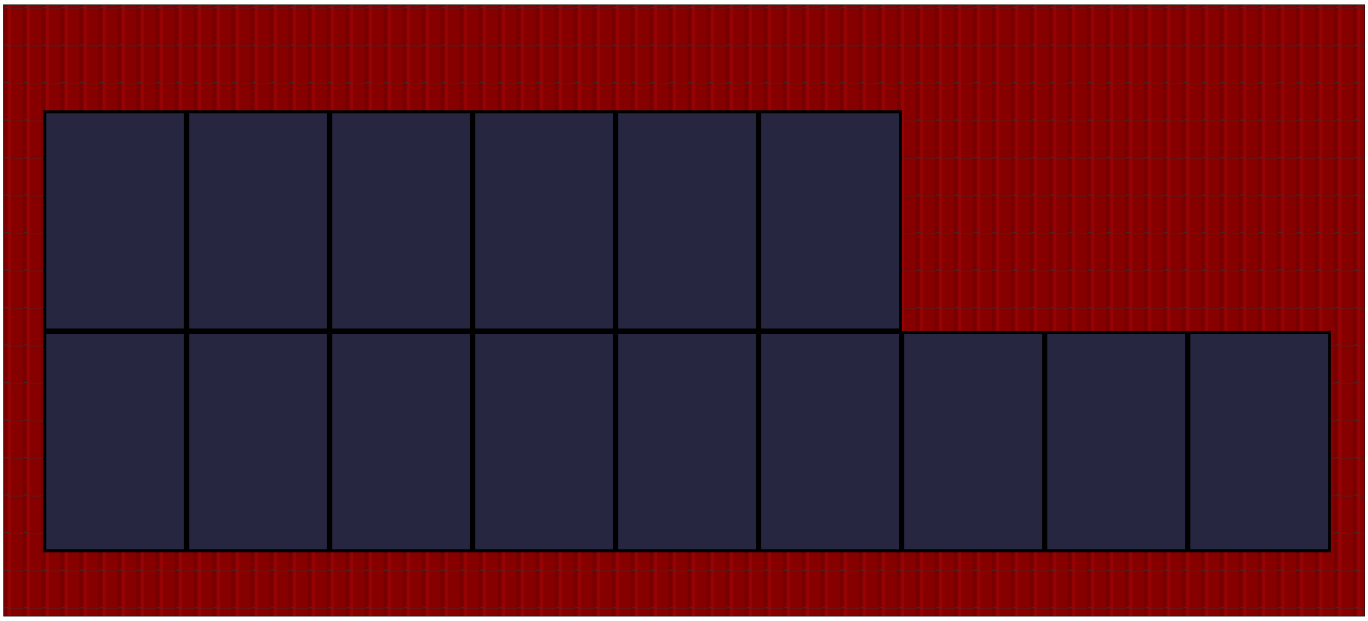
Robert Ward

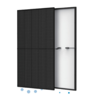
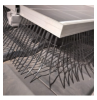
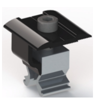
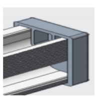
Project Name: WARD_BB7 4QS_SOLAR
Phone: 07542772114
Address: Hill House Farmhouse, BB7 4QS
Date Created: 13th November 2023
Designer: Alex Horrocks

Roof Layout

Roof 1



Component list

	Item	Quantity
	Trina Vertex S 415W All Black Mono solar panel	15
	FOX ESS Hybrid Inverter (6.0) inverter	1
	**NET** Emlite Bi-directional Meter ECA2.n*	1
	Label sheet	1
	Reinforced BirdBlocker 200mm for Solar Panels	1
	AC isolator - IMO - 32A 4-pole	2
	Mira HV25	4
	IMO DC isolator 16A 2p 1string	2
	Pair of MC4 connectors	4
	50m reel of 4mm2 solar cable	1
	Fastensol black universal clamp	34
	Fastensol black end cap	8
	Fastensol portrait concrete tile roof hook	34
	Fastensol rail splice	6
	Fastensol silver rail 3550mm	10

Inverter checks

FOX ESS Hybrid Inverter (6.0)

Panels

PV power	**6225**	Rated AC output	**6000**

Input 1: 6 Trina Vertex S 415W All Black Mono solar panels in 1 strings

Panels		**Inverter**	
PV power	**2490 W**		
Open circuit voltage at -10° C	**323 V**	Max DC voltage	**600.1 V**
V_{mpp} at 40° C	**237 V**	V_{mpp} lower limit	**80 V**
V_{mpp} at -10° C	**268 V**	V_{mpp} upper limit	**550 V**
I_{mpp} at 40° C	**10 A**	Max DC input current	**13.5 A**

Max voltage

The open circuit voltage of the solar panels never exceeds the voltage limit of the inverter.

✓

Max power point range

The maximum power point voltage of the solar panels is always above the lower limit of the inverter MPPT tracker. The maximum power point voltage of the solar panels is always below the upper limit of the inverter MPPT tracker.

✓

Max Current

The maximum power point current of the solar panels is always below the maximum current for the inverter MPPT tracker.

✓

Input 2: 9 Trina Vertex S 415W All Black Mono solar panels in 1 strings

Panels		Inverter	
PV power	**3735 W**		
Open circuit voltage at -10° C	**485 V**	Max DC voltage	**600 V**
V_{mpp} at 40° C	**355 V**	V_{mpp} lower limit	**80 V**
V_{mpp} at -10° C	**403 V**	V_{mpp} upper limit	**550 V**
I_{mpp} at 40° C	**10 A**	Max DC input current	**13.5 A**

Max voltage

The open circuit voltage of the solar panels never exceeds the voltage limit of the inverter.

✓

Max power point range

The maximum power point voltage of the solar panels is always above the lower limit of the inverter MPPT tracker. The maximum power point voltage of the solar panels is always below the upper limit of the inverter MPPT tracker.

✓

Max Current

The maximum power point current of the solar panels is always below the maximum current for the inverter MPPT tracker.

✓

Electrical

FOX ESS Hybrid Inverter (6.0)

AC Isolator

A AC isolator - IMO - 32A 4-pole has been specified for this input

Current

The rated isolator current (32A) is greater than the rated inverter current (28.7A)

✓

Phases

The isolator is suitable for use on a single phase inverter.

✓

Input 1

DC Isolator

A IMO DC isolator 16A 2p 1string has been specified for this input

Current

The isolator is rated for a current of 16A, which is more than the expected maximum current of 10.64A.

✓

Voltage

At 16A the isolator is rated for a voltage of 600V, which is more than the expected maximum voltage of 296.4V.

Cable

10m of 4mm2 solar cable has been specified

Voltage drop

Voltage drop at maximum power point at 40°C will be around **0.85 V (0.36 percent)**

Input 2

DC Isolator

A IMO DC isolator 16A 2p 1string has been specified for this input

Current

The isolator is rated for a current of 16A, which is more than the expected maximum current of 10.64A.

Voltage

At 16A the isolator is rated for a voltage of 600V, which is more than the expected maximum voltage of 444.59999999999997V.

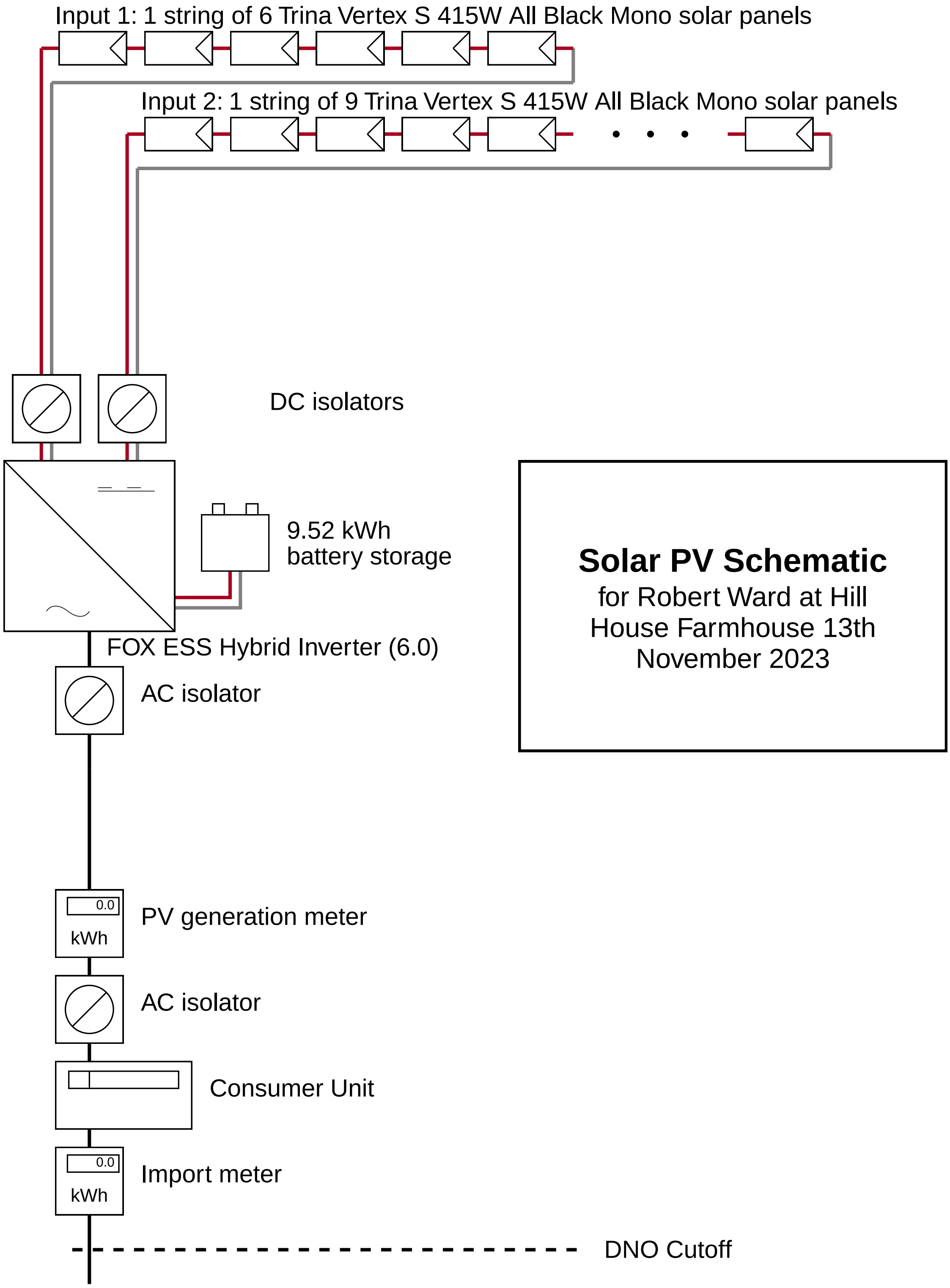
Cable

10m of 4mm2 solar cable has been specified

Voltage drop

Voltage drop at maximum power point at 40°C will be around
0.85 V (0.24 percent)

Schematic diagram



Structural calculations

Weight loading calculations

Roof 1

Dead load from roof covering	0.45 kN/m^2
Imposed load	0.75 kN/m^2
Total loading without solar array	**1.2 kN/m^2**

Weight of solar panels and mounting	306 kg
Area covered by solar array	24 m^2
Loading imposed by solar array	0.13 kN/m^2
Total loading with solar array	**1.3 kN/m^2**

Increase in loading due to solar array: 10.8%

An increase of less than 15% in the load imposed on a roof is not considered to be a significant change (The Building Regulations 2010, Approved Document A). ✓

For a traditional cut roof with rafters and purlins we recommend also using our rafter calculator to check the load-bearing capacity of the rafters. Even if the increase in loading is more than 15% the rafters may well be able to take the additional weight.

Please note that this method does not calculate the strength of the roof, and if a roof was badly constructed, does not meet existing building regulations, or is in poor condition then it may still not be appropriate to install an array.

Span tables calculations

Roof 1

Total dead load of solar array, mounting and roof covering	0.58 kN/m^2
Roof pitch	30
Rafter depth	100
Rafter breadth	47
Maximum unsupported span	**1.2**
Maximum permitted span	**2.36**

For a dead load of between 0.50 and 0.75kN/m^2 and a roof pitch of 22.5 to 30 degrees, with roof timbers of 47 x 100 mm at 400 centers, the maximum permitted unsupported span according to Trada span tables is 2.36m.

The maximum unsupported length of the roof timbers is within the permitted span. ✓

Wind loading calculations

The maximum force acting on a solar array from wind loading is given by the following formula in BRE Digest 489:

$$F = q_p \times C_{p\ net} \times C_a \times C_t \times A_{ref}$$

Roof 1

Q_p		1038 Pa
From Fig 34 in Guide to the Installation of Photovoltaic Systems for a building 10 m high, in windzone 2, in country terrain, at a distance of greater than 20km from the sea		
$C_{p\ net}$	Roof Centre	Roof edge
Uplift	-1.3	-2.2
Pressure	1	1.1
C_a		1.07
At an altitude of 12m		
C_t		1
When there is no significant topography		
A_{ref}		$23.98m^2$
F	Roof Centre	Roof edge
Uplift	**-34620N**	**-58587N**
Pressure	**26631N**	**29294N**

With 28 roof hooks we should allow for an uplift force per hook in the central zone of **1236N**, rising to **2092N** at the edges. If 2 screws are used per roof hook, this equates to **618N**per fixing in the central zone, and **1046N** at the edges.

Concrete tile roof hooks are fixed with screws that pass through the 5mm plate of the roof hook and are then buried fully into the rafter beneath. So there is approximately 65 mm of thread in the timber. The pull-out force in C16 timber is given by tables and formulae in BS5268 Part 2:

$$17.3 \times 1.25 \times 65 = \mathbf{1406N}$$

The pullout force on the fixings is more than the expected wind loading, even when the fixings are close to the edge of the roof.

Performance Estimate

Site details

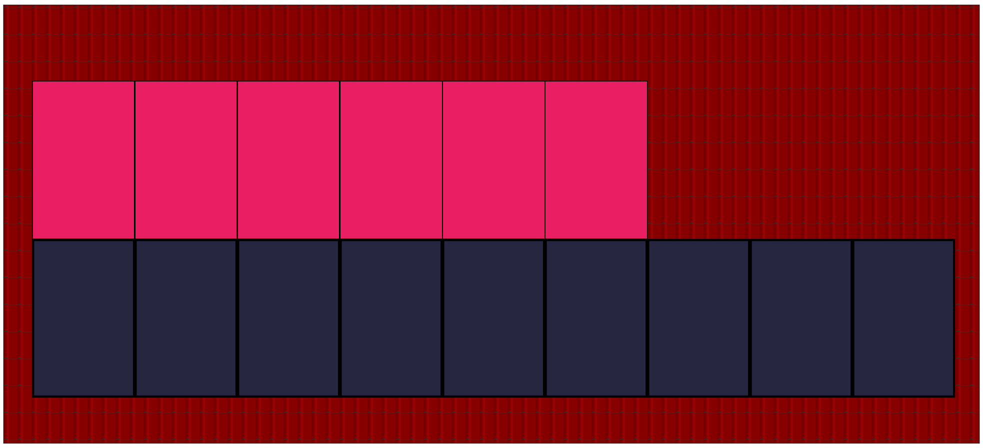
Client	Robert Ward
Address	Hill House Farmhouse

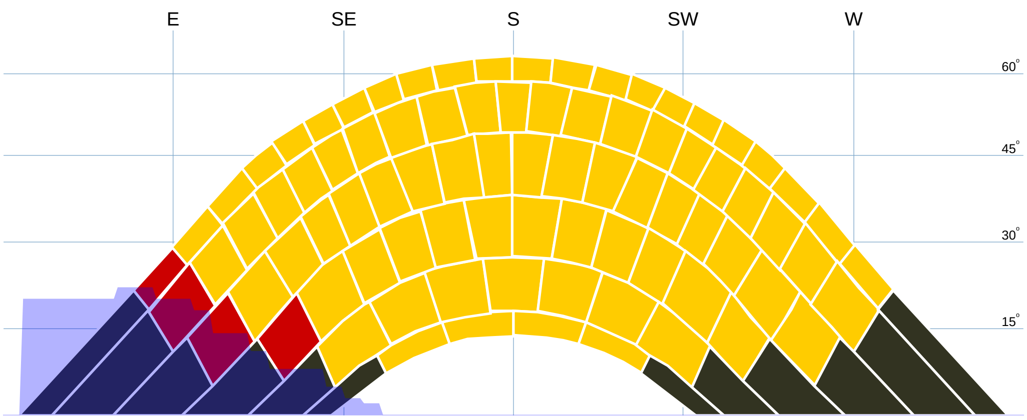
The sunpath diagram shows the arcs of the sky that the sun passes through at different times of the day and year as yellow blocks. The shaded area indicates the horizon as seen from the location of the solar array. Where objects on the horizon are within 10m of the array, an added semi-circle is drawn to represent the increased shading. Blocks of the sky that are shaded by objects on the horizon are coloured red, and a shading factor is calculated from the number of red blocks. The performance of the solar array is calculated by multiplying the size of the array (kWp) by the shading factor (sf) and a site correction factor (kk), taken from tables which take account of the geographical location, orientation and inclination of the array.

Inverter 1

FOX ESS Hybrid Inverter (6.0)

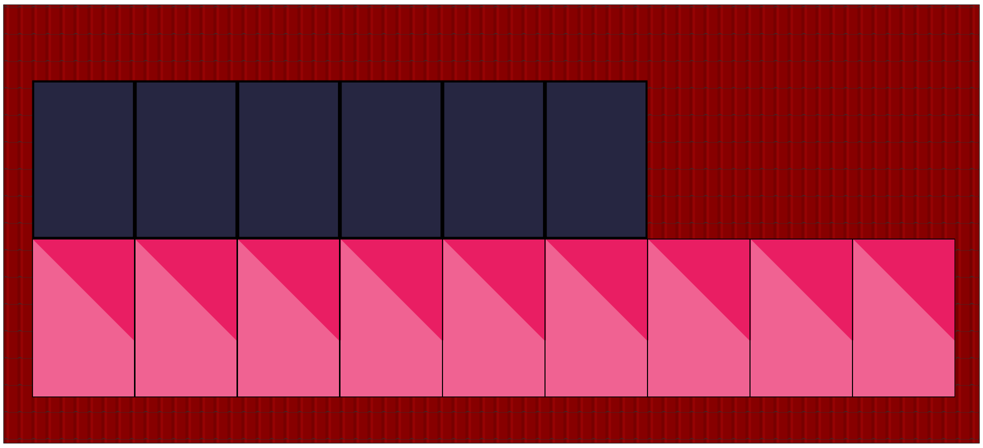
Input 1

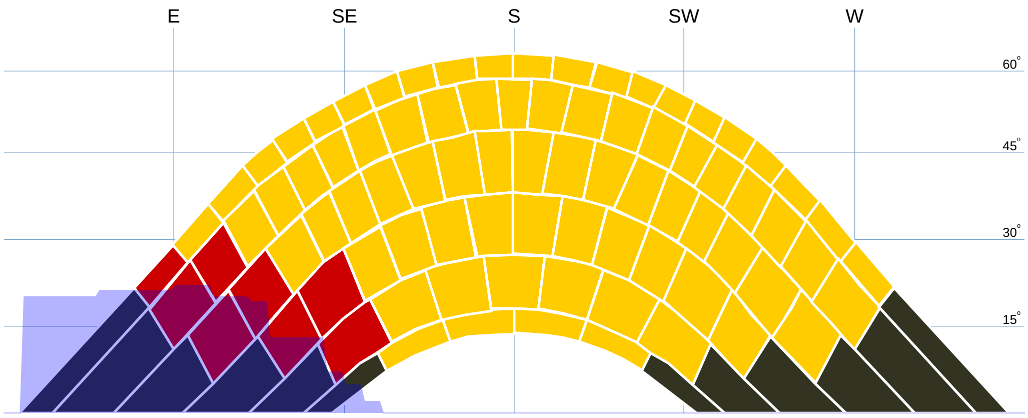




A. Installation data		
Installed capacity of PV system - kWp (stc)	2.490	kWp
Orientation of the PV system - degrees from South	-17	°
Inclination of system - degrees from horizontal	30	°
Postcode region	7E	
B. Performance calculations		
kWh/kWp (Kk)	855	kWh/kWp
Shade factor (SF)	0.96	
Estimated output (kWp x Kk x SF)	2044	kWh

Input 2





A. Installation data		
Installed capacity of PV system - kWp (stc)	3.735	kWp
Orientation of the PV system - degrees from South	-17	°
Inclination of system - degrees from horizontal	30	°
Postcode region	7E	

B. Performance calculations		
kWh/kWp (Kk)	855	kWh/kWp
Shade factor (SF)	0.92	
Estimated output (kWp x Kk x SF)	2938	kWh

Performance Summary

A. Installation data		
Installed capacity of PV system - kWp (stc)	**6.225**	kWp
Orientation of the PV system - degrees from South	**See individual inputs**	
Inclination of system - degrees from horizontal	**See individual inputs**	
Postcode region	**7E**	
B. Performance calculations		
kWh/kWp (Kk)	**See individual inputs**	
Shade factor (SF)	**See individual inputs**	
Estimated output (kWp x Kk x SF)	**4982**	kWh
C. Estimated PV self-consumption - PV Only		
Assumed occupancy archetype	**home all day**	
Assumed annual electricity consumption, kWh	**3500**	kWh
Assumed annual electricity generation from solar PV system, kWh	**4982**	kWh
Expected solar PV self-consumption (PV Only)	**1245.5**	kWh
Grid electricity independence / Self-sufficiency (PV Only)	**35.59**	%
D. Estimated PV self-consumption - with EESS		
Assumed usable capacity of electrical energy storage device, which is used for self-consumption, kWh	**8.568**	kWh
Expected solar PV self-consumption (with EESS)	**3039.02**	kWh
Grid electricity independence / Self-sufficiency (with EESS)	**86.83**	%

Important Note: The performance of solar PV systems is impossible to predict with certainty due to the variability in the amount of solar radiation (sunlight) from location to location and from year to year. This estimate is based upon the standard MCS procedure is given as guidence only for the first year of generation. It should not be considered as a guarantee of performance.

The solar PV self-consumption has been calculated in accordance with the most relevant methodology for your system. There are a number of external factors that can have a significant effect on the amount of energy that is self-consumed so this figure should not be considered as a guarantee of the amount of energy that will be self-consumed

Shading will be present on your system that will reduce its output to the factor stated. This factor was calculated using the MCS shading methodology and we believe that this will yield results within 10% of the actual energy estimate stated for most systems.

Equipment and Services

Equipment Costs	
15x Trina Vertex S 415W All Black Mono solar panel	£1,957.50
FOX ESS Hybrid Inverter (6.0) inverter	£1,451.81
NET Emlite Bi-directional Meter ECA2.n*	£48.52
Label sheet	£2.38
Reinforced BirdBlocker 200mm for Solar Panels	£206.76
2x AC isolator - IMO - 32A 4-pole	£39.38
4x Mira HV25	£3,074.00
2x IMO DC isolator 16A 2p 1string	£61.33
4x Pair of MC4 connectors	£10.90
50m reel of 4mm2 solar cable	£36.98
34x Fastensol black universal clamp	£46.34
8x Fastensol black end cap	£4.41
34x Fastensol portrait concrete tile roof hook	£192.76
6x Fastensol rail splice	£13.31
10x Fastensol silver rail 3550mm	£221.85
Total equipment cost	**£7,368.23**

Services Costs	
Installation & Commissioning	£3,750.00
Total services cost	**£3,750.00**

Totals	
Total before tax	**£11,118.23**

VAT at 0%	**£0.00**
Total including tax	**£11,118.23**

Financial

Generation

The system is expected to generate 4982 kWh per year initially, decreasing gradually as the solar cells degrade. Over the 25 year term of this financial projection the total generation is expected to be 117062 kwh, of which 73732 kWh will be consumed on site and 43331 kWh exported.

117 MWh

Payback

After adjusting projected costs and benefits for inflation, and applying a discount rate of 4%, the initial system cost of £11,118.23 is expected to be recouped after 8 years.

8 years

Net Present Value

The total present value of future benefits and costs, using a discount rate of 4% per year, is £50,730.21. The cost of the PV system is £11,118.23. The net present value of the project is therefore £39,611.98. A positive net present value is a good indication that the project is financially worthwhile.

£39611.98

IRR

The Internal Rate of Return is a useful measure for comparing the relative profitability of investments.

16.3 %

Disclaimer

Our financial model calculates the benefits of a solar PV installation (such as savings in electricity, or payments for exported electricity) and costs (the initial purchase cost, and any future maintenance costs if entered), over the projected lifespan of the system. Values are corrected for inflation, system degradation, and discount rate - a measure that accounts for the fact that a promise of a monetary sum in the distant future is usually considered less valuable than the promise of the same sum in the near future.

A model is only as accurate as the assumptions it makes. You should consider whether the values chosen are appropriate for your situation. There are many variables that dictate the financial return of a solar installation and we cannot forecast how they may change in the future. This financial projection shows a likely scenario for future financial returns. Actual returns may vary significantly from this forecast.

Assumptions

Inflation rate	8%
Cost of electricity	£0.29 /kWh increases at 2% above inflation per year
System size	6.225 kWp degrades at 0.5% per year
Discount rate	4%
Projection length	25 years

Income and savings

The projected income from the system over the project lifetime in payments for generated and exported electricity, along with electricity savings, are shown in the table and graph below.

These figures assume an inflation rate of 8 percent.

£8232

Total Export Payments

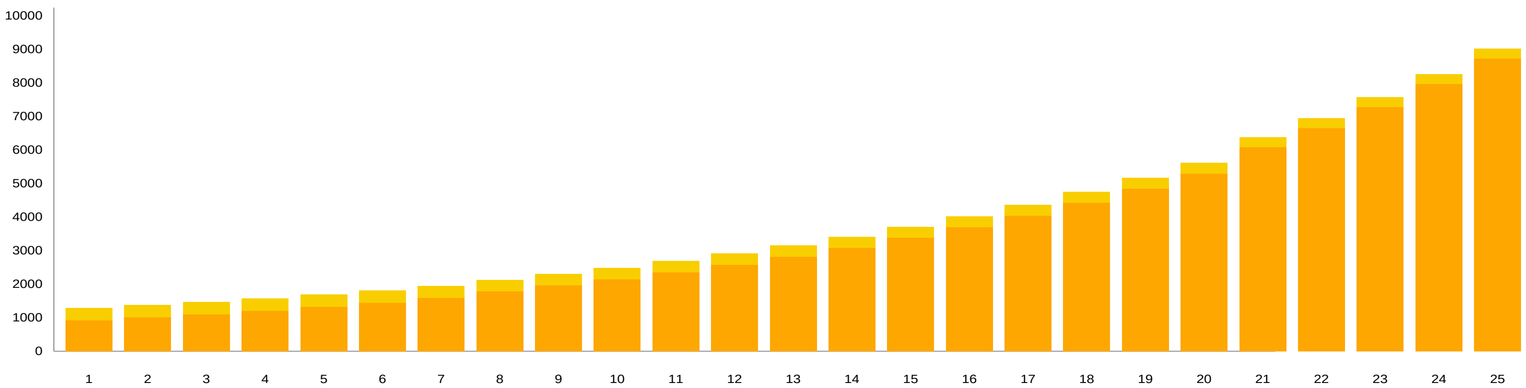
over 25 years

£87726

Electricity savings

over 25 years

	Export payments	Electricity savings	**Total**
Year 1	368	923	**1291**
Year 2	366	1010	**1377**
Year 3	365	1106	**1470**
Year 4	363	1210	**1573**
Year 5	361	1325	**1686**
Year 6	359	1450	**1809**
Year 7	357	1587	**1944**
Year 8	337	1794	**2131**
Year 9	336	1963	**2299**
Year 10	334	2149	**2483**
Year 11	332	2352	**2684**
Year 12	331	2574	**2905**
Year 13	329	2817	**3146**
Year 14	327	3084	**3411**
Year 15	326	3375	**3701**
Year 16	324	3694	**4018**
Year 17	322	4043	**4365**
Year 18	321	4425	**4746**
Year 19	319	4843	**5162**
Year 20	318	5301	**5618**
Year 21	290	6078	**6368**
Year 22	289	6652	**6941**
Year 23	288	7281	**7569**
Year 24	286	7969	**8255**
Year 25	285	8722	**9007**



The bottom line

The table and graph below show the discounted costs for the project (including the initial capital required for the installation), against the total discounted benefits from income and savings on electricity bills.

The system pays for itself in 8 years.

	Discounted benefits	Cumulative benefits	Discounted costs	Cumulative costs	**Cashflow**
Year 1	1265	1265	0	11118	**-9853**
Year 2	1295	2561	0	11118	**-8558**
Year 3	1328	3889	0	11118	**-7230**
Year 4	1364	5253	0	11118	**-5866**
Year 5	1403	6656	0	11118	**-4463**
Year 6	1445	8101	0	11118	**-3017**
Year 7	1491	9592	0	11118	**-1526**
Year 8	1569	11162	0	11118	**43**
Year 9	1625	12787	0	11118	**1669**
Year 10	1685	14472	0	11118	**3354**
Year 11	1749	16221	0	11118	**5102**
Year 12	1817	18037	0	11118	**6919**
Year 13	1889	19927	0	11118	**8808**
Year 14	1966	21893	0	11118	**10775**
Year 15	2048	23941	0	11118	**12822**
Year 16	2134	26075	0	11118	**14957**
Year 17	2226	28301	0	11118	**17183**
Year 18	2324	30625	0	11118	**19507**
Year 19	2426	33051	0	11118	**21933**
Year 20	2535	35586	0	11118	**24468**
Year 21	2759	38345	0	11118	**27227**
Year 22	2886	41231	0	11118	**30113**
Year 23	3021	44253	0	11118	**33135**
Year 24	3164	47417	0	11118	**36298**
Year 25	3314	50730	0	11118	**39612**