

Solex Energy Ltd

Solar PV Tile Installation Manual

Version 5 – 06/12/2023



Overview

Solex Solar Tiles offer an alternative to conventional solar panels for new roof applications.

They use the same technology as modern solar panels – monocrystalline half cells – and produce electricity in the same way. The difference is that they form the actual roof covering, replacing conventional tiles.

The tiles connect together using industry standard MC4 compatible connectors, and are usually connected to a string inverter, with or without optimisers.

Planning the Work

Planning Permission

Fitting solar roofing to a dwelling house or a block of flats, or to a building within its curtilage:

- Applies to all buildings, including in conservation areas, excluding listed buildings
- Installing solar roofing is considered permitted development and so does not require planning permission – see the General Permitted Development Order (GPDO), Schedule 2, Part 14, Class A

Fitting solar roofing to a non-domestic building:

- Applies to all non-domestic buildings, except listed buildings
- Excludes buildings on Article 2(3) land which is:
 - Areas of Outstanding Natural Beauty AONB
 - Land within a National Park
 - Conservation Areas
 - The Broads
 - World Heritage Sites
- Installing solar roofing is considered permitted development and so does not require planning permission – see the General Permitted Development Order (GPDO), Schedule 2, Part 14, Class J
- A condition of this right is that it is not installed within 1m of the edge of the roof

Skills Required

The Solex PV roof tile system can be fitted by a solar installer competent at fitting double lapped slates, or a solar installer and roofer working together. In general:


- The battens and tiles should be installed by a roofer under the guidance given in the manual
- The connection of the solar tiles should be by, or under the guidance of, a solar installer
- All internal electrical wiring and components should be installed by a solar installer

Roof Requirements

The roof must conform to these requirements:

- 25 x 50mm timber roofing battens graded to BS5534
- Max 600mm horizontal batten fixing centres
- Vertical battens centres in the range 250mm to 265mm
- Compatible interlocking slates (if required) 300mm x 600mm
- Minimum 25mm space under battens to thread cables and connectors.
- Roof pitch between 22° and 90° (8°-22° using a waterproof layer beneath)

Designing the Roof PV Tile Area – Staggered or Inline

<p>Staggered Arrangement</p> <ul style="list-style-type: none"> • This is most suited to whole roof applications, and is suited to simple shaped roofs with few obstructions and penetrations • Coverage can be from eaves to ridge and verge to verge/hip/valley etc. • Blank matching tiles supplied for cutting in details/hips/valleys etc • Verge cappings supplied • Output of 172-180 Wp/m² 																					
<p>Vertical Coverage</p> <p>Vertical coverage is in batten spacing increments which may fall in the range 250 – 265mm</p> <p>Note that one tile covers two batten spaces. For 15 batten spaces/roof courses you will need 7.5 tiles – 7 standard tiles and one half tile*</p> <p>*Half tiles used in the staggered arrangement only</p>	<p>Horizontal Coverage for Staggered</p> <table border="1" data-bbox="842 727 2078 847"> <tr> <td>Tiles</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> <td>9</td> </tr> <tr> <td>Coverage</td> <td>1200</td> <td>2250</td> <td>3300</td> <td>4350</td> <td>5400</td> <td>6450</td> <td>7500</td> <td>8550</td> <td>9600</td> </tr> </table> <p>Note: 900 tiles cover 750 width and 600 tiles cover 450 width</p>	Tiles	1	2	3	4	5	6	7	8	9	Coverage	1200	2250	3300	4350	5400	6450	7500	8550	9600
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<p>Inline Arrangement</p> <ul style="list-style-type: none"> • This is most suitable for creating a solar area within a larger slated roof area • Often used to inset a solar area within a complex roof shape • The solar tiles lap seamlessly with the surrounding natural or artificial slates • Output of 150-158Wp/m² 	<p>Horizontal Coverage for Inline</p> <table border="1" data-bbox="842 1107 2078 1227"> <tr> <td>Tiles</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> <td>8</td> <td>9</td> </tr> <tr> <td>Coverage</td> <td>1200</td> <td>2412</td> <td>3624</td> <td>4836</td> <td>6048</td> <td>7260</td> <td>8472</td> <td>9684</td> <td>10896</td> </tr> </table> <p>Note: 900 tiles cover 912 width and 600 tiles cover 612 width</p>	Tiles	1	2	3	4	5	6	7	8	9	Coverage	1200	2412	3624	4836	6048	7260	8472	9684	10896
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Power Output

As a guide our Solar Tiles output 155-180Wp/m² depending on installation type. This is a guide figure for best performance in full sun, and is comparable with the quoted output of other solar panels on the market (i.e. tested under the same conditions).

It is beyond the scope of this guide to recommend or specify inverters, optimisers, batteries, isolators or other controls. It is assumed that a qualified person is installing the system and will specify the other components as required, with reference to our tile specifications:

Electrical Connections Layout

- It is recommended that for ease of installation the tiles are connected vertically where possible.
- The tiles are connected in series to achieve the inverter input voltage required and/or permitted
- A maximum voltage of 1000V per string is permissible, however usually working with lower maximum voltages is desirable
- Identical voltage strings may be paralleled and fed into an inverter MPP tracking input
- Non identical strings (or strings where shading may occur) should be fed into separate MPPT inputs
- Optimisers may be specified and fitted with reference to the tile voltages and optimiser specifications
- Typical sub-strings lengths of 2 to 5 tiles are fed into optimisers

Use the specifications at the end of the manual to work out the string(s) layout

Tools and Materials

- Impact driver with pozi-drive bits (PZ2)
- Chalk line for setting out tile fixings
- Scissors for cutting spacers
- Tape measure
- MC4 connectors
- Connector crimping tool
- Solar cable as required
- White spirit to remove foam adhesive
- Hacksaw or small grinder for cutting verge capping at the ridge, if applicable
- Utility knife for cutting spacer lugs in systems lapped with slate

Delivery and Storage of Materials

- Storage of solar roof tiles and associated materials must be in a dry place
- Do not stack more than 2 boxes of panels high
- Ideally tile packing crates should be forklifted onto scaffolding just before use

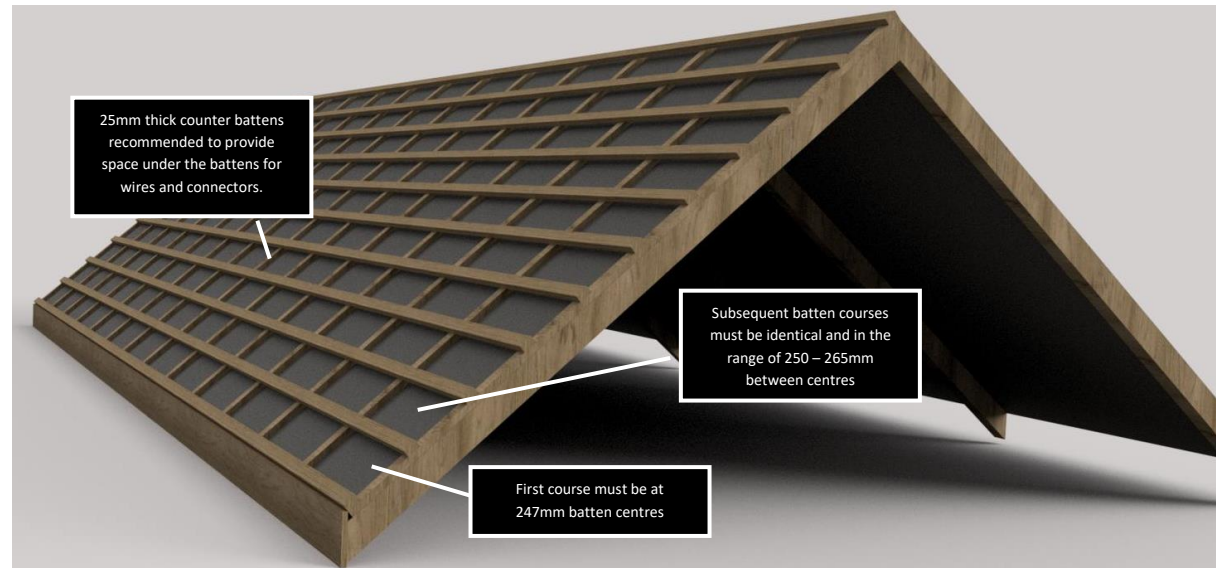
Sitework & Health and Safety Considerations

- When handling tiles avoid touching the corners or edges of the tiles against hard materials e.g. scaffolding or masonry, as this can shatter the tile
- If you need to stack the tiles loose, do not stack on hard materials. Stack them on their edges on wooden bearers e.g. batten offcuts
- Be aware that the panels are large and the wind can easily overturn loose panels and flip them off the roof or scaffolding
- When several panels are connected together in a string the end connectors carry a dangerously high DC voltage

Installation – Whole Roof Applications

Battening Out

- 25 x 50mm timber battens to BS5534
- Max 600mm horizontal batten fixing centres
- Minimum 25mm space under battens to thread cables and connectors
- First batten tight against fascia
- First two battens at 247 centres
- Subsequent battens centres identical and in the range 250mm to 265mm
- Spacing accurate to at least a couple of mm
- Membrane above or below counterbattens as required – below is easier

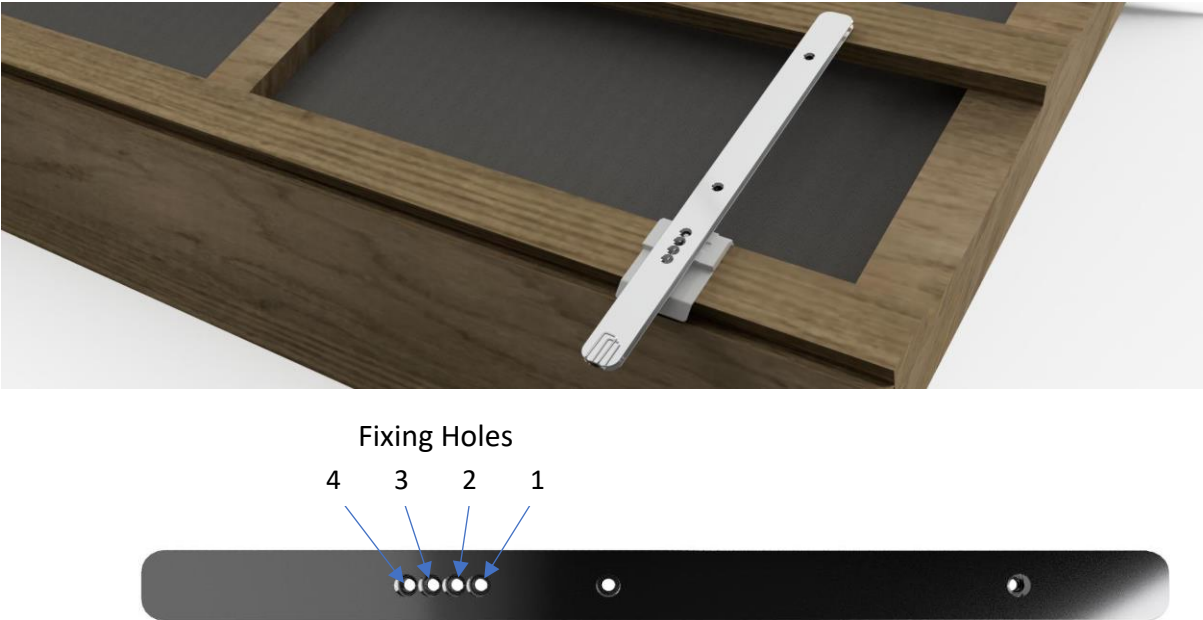


Batten Centre Calculation

Use this formula to ensure complete eaves to ridge coverage in whole courses

Use the length up the rafters from the back of the fascia board to the front of the ridge board

$$\frac{(\text{Rafter Length in mm} - 297)}{(\text{Number of Courses} - 1)} = \text{Batten Spacing Centres to use}$$

<p>Batten Centres Range</p> <p>Solar Tiles may be installed at any headlap in any exposure area</p> <p>The headlap in the table may be relevant where compatible conventional slates are used on the same roof face</p>	<table border="1"> <thead> <tr> <th>Batten Centres</th> <th>Headlap</th> </tr> </thead> <tbody> <tr> <td>249</td> <td>[not permitted]</td> </tr> <tr> <td>250</td> <td>100</td> </tr> <tr> <td>251</td> <td>98</td> </tr> <tr> <td>252</td> <td>96</td> </tr> <tr> <td>253</td> <td>94</td> </tr> <tr> <td>254</td> <td>92</td> </tr> <tr> <td>255</td> <td>90</td> </tr> <tr> <td>256</td> <td>88</td> </tr> <tr> <td>257</td> <td>86</td> </tr> </tbody> </table>	Batten Centres	Headlap	249	[not permitted]	250	100	251	98	252	96	253	94	254	92	255	90	256	88	257	86	<table border="1"> <thead> <tr> <th>Batten Centres</th> <th>Headlap</th> </tr> </thead> <tbody> <tr> <td>258</td> <td>84</td> </tr> <tr> <td>259</td> <td>82</td> </tr> <tr> <td>260</td> <td>80</td> </tr> <tr> <td>261</td> <td>78</td> </tr> <tr> <td>262</td> <td>76</td> </tr> <tr> <td>263</td> <td>74</td> </tr> <tr> <td>264</td> <td>72</td> </tr> <tr> <td>265</td> <td>70</td> </tr> <tr> <td>266</td> <td>[not permitted]</td> </tr> </tbody> </table>	Batten Centres	Headlap	258	84	259	82	260	80	261	78	262	76	263	74	264	72	265	70	266	[not permitted]
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<p>Solar Tile Fixings</p> <p>The aluminium support bars are assembled with the plastic spacers before use</p> <p>The spacers are fitted to the correct holes in the support bar which depends on the batten spacing</p> <p>The exception is the eaves course which always uses hole 1</p> <p>The spacers are fitted to the support bars so there is a clear hole for the screw through the correct hole</p> <table border="1" data-bbox="237 1075 725 1318"> <thead> <tr> <th>Batten Spacing Centres (mm)</th> <th>Support Bar Hole Number</th> </tr> </thead> <tbody> <tr> <td>250 – 252</td> <td>1</td> </tr> <tr> <td>253 – 256</td> <td>2</td> </tr> <tr> <td>257 – 260</td> <td>3</td> </tr> <tr> <td>261 – 265</td> <td>4</td> </tr> </tbody> </table>	Batten Spacing Centres (mm)	Support Bar Hole Number	250 – 252	1	253 – 256	2	257 – 260	3	261 – 265	4																																
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Installing the Fixings

Start at a bottom corner by a verge or gable.

Work out where the first tile will start. Look at the sections below on verge capping and verge overhang to work out this start point

Mark out the position of the first tile from this start point: 1200 – 1070 – 625 – 180 – 0

At the top of the roof mark the 1200 and 1070 points and run chalk lines between

Accuracy in setting out is of the utmost importance, especially the 1070 line, as this sets the side lap to the next column. If there is too much side lap then shading of cells could occur with output losses.

Install three support bars as shown with the edge of the spacer on these points. Use the 45x4 pozi stainless screws (supplied). **Remember Hole 1 for all support bars at the eaves**

If the screw falls on a joint between two battens use a 60x4 screw instead

If marking out for 900 tiles use these figures:
900 – 770 – 475 – 180 – 0

If marking out for 600 tiles use these figures:
600 – 470 – 180 – 0



Installing the First Tile

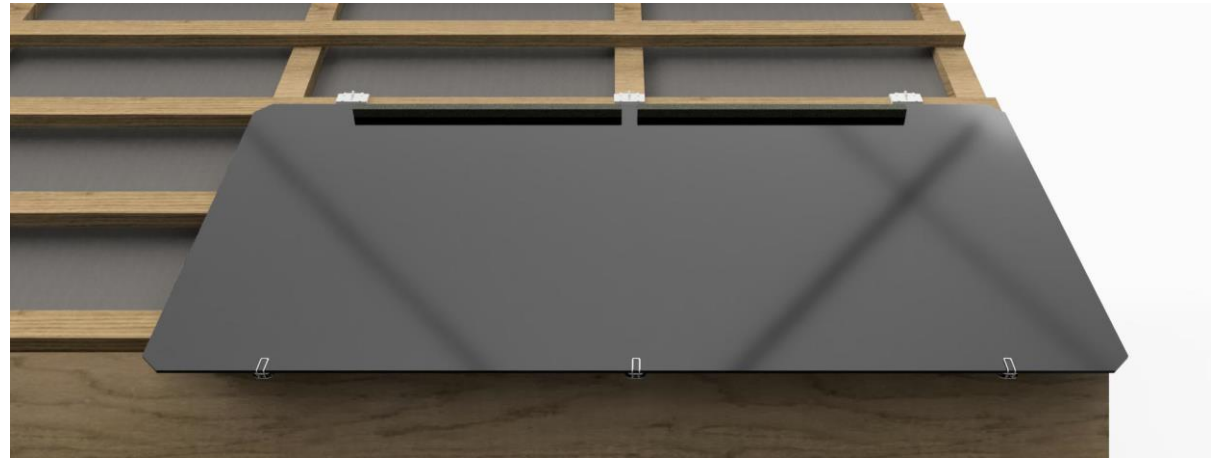
Fit a tile onto the hooks on the first three bars

Lay it back onto the roof and feed the cables under the battens so they are available to connect up where required, depending on the stringing layout

Remove the diagonal foam strip (not shown here) from the tile by the roof edge. Use white spirit if required to remove the adhesive

Fit a horizontal foam strip in its place (supplied) to match the rest of the top foam strip

If verge capping is being used this is ideally fitted at the same time, as then the foam strip can be fitted over the capping



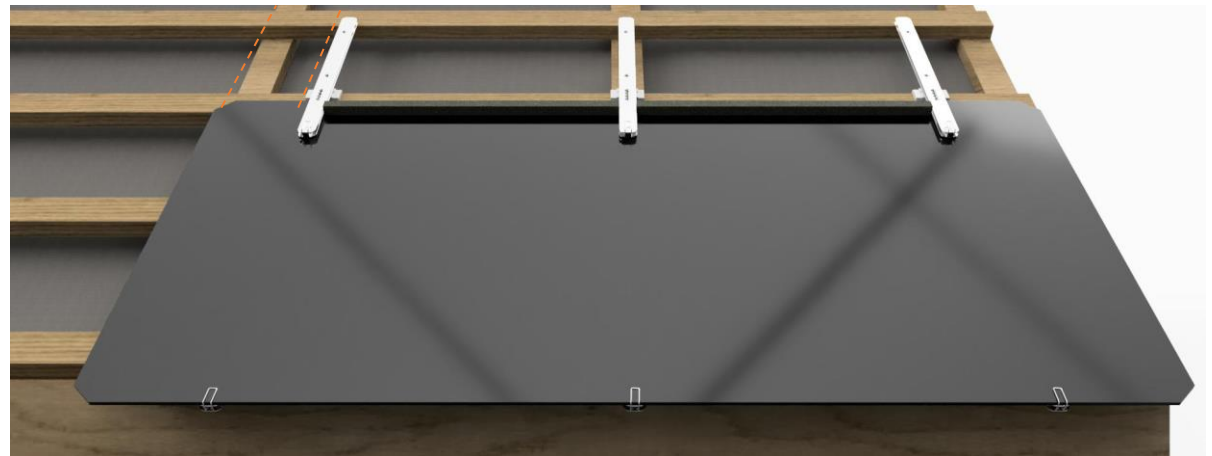
Installing the Fixings for the Second Tile

Fit the next row of three support bars

These should all have been preset at Hole 1, 2, 3 or 4 as in the table above

One support bar must be accurately on the chalk line, the other two can be positioned using the foam for guides

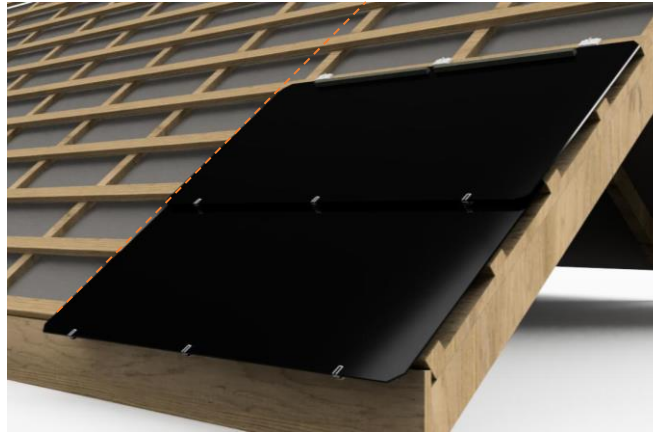
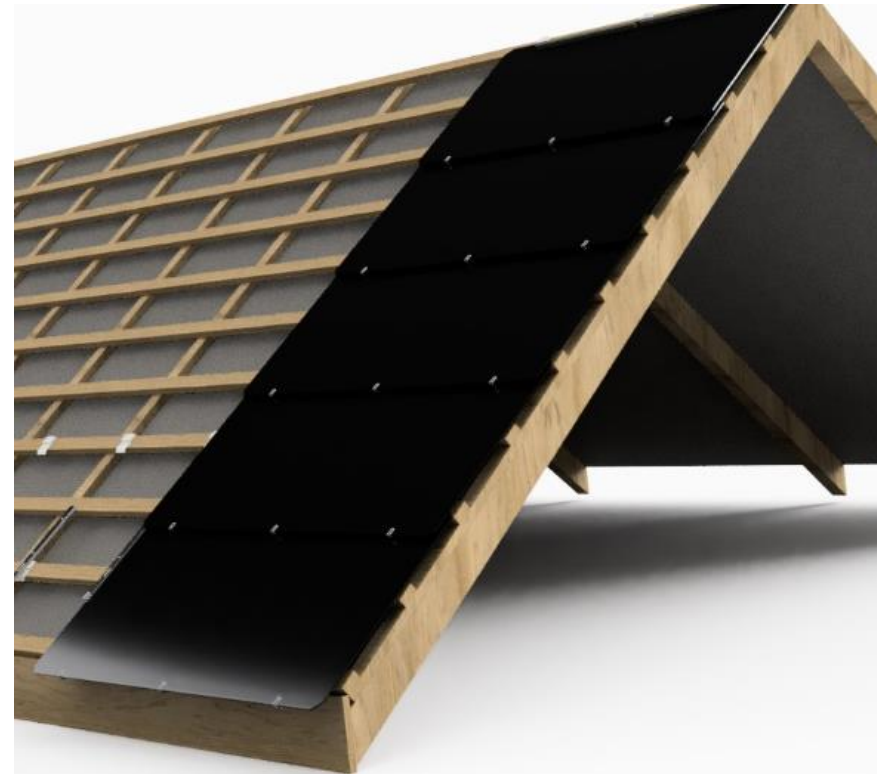
The flanges of the spacers must be pushed under the top edge of the tile, so the spacers sit flat on the batten



Fitting the Second Tile

Fit the second tile as above, connecting one cable to the tile below and leaving one for the tile above

Use the 1200 chalk line to check the tile positioning

**Complete the Column to the Ridge**

Retaining the Top Tile

At the ridge fit three spacers with stainless ridge clips as shown

This assumes you have finished on a whole tile as opposed to a half tile

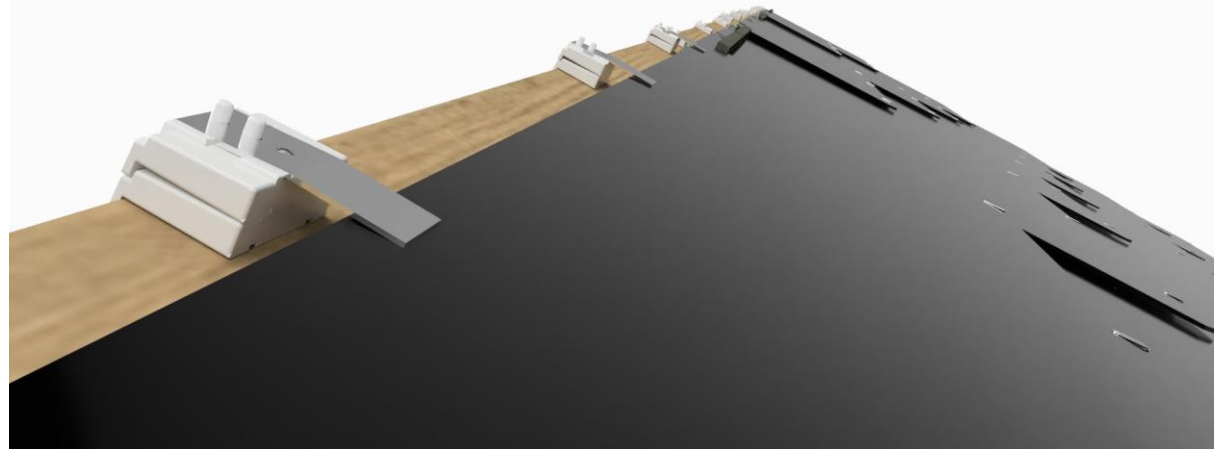
**Ending a Column with a Half Tile**

Every second column will end on a half tile

Fit the support bars in the normal way and fit the half tile

Cut the flanges off 6 spacers and screw them on in pairs with ridge clips as shown

Remove the diagonal foam strips from the half tiles, as they are not required



Ridge Tile Fitting

The way the solar tiles lap means that there is a significant step at the ridge between alternate columns.

To alleviate this we supply black acrylic packing strips to maintain a constant line for the ridge tiles. We supply 900 long acrylic strips and a 1050 long strip for the first column

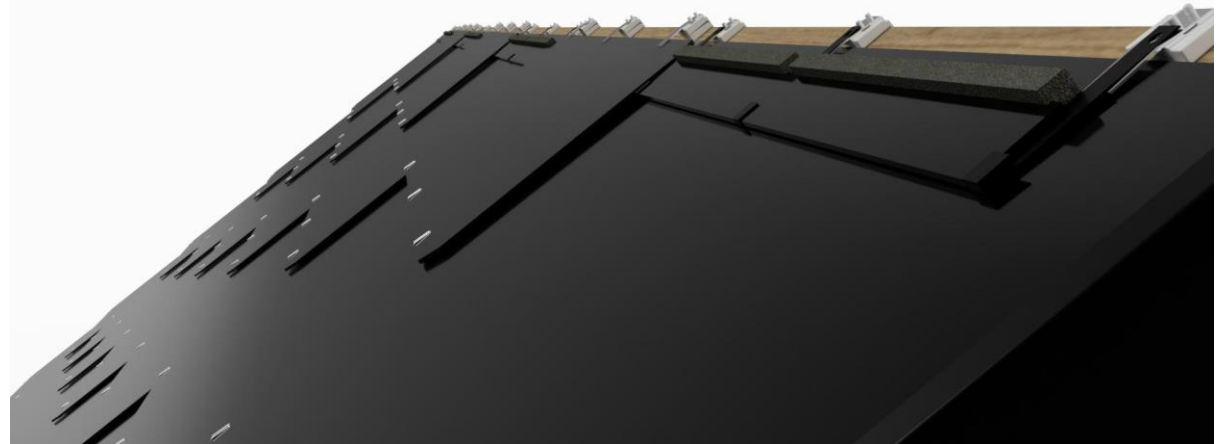
Hang the strips with the stainless hooks supplied, which are fixed over the ridge clips

Over this fit your dry fit ridge system and ridge tiles

Very Important – the ridge and/or fixing system must not shade the top row of solar cells of any of the solar tiles



Roof Ready for Ridge Tiles



Marking Out the Second Column

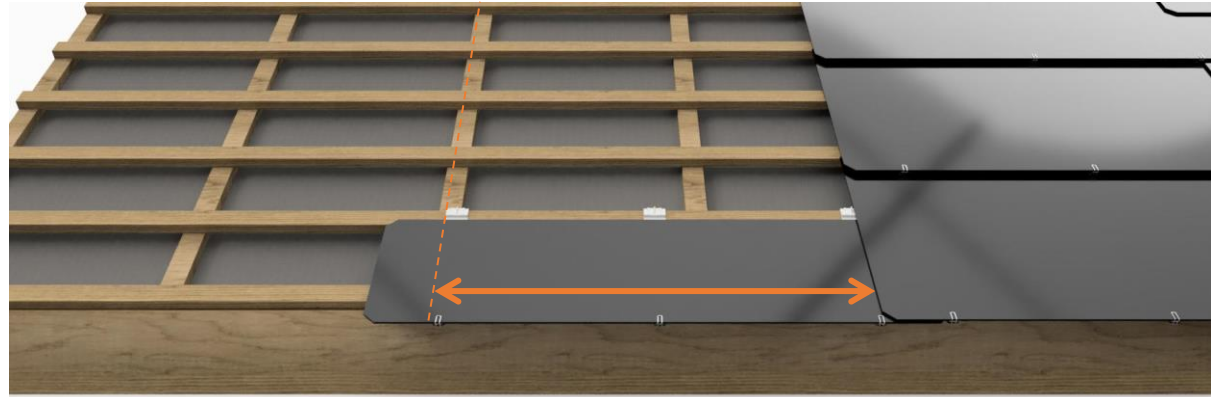
Mark out the second column spacers at 920 from the first column tile edges

Accuracy is important to prevent cell shading

Alternatively the whole roof can be lined out from the start. If doing this use these measurements:

0 – 180 – 635 – 1070 – 1200 – 2120 – 3170 – 4220
 – 5270 – 6320 – 7370 – 8420 – 9470 – 10520 –
 11570 – 12620 – 13670 – 14720 – 15770 – 16820

For longer roofs just keep adding 1050



Half Tile at the Eaves

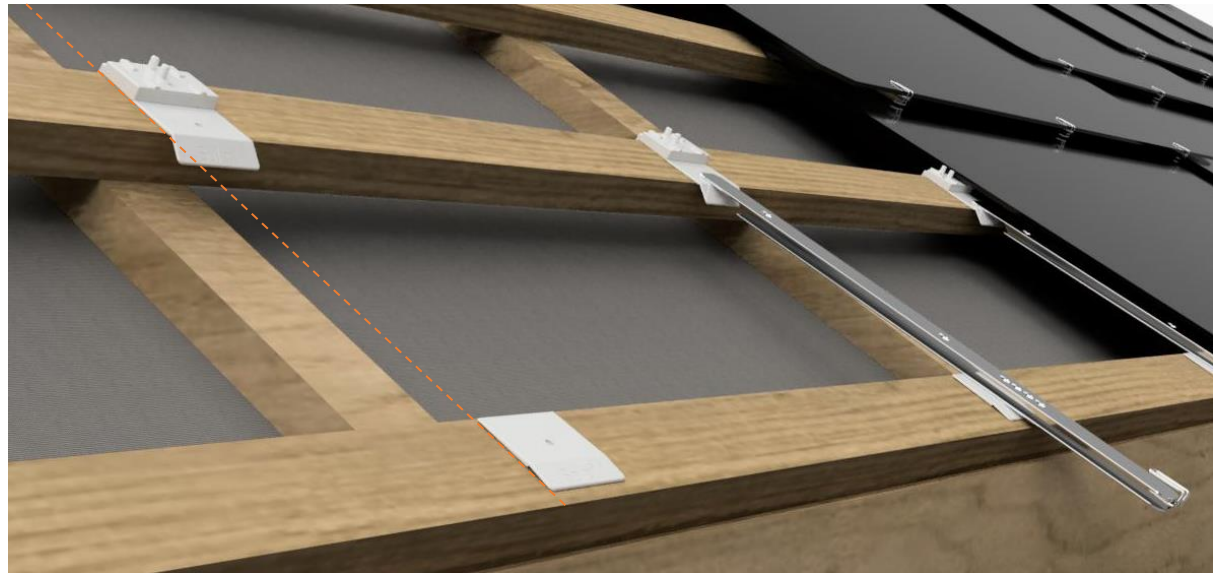
At the start of the second column you will need a half tile

Half tiles at the eaves (not at the ridge) sit on special support bars as shown

They also sit on cut down spacers – cut the flanges off 3 spacers with scissors and use these. Position these spacers flush with the top of the batten

- The LH spacer/support bar goes on the line
- The RH spacer/support bar goes as close as reasonable to the RH tile
- The Mid spacer goes midpoint between

Use Hole 1 for these eaves support bars



Fitting the Second Column Tile

Fit the tile into the hooks, and push it sideways until it stops in the flanges of the support bar under the adjacent column tile

The first column support bars determine the position of the second column tiles – hence the accuracy required in setting out



Installing the Next Tile

Install the support bars for the next tile

- Use the line to position the LH bar
- Use the foam to position the Mid bar
- Push the RH bar up to the adjacent column tile

The spacer flanges must go **under** the eaves support bars (see image, two above)



Install the Second Column Tiles



Verge Capping

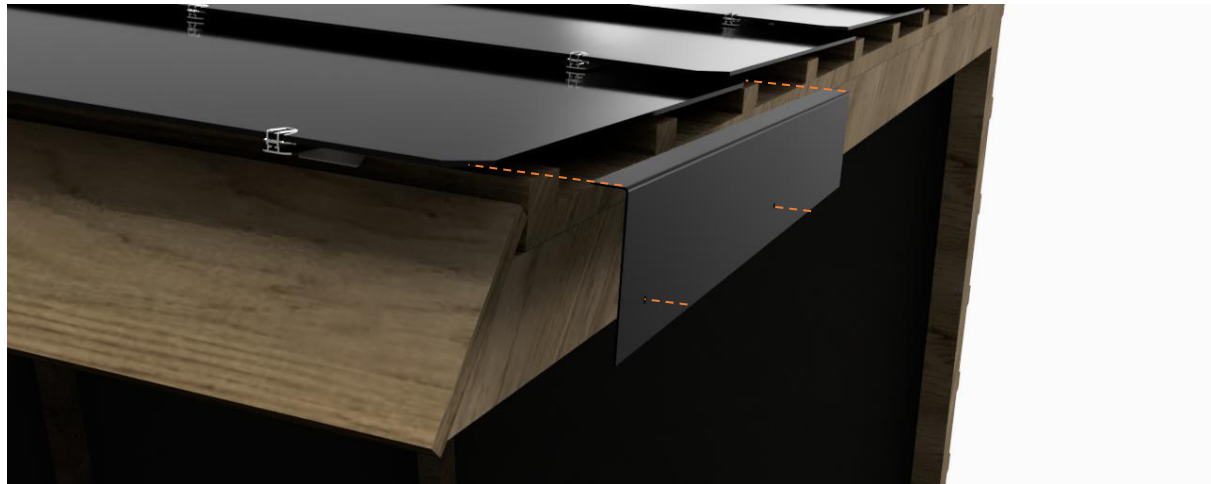
There must be a flat surface available to screw the capping to

A batten on its side may be used to give a good line, and to space the verge capping off the wall to give it a drip (no batten is shown here)

The tiles **must** be installed in line with whatever the capping will be screwed to, so allow for this at the set-out stage

The lower edge of the batten or spacer should be no lower than 50 from the underside of the tiling battens

The holes securing the capping are 30 below the tiling battens



Verge Capping

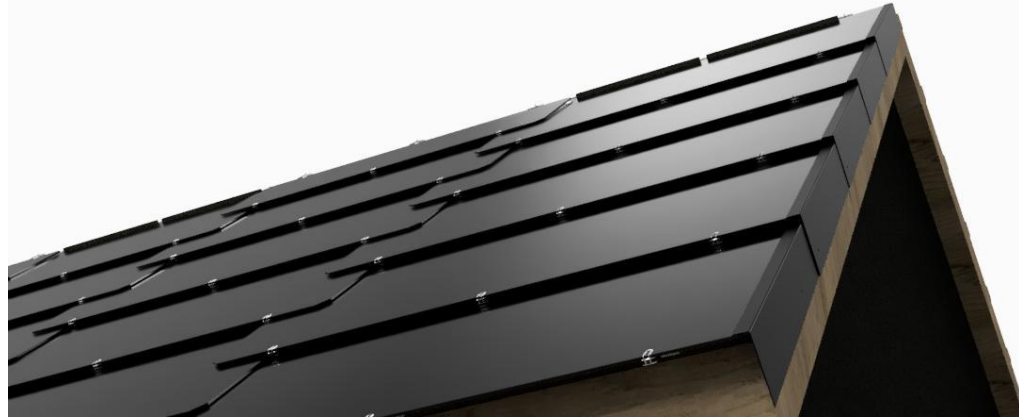
Screw on the verge capping with the 30x5 stainless pan head screws supplied, or use longer screws if into masonry

Some screws may go through the capping beneath, so a pilot hole should be drilled

We supply a special half tile capping for half tiles at the eaves

For half tiles at the ridge cut down a whole capping piece as required

Ideally the verge capping goes on with the tiles so the foam tile tape will cover the capping

**Alternative Overhanging Verge**

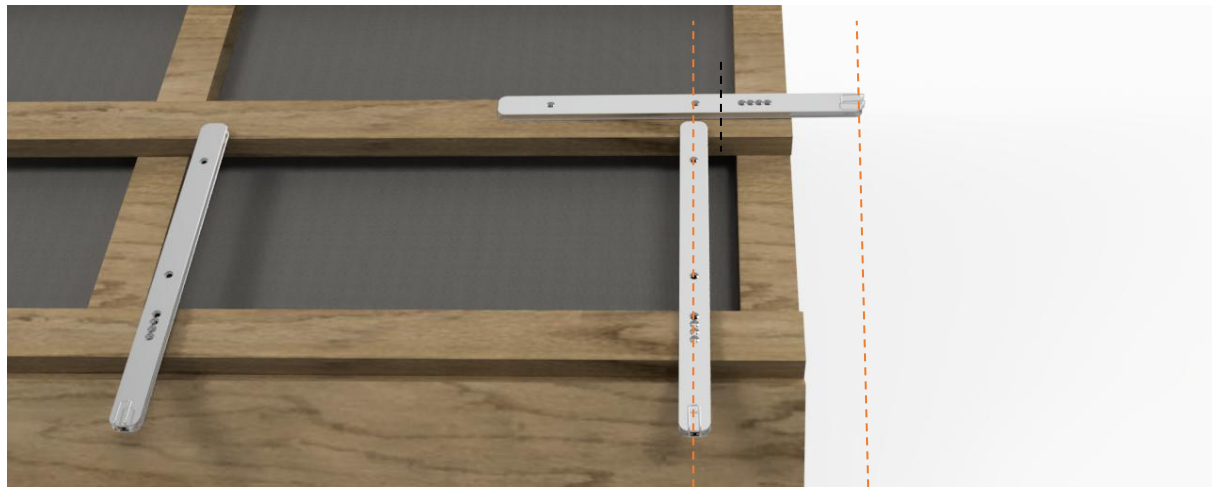
If an overhang is required then this is achieved using support bars on their sides

These are fixed to every second batten just above the support bars as shown. Use two screws in the most appropriate holes

They should be positioned with the centre hole in line with the support bar

If there is a half tile at the eaves you will need to cut the support bar on the black line (25 from the hole) and screw it to the lowest batten

The overhang over the batten ends can be in the range 0 to 130 using this method

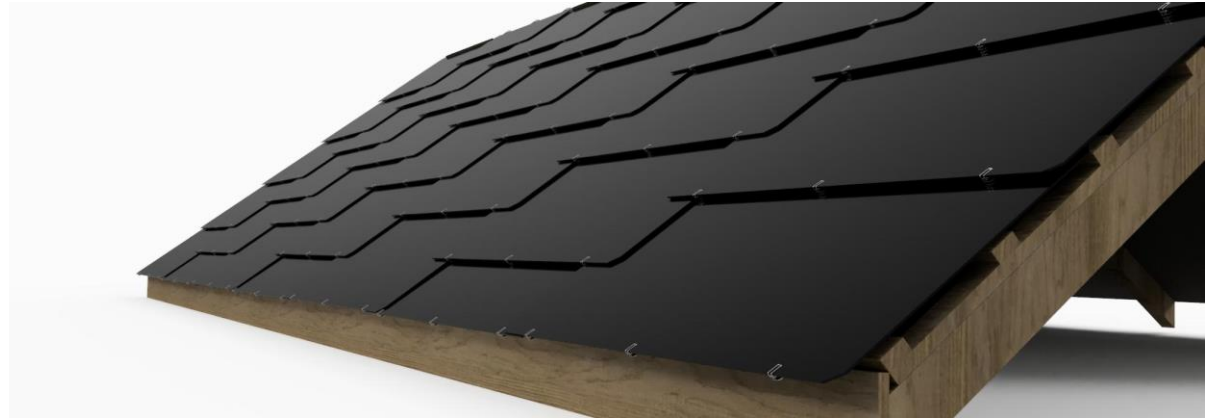


Fill-In Tiles and Blank Tiles

When working towards the end of the roof, fill-in tiles (900 or 600) may be used to maximise the solar coverage

If the roof doesn't end on a whole tile then we supply blank tiles for cutting. These may be cut with a woodworking saw, and mounted in the standard support bars.

At hips and valleys they may be drilled and screwed as required, as long as weatherproofing is observed at the screw holes



Removing and Replacing Individual Tiles

Use pliers to remove the 3 stainless clips holding the tile. These may be bent down and pulled out one leg at a time – or bend them down first, and remove the clips from the bars when the tile is out

Be careful not to touch or lever against the tile edge

Slide the tile out of the roof. At first it will stick on the foam, then it should slide. If necessary push a thin plastic object – e.g. a ruler – into the overlap above and below the tile to gently loosen any stuck foam

Ease the cables out and disconnect them

A tile can then be refitted in the same way.

Use new clips, hold them with pliers, and push them up into the support bars until they click into place. A block of wood can be used to gently tap them home while keeping the tile pushed all the way up



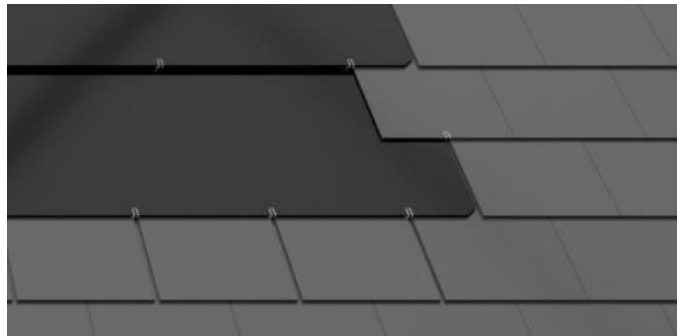
Installation – Lapping with Conventional Slates

Compatible Slates and Battens

All the details above with regards to battening out apply to lapped-in arrangements

The system is compatible with artificial and natural slates size 300 x 600 and up to 5.5mm thickness

Batten spacing must be in the range 250 – 265mm



Inline Arrangement

Generally* when installing a patch of solar tiles within a slate roof the inline arrangement should be used for ease of installation – see picture. (It is possible to use the staggered arrangement, though it is a little more complicated for patches)

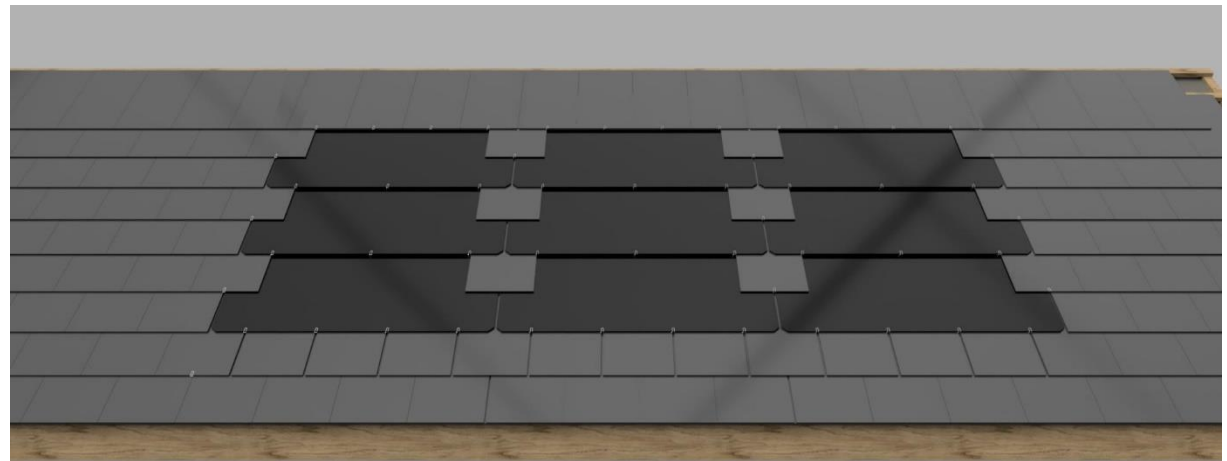
The inline arrangement puts the solar tiles in line in the courses, with a 300x600 slate covering the laps

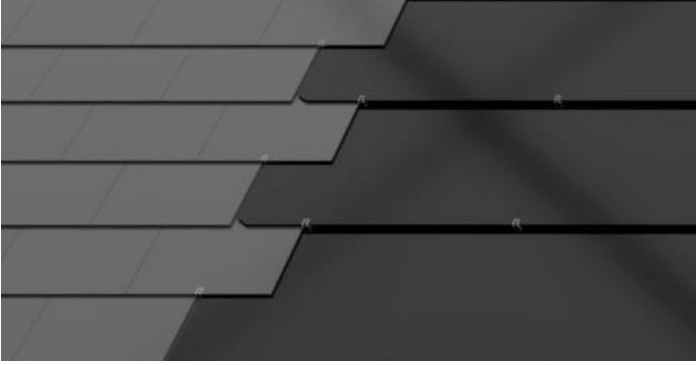
The 300x600 slates for the laps may be fibre cement, natural, or a matching aluminium composite slate supplied by us (this looks best)

When installing the solar tiles into the support bars, a 2mm gap should be left for thermal expansion – i.e. it should be possible to slide the tile left to right by a couple of mm between the bars

Half tiles cannot be used in the inline arrangement

*Complete vertical strip installations from eaves to ridge with slates just to the left and/or right are best installed staggered.



<p>Side Lapping</p> <p>The slates adjacent to the solar tiles and in the same courses as them are fitted to the battens in the usual manner for slates with nails or clips as required</p> <p>Slates adjacent to the solar tiles and which overlap with the solar tiles are mounted using the Solex supports bars and spacers. In this way all solar tiles are completely surrounded with the Solex fixings</p>	
<p>Lapping Solar Tiles Over Slates</p> <p>The slate roof is installed up to where the solar tiles will begin</p> <p>Note that the average horizontal laying gauge for the slates must be 303mm, otherwise gradually the slates will become out of alignment with the tiles</p> <p>The first course of support bars is installed for the solar tiles, however instead of 3 bars per tile, 4 must be installed per tile in this first course</p> <p>Between these 4 support bars are fitted slates cut down to around 340mm (depends slightly on batten spacing). These slates must also be cut narrower from 300 down to about 288 so they fit between the aluminium bars</p> <p>The slates are nailed to the battens in the usual manner</p> <p>The solar tiles may then be installed in the usual manner on the hooks</p>	<p>[picture to follow]</p>

<p>Lapping Slates Over Solar Tiles</p> <p>At the top of the solar area the transition back to slates must be made</p> <p>The slates in the course over the tiles are cut down to around 340 high, with the nail holes at the bottom</p> <p>Use a utility knife to cut the top lugs off 6 spacers</p> <p>Install the spacers with the flanges under the solar tile and fix the slates with screws through the spacers</p> <p>Continue the next course of slates over in the conventional manner</p>	[picture to follow]
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Specifications

Solar Roof Specifications	Batten Size	25mm x 50mm			
	Batten Spacing	250 - 265mm			
	Head lap	70 - 100mm			
	Roof Loading	12.5kg/m ²			
	Power Output	180W/m ² (Staggered arrangement)			
	Power Density	5.4m ² /kWp			
	Maximum System Voltage	1000Vdc			
	Rated Wind Uplift	1900Pa			
	Compatible Slates (w x h x t)	300mm x 600mm x 4 - 6mm			
	Roof Guarantee Parts Only	25 years			
Tile Physical Specifications	Module Structure	Glass/EVA/Solar Cell/EVA/Back sheet			
	Cell Type	Monocrystalline Silicon Half Cells			
	Encapsulant (EVA)	F406P and F806P			
	Back sheet	TPT (Black)			
	Cables	1000mm long x2			
	Cable Connectors	MC4 Compatible			
	Tile Model	1200	Half	900	600
	Dimensions (w x h x t)	1200x600x4.5mm	1200x340x4.5mm	900x600x4.5mm	600x600x4.5mm
	Weight	6.3kg	3.7kg	4.8kg	3.3kg
Tile Electrical Specifications	Maximum Power (Pmax)	95Wp	29Wp	63Wp	24Wp
	Voltage at Max. Power (Vmp)	19.5V	5.96V	13.0V	4.88V
	Open-Circuit Voltage (Voc)	23.01V	7.03V	15.3V	5.75V
	Current at Max. Power (Imp)	4.87A			
	Short-Circuit Current (Isc)	5.3A			
	Bypass diode	Yes			
	Cable Size	4mm ²			
	Solar Cell Efficiency	22% or higher			
	Output Guarantee	25 years for 80% of Pmax / -0.5% per year			
	Standard Test Conditions	1000W/m ² , AM1.5, 25°C			
	Storage & Operating Temperature	-40°C to +85°C			
	Power Tolerance -3% to +3%	-3% to +3%			
	Temperature Coefficient of Pmax	-0.35%/°C			
Temperature Coefficient of Voc	-0.27%/°C				
Temperature Coefficient of Isc	-0.048%/°C				