SOLAR ENERGY ALLIANCE
RESPONSIBLE ENERGY

Small Scale Solar Electric Systems

Solar Electric Information pack
Domestic & small scale commercial installations

In this pack we cover what you need to consider before installing a domestic or small scale commercial Solar Photovoltaic (PV) system.

If you have any questions please do not hesitate to contact us.

This pack covers Grid tied / Grid connected systems - if your intention is to install an off grid system (Battery Storage) please contact us - there are several additional considerations such as tailoring the system to the power use required / scaling of the battery rack and the like.

Whilst we have kept things fairly simple a certain level of technical detail is usually preferred by our clients and has been included.

Is my building suitable for PV?

Solar PV in England works best when it is facing due south and pitched at around 30 degrees. Below is a more comprehensive list of factors and their effect.

Area required

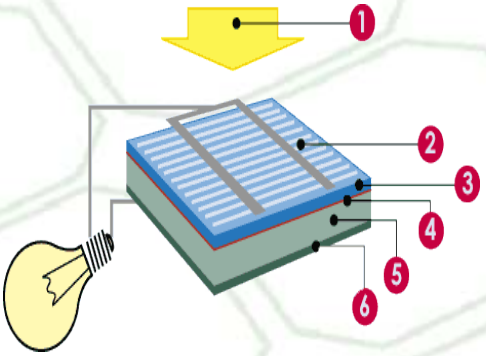
Each kW of system (technically each kWp = kilowatt potential) requires around 8 square metres of roof area - so a 3kW system will need around 24 square metres of roof area. Generally you will need to leave at least half a meter around the array for ease of install, maintenance and drainage issues.

There are exceptions to the above rule of thumb, for example there are panels that can produce more power per square metre - but these are more expensive and do not provide such a good return on investment. Similarly on flat roofs, depending on the mounting system used, more area is generally required as you need to leave room between rows to avoid shading issues.

However - 8m square per kWp installed is a good guide for most domestic and small scale PV installs, particularly on normal pitched roof retro-fit installations.

How PV Works

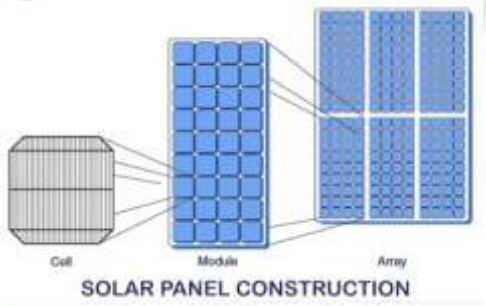
Solar Electric panels (known as Photovoltaic or PV) convert energy from the sun directly into electricity. They work during daylight hours, but more electricity is produced when the sunshine is more intense (a sunny day) and is striking the PV modules directly.



.

1. light (photons) **2. front contact**
3. negative layer **4. diversion layer**
5. positive layer **6. back contact**

A solar panel is made up of several photovoltaic cells, these cell are connected together in series, to boost the current.



SOLAR PANEL CONSTRUCTION

A photovoltaic cell consists of two types of silicon P-Type and N-Type. The surface of the cell is transparent so the light can pass through and fall onto the first layer of silicon. This layer of silicon has been manufactured to be positively charged. Likewise the other layer of silicon is made to be negatively charged.

When sunlight falls onto the cell a flow of electrons is created through the cell causing an electric current. This current can then be harvested and either used straight away, stored or exported.

Solar Energy Alliance Ltd. 8 Battery Green Road, Lowestoft. NR32 1DE **Company.** 06391061 **VAT.** 711 6535 56
Telephone: +44(0)1502 515532 **Email:** info@solarenergyalliance.com **Website:** www.solarenergyalliance.com

SOLAR ENERGY ALLIANCE
RESPONSIBLE ENERGY

Orientation & Pitch

Solar panels in England perform best if they are facing due South and are elevated to a 35 degree pitch. However - so long as they are between 10 degrees and 35 degrees it does not make a huge difference in performance on an annual basis. For flat roofs we would install a mounting system which angles the panels (so they are not lying flat on the roof). We can advise on the best mounting system for your property and provide an accurate assessment of the likely annual yield.

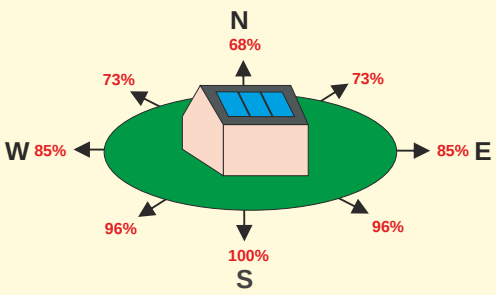


Figure 1.1 Percentage of potential yield from Solar PV panels
Pitched at 30° / UK / depending on the direction they are facing
Based on SAP 2005 figures © Solar Energy Alliance 2010

Figure 1.1 shows the effect on system yield for different orientations. Within 90 degrees of South provides the optimum performance.

Panels laid flat on a roof with no shading operate at around 93% of potential, and those mounted on vertical walls facing South at between 65% and 70% of optimum.

For those who require further information the actual calculation for assessing the performance of a solar PV system in the UK is as follows.

0.8 x kWp x S x ZPV (M1)

Where S is the annual solar radiation from Table H2 (depending on orientation and pitch), and ZPV is the shading factor from Table H3.

Table H2 : Annual solar radiation, kWh/m²

Tilt of collector	Orientation of collector				
	South	SE/SW	E/W	NE/NW	North
Horizontal	933				
30°	1042	997	886	762	709
45°	1023	968	829	666	621
60°	960	900	753	580	485
Vertical	724	684	565	427	360

Table H3 : Overshading factor

Overshading	% of sky blocked by obstacles.	Overshading factor
Heavy	> 80%	0.5
Significant	> 60% - 80%	0.65
Modest	20% - 60%	0.8
None or very little	< 20%	1.0
Note: Overshading must be assessed separately for solar panels, taking account of the tilt of the collector. Usually there is less overshading of a solar collector compared to overshading of windows for solar gain (Table 6d).		

*As a rule of thumb for arrays between 10 and 30 degrees pitch use the 30 degree reading - below 10 degree use the horizontal reading

Planning Permission

In most cases fixing solar panels to the roof of house is likely to be considered 'permitted development' under planning law, with no need to apply for planning permission.

There are, however, important exceptions and provisos which must be observed.

These permitted development rights apply to houses. If you live in a flat and are considering fitting solar panels you are advised to contact your Local Planning Authority for guidance.

Important exceptions and provisos

Panels should not be installed above the ridge line of the roof and should project no more than 200mm from the roof or wall surface.

If your property is a listed building installation is likely to require an application for listed building consent, even where planning permission is not needed.

If your property is in a conservation area, or in a World Heritage Site planning consent is required when panels are to be fitted on the principal or side elevation walls and are visible from the highway. If panels are to be fitted to a building in your garden or grounds they should not be visible from the highway.

If there is any doubt it may be worthwhile applying for a Certificate of Lawful Development (CLEUD) which normally costs £75. It is basically rubber stamping your rights under permitted development law, but is a small price to pay in relation to the cost of a grid tied solar system.

SEA will advise on planning issues as part of our site survey and can assist with or submit a planning application on your behalf when required.

Solar Energy Alliance Ltd. 8 Battery Green Road, Lowestoft. NR32 1DE **Company.** 06391061 **VAT.** 711 6535 56
Telephone: +44(0)1502 515532 **Email:** info@solarenergyalliance.com **Website:** www.solarenergyalliance.com

SOLAR ENERGY ALLIANCE
RESPONSIBLE ENERGY

So - for a 3kW system facing due South on a 20 degree pitch roof with no shading the annual output would be calculated as:

0.8 x 3.0 x 997 x 1.0 = 2500.8 units (Kilowatt hours)

The same system facing SE/SW would yield 2392.8 units, whilst if facing due East or West would yield only 2126.40 units per annum (and facing North only 1700 units).

You can see why we advise that panels should be "within 90 degrees of due south".

Shading Issues

The area where the panels are installed needs to be as free of shadows and shading as possible. Some shading in the early morning and late evening (particularly in winter) will not have a dramatic effect on system performance, however heavy shading or shading at peak times of the day can affect the output quite dramatically.

This includes shading from other areas of the building, chimney stacks and the like as well as from trees, neighbouring buildings or other obstructions.

The best advice is to check the area you are considering putting your solar array at different times of day - just to be sure there are no shadows or major shading.

Nature of roof & Obstructions

For retrofit on-roof systems the area needs to be relatively free of obstructions. For example, small flues / vents / air vent tiles and the like need to be considered and planned for (and occasionally moved).

Similarly the nature of the roof covering it's self is a factor. Modern tiles are generally easily catered for - but particularly older roofs, slate roofs and the like need special mounting systems (and may indeed be unsuitable). If in doubt please let us know the nature of your roof and we can advise on suitability.

Exporting Power

Most homes have a single phase electrical supply. Under G83/1 regulations the largest export that can be connected to a single phase supply is 3.7 kW. This limits most homes to a 4kWp PV system.

Sometimes we can connect up to 6kW (or even more) on a single phase, but this is at the discretion of the District Network Operator (DNO).

We can contact the DNO on your behalf if you are interested in a system larger than 4kWp to request a ruling on the largest system your particular property can have.

Some homes and commercial premises have a three phase supply. The export potential of a three phase supply is much greater, but needs to be checked with the DNO on what the specific limit is for a given property. It may also require the implementation of G59 regulations which are usually more expensive.

In either instance a parallel connection agreement is required to connect a system to the national grid.

SEA handle the parallel connection agreement for you as part of our service. It is however down to you to negotiate with your electricity provider on your rates for buying and selling electricity.

SOLAR ENERGY ALLIANCE
RESPONSIBLE ENERGY

How much does a PV array weigh?

Typically on a standard retrofit system each panel and associated mounting frame weights around 28kg. A 3kW system would require between 12 and 14 panels (depending on the exact panels and their power rating) and will weigh between 336kg and 392kg.

This is not a big issue for most roof structures, but upon occasion we may require an independent structural engineer to assess the roof as being suitable for such an installation.

Ways of mounting Solar PV panels

There is quite a wide variety of both Solar PV panels and mounting possibilities. Below we cover the main types applicable to domestic and small commercial systems.

Pitched Roof

The most common array for domestic customers is the pitched roof retrofit array. A block of panels mounted on an aluminium array frame and bolted to the roof girders of the building.

Flat Roof tilted arrays

More common in commercial scale projects, but equally possible for domestic premises. PV panels are mounted in rows, and tilted towards the sun using angled module casings or frames.

Ground Mounted / outbuilding

If you do not have a suitable roof all is not lost. If you have a suitably un-shaded area of garden or land you could install a ground mounted solar array, or even a solar tracker (see below). For a ground mounted array a framework is built on simple foundations to which an array of solar panels is then attached.

Security can be an issue on ground mounted arrays, so we use lockable bolts and other modifications to ensure the panels cannot be removed.

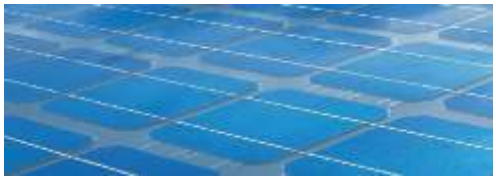
Types of PV panels

The are 2 main types of PV panels used for domestic solar arrays

Monocrystalline cells are cut from a single crystal of silicon. They are a single slice of crystal. Monocrystalline cells are the most efficient, but also the most expensive to produce.

Polycrystalline (or Multicrystalline) cells are made from a slice cut from a block of silicon, but whereas Monocrystalline cells are from a single crystal, these cells consist of a large number of crystals. This gives them a speckled reflective appearance. PV solar panels made from these types of cell are slightly less efficient, but also slightly cheaper than Monocrystalline cells. The performance gap between Poly and Mono has closed quite considerably in the past few years.

Please Note: *A 230w panel whether Mono or Poly is a 230w panel. The nature of the panel does not affect performance testing.*



Other options: There are other types of solar PV panels such as Amorphous, and other ways to integrate cells such as transparent PV glazing, however these are more specialist and expensive solutions. If you have a project in mind please contact us for further options on both panels and mountings.

Solar Energy Alliance Ltd. 8 Battery Green Road, Lowestoft. NR32 1DE **Company.** 06391061 **VAT.** 711 6535 56
Telephone: +44(0)1502 515532 **Email:** info@solarenergyalliance.com **Website:** www.solarenergyalliance.com

SOLAR ENERGY ALLIANCE
RESPONSIBLE ENERGY

Some clients prefer to build an outbuilding or large shed to accommodate such an array and this is a good way of achieving some usable storage or workshop space as part of the project whilst still enabling a well oriented and pitched foundation for a panel array.

Mast mounted Solar Tracker

Solar tracker arrays produce up to 30% more power than normal static arrays. They do however cost a bit more to install - but are an excellent way of maximising the output from a given system size. Feed in tariff generation grants are paid according to system size (kWp) - not system potential output - therefore to get more output from the same sized system means greater grant payments and these can more than compensate for the increased cost to install resulting in a greater return on investment. Please contact us if you are interested in a solar tracking array.

Other Building Integrated Options

There are many other ways to mount PV panels and integrate them into the fabric of a building, however most of these are not applicable to homes or smaller scale commercial projects.

Some examples are solar glazing, building cladding, solar roofs and small building mounted solar trackers to name but a few. If you have a new build or large scale retro-fit project and would like to explore further options please do drop us a line.

Grants & Feed In Tariff Explained

There are no longer any capital grants for domestic systems, that is to say where the grant pays part of the capital cost of installing the system as a lump sum.

These programs have been replaced by grants that reward you for generating electricity from renewable means. This new Feed Inn Tariff(FIT) scheme went live on 1st April 2010.

Solar Roof Tiles

These tiles replace existing roof tiles or slates to form an integral part of the roof covering

A variety of sizes and styles are available. They are not as efficient as normal PV panels and require a larger surface area per kWp installed.

Usually we fit these as part of a new build project or roof renovation where the cost of the roof covering they replace can be discounted against the price of the PV tiles. Retrofitting these tiles to an existing roof is much more expensive than using normal PV panels.

They have a low visual impact making them suitable for some listed buildings with appropriate permissions (where normal panels are often unsuitable).

Example Prices for New Build install

System Size (kWp)	System Output (KW PA)	Installed Price (Ex. VAT)
0.94	777	£ 9,780
1.25	1036	£12,510
1.87	1554	£15,060
2.18	1813	£16,840
2.50	2072	£18,560
2.80	2331	£20,310
3.12	2590	£22,030
3,74	3108	£26,650

The above prices include full installation, commissioning and grid connection but excludes VAT if applicable, scaffolding if required, ground works or non standard cabling / requirements. Output figures are SAP2005 but based on a system facing due South pitched at 30 degrees

Solar Energy Alliance Ltd. 8 Battery Green Road, Lowestoft. NR32 1DE **Company.** 06391061 **VAT.** 711 6535 56
Telephone: +44(0)1502 515532 **Email:** info@solarenergyalliance.com **Website:** www.solarenergyalliance.com

SOLAR ENERGY ALLIANCE
RESPONSIBLE ENERGY

Each unit (kilowatt hour) generated from renewable means gains a generation grant payment (see the table below). If the unit is used on-site you also do not have to buy the unit in, and save the cost of buying that unit. If the unit is exported from site (into the national grid) you qualify for an export payment of 3 pence per unit.

Considering most domestic premises are paying between 14p and 16p per unit it is infinitely more beneficial to use the electricity generated yourself rather than export it.

Table of feed in tariff generation payments for PV to 2013

Technology	Scale	Tariff level for new installations in period (p/kWh) [NB tariffs will be inflated annually]			Tariff lifetime (years)
		Year 1: 1/4/10 – 31/3/11	Year 2: 1/4/11 – 31/3/12	Year 3: 1/4/12 – 31/3/13	
PV	≤4 kW (new build)	36.1	36.1	33.0	25
PV	≤4 kW (retrofit)	41.3	41.3	37.8	25
PV	>4-10 kW	36.1	36.1	33.0	25
PV	>10-100 kW	31.4	31.4	28.7	25
PV	>100kW-5MW	29.3	29.3	26.8	25
PV	Stand alone system	29.3	29.3	26.8	25

The tariff shown will be paid for the lifetime of the grant as noted on the right and will also be index linked to the retail price index (so will increase in value each year roughly in line with inflation).

Example calculation on the value of a 3kWp system

You (or we) will need to calculate the value of the annual energy produced for your particular project. This will depend on your actual output (in units) - the applicable generation grant, and how much of the energy is likely to be used on site.

For this example we will look at a 3kWp PV system facing due South elevated at 30 degrees, and where 70% of the energy is used on site (normal domestic rate here 14ppu) and 30% of the power generated is exported to the grid.

Projected system output = 2500 units per year
Applicable FIT generation tariff = 41.3 pence per unit = £1032.50
Export FIT tariff = 3ppu on 30% of the above = £22.50
Cost saving on 70% of above used on site @ 14ppu = £245
Annual financial benefit of system circa £1299.50

Company Profile

Solar Energy Alliance (SEA) design and install renewable electricity solutions. We also supply and install systems for storing power; converting power and exporting power to the national grid.

Over the past twenty five years we have supplied systems for a wide range of clients, from government departments, local councils, educational institutions, through to smaller companies and private individuals.

In the early days we specialised in fitting wind turbines and solar PV to boats; word soon got around, and after a while enquiries were coming in from across the country. To provide a national service we teamed up with several other renewable energy companies and the Solar Energy Alliance was born!

With advances in technology things soon moved from marine projects onto dry land, developing self sufficient systems mostly for rural properties and specialised remote applications such as radio and television boosters. With the advent of grid-connection renewable energy really came of age in the UK - over 90% of our work these days is installing grid linked systems.

SEA have installed over a hundred wind turbines, and a huge number of PV arrays in all kinds of situations and locations.

Solar Energy Alliance Ltd. 8 Battery Green Road, Lowestoft. NR32 1DE **Company.** 06391061 **VAT.** 711 6535 56
Telephone: +44(0)1502 515532 **Email:** info@solarenergyalliance.com **Website:** www.solarenergyalliance.com

SOLAR ENERGY ALLIANCE
RESPONSIBLE ENERGY

This calculation can be adjusted to assess the likely financial benefit of the system you are considering. If you work from home or if the house is almost permanently occupied you will likely use all the power you generate - if the house is empty for most of the daylight hours you may export more than 30%.

Some utility companies are applying a 50/50 rule to save installing an export metre (i.e. they work on the basis that 50% is used on site and 50% is exported) and we have heard rumour that some companies are looking at paying on a 100% export basis.

Things are still settling down after the introduction of the feed-in tariff but you should check what deal your provider is offering, and it definitely pays to shop around.

Solar PV Domestic System offers Autumn 2010

The below are example prices based on an MCS accredited 240w Monocrystaline panel. These are basic system prices for a standard retro-fit pitched roof install - scaffolding, difficult cabling or preparatory electrics work is not included. E&OE

System capacity kWp	**1.44**	**1.92**	**2.88**	**3.84**	**4.32**	**4.8**	**5.76**	**7.2**
Number of modules	6	8	12	16	18	20	24	30
Annual electricity generation (kWh)	1200	1600	2400	3200	3600	4000	4,800	6,000
Avoided CO2e annual	636kgs	848kgs	1272kgs	1696kgs	1908kgs	1908kgs	2544kgs	3180kgs
Module area M2	9.81	13.08	19.62	26.16	29.43	32.7	39.24	49.05
Basic cost	**£5,995**	**£7,995**	**£11,495**	**£14,995**	**£16,495**	**£17,995**	**£20,995**	**£25,995**
VAT @ 5%	£299.75	£399.75	£574.75	£749.75	£824.75	£899.75	£1,049.75	£1,299.75
Sub total	£6,294.75	£8,394.75	£12,069.75	£15,744.75	£17,319.75	£18,894.75	£22,044.75	£27,294.75
FIT Generation tarriff (Retrofit)	0.413	0.413	0.413	0.413	0.361	0.361	0.361	0.361
Value of FIT (GEN) £ per annum	495.6	660.8	991.2	1321.6	1299.6	1444	1732.8	2166
Value of Energy (50/50 @ 9ppu)	108	144	216	288	324	360	432	540
Total value of generation	603.6	804.8	1207.2	1609.6	1623.6	1804	2164.8	2706
System annual return (Ex. VAT)	10.1%	10.1%	10.5%	10.7%	9.8%	10.0%	10.3%	10.4%
System annual return (VAT@5%)	**9.6%**	**9.6%**	**10.0%**	**10.2%**	**9.4%**	**9.5%**	**9.8%**	**9.9%**
System Payback Period (years / Ex. VAT)	9.9	9.9	9.5	9.3	10.2	10.0	9.7	9.6
System Payback Period (years / VAT@5%)	10.4	10.4	10.0	9.8	10.7	10.5	10.2	10.1
Price Per kWp installed	**4163**	**4164**	**3991**	**3905**	**3818**	**3749**	**3645**	**3610**

Notes: Value of energy above is based on a 50% used and 50% exported with the unit price of 14ppu and an export FIT of 3ppu making an average of 9ppu. This is by way of an example only and your specific situation will need to be calculated based on energy usage and the terms of your utility supplier contract. The above does not constitute a formal quotation or guarantee in any way but is provided as an indication of current offers. Performance figures are based on a south facing roof pitched at 30 degrees with no obstructions using SAP2005 calculations. Carbon saving is based on Carbon Trust 0.53g Co2e per kW offset. Two sets of return figures have been provided inc. and ex. VAT (a VAT registered company will gain their VAT back - a householder will pay 5% reduced rate as indicated). SEA are an MCS qualified installer and able to register your system for the feed in tariff - applicable system rates shown above.

CARBON TRUST
The Low Carbon Partnership
REA
REA
renewableUK
The voice of wind & marine energy

Solar Energy Alliance Ltd. 8 Battery Green Road, Lowestoft. NR32 1DE **Company.** 06391061 **VAT.** 711 6535 56
Telephone: +44(0)1502 515532 **Email:** info@solarenergyalliance.com **Website:** www.solarenergyalliance.com