Area = 195m^2: Minimum Energy Yield = 1,700 kWh/year.
(v) Total Floor Area = 220m^2: Minimum Energy Yield = 1,850 kWh/year.
(vi) Total Floor Area = 275m2: Minimum Energy Yield = 2,000 kWh/year.

Failure to achieve compliance will likely result in the non-payment of the grant so it is important that the compliance check is carried out before work begins.

Note: Although this table sets out the minimum output expected of a solar hot water system grant-

funded by SEAI, it is not to be used as a sizing guide. The estimation of the appropriate number of panels/tubes, type of panels/tubes, cylinder volume and dedicated solar storage volume should be carried out by an appropriately qualified contractor, as outlined in the SEAI's Domestic Technical Standards and Specifications and Better Energy Homes Contractor's Code of Practice, and in accordance with relevant industry standards (see, for example, References [2], [3] & [4] at the end of this document.

3. Checking Compliance of Solar Hot Water Installations in the Better Energy Homes Programme

A compliance-checking tool has been made available to download at the SEAI website to help registered contractors determine whether a particular solar hot water installation will comply with the requirements of the BEH programme.

The tool is a Microsoft Excel file that requires the user to input the information about the dwelling, the solar panel and the hot water cylinder.

This Excel file is designed using the DEAP solar contribution to domestic hot water formula:

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

Each of the required inputs is described for reference.

Dwelling Details
Total Floor Area of Dwelling
The Total Floor Area (TFA) of the house as defined by DEAP [5], measured from the interior face of external/party walls. TFA is measured in square meters (m^2).
Please ensure that this is calculated correctly.

Solar Panel Details
Solar panel performance details must be taken from one of the following sources:

- The HARP database;
- Certified data for the collector measured according to IS EN 12975-2 [6];
- Table H1 of the DEAP manual;

The system must be listed on the SEAI Solar Thermal Registered Product List.

Collector Area
This is the total **aperture** area of the collectors, i.e. the area of the opening through which solar radiation is admitted, not the total collector area.

Zero-loss Collector Efficiency (η_o)
In an ideal system all the sunlight that falls on the collector would be absorbed but this is not the case

in reality. The zero-loss collector efficiency measures the fraction of sunlight absorbed by a collector. It has a value between 0 and 1 with a higher value indicating more energy is absorbed.

Collector Heat Loss Coefficient (a_1)
As the collector absorbs sunlight it will heat up and become warmer than its surroundings, which inevitably leads to some loss of heat from the collector. The heat loss coefficient, a_1, accounts for this heat loss. A small value indicates that only a small amount of the heat absorbed is lost to the surroundings.

Ideally, the collector should be installed in such a way as to maximise the exposure to sunlight. This depends on the direction faced, the angle of the collector and the amount of shading.

Orientation
The direction the collector is facing. One of the following values must be selected:

- North
- North-east/North-west
- East/West
- South-east/South-West
- South

The optimal value is South though a collector facing anywhere between South-east and South-west will be close to optimal.

Tilt
The angle made by the collector to the horizontal plane. For a collector installed on a roof – whether above or integrated with the roof tiles – the tilt is the same as the pitch of the roof. Select the value in the list, which is closest to the actual value.

Overshading
The amount of shading of the collector by adjacent structures, e.g. buildings, trees, etc. There are four options:

- Heavy – 80% of the sky blocked by obstacles
- Significant – 60% to 80% of the sky blocked by obstacles
- Modest – 20% to 60% of the sky blocked by obstacles
- None or Very Little – less than 20% of the sky blocked by obstacles

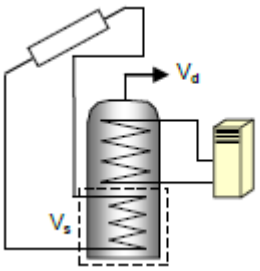
The ideal situation is to have a collector in direct sight of the sun as much as possible so 'None or Very Little' is the optimal value for overshading.

Cylinder Details
Volume of Cylinder Heated by Collector (litres)
The total volume of the cylinder heated by the solar collectors, regardless of whether the cylinder is also heated by other heating systems.

Is solar storage contained within a combined cylinder?
If the cylinder is only heated by the solar collector select 'No', otherwise select 'Yes'.

Dedicated solar storage volume of the combined cylinder (litres)
Note: this filed is only visible if 'Yes' is selected for the previous field.

If the cylinder is heated by other heating appliances, e.g. an oil/gas boiler or a solid fuel back boiler, this is the volume of that part of the cylinder heated only by the solar coil. In a typical dual-coil cylinder the dedicated solar storage is the volume marked by the dashed line in the following diagram:



A Dual-Coil System:
The Dedicated Solar Storage is
the region within the dashed line

The dedicated solar storage volume may be calculated by one of the following methods (this applies if the cylinder is heated by a boiler and/or an immersion heater):

(i) Derived from heating coil locations on a cylinder datasheet:
The datasheet may contain a diagram of the cylinder showing the location of the internal cylinder coils or location of upper and lower coil connections to the cylinder. The dedicated solar storage applies to the volume of storage below the coil lying directly above the solar heated coil. If, for example, the combined cylinder is 300L and the connections of the upper coil are halfway down the cylinder, then the dedicated solar storage can be assumed to be 150L.

(ii) It may also be possible to determine the location of the coil connections on site. The dedicated solar storage is the cylinder volume lying below the coil directly above the solar coil.

(iii) The cylinder documentation/datasheet may state the volume dedicated to solar storage along with relevant standards for storage volume specification. This is acceptable, but the Contractor should cross check that that stated dedicated solar storage volume does not include sections of the cylinder heated by coils above the solar heated coil.

(iv) Where the dedicated solar volume is not known a value of zero should be entered. (In this case, the calculator will automatically enter a default value for the dedicated solar storage, calculated as a fixed proportion of the total cylinder volume).

If the cylinder is heated by a boiler, is there a cylinder stat?
Select 'Yes', 'No' or 'Not Applicable' as appropriate.
Please read the reference documents noted at the end of this document to ensure that you are fully familiar with the installation requirements as set out therein.

The Solar Hot Water Compliance Calculator will calculate if the proposed installation complies with the BEH performance requirements or not. It will calculate the energy yield for the solar panels installed, and the energy yield per meter squared where appropriate, confirm what the requirements are for that house size, the total energy yield as well as the solar fraction.

The calculator automatically outputs the result per meter squared for properties up to 170 square meters (Q_s in kWh/m^2/year) and total output for properties over that area (Q_s in kWh/year).

4. An Example of Compliance Check

For your guidance an example of a solar hot water installation is checked for compliance with the BEH programme requirements using the Excel tool mentioned in the previous section.

System Details
Two *"Acme 999 p"* solar panels are to be installed in a house with a total floor area of 162m^2. A valid manufacturer's certificate has been provided indicating that this model has been tested to IS EN 12975-2 and has the following performance values:

Collector Area = 2.12m^2 per panel
Zero-loss Collector Efficiency, η_o = 0.762
Collector Heat Loss Coefficient, a_1 = 3.489 W/m^{2}K

The panels are located on a roof facing south with a pitch of 45˚ with no nearby obstacles to case shading. A dual coil cylinder (with the other coil heated by an oil boiler) of volume 200 litres is used. The dedicated solar storage of the cylinder is declared as 120 litres.

These details are entered in the compliance checking tool as follows:

Dwelling Details	
Total Floor Area of Dwelling [m^2]	162

The total floor area is entered as measured.

Solar Panel Details	
Collector Area	4.24
Zero-loss collector efficiency (η_o)	0.762
Collector heat loss coefficient (a_1)[W/m^{2}K]	3.489
Orientation	South
Tilt	45˚
Overshading	None or Very Little

The collector details are taken from the certificate.
Note the collector area = 2.12m^2 x 2 No. = 4.24m^2

The panels are on a roof with a pitch of 45˚, which is taken as the Tilt of the collector. There are no shading obstacles and therefore overshading is set to 'None or Very Little'.

Cylinder Details	
Volume of Cylinder Heated by Collector (litres)	200
Is solar storage contained within a combined cylinder?	Yes
Dedicated solar storage volume of the combined cylinder (litres)	120 *Enter 0 if this is not known*
If the cylinder is heated by a boiler, is there a cylinder stat?	Yes

Cylinder volume is given as 200 litres. It is a dual cylinder heated by the solar collector and also by an oil boiler – so this is a combined cylinder. Manufacturer's information provided indicates the Dedicated Solar Storage is 120 litres.
Note that if we didn't know the Dedicated Solar Storage, a value of zero would be entered.

Results		Does not Comply with BEH Requirements
Energy Yield for Solar Panels Installed	9.09	kWh/m^2/year
Required Energy Yield for Solar Panels Installed	10.00	kWh/m^2/year
Total Energy Yield	1472	kWh/year
Solar Fraction	49%	

The output of this configuration is 9.09 kWh/m^2/year. The required output to comply with the BEH for this property size is 10 kWh/m^2/year. Therefore, this installation does not comply and this result is highlighted in the Red box above.
To achieve compliance a larger system would be required. Shown below is the output when an extra panel is added and the cylinder size increased accordingly to 250 litres with a dedicated solar storage of 140 litre.

Results		Complies with BEH Requirements
Energy Yield for Solar Panels Installed	10.71	kWh/m^2/year
Required Energy Yield for Solar Panels Installed	10.00	kWh/m^2/year
Total Energy Yield	1735	kWh/year
Solar Fraction	57%	

Now the output of this configuration is 10.71 kWh/m^2/year, which is larger than the required output of 10 kWh/m^2/year so this installation now complies with the BEH requirements as stated in the box above, which is now highlighted in green.

Solar Fraction
The Solar Fraction is the percentage of the hot water load that is provided by the solar hot water system. In the example above, the 2-panel system has a solar fraction of 49% and the 3-panel system

has a solar fraction of 57%.
In the BEH programme it is recommended that for solar collector systems *providing hot water only*, the solar fraction should not be more than 60% because of the danger of overheating and stagnation. If a 4-panel *"ACME 999 P"* system was installed in this house with a 300 litre tank (180 litres dedicated solar storage) the results would be as follows:

Results		Complies with BEH Requirements
Energy Yield for Solar Panels Installed	11.28	kWh/m^2/year
Required Energy Yield for Solar Panels Installed	10.00	kWh/m^2/year
Total Energy Yield	1827	kWh/year
Solar Fraction	60%	
If solar fraction is >60% then the system may be oversized.		
This statement does not apply to solar heating systems also providing space heating.		

While this complies with the BEH requirement the solar fraction is 64%, which is above the recommended limit so a warning message is displayed in red text indicating that this system may be oversized.

Dwelling Occupancy
In the calculation of the required output of the solar panel an assumption is made about the number of occupants in the house based on the size (total floor area) of the house. This may differ from the actual number of people living in the house, e.g. a 190m^2 house may only have 2 occupants but the calculation based on the floor area assumes there are 5 occupants.

In a case like this the solar hot water system required to meet the BEH standards may exceed that of the hot water demand for the number of people currently occupying the house. The occupants should be made aware of this situation and should be informed that it may be more appropriate to install a smaller system in which case the grant would no longer be available.

5. How to Fill Out the Solar Declaration of Works Form

In addition to filling out the measure cost in Section 2 (a) and the Contractor Declaration in Section 2 (c), each contractor is required to fill out details about solar system as installed 2(b).

An example using the figures of the compliant system demonstrated above is shown for both the current version of the Solar Declaration of Works form and the original version.

Current Solar Declaration of Works Form

(b) Measure Specification

(Please **COMPLETE ALL** of the following)

Before Works Condition		
If there are existing solar panels present please indicate area?	Tube: 0 . _____ m^2 Plate: 0 . _____ m^2	
Installed Works		
Produce ID of Solar Panel Installed (per GHS list)	SEI – ST - 999P	
Panel Type Installed (Tick One)	Tube ☐	Plate ☒
Aperture Area of Panels Installed (m^2)	4.24 m^2	
Total Solar Input for Solar Panels Installed (Q_s)	1735 kWh/yr	
Dwelling Floor Area (m^2)	162 m^2	
Solar Input per meter squared of dwelling (Q_s / m^2)	10.71 kWh/m^2/yr	
Solar installation meets or exceeds minimum requirements of the programme (Please Tick)	Yes ☒	*No ☐

* If the answer to above is No, please provide a detailed explanation in comments box overleaf or attach a separate sheet. Failure to meet the programme specification will likely result in the grant being ineligible.

The Energy Yield for Solar Panels Installed is the annual solar energy contribution of the proposed collectors which is calculated as per Appendix H of the DEAP manual. This figure can be calculated using the table provided in Appendix H or it can be calculated by the compliance checking tool referenced above.

6. References

[1] "Better Energy Homes programme SEAI's Domestic Technical Standards and Specifications and Better Energy Homes Contractor's Code of Practice, February 2019.
[2] "Code of Practice for Building Services – Part 2: Solar Panels", SR 50-2:2010, NSAI.
[3] "Solar Heating Design and Installation Guide", 2007, CIBSE.
[4] "Heating and Domestic Hot Water Systems for Dwellings – Achieving Compliance with Part L 2008", 2008, SEAI.
[5] "Dwellings Energy Assessment Procedure", SEAI, 2009.
[6] IS EN 12975-2:2006, "Thermal Solar Systems and Components – Solar Collectors – Part 2: Test Methods2, 2006, NSAI.