



**IRISH AGRÉMENT BOARD  
CERTIFICATE NO. 18/0395**

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## Passive House Systems Solar PV Systems

### Le système solaire photovoltaïque Photovoltaik-Anlage

**NSAI Agrément (Irish Agrément Board)** is designated by Government to carry out European Technical Assessments. NSAI Agrément Certificates establish proof that the certified products are **'proper materials'** suitable for their intended use under Irish site conditions, and in accordance with the **Building Regulations 1997 to 2017**.



#### PRODUCT DESCRIPTION:

This certificate relates to the following Passive House Solar PV Systems:

- PHS Monocrystalline Solar PV System.
- PHS Polycrystalline Solar PV System.

Each system is comprised of an array of photovoltaic solar modules, DC to AC inverter equipment and cables, on-roof fixing kit, user & installation manual and labelling packs.

This certificate certifies compliance with the requirements of the Building Regulations 1997 to 2017.

#### USE:

The Passive House Systems (Certificate Holder) solar PV modules are suitable for application on new and existing buildings with a roof pitch range of between 5° -70°. The collectors must be fixed to a roof that meets the requirements of SR 82:2017. In addition, all relevant aspects related to the fixing of the PV panel to the roof structure shall be designed and installed to comply with SR 50-2:2012.

The solar PV systems should be installed by a competent person with suitable training and practical experience of the systems, and have been approved by Passive House systems to install the system.

#### MARKETING, DESIGN AND MANUFACTURE:

The Passive House Systems solar PV modules are manufactured on behalf of

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Passive House Systems also design, market and distribute the Passive House Solar PV Systems.

### **1.1 ASSESSMENT**

In the opinion of NSAI Agrément, the Passive House Systems solar PV systems, if used in accordance with this certificate can meet the requirements of the Building Regulations 1997 to 2017, as indicated in Section 1.2 of this Agrément certificate.

### **1.2 BUILDING REGULATIONS 1997 to 2017**

#### **REQUIREMENTS:**

#### ***Part D – Materials and Workmanship***

##### **D3 – Proper Materials**

The solar PV systems, as certified in this certificate, are comprised of 'proper materials' fit for their intended use (see Part 4 of this Certificate).

##### **D1 – Materials & Workmanship**

The solar PV systems, as certified in this certificate, meet the requirements for workmanship.

#### ***Part A - Structure***

##### **A1 – Loading**

The Passive House Systems solar PV systems, once appropriately designed and installed in accordance with this certificate, have adequate strength and stability to meet the requirements of this Regulation (see Part 3 of this certificate).

#### ***Part B – Fire Safety/Vol 2 (Dwelling Houses)***

##### **B4/B9 – External Fire Spread**

The solar PV systems will not affect the external fire rating of the roof structure on which they are installed (see Part 4 of this certificate).

#### ***Part C – Site Preparation and Resistance to Moisture***

##### **C4 – Resistance to Weather and Ground Moisture**

The solar PV systems once appropriately designed and installed in accordance with this certificate, will not affect a roof's resistance to the ingress of moisture (see Part 4 of this certificate).

#### ***Part L – Conservation of Fuel and Energy***

##### **L1 – Conservation of Fuel and Energy**

The solar PV systems can be designed to meet the minimum level of energy provision from renewable technologies stated in this Regulation (i.e. 4 kWh/m<sup>2</sup>/annum), contributing to electrical energy use for domestic buildings.

The Solar PV technology referenced on this certificate can contribute to the Renewable Energy Ratio (RER) requirements of TGD Part L Non-Domestic Energy Assessment Procedure (NEAP). The RER is the ratio of primary energy from renewable energy sources to total primary energy.

## 2.1 PRODUCT DESCRIPTION

This certificate relates to the Passive House Systems solar PV systems utilising Monocrystalline and Polycrystalline range of photovoltaic (PV) collectors and ancillary items.

Each system is comprised of an array of photovoltaic solar collectors, a DC to AC inverter, solar DC cable, a DC electrical isolator, extruded aluminium mounting rails, end and mid panel fixing clamps, an AC electrical isolator, an on-roof fixing kit, user & installation manuals, and a labelling pack.

Figure 1 shows the main elements of the Passive House Systems solar PV systems. Tables 1-5 highlight the Solar PV systems range and technical specifications.

The Passive House Systems PV modules have been tested to the requirements of I.S. EN 61215:2005.

### 2.1.1 Passive House Systems Solar Photovoltaic Modules

The manufacturing and testing facilities of the PV modules are audited annually by, or on behalf of NSAI. The solar PV modules are also assessed and approved to MCS 010: Issue1.5.

Passive House systems offer three cell-sized PV modules: 54 cell, 60 cell and 72 cell modules. These PV modules consists of six strings of PV cells 156mm x 156mm square, monocrystalline or polycrystalline. The front cover consists of 3.2mm thick tempered glass and the rear coating consists of layers of specialist polymers. The frame of the PV modules consists of a 40mm anodized aluminium alloy. The junction box on the PV module has a minimum protection class of IP67.

The collectors operate by daylight, entering the solar cells causing movement of electrons which generates an electrical DC current.

The PV modules can be arranged into an array of variable size, depending on the requirements of the design and the available mounting space.

### 2.1.2 Inverters

A DC/AC inverter is required to convert the direct current (DC), generated by the PV modules into a usable alternating current (AC) so the power produced by the PV modules can be used by the electrical appliances in the building. There are two types of inverters approved in this certificate:

- String Inverters (Goodwe, Solis)
- Micro-inverters. (AP Systems)

The inverter specified by Passive House Systems is sized according to the number of PV modules required in the design.

#### 2.1.2.1 String Inverters

With residential string inverters, all solar collectors are connected in a DC circuit, which is then connected to a single inverter.

The string inverter should be mounted at a suitable location in an accessible loft space or beside the property's main AC consumer unit. String inverters produce power at a slightly higher voltage than the grid. The inverter is wired back to the consumer unit where it delivers power to the electric loads within the building, or exported.

The maximum amount of panels that can be installed using a string inverter is limited by the kW capacity of the inverter. All DC and AC cabling must be sized correctly to carry the electrical load from the panels, back to the inverter which is then wired to the consumer board.

#### 2.1.2.2 Micro Inverters

Micro-inverters are small roof mounted DC-AC inverters rated to handle the output of one to two PV panels each. The use of micro-inverters ensures that any panel which is under-performing will not affect the performance of the other panel.

Additional compatible panels can be added to an array at any time once all other requirements of this certificate are met. Micro-inverters produce grid-matching (AC) power directly at the panel. Arrays of panels are connected in parallel to each other, and then to the grid. Additional panels can be added, up to a maximum of seven micro-invertors per branch. Three branches can be connected in a three phase system (21 panels).

## 2.2 MANUFACTURE AND OPERATION

The Passive House Systems solar PV collectors consist of both the PS and AS, monocrystalline or polycrystalline designs, available in three different cell configurations (See Tables 1 – 5) :

- 6 x 9 cells.
- 6 x 10 cells.
- 6 x 12 cells.

The cells of the polycrystalline PV collectors are manufactured using thin wafers of silicon which has been cut from a block of silicon crystal which are made up from multiple crystals. The cells used in the Monocrystalline PV collector are manufactured from a large single silicon crystal.

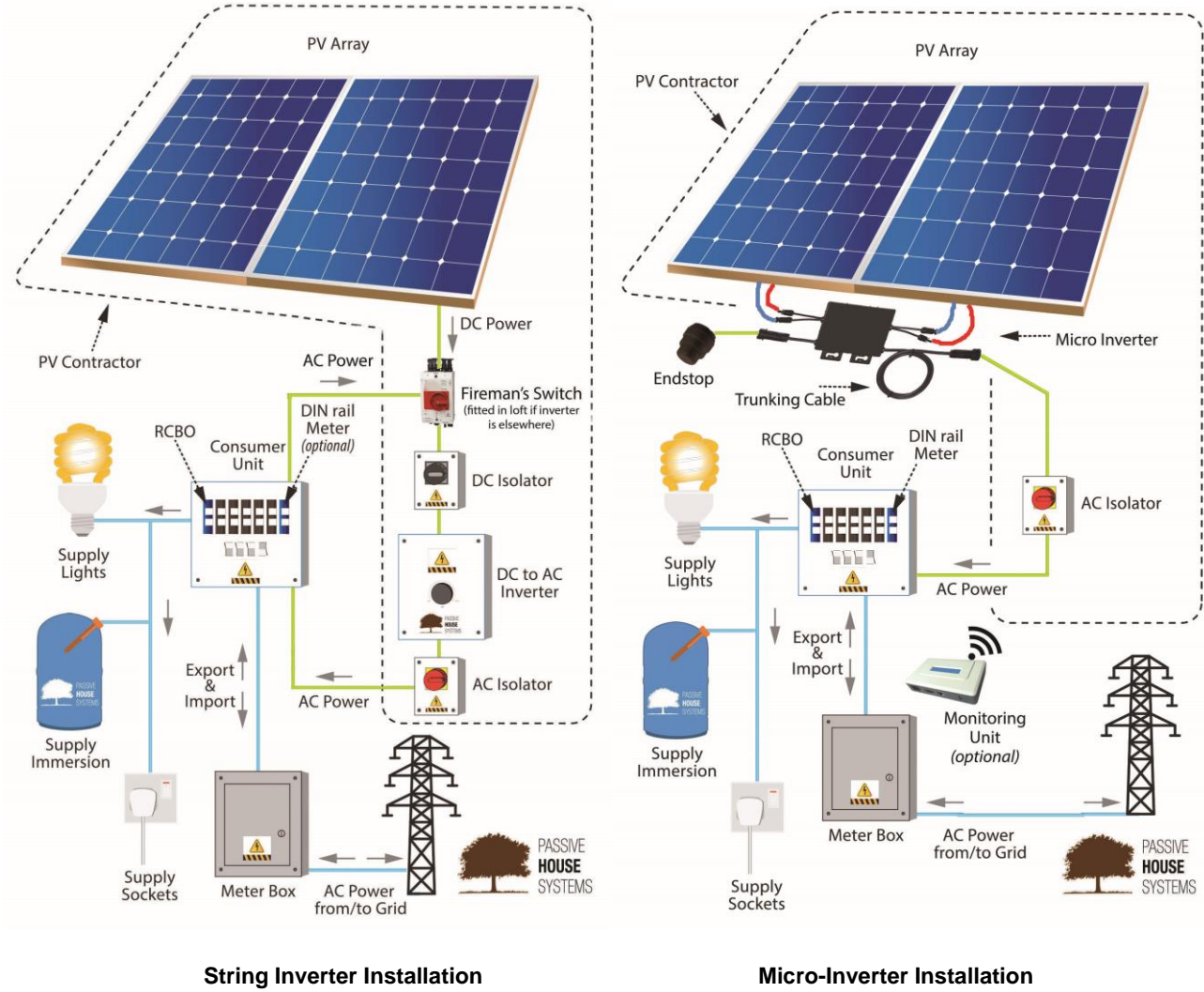
Both the monocrystalline and polycrystalline PV collector contains cells measuring 156mm x 156mm squares, which are housed in an anodized aluminium alloy frame complete with 3.2mm toughened glass.

## 2.3 DELIVERY, STORAGE AND HANDLING

Passive House Systems supply a complete package for each PV system, which includes the PV modules, inverters, electrical isolators, roof mounting kit, user & installation manual and safety labelling packs.

Collectors should always be stored indoors, preferably in a vertical position, otherwise on the flat (frame on frame) ensuring no weight is applied to the wafer area, with the glass facing upwards. Heavy goods should not be loaded on top of the kit boxes. Care should be taken when opening boxes to prevent scratches or sudden shocks to the flat panels.

Associated components also supplied should be stored in a clean, dry and frost free environment until ready for installation. Parts should be inspected for damage on arrival to site. Current health and safety legislation apply to these products with regard to safe lifting and manual handling.



**String Inverter Installation**

**Micro-Inverter Installation**

**Figure 1: System Component**

Table 1: PV Module Specification			
Photovoltaic panel type	Monocrystalline/Polycrystalline		
	54 Cell	60 Cell	72 Cell
Panel length (up roof) (m)	1.480	1.640	1.956
Panel width (across roof) (m)	0.994	0.994	0.994
Panel width (mm)	992	992	992
Aperture area (m <sup>2</sup> )	1.47	1.63	1.94
Panel weight (kg)	17kg	18.5kg	24kg

**Table 2: Electrical Characteristic /Performance <sup>(1)</sup> – PS range of Monocrystalline Panels**

Photovoltaic panel type	PS275M-20/U	PS280M-20/U	PS285M-20/U	PS290M-20/U	PS310M-24/T	PS320M-24/T	PS330M-24/T	PS340M-24/T	PS350M-24/T	PS355M-24/T
Number of Cells	60	60	60	60	72	72	72	72	72	72
Nominal peak power rating (W)	275	280	285	300	310	320	330	340	350	355
Tolerance (%)	±3	±3	±3	±3	±3	±3	±3	±3	±3	±3
Open circuit voltage (V)	38.4	38.5	38.7	38.9	46.3	46.7	47.1	47.3	47.7	47.8
Maximum power voltage (V)	31.4	31.6	31.7	31.9	37.1	37.4	38.0	38.7	39.0	39.3
Short circuit current (A)	9.10	9.15	9.15	9.29	8.75	8.9	8.99	9.09	9.12	9.27
Maximum power current (A)	8.75	8.86	8.86	9.09	8.36	8.55	8.68	8.78	8.85	8.92
Module efficiency (%) <sup>(2)</sup>	16.90	17.2	17.51	18.4	15.98	16.49	17.00	17.52	18.04	18.30
Maximum System voltage (V)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Series fuse rating (A)	15	15	15	15	15	15	15	15	15	15

<sup>(1)</sup> Performance of standard test conditions: irradiance 1000W.m<sup>-2</sup>, cell temperature 25°C, AM 1.5 spectrum.

<sup>(2)</sup> Based on aperture area.

Note: the watt rating of the PV modules are increasing annually due to improvements in technology, manufacturing processes and efficiencies. The watt rating of the PV modules is likely to increase after the date this document has been published.

**Table 3: Electrical Characteristic /Performance <sup>(1)</sup> – PS range of Polycrystalline Panels**

Photovoltaic panel type	PS260P-20/U	PS265P-20/U	PS270P-20/U	PS275P-20/U	PS280P-20/U	PS285P-24/T	PS295P-24/T	PS300P-24/T	PS310P-24/T	PS320P-24/T	PS330P-24/T	PS345P-24/T
Number of Cells	60	60	60	60	60	60	72	72	72	72	72	72
Nominal peak power rating (W)	260	265	270	275	280	285	295	300	310	320	330	345
Tolerance (%)	±3	±3	±3	±3	±3	±3	±3	±3	±3	±3	±3	±3
Open circuit voltage (V)	38.0	38.1	38.2	38.3	38.4	38.5	45.4	45.6	46.0	46.4	46.7	47.3
Maximum power voltage (V)	30.6	30.8	31.0	31.2	31.4	31.6	36.3	36.4	36.7	37.0	37.8	38.8
Short circuit current (A)	8.90	9.00	9.10	9.20	9.30	9.40	8.12	8.24	8.80	8.95	9.03	9.15
Maximum power current (A)	8.54	8.61	8.71	8.81	8.91	9.02	8.58	8.65	8.45	8.65	8.73	8.89
Module efficiency (%) <sup>(2)</sup>	15.9	16.29	16.6	16.87	17.17	17.48	15.21	15.46	15.98	16.23	17.01	17.78
Maximum System voltage (V)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Series fuse rating (A)	15	15	15	15	15	15	15	15	15	15	15	15

<sup>(1)</sup> Performance of standard test conditions: irradiance 1000W.m<sup>-2</sup>, cell temperature 25°C, AM 1.5 spectrum.

<sup>(2)</sup> Based on aperture area.

Note: the watt rating of the PV modules are increasing annually due to improvements in technology, manufacturing processes and efficiencies. The watt rating of the PV modules is likely to increase after the date this document has been published.

**Table 4: Electrical Characteristic /Performance <sup>(1)</sup> –AS range of Monocrystalline Panels**

Photovoltaic panel type	AS-6M27-250	AS-6M27-255	AS-6M27-260	AS-6M30-270	AS-6M30-280	AS-6M30-285	AS-6M30-290
<b>Number of Cells</b>	54	54	54	60	60	60	60
<b>Nominal peak power rating (W)</b>	250	255	260	270	275	285	290
<b>Tolerance (%)</b>	0+3%	0+3%	0+3%	0+3%	0+3%	0+3%	0+3%
<b>Open circuit voltage (V)</b>	34.5	34.6	34.7	38.2	38.4	38.5	38.6
<b>Maximum power voltage (V)</b>	28.1	28.2	28.3	31.1	31.3	31.4	31.5
<b>Short circuit current (A)</b>	9.33	9.47	9.60	9.12	9.37	9.49	9.62
<b>Maximum power current (A)</b>	8.90	9.05	9.19	8.69	8.82	9.08	9.21
<b>Module efficiency (%) <sup>(2)</sup></b>	17.03%	17.37%	17.71%	16.6%	17.2%	17.5%	17.8%
<b>Maximum System voltage (V)</b>	1000V	1000V	1000V	1000V	1000V	1000V	1000V
<b>Series fuse rating (A)</b>	15A	15A	15A	15A	15A	15A	15A
<sup>(1)</sup> Performance of standard test conditions: irradiance 1000W/m <sup>2</sup> , cell temperature 25°C, AM 1.5 spectrum. <sup>(2)</sup> Based on aperture area. Note: the watt rating of the PV modules are increasing annually due to improvements in technology, manufacturing processes and efficiencies. The watt rating of the PV modules is likely to increase after the date this document has been published.							

**Table 5: Electrical Characteristic /Performance <sup>(1)</sup> – AS range of Polycrystalline Panels**

	AS-6P27-250	AS-6P30-260	AS-6P30-265	AS-6P30-270	AS-6P30-260 (Full Black)	AS-6P30-265 (Full Black)	AS-6P30-270 (Full Black)	AS-6P-310	AS-6P-315	AS-6P-320
<b>Number of Cells</b>	54	60	60	60	60	60	60	72	72	72
<b>Nominal peak power rating (W)</b>	250	260	265	270	260	265	270	310	315	320
<b>Tolerance (%)</b>	0+3	0+3	0+3	0+3	0+3	0+3	0+3	0+3	0+3	0+3
<b>Open circuit voltage (V)</b>	34.7	38.2	38.3	38.4	38.2	38.3	38.4	45.5	45.6	45.7
<b>Maximum power voltage (V)</b>	27.9	30.7	30.9	31.1	30.7	30.9	31.1	36.9	37.0	37.1
<b>Short circuit current (A)</b>	9.40	8.90	8.98	9.06	8.90	8.98	9.06	8.85	8.93	9.00
<b>Maximum power current (A)</b>	8.97	8.47	8.58	8.69	8.47	8.58	8.69	8.41	8.85	8.63
<b>Module efficiency (%) <sup>(2)</sup></b>	17.03	15.9	16.3	16.6	15.9	16.3	16.6	15.9	16.2	16.5
<b>Maximum System voltage (V) DC</b>	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
<b>Series fuse rating (A)</b>	15	15	15	15	15	15	15	15	15	15
<sup>(1)</sup> Performance of standard test conditions: irradiance 1000W/m <sup>2</sup> , cell temperature 25°C, AM 1.5 spectrum. <sup>(2)</sup> Based on aperture area. Note: the watt rating of the PV modules are increasing annually due to improvements in technology, manufacturing processes and efficiencies. The watt rating of the PV modules is likely to increase after the date this document has been published.										

**Table 6: Annual Solar Radiation, kWh/m<sup>2</sup> <sup>(1)</sup>**

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

<sup>1</sup> Taken from Table H2, DEAP Version 3.2.1

**Table 7: Overshading Factors from SEAI DEAP Manual**

Over Shading	% sky blocked by obstacles	Overshading Factor
Heavy	>80%	0.50
Significant	60% - 80%	0.65
Modest	20% - 60%	0.80
None or Very Little	< 20%	1.00

<sup>1</sup> Taken from Table H2, DEAP Version 3.2.1

**Worked DEAP Example**

$$\text{Output (kWh)} = 0.8 \times \text{kWp} \times S \times Z_{\text{ov}}$$

Where:

kWp = installed peak power

S = annual solar radiation (from Table 6)

 Z<sub>ov</sub> = over shading factor (from DEAP manual Table 7, typically a value of 1 were placed on a roof with no shading)

**Example calculation**

For an array of 4 monocrystalline silicon panels each with a nominal peak power of 250 Wp (i.e. nominal peak power rating for the AS-6M27-250 panel per Table 4), mounted on a roof with a 30° pitch facing directly south with no overshading, the total installed capacity would be:

 Installed peak power:  $0.25 \times 4 = 1.00$  kWp (250Wp=0.25kWp, x No. of panels in array).

 The annual approximated output would be:  $0.8 \times 1.00 \times 1,074 \times 1 = 859.2$  kWh.

*\*This calculation method is used in the SEAI DEAP software.*



## 2.4 INSTALLATION

### 2.4.1 General

The Passive House Systems solar PV systems should be installed by competent person with suitable training and practical experience of the systems, and who have been approved by Passive House Systems to install the system. The installer shall fully understand the requirements of the customer, have completed a user health & safety risk assessment and an installation health & safety risk assessment.

The necessary electrical installation work should be undertaken by a qualified RECI electrical contractor. Solar PV panel installation must be performed in accordance with all Health & Safety legislation and local building/planning regulations, and must comply with ET101 for the system components, including the cables, connectors, charging controllers, inverter, etc.

Under normal conditions, a module is not likely to produce more current and/or voltage than reported under standard test conditions (stc). Accordingly, the values of current short circuit (Isc) and voltage open circuit (Voc) marked on the module nameplate should be multiplied by the following safety factors:

- Voltage > Voc(stc) x M x 1.15;
- Current > Isc(stc) x (N-1) x 1.25.

Where M is the number of modules in a string and N is the number of strings in the array.

#### **Example calculation**

(for the AS-6M27-250 panel per Table 4)

- 2 strings of 6 PV panels
- 34.5 Voc, 9.33 Isc, from PV Module datasheet

$$34.5 \times 6 \times 1.15 = 238 \text{ Vmin}$$

$$9.33 \times (2-1) \times 1.25 = 11.66 \text{ Imin}$$

All electrical components on the circuit must have a voltage and current rating greater than 238V D.C. and have a current carrying capacity of greater than 11.66 amps.

Passive House Systems can be contacted for guidance when determining the component voltage ratings, conductor current ratings, fuse sizes and the size of controllers connected to the photovoltaic system.

Care is required when working with electric cables. Electrical connectors should never be opened or unplugged while the circuit is under load (when there is direct light on the panels). Extreme care should also be exercised not to touch the live cables during installations when the modules are exposed to daylight.

To protect the installer from current and voltage shock during installation, the DC cables should be first safely fitted into a junction box in the building before connecting the PV modules.

In addition, an opaque board can be used to cover the modules while making electrical connections. Only industry approved insulated tools shall be used during installation.

Earthing of the PV array shall be performed in accordance with IEC 62540. Earthing/bonding of exposed conductive parts of a PV array shall be performed by bonding of an earth cable to the metal frame.

The conductor used to earth exposed metallic frames of the PV array shall have a minimum size of 6mm<sup>2</sup> copper or equivalent.

If the PV array requires lightning protection a 16mm<sup>2</sup> copper conductor shall be bonded to the array and fitted to the existing Lightning protection system.

The Passive House Systems PV modules and inverters comply with the conditions specified in *CSN EN 50438: 2007* and are supplied with Irish electrical grid settings.

For safety, the inverters require a small mains current to operate, and in the event of loss of mains supplied electricity, they will not operate or generate electricity.

Fixings used with the PV solar collectors must comply with Clause 4.11 (fittings) and 5.9 (battens and counter-battens) of SR 82:2017. All tiles adjacent to the collectors shall be mechanically fixed in place and the fixing design shall comply with the requirements of SR 50-2:2011.

### 2.4.2 Pre-Installation

#### **Product Details**

The nameplate labels are affixed to the back of each module which provide the following information:

- Product Description
  - Rated power\*
  - Rated current\*
  - Rated voltage\*
  - Open circuit voltage\*
  - Short circuit current\*
  - Weight, dimensions etc.
  - A 15 digit barcode
- (\* measured under Standard Test Conditions)

Note: The value of VOC (voltage at open circuit) times the number of modules in series shall not be greater than the maximum system voltage marked in the nameplate (1000V DC).

The roof is assessed to establish the best position and orientation of the modules. To minimise uplift caused by wind loads, collectors shall not be installed within 0.5m from the edge of the roof or projection.

#### 2.4.2.1 Risk assessment

Before work commences on the installation, a health and safety risk assessment must be completed and recorded by the installer in the Risk Assessment Form. Items assessed to include:

- Safe access to the roof.
- Ability of roof structure to accommodate all applied loadings.
- Working at height.
- Manual handling.
- Working in dusty/dark/confined spaces.
- Lifting of materials including cranes, telehandlers and forklifts
- Working near or close to openings i.e. stair or loft openings.
- Safe access within lofts.
- Use of power tools.
- Effects of wind and snow loads.
- Fire mitigation.
- Fireman Safety
- Access for routing electrical cables.
- Protection from overhead wires.
- Any other risk associated with the installation.

Cautions to include:

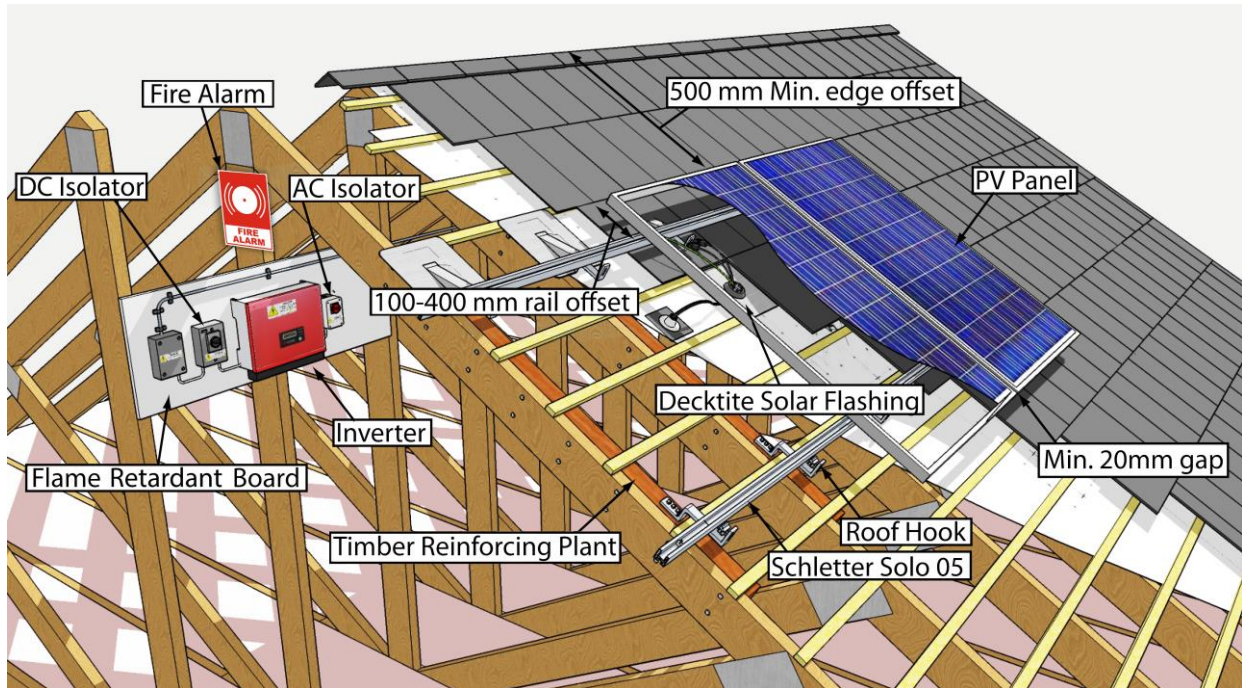
- Hardware used must be compatible with the mounting material to avoid galvanic corrosion.
- Only connectors that are designed for photovoltaic systems and that match the PV modules shall be used.
- Only specialist tools, as recommended by the connector manufacturer shall be used when making electrical connectors for panel.
- The maximum number of series connected modules, which depends on system design, the type of inverter used and environmental conditions, shall not be exceeded.
- The grounding cable must be properly fastened as referenced in 2.4.1
- As the supply from PV modules cannot be switched off, special precautions shall be made to ensure that live parts are either not accessible or cannot be touched during installation, use and maintenance.
- If the inverter is mounted in the loft it shall be within 1.5m from the DC cable point of entry. Otherwise a fireman switch shall be fitted, again, within 1.5m of the DC cable entering the loft.

- PV modules are current-limiting devices, which require a non-standard approach when designing fault protection systems. Fuses are not likely to operate under short-circuit conditions. DC Fuses are required when joining three or more strings of PV panels in parallel.
- If the building is deemed to require a lightning protection system (LPS), a suitably qualified lightning protection design professional shall be engaged. The advice of Passive House Systems shall be sought in such instances.

#### 2.4.3 Site Survey

Following completion of the initial risk assessment, a site survey must be carried out by the installer using the pre-installation survey form. Copies of this should be kept by the homeowner and installer. This survey will typically cover the following points:

- Verify details from the Solar Quotation Enquiry Form.
- Identification of any special user requirements.
- Shade, such as that cast from trees or neighbouring buildings can have a significant impact on the performance of a system. Both the current and the future potential risk should be considered.
- Suitability of roof (is the roof structure in good condition). Any timbers showing signs of damaged or rot must be replaced.
- The buildings location and orientation of the modules will have a significant effect on the power generated by the system. A south facing elevation at 35° pitch is ideal (south-east or south-west elevations can also achieve favourable results).
- The pitch of the roof is greater than 15° (5° if a flat roof mounted system utilised)
- The pitch of the roof is less than 70°.
- If the panels are required to go on two orientations, then each orientation should be split into two separate strings.
- Annual solar radiation for different roof pitch and orientation is given in Table 4.
- Access to collector location for both installation and maintenance.
- All DC cables should be installed to provide the shortest run possible. Positive and negative cables of the same string or main DC supply should be installed together, avoiding the creation of loops in the system. This requirement includes any associated earth/bonding conductors.
- A suitable location for the inverter, ideally in the loft mounted on a fireproof board (provided there is a safe means of access), alternatively in the utility room or next to the main consumer board.



**Figure 2: Roof fixing layout**

#### 2.4.4 Roof Fixings

Passive House Systems define the roof kit to be used, depending on the type of slate/tile used. Only approved Schetter roof brackets supplied by Passive House Systems shall be used. These are manufactured from stainless steel for tile roofs and high-grade aluminium for slate roofs. All roof fixings specified for types of all pitched roofs are MCS 012 certified. Isolation gaskets shall be used where necessary to ensure bi-metallic corrosion does not occur.

The PV modules and fixing bracket systems are designed to cover all Irish wind zones (as illustrated in figure NA.1 in Irish National Annex to EN1991-1-4, Eurocode 1). However, in high wind load areas, e.g. at excessive heights or very exposed areas, additional roof fixing brackets may be required. The advice of Passive House Systems shall be sought in all such instances, or if doubt exists.

Two bracket sets per collector are required as a minimum, dependant on the site-specific wind load analysis of the building. These brackets should be directly fixed into a timber reinforcing plants (not standard rafters or battens). See figure 2 and 4 and Cl. 2.4.5.2 of this certificate. The coach screw locations are pre-drilled with a 5mm drill bit, to prevent damaging the structure of the timber reinforcing plant when installing the 8mm x 60mm coach screw. The installer shall ensure the coach screws are securely fixed to the timber reinforcing plant.

Slates/tiles at fitting locations shall be trimmed or re-worked as required to accommodate non-transference of mechanical loads due to wind deflections. See figures 6 and 7.

A membrane grommet is installed beneath the PV modules to facilitate wire transit through the underlay. (See figure 8). This seals the wire penetration as required to maintain weather tightness of the roofing membrane.

Module bearing rail Schletter Solo 05, module clamps Schletter Rapid 2+ are used to secure PV modules to roof hooks.

#### 2.4.5 Solar PV Modules, Mounting Frame Installation

The complete procedure for the installation of the Solar PV modules and mounting frames are detailed in the Passive House Systems solar PV system Installation Manual.

The Schletter PV mounting frame consists of roof hooks specified to the roof finish, aluminium horizontal profile frames, anodised middle and end clamps. The aluminium horizontal mounting profiles are fixed to the roof hooks. The roof hook has a specialised clamp that fits into a slot on the lower side of the horizontal rail and clamps shut once the screw is tightened.

The solar PV Panels are supported on upper and lower aluminium profiles as per figure 2. The PV module is fixed to the profile with the special module clamps as shown in figure 3.



**Figure 3: Module Clamps**

**2.4.5.1 Timber reinforcing plant installation**

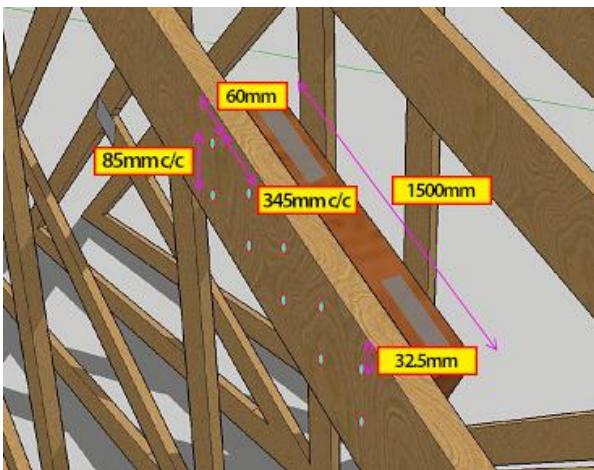
Solar collectors shall not be secured directly to rafter timbers and shall only be fixed via timber reinforcing plants to meet the requirements of SR 50-2: 2012.

**New build:**

The main contractor shall ensure that the roof, including any support system for the PV array, is designed and constructed to comply with the relevant technical specifications for the use of structural timber: I.S. EN 1995-1-1:2005 Eurocode 5. All other relevant requirements described for retrofit installation shall also apply.

**Retrofit installations:**

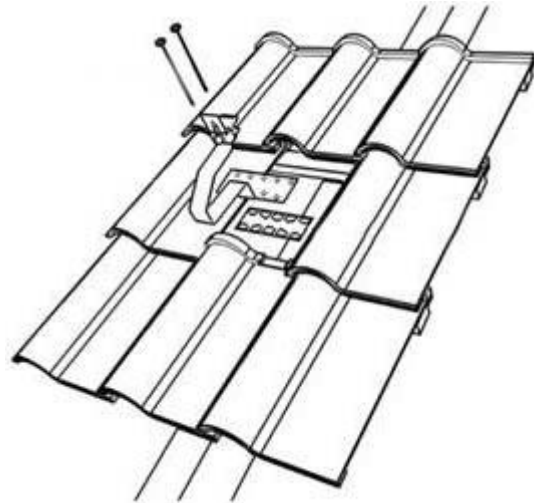
An assessment of the condition of the rafter timbers is part of the site survey report. Any timbers showing signs of damage or rot must be replaced. A single length of timber reinforcing plant (1500mm x 100mm x 75mm C24 grade timber) is installed as shown in Fig. 2 and Fig. 4 to accommodate each pair of hook fittings. Additional timber reinforcing plants can be installed as required to accommodate additional sets of fixings. The full details of the standard timber reinforcing plant design is available in Passive House Systems installation manual.



**Figure 4: Timber Reinforcing Plant Detail**

The timber reinforcing plant fixing design shall always be checked by a Chartered Structural Engineer for suitability in relation to the applicable point loads.

Any resulting modification required to the existing roof structure, shall form part of the structural design report and sign off documentation issued by the Structural Engineer. This should be completed prior to commencement of works.



**Figure 5: Roof Hook Fixing Detail**

**2.4.5.2 Roof Hook Fixing**

Passive House Systems supplies the Schletter range of MCS012 approved roof hook and fixings for securing the PV module mounting frame to the roof structure via the timber reinforcing plants.

The complete procedure for the installation of the solar PV roof hooks is detailed in the Passive House Systems solar PV system installation manual.

The roof hook is fixed directly into the timber reinforcing plant with a minimum of two coach screws into predrilled 5mm holes to avoid the timber splitting.

To meet minimum loading requirements, a minimum number of two roof hooks is required per PV module. Because the hook fixing is subject to deflection under wind load which could result in tiles/slates cracking, tiles/slates should be locally notched and cut as required by the installer to accommodate the roof hooks and flashing kits, however notches should not create excessive gaps, larger than those that naturally exist between tiles. Refer to figures 6 and 7 as an example of a notched tile.



**Figure 6: Tile Notching**



**Figure 7: Notched Tile**

For roofs incorporated single lapped or profiled tiles (Roman, Spanish, Mission etc.), consideration shall be given to the location of the hook fitting to minimise the interference/contact between the fitting and the tile. On profiled tiles, hooks should be installed to line up with the tile trough, notching to provide clearance with the hook fixing.



**Figure 8: Dektite Solar Flashing**

Passive House Systems supplies the Dektite solar flashing (See figure 8) to carry electrical cables through the roof into the loft space. This Dektite solar flashing is manufactured from a lead base material with a black EPDM cone and is AA fire rated when tested to BS 476-3:2004. The solar flashing will have a design life equivalent to the solar PV modules and must be inspected as part of routine maintenance on the system.

The Dektite lead apron is fitted in the same way as a conventional lead weathering slate and positioned beneath one of the PV panels to give added protection from wind driven rain and UV light.

A Passive House Systems felt grommet is positioned in the roofing breather membrane, higher up the roof than the Dektite solar flashing to facilitate the water-tight transit of the wires through the felt. See figure 9.



**Figure 9: Passive House Felt Gromit**

When installed in accordance with the installation instructions, this system creates a permanent seal which ensures the water-tightness of the external building envelope is maintained. Airtightness tapes can be added as required to reinstate the airtightness at all service penetrations.

Where existing insulation and/or plasterboard is displaced, or there is a break in the underlay, it must be replaced with similar material and made airtight. Passive House Systems recommends the Gerband range of seals and tapes for this purpose, where required.

#### 2.4.6 Flat Roof mounting system

The flat roof system is held in place by ballast, as calculated by the site specific wind load analysis in conformance with Eurocode 1. The ballast used is standard concrete blocks with a density of 960kg/m<sup>3</sup> placed within the ballast tray and on the base rail.

The use of ballast eliminates the need for roof penetrations. The minimum ballast weight is determined by Passive House Systems and the weight of the ballast will vary depending on the roof height, geographic location and position within the array, as the edge of the array will be subject to higher wind loads.

The ballast trays shall be configured to hold a maximum load of 100 kg/module. The load shall be distributed as required by the ballast distribution plan. Kit supplied roof protection pads shall be used to prevent damage to the roof waterproofing system. See figure 11.

For smaller systems Passive House Systems recommends the use of the Renusol CS+ mounting system. Passive House Systems shall specify the best suited mounting system dependant on a site-specific design. The PV panels are fixed to the support with standard module clamps.

The complete procedure for the installation of the flat roof mount solar PV systems are detailed in the Passive House Systems solar PV system installation manual.



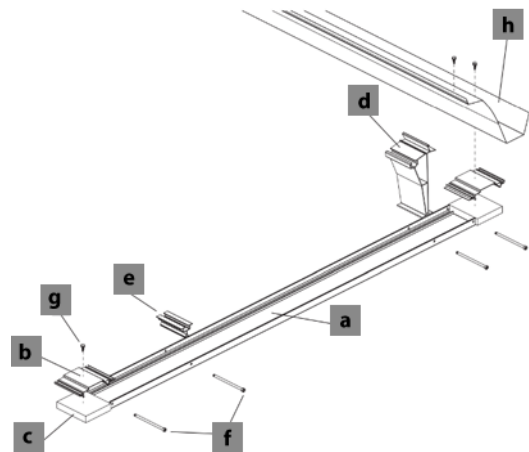
**Figure 10: Flat Roof Installation**

The flat roof mounting system design has been subject to simulation wind tunnel testing to determine the aerodynamic coefficients and designed with safety factors in accordance with Eurocode 0.

The calculation standards used in the design of the mounting system for the materials used include, Eurocode 9 - *Design of aluminium structures*, Eurocode 5 - *Design of timber structures* and Eurocode 3 - *Design of steel structures*

For new builds, the dead load of a PV panel and ballast shall be included in the structural design of the flat roof. For retrofit of roof installations, the adequacy of the roof structure to support the PV panel and ballast shall be assessed by a chartered structural engineer. If the flat roof is found to have insufficient structural capacity, remedial strengthening measures may be required before installation is commenced.

The PV system may only be mounted on sufficiently load-bearing roof surfaces and substructures. The structural load-bearing capacity of the roof and the substructure must be assessed at the installation site before mounting the PV system. The use a chartered structural engineer shall be used to assess and report on any remediation work required on the roof structure before work commences. The advice of Passive House Systems shall be sought in all such instances.



- a. Base rail
- b. Base rail connector
- c. Roof protection pad
- d. Tilt support
- e. Eave support
- f. Cylinder screws
- g. Self drilling screws
- h. Streamliner ballast tray

**Figure 11: Schletter Flat Roof Mounting Kit**

The flat roof mount system has been assessed by TÜV to qualify as a mounting system for PV modules.

#### 2.4.7 Wiring the Solar PV system

All electrical aspects of the installation should be undertaken in accordance with ETCI regulations by a qualified RECI electrical contractor.

An inverter must not be connected by means of a plug with contacts which may be live when exposed. AC cables are to be specified and installed in accordance with I.S. EN50438: 2013.

The AC cable connecting the inverter(s) to the consumer unit should be sized to minimise voltage drop. The volt drop must remain within voltage drop limits as prescribed by with *ET101*.



**Figure 12. DC and AC isolators**

The AC isolator switch shall clearly show the ON and OFF positions and be labelled as 'PV system – main AC isolator'. The DC isolator switch shall clearly show the ON and OFF positions and be labelled as 'PV system – main DC isolator'. Isolation and switching of both the AC and DC side of the installation shall also comply with the requirements of with ET101.

Cable protection from the inverter(s) must be provided at the distribution board. This protective measure shall be specified and installed in accordance with the requirements of IEC 60364, ensuring there is no requirement for additional overcurrent protection to be installed at the inverter end of the AC installation.

All the DC component ratings (cables, isolators/disconnectors, switches, connectors, etc) of the system must be derived from the maximum voltage and current of the relevant part of the PV array. String cables must be rated as detailed in Cl. 2.4.1 of this certificate

For every DC system, double insulation cabling must be applied as the method of shock protection. In this instance the use of suitably CE certified rated cables, connectors and enclosures along with controlled installation techniques are defined in ET101.

As per TGD part B Cl. 5.4.5.1, where Photovoltaic (P.V.) panels are provided on buildings, provision should be made for the isolation of the panel array externally in accordance with ET101.

The inverters are fitted with an anti-islanding feature (automatic disconnection of circuit) and require a live grid connection to function. Therefore, if the power is switched off at the mains, there will be no current downstream from the inverter. If the DC cable is more than 1.5 meters in length within the building, a fireman's safety switch shall be fitted within 1.5m of the point of entry of the DC cables, this will interrupt the DC current should the mains electricity be shut off. See figure 1.

Exterior cable colour coding is not required for PV systems. PV cables are black in colour to assist in UV resistance. For all cable runs, cables shall be labelled along the DC cables as follows: "Danger Live DC cable". Labels shall be fixed every 5 to 10m on straight runs, where a clear view is possible between labels

DC cables should be fitted with additional mechanical protection (installed in a Kopex sleeve) between the point of entry of the DC cables and the inverter location or the fireman safety switch.



**Figure 13**

PV DC cable runs should be kept as short as practical. Where multiple PV sub-arrays and/or string conductors enter a junction box - they should be grouped or identified in pairs so that positive and negative conductors of the same circuit may easily be clearly distinguished from other pairs.

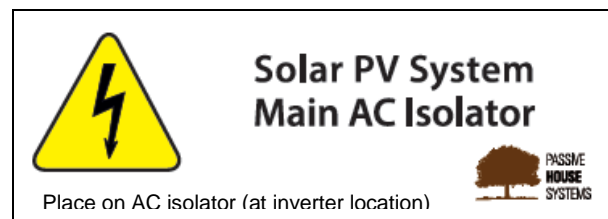
If there is more than one string, the DC junction box is normally the point at which they are connected together in parallel. The box may also contain string fuses and test points.

The DC junction box must be labelled as 'PV array DC junction box' and also labelled with 'Danger, contains live parts during daylight'. All labels must be clear, legible, located so as to be easily visible, and durably constructed and affixed to last the lifetime of the installation.

A PV system cannot be turned off – terminals will remain live at all times during daylight hours. It is important to ensure that anyone opening an enclosure is fully aware of this. The short-circuit protection afforded by the cable installation throughout the rest of the DC circuit needs to be maintained in the construction, and makeup of the DC junction box. (See *IEC 61140 4th Edition, January 1, 2016*).

To protect the AC system, when required, surge suppression devices may be fitted at the main incoming point of AC supply (at the consumer's cut-out). To protect the DC system, surge suppression devices can be fitted at the inverter end of the DC cabling and at the array.

An accessible means of AC isolation shall be provided in addition to the RCBO fitted in the consumer unit. The AC isolator shall be fitted adjacent to the inverter to allow for a means of isolation should the need arise for maintenance on the PV system. See figures 1 and 15.



**Figure 14: Example of Labelling**

This isolator shall be located in close proximity to the Inverter to fulfil the following requirements/conditions:

- To switch all live and neutral lines.
- To clearly show the ON and OFF positions. They shall be labelled as 'PV system – main AC isolator'. See figure 14.

Short-circuit protection shall be achieved by:

- Fabrication of the enclosure from non-conductive material.
- Positive and negative bus-bars and terminals adequately separated and segregated within the enclosure and/or by a suitably sized insulating plate, or separate positive and negative junction boxes.
- Suitably designed cable and terminal layouts to ensure that short-circuits during installation and subsequent maintenance are extremely unlikely.

The Goodwe string inverter contains a kWh meter and logs the daily and cumulative energy production of the PV system, which can be reviewed by the end user. In situations where the inverter is located in the loft or when micro-inverters are used, a Garo GM1D din-rail mounted kWh meter or similar may be installed in, or adjacent to the consumer unit to facilitate easy access to view the power production of the PV system.

Where there is a perceived increase in risk of direct lightning strike as a consequence of the installation of the PV system, specialists in lightning protection should be consulted with a view to installing a separate lightning protection system in accordance with I.S. EN 62305-1: 2011: *Protection against lightning: General Principles*.

#### **2.4.8 Inspection and Testing – DC Side (PV Array)**

The inspection and testing of the DC side of the PV system shall be performed in accordance with the requirements of BS 7671:2008+A3:2015 and I.S. EN 62446: 2016.

This inspection/verification sequence includes:

- Following an inspection schedule.
- Continuity test of protective earthing and/or equipotential bonding conductors (if fitted).
- Polarity test.
- String open circuit voltage test.
- String short circuit current test.
- Functional tests.
- Insulation resistance of the DC circuits.

These tests shall be recorded by the installer in the Passive House Systems, Solar PV Systems installation checklist and the PV array test report documents provided by Passive House Systems. Full details of the inspection schedule and guidance on test procedures are contained with I.S. EN 62446.

To allow for maintenance and inspection tasks to be carried out safely, a means of isolation needs to be provided on the DC side of an inverter. The means of isolation shall:

- Be readily accessible and immediately adjacent to or incorporated into the inverter
- The DC switch must isolate all live conductors (double pole to isolate PV array positive and negative conductors).
- The switch must be rated for DC operation at the system maximum voltage.
- The DC switch must be labelled as 'PV array DC isolator', with the ON and OFF positions clearly marked. Switch enclosures must also be labelled with 'Danger - contains live parts during daylight'. All labels must be clear, easily visible and durable. During routine maintenance, labels showing signs of degradation shall be replaced.
- An additional DC switch may be specified for systems with long DC cable runs (typically at the point of cable entry into the building) – so as to provide a means of isolating the cable for safety reasons or maintenance works.

Installations using micro-inverters shall omit the DC switch disconnecter where all of the following requirements are met:

- The micro-inverter is located immediately to the rear of the PV modules.
- The micro-inverter is plugged directly into the leads provided by the module manufacturer (no extensions to the leads may be used).
- The micro-inverter and DC cables are generally inaccessible or only accessible to trained or authorised personnel.
- The DC conductors between the module and micro-inverter are adequately protected against mechanical damage.

## **2.5 SYSTEM EARTHING**

### **2.5.1 DC Side Earthing**

As specified in IEC/TS 62548: Edition1.0., there are a number of possible PV array system earthing scenarios which can be summarized as follows:

- No earth connection.
- Hardwired connection of positive or negative conductor to earth.



- Centre tapped array – with / without earth connection.
- High impedance connection of positive or negative conductor to earth (for functional reasons).

Positive and negative cables of the same string or main DC supply should be bundled together, avoiding the creation of loops in the system. This requirement includes any associated earth/bonding conductors. Long cables (eg PV main DC cables over 50m) shall be installed in earthed metal conduit or trunking, or be screened (armoured) cables. In addition, all panels shall be bonded in order to avoid electrical potential differences.

A number of earthing or bonding options of the PV array exist as follows:

- Functional earthing of conductive non-current carrying parts (e.g. to allow for better detection of leakage paths to earth). Earthing/bonding of exposed conductive parts of a PV array shall be performed in accordance with IEC 62548 requirements.
- Earthing for lightning protection.
- Equipotential bonding to avoid uneven potentials across an installation.
- Functional earthing of one current carrying pole of the PV array - functionally earthed PV array.

An earth conductor may perform one or more of these functions in an installation. The dimensions and location of the conductor are dependent on its function.

### 2.5.2 Bonding conductor size

The conductor used to earth exposed metallic frames of the PV array shall have a minimum size of 6 mm<sup>2</sup> copper or equivalent. For some system configurations, the minimum conductor size may need to be larger due to lightning system requirements.

### 2.6 INVERTER LOCATION

The string inverters specified in this certificate are air cooled passively by natural convection of air on the heat dissipation fins on the rear of the inverter. It is important that the air flow is never impeded or blocked by other components or debris by adhering to the clearance advice in the inverter installation manual.



**Figure 15: Installed inverter with electrical isolators**

The inverter shall also be mounted on a fire-resistant material, preferably on a concrete or masonry wall. If this option is not available, the inverter shall be mounted on a fire resistant substrate fitted between the trusses in the loft to and sized to extend a minimum of 150mm beyond the edge of the inverter. See figures 2 and 15.

To comply with the requirements of TGD B to the Irish Building Regulations and ET101 a fire alarm shall be installed in the loft space where electrical installation have been installed. All installation details of the fire alarm shall comply with I.S. 3218:2013.

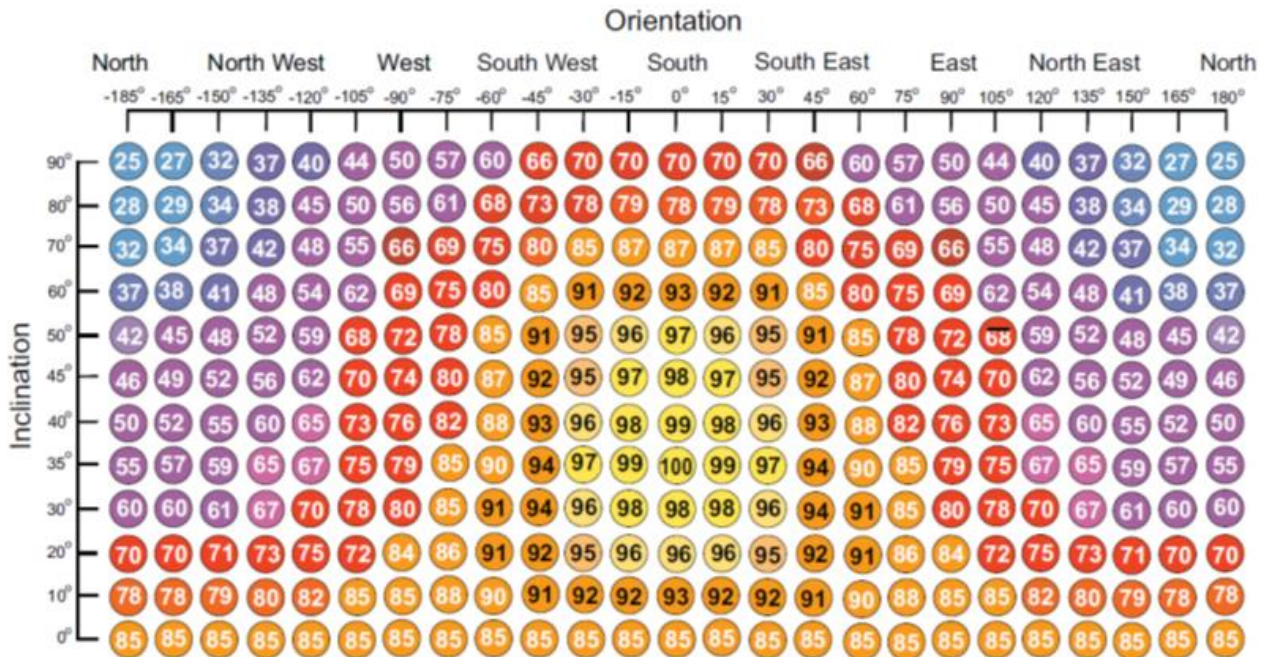
### 2.7 A.C CABLE PROTECTION

Protection for the cable from the inverter(s) must be provided at the distribution board. This protective measure shall be as specified and installed in accordance with the requirements of ET101. Passive House Systems recommend that the AC side of the system shall be protected by suitably sized 30mA B type RCBO in accordance with IEC 62423:2011.

A suitably sized DC Fuse will be required on each string if three or more strings of PV are connected in parallel. These fuses are normally housed within the DC junction box

### 2.8 SYSTEM PERFORMANCE

Shade makes a big impact on the performance of a PV system. Even a small degree of shading on part of an array can have a very significant impact on the overall array output. Shade is one element of system performance that can be specifically addressed during system design – by careful selection of array location, equipment selection and layout and in the electrical design (string design to minimise shade effects).



**Figure 16: Performance depending on Orientation and Inclination**

Shading from objects adjacent to the array (from vent pipes, chimneys satellite dishes, trees etc.) can have a very significant impact on the system performance. Where such shading is apparent, the array should be repositioned, or where possible, the object casting the shade should be relocated.

In Ireland the optimum orientation and tilt of an array is due south at 35°. Any deviation for this will result in a lower output as outlined in figure 16.

**2.9 COMMISSIONING**

The commissioning, testing and inspection of the system should comply with the requirements of IEC 62446:2016, including:

- Confirmation that all AC and DC wiring is correct and that no cable has been pinched or damaged during installation.
- Confirmation that all AC junction boxes are correctly installed and closed.
- Performing continuity test of protective earthing and/or equipotential bonding conductors (where fitted).
- Performing a polarity test.
- Performing a string open circuit voltage test.
- Performing string short circuit test.
- Performing an insulation resistance test on the DC circuit.
- Performing an inverter Loss of Mains test.
- Recording/Log the number of PV modules.
- Recording/Log the make and model of the inverter.

**2.9.1 Certification/Manuals/Warranty**

- The installer must complete the Commissioning Certificate which is contained in the Installation manual.
- The installer must complete the Maintenance Log, and locate it in a viewable position.
- The installer shall hand over the User Manual to owners, and instruct users on all aspects of the documentation and how to effectively use the solar equipment.
- Details of the Installation and Warranty conditions are located in the installation manual. The warranty card should be completed and sent to Passive House Systems with all relevant details completed.

**2.9.2 User Manual**

After commissioning, the user manual is provided to the homeowner. The user manual includes a recommended maintenance schedule, commissioning certificate, full contact details of the installer and guidance on the use of the PV system.

System installer information shall contain the following;

- A checklist of what to do in case of a system failure.
- Emergency shutdown/isolation procedures
- Maintenance and cleaning recommendations (if any).
- Considerations for any future building works related to the PV array (e.g. roof works).

- Warranty documentation for PV modules and inverters - to include starting date of warranty and period of warranty.

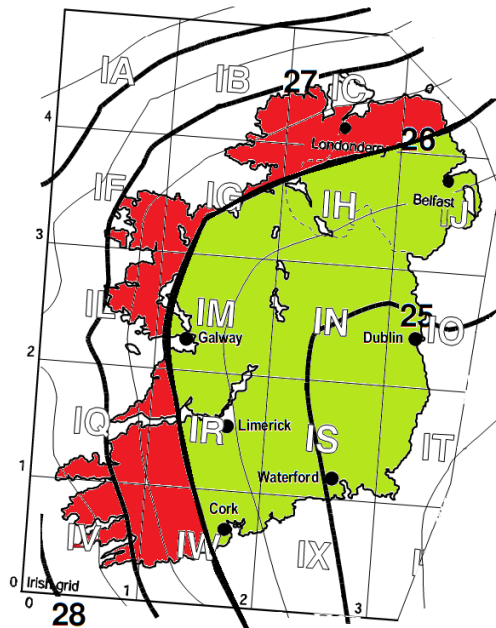
### **2.9.3 Decommissioning the System**

Due to the presence of AC and DC electrical power, only qualified persons should decommission a system.

When carrying out maintenance, the systems must be switched off using the installed AC and DC isolators. The maintenance pack provided by the installer to the homeowner shall be provided to those suitably qualified to perform maintenance on the PV system.

### **2.10 RETROFITTING/REPLACING**

The Passive House Systems range of PV Modules can be retrofitted onto existing roofs. Reference shall be made to Cl. 2.4 of this certificate and Passive House Systems installation manual for all conditions to be met.



**Figure 17: Basic Wind Velocity (ref. Irish National Annex to Eurocode 1)**

### 3.1 STRENGTH AND STABILITY

When mechanical load tested in accordance with I.S. EN 61215-2. The Passive House Systems solar PV modules achieved the maximum resistance to wind loading allowed by the standard of 5400 Pa positive pressure and 2400 Pa negative pressure without suffering any degradation in performance. Using a safety factor of 1.5 for positive pressure (S.R. 50-2) and a safety factor of 2 for negative pressure, Passive House Systems solar PV modules, can be deemed to withstand a positive pressure of up to 3,600 Pa and a negative pressure of up to 1,200Pa

Testing performed per Microgeneration Certification Scheme (MCS) 12 and EN 61215-2, in conjunction with calculations performed in accordance with, I.S. EN 1995-1-1: Eurocode 5, have shown that, provided timber reinforcing plants are used as detailed in Cl. 2.4.5.1 of this certificate (see also figures 2 and 4) in conjunction with Passive House Systems supplied roof hooks, mounting rail and module clamps, will adequately fix the panels to the pitched roof and resist the positive and negative loading up to the limits.

The collectors and the correct fixing bracket systems are designed to cover Irish wind zones 2 and 3 (as illustrated in figure NA.1 in Irish National Annex to Eurocode 1) up to an altitude of 150m, see figure 17. However, in wind zones 0 and 1, and in high wind load areas above 150m in altitude, at excessive heights or very exposed areas, wind loads should be calculated in accordance with I.S EN 1991-1-4: Eurocode 1. The advice of Passive House Systems shall be sought when the force acting upon the solar collector is calculated to be greater than the aforementioned values. In such cases, Passive House Systems will advise on additional fixings required.

To minimise the effect of wind load on the collectors, it is recommended that collectors are not installed within 0.5m of the roof edge, ridge, eaves or projections such as parapets, chimneys or dormer windows.

The host roof structure and any modifications necessary to accommodate the solar PV modules should be checked by a suitably qualified engineer in accordance with the Irish Building Regulations 1997 to 2017. The main building contractor must ensure that this has been done prior to commencing installation and the timber reinforcing plant installed as detailed in Cl. 2.4.5.1 of this certificate.

### 3.2 DESIGN CRITERIA AND TESTING

The electrical characteristics and performance of each of the Passive House Systems solar PV module designs are shown in Tables 2 to 5, however reference should be made to Cl. 2.8 of this certificate for factors that affect the efficiencies and performance of the system.

Reference should be made to Cl. 2.4 of this certificate for all aspects of wiring of the PV system, including lightning protection requirements where applicable.

The scope of testing per I.S. EN 61215, is to determine the electrical and thermal characteristics of the modules and to show their capability to withstand prolonged exposure to climatic conditions.

**Table 6: Testing per I.S EN 61215 <sup>(1)</sup>**

<b>Test Criteria</b>	<b>Result</b>
<b>Detailed inspection for visual defects</b>	Pass
<b>Maximum power determination</b>	Pass
<b>Insulation test</b>	Pass
<b>Measurement of temperature coefficients</b>	Pass
<b>Measurement of Nominal Operating Cell Temperature [NOCT, °C]</b>	Pass
<b>Performance at STC and NOCT</b>	Pass
<b>Performance at low irradiance</b>	Pass
<b>Outdoor exposure test</b>	Pass
<b>Hot spot endurance test</b>	Pass
<b>UV test</b>	Pass
<b>Thermal cycling test (200 cycles)</b>	Pass
<b>Humidity freeze (10 cycles)</b>	Pass
<b>Damp heat test 1000 hours</b>	Pass
<b>Robustness of terminations test</b>	Pass
<b>Wet leakage current test</b>	Pass
<b>Hail test 23m/s</b>	Pass
<b>Bypass diode thermal test</b>	Pass

<sup>1</sup> TÜV Nord test reports No. 492010435.003 and TÜV SÜD No. 70.406.13.574.01 refers.

#### 4.1 BEHAVIOUR IN RELATION TO FIRE

The roof covering on which the collectors are installed must have an AA, AB or AC rating as stated in Table 4.4 of TGD to Part B of the Building Regulations 1997 to 2017.

Each of the Passive House Systems solar PV modules have also been fire tested in accordance with I.S EN 61730-2. The MST 23 fire test is performed to determine the fire-resistance characteristics of the modules when exposed to a fire source originating from the outside of the building and consists of single burning brand and spread of flame tests. All modules in the Passive House Systems solar PV range achieved a Class C minimum fire resistance rating.

Multi-cable fire stops must be used to effectively seal cable bunches in electrical trunking and cable trays where they pass through fire rated walls and floors to meet the requirements of TGD Part B to the Irish Building Regulations.

See Cl. 2.6 of this certificate for issues related to the installation and location of the inverter and the requirement to install a fire alarm in the loft space of the building.

#### 4.2 WEATHERTIGHTNESS

The Passive House Systems range of PV Modules are fixed to the roof structure using roof hook fittings as described in Cl. 2.4.5.2 of this certificate. By locally trimming the slate /tile to accommodate the fitting all unprotected gaps caused by the mounting and installation arrangement shall be no greater than those pre-existing before their installation. The Schletter roof hook system has been tested in accordance with the requirements of CEN/TR 15601:2012 and MCS 012.

As part of their installation kit, Passive House Systems supplies the Dektite solar flashing for the cables from the PV panels that pass through the roof, (See figure 8). This flashing is located under the installed panels for additional protection from the elements. A Passive House Systems felt collared grommet is installed on the roofing felt to facilitate the water-tight transit of the wires through the felt. See figure 9.

Completed roofs will provide adequate resistance to weather ingress, when installed in accordance with this Certificate and Passive House Systems installation instructions. Particular attention should be paid to correct installation of all components and to the detailing and positioning of gaskets/grommets where cables enter the building.

The Passive House Systems range of PV Modules have also been subjected to the weather related tests per I.S. EN 61215 as listed in the Table 6 of this certificate.

#### 4.3 MAINTENANCE

All maintenance should only be carried out by a suitably qualified person approved by Passive House Systems. The electrical and mechanical connections shall be periodically checked to make sure they are clean, safe, complete and secure, including the mechanical fixing to the roof structure. In the event of a problem, a suitably qualified PV design professional shall be engaged or Passive House Systems shall be contacted. High-voltage gloves and glove protectors must always be worn when working on live high-voltage DC circuits. The front surface of the modules should be covered by an opaque cloth or other material before any maintenance commences on the live portion of the circuitry. Fall-protection equipment, including harnesses, safety lines, and proper anchoring systems, shall also be used.

The inverter status should also be periodically checked including, voltage levels, frequency level and current power generation levels during daylight hours, to ensure that the system is operating correctly. If any anomalies are noted, the installer/commissioner or Passive House Systems should be contacted.

The homeowner should be aware of any shading developing, i.e. from trees or vegetation growing in the vicinity. Shade from such vegetation can have a significant impact on the performance of a system.

Any build-up of dirt, dust, bird droppings etc., that is not washed away by rain, can also affect the performance of the modules. In such instances, the panel may require washing. Passive House Systems recommend that the PV modules to be cleaned with cold water when required. Climbing onto the roof is to be avoided and the services of a qualified professional who is trained in occupational health and safety procedures to clean the PV modules is highly recommended.

#### **4.4 DURABILITY**

The PV modules have been assessed for durability in accordance with I.S. EN 61215: 2005. Passive House Systems warrants the power output from the PV modules to 90% of nominal after 10 years and 80% after 25 years. The terms of the warranty are outside the scope of this certificate

The string inverters offered by Passive House Systems have a warranty that extends to ten years and may need replacing after this time period. The micro-inverters offered by Passive House Systems have a warranty that extends to 20 years and have a design/service life comparable to the life of the PV modules.

The structural durability of the Passive House Systems solar PV module, fixings, flashing, etc., has been assessed, and if maintained as per the maintenance schedule, should have a design life equivalent to that of the roof structure on which they are incorporated.

#### **4.5 END OF LIFE**

Disposal of any components must comply with the Waste Electrical and Electronic Equipment (WEEE) and Restriction of Hazardous Substances (RoHS) directives established in 2003.

#### **4.6 OTHER INVESTIGATIONS**

- (i) Existing data on systems properties in relation to fire, electrical safety, performance, durability and the mechanical strength/stability of the PV modules and system components were assessed.
- (ii) The manufacturing process of each of the module designs were audited and examined including the methods adopted for quality control and details were obtained of the quality and composition of the materials used.
- (iii) Site visits were conducted to assess the practicability of installation as well as the history of performance in use of the product.
- (iv) An assessment was also performed on all installation control paperwork and well as training and technical support offered to installers registered with Passive House Systems

**5.1** National Standards Authority of Ireland ("NSAI") following consultation with NSAI Agrément has assessed the performance, method of installation of the product/process and the quality of the materials used in its manufacture, and certifies the product/process to be fit for the use, for which it is certified, provided that it is manufactured, installed, used and maintained in accordance with the descriptions and specifications set out in this Certificate and in accordance with the certificate holders instructions remain valid for five years from date of issue so long as:

- (a) the specification of the product is unchanged;
- (b) the Building Regulations 1997 to 2017 and any other regulation or standard applicable to the product/process, its use or installation remains unchanged;
- (c) the product continues to be assessed for the quality of its manufacture and marking by NSAI;
- (d) no new information becomes available which in the opinion of the NSAI, would preclude the granting of the Certificate;
- (e) the product or process continues to be manufactured, installed, used and maintained in accordance with the description, specifications and safety recommendations set out in this certificate;
- (f) the registration and/or surveillance fees due to NSAI Agrément are paid.

**5.2** The NSAI Agrément mark and certification number may only be used in relation to product/processes, in respect of which a valid Certificate exists. If the Certificate becomes invalid the Certificate holder must not use the NSAI Agrément mark and certification number, and must remove them from the products already marked.

**5.3** In granting Certification, the NSAI makes no representation as to:

- (a) the absence or presence of patent rights subsisting in the product/process;
- (b) the legal right of the Certificate holder to market, install or maintain the product/process;
- (c) whether individual products have been manufactured or installed by the Certificate holder in accordance with the descriptions and specifications set out in this Certificate.

**5.4** This Certificate does not comprise installation instructions and does not replace the certificate holders directions or any professional or trade advice relating to use and installation which may be appropriate.

**5.5** Any recommendations contained in this Certificate relating to the safe use of the certified product/process are preconditions to the validity of the Certificate. However, the NSAI does not certify that the manufacture or installation of the certified product or process in accordance with the descriptions and specifications set out in this Certificate will satisfy the requirements of the Safety, Health and Welfare at Work Act 2005, or of any other current or future common law duty of care owed by the manufacturer or by the Certificate holder.

**5.6** The NSAI is not responsible to any person or body for loss or damage including personal injury arising as a direct or indirect result of the use of this product or process.

**5.7** Where reference is made in this Certificate to any Act of the Oireachtas, Regulation made thereunder, Statutory Instrument, Code of Practice, National Standards, certificate holders instructions, or similar publication, it shall be construed as reference to such publication in the form in which it is in force at the date of this Certification.



## **Bibliography**

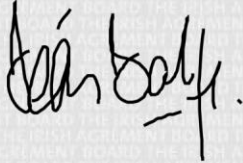
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- SR 82:2017, *Irish code of practice – Slating and Tiling.*
- SR 50-2:2012 *Code of practice for building services – Part 2: Thermal solar systems.*

## NSAI Agrément

This Certificate No. **18/0395** is accordingly granted by the NSAI to **NZEB Products Ltd T/A Passive House Systems** on behalf of NSAI Agrément.

Date of Issue: **8<sup>th</sup> January 2018**

Signed



**Seán Balfe**  
**Director of NSAI Agrément**

Readers may check that the status of this Certificate has not changed by contacting NSAI Agrément, NSAI, 1 Swift Square, Northwood, Santry, Dublin 9, Ireland. Telephone: (01) 807 3800. Fax: (01) 807 3842. [www.n Sai.ie](http://www.n Sai.ie)