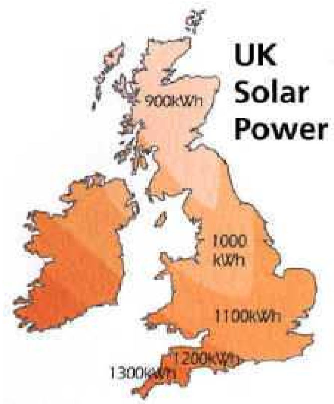
Pay-Back Calculations for various Solar Systems

To the general public, the first two reasons are generally all that counts. Although there is a proportion of the population that will figure environmental reasons into their thinking, and will pay more as a result, the vast majority are only bothered about the economics - will it save or make them money!

To calculate the likely financial benefits from any solar system is not easy. This is down to the variation in performance that is obtained at different locations and from different equipment, as well as the usage patterns of the end-user. A summary of points to consider is as follows:

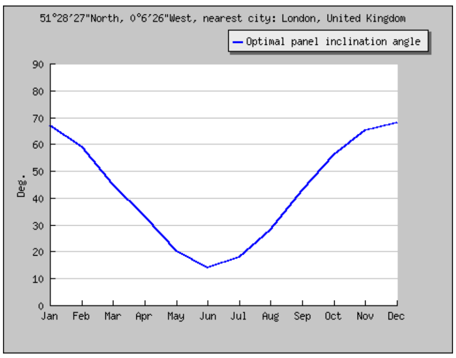
- Initial equipment costs.
- Installation costs.
- Maintenance.
- Life expectancy of the system, and any likely repair costs.
- Location in the county - how sunny is it ?
- Orientation of roof - how much sun does the panel catch ?
- Panel efficiency.
- Price of gas or electricity, and how this is likely to change.
- Government grants available.

Gains.

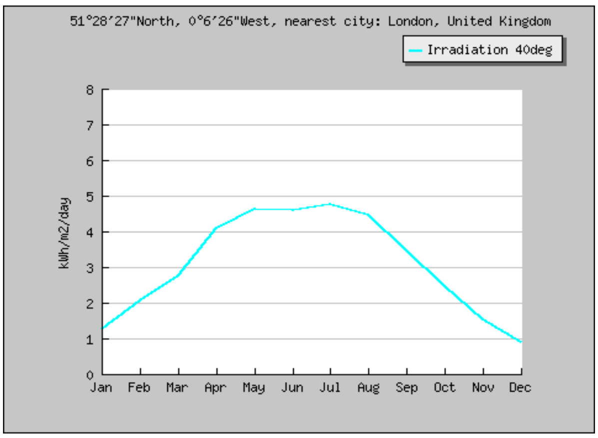


To start, we will work out the gains, or how much we can get from a system. it is easiest to pick a location in the country upon which to base calculations, and adjust any figures for different locations. For the purpose of this exercise we will choose London. The end figure we are usually after is in kilowatt hours (kWh) which is used a standard for fuel prices and energy calculations. 1 kilowatt hour is often referred to as a 'unit' and may be seen on most electricity meters. This is how much energy is takes to heat 24 litres of hot water (3 minute shower).

The first figure we are often quoted is one for Solar Irradiation - the amount of sun hitting the earth. From the graph of the UK above we can get a rough estimate of 1100kWh per year. Another source of information on solar irradiation by area, and angle to sun, European Commission Join Research Centre, SOLAREC, see http://re.jrc.cec.eu.int/pvgis/solradframe.php?en&europe. This provides a great deal of useful data on solar, as well as independent testing.



For example, the graph to the left was obtained showing how the optimum panel angle varies. The graph to the right shows the irradiation in London at an angle of 40°C. We can also get a figure of average solar irradiation in London of 3.092kWh /m2/day, which in turn provides us with a maximum energy input figure for London of 1130kW/m2 each year.



As a quick example of a calculation relating to a real panel, *Navitron* provide the figures below for UK latitudes, and quote an absorber efficiency of 93%. Comparing to the EC data above it is only slightly higher, so readings are probable taken nearer South Coast.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
kWh/day per m2	0.64	1.17	1.94	3.22	4.17	5.00	4.44	3.61	2.78	1.67	0.78	0.47
Heat Gain from 1 Navitron panel per day	1.15 kWh	2.11 kWh	3.49 kWh	5.80 kWh	7.51 kWh	9.00 kWh	7.99 kWh	6.50 kWh	5.00 kWh	3.01 kWh	1.41 kWh	0.85 kWh
Heat Gain from 1 Navitron panel per month	34.5 kWh	59.08 kWh	108.19 kWh	174 kWh	232.81 kWh	270 kWh	247.69 kWh	201.5 kWh	150 kWh	93.31 kWh	42.30 kWh	26.35 kWh

This table gives us a total for year for a *20 tube Navitron SFB20 panel* at 1640kWh/year.

From our previous figure of 1130kWh/m2/year in London, at 93% quoted panel efficiency we get 1051kWh/m2/year. A *20 tube Navitron panel* has a specified *absorber surface area* of 2.2m2, giving us a total theoretical annual energy gain from this panel at 2312kWh/year. However, this is more than the actual figures provided because the quoted 93% is under certain conditions. This shows the importance of using provided annual data rather than calculating from the solar irradiation data and a set efficiency. Solar irradiation data should only really be used to compare relative positions around the UK.

As another example, take the *Worcester Greenskies FK240 Solar Panel*. The following is provided.

Classification	**Worcester Greenskies FK240 Solar Panel**
Net surface area	2.1m^2
Stagnation temperature	181°C
Max operation pressure	3 bar
Min efficiency	525 kWh/m^{2}a
Absorption	92%
Emission	12%

As the Worcester pack comes with two FK240 panels, the quoted minimum annual energy gain is 2205kWh/year.

We now have a figure of how much energy we will get in a typical year from a system, we need to convert this into money. A simple way is to take the available cheap rate electricity price, for example Economy 7. This may be up to 4p per unit. *Powergen* provide renewable at 8.631 pence per kWh, as another interesting comparison.

Accurately calculating energy prices over the next 20 years is not easy, with more nuclear power on the horizon, rising energy requirements from the populations, and limited gas supplies all in the mix. If anything one can guess at it will probably rise more than inflation, so I am using a figure of 6p per kWh. More than the cheapest electricity, but less than current peak rate. For one's one calculations it may be preferable to compare to gas prices, as this can be half the price.

For our two examples then we obtain monetary gains of...

2 x 20 tube Navitron SFB20 panels with 1640kWh/year each giving us **£196.80 / year.**

2 x Worcester Greenskies FK240 panels with 2205kWh/year giving us **£132.30 / year.**

Costs.

Next onto the costs. Fundamentally there are two ways to install solar. The first is to retro-fit it to an existing installation. The second is to upgrade the existing system to one that is compatible with the solar. The cost of removing a hot water cylinder and replacing with a new one will considerably increase the overall costs, and hence the pay-back. For the moment, we will assume the system is to be retro-fitted. This will give us a best case scenario, and in reality is often possible.

The costs can then be broken down into parts and labour. Is is important to split these in calculations, as many people are interested in DIY installations if possible. The parts required depend on the system, so to start with one example, the following is an estimated parts list for retro-fitting a Navitron panel. These are trade prices excluding VAT.

Part	Cost
2 x 20 tube Navitron SFB20 panel	£ 672.34
2 x Roof Mounting Kit	£ 16.00
Solar Controller	£ 80
Bronze Pump and Valves	£ 100
Pipework and High Temp Insulation (10m)	£ 85
Non-Return Valve & Retro Fit Fittings	£ 50
Electronic Anti-Scale Protection	£ 80
Delivery Charges	£ 150
Total Parts	**£ 1233**

The labour costs can be split into two. The first is fitting the panel on the roof, and the second is the plumbing, wiring and commissioning.

Grants.

Another lucky break that one can obtain is grants for the solar equipment. Currently a domestic system can get £400 from the DTI's Low Carbon Buildings Programme (LCBP), see http://www.lowcarbonbuildings.org.uk/home/

In our example above this would take the equipment cost down to **£ 773.00**

Other grants are also available from local authorities and other organizations.

Pay-Back.

We should now have an idea of the costs and the benefits of solar, financially speaking. We are near a first estimate for the pay-back period. In our Navitron example...

For Navitron 40 tube retro-fit, equipment cost without a grant is **£ 1173 ex. vat, £ 1378 inc. vat at 17.5%**
Gains from solar are **£ 196.80 / year.** So our lowest estimate of pay-back for a DIY installed system is 7 years using 40 Navitron tubes.

For Worcester 2 FK240 panels retro-fit, equipment cost without a grant is **£ 1250 ex. vat, £ 1469 inc. vat**
Gains from solar are **£ 132.30 / year.** Estimate of pay-back for a DIY installed system is 11 years using Worcester system. However the Worcester system qualifies for a grant, and if we allow for a £400 LCBP grant, the pay-back is reduced to a period of 8 years.

Additional costs based on pay-back at £197 / year:
Labour at £30 hour, for 10 hours is an optimistic £300, or **1½ to 2 years** additional pay-back time.
Scaffolding and roofer charges £300, or **1½ years.**
Backup power supply £65, or **4 months.**
Replacing a broken tube, £50 parts + £50 labour, or (3+3) **6 months.**
Replacing hot water cylinder with mains solar cylinder including labour £1200, or **6 years.**

Central Heating.

Regarding the use of solar for central heating, this is often thought to be unworkable, but experience shows that there are increasing numbers of installations doing exactly that, especially with underfloor heating. If we consider that the extra cost per 20 tube panel can be as low as £500 including vat and extra labour, and at 6p/kWh will pay-back in 5 years if all energy is used. If the panels are for central heating, then some of the useful energy is outside the heating season, and the energy may not be usable.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water for 1 person per month	Approx 80 kWh per month per person											
possible Central Heating for 3 bed property	3000 kWh	2500 kWh	2000 kWh	1000 kWh	500 kWh	0 kWh	0 kWh	0 kWh	500 kWh	1200 kWh	2500 kWh	3000 kWh
Heat Gain from 1 Navitron20 panel per month	34.5 kWh	59.08 kWh	108.19 kWh	174 kWh	232.81 kWh	270 kWh	247.69 kWh	201.5 kWh	150 kWh	93.31 kWh	42.30 kWh	26.35 kWh

With central heating from September to May as above, a 20 tube panel used for heating will generate 920 kWh per year for heating, and at 6p/kWh this would pay-back in about 10 years. The important addition to the system that will be required is recoverable overheat protection, as the excess level of heat in summer months will need to be dissipated.

Summary.

Best estimates see pay-back times for solar from 7 years plus, for a DIY retro-fit system, and 10 years plus for an installed retro-fit system. 13 years plus, for a full DIY mains solar storage system, and 15 years plus for an fully installed mains solar storage system.

The labour rates are the big factor, and with high priced installers and a few hitches, pay-back can get 20 years plus. As installers become more familiar with the technologies, prices will go down. In reality, the plumbing side of solar requires little more knowledge than installing a sealed heating system. The only tricky bit is mounting the panel on the roof, and weather-proofing pipework, and with a growing market one would expect to see sub-contractors or panel suppliers providing this function separately, thereby allowing any DIY installer, plumber or heating engineer to effectively go solar.

Note that the calculation of pay-back in this article have been ay 6 pence per kWh or unit. This may be a good current average for electricity, and maybe for gas over next 10 years, however current gas prices are lower, somewhere between 2.7 and 5 pence per kWh, making the relative pay-back of solar longer. If gas and electricity prices rise ahead of inflation, then the figures get better at time goes on.

If indeed adding solar to a house adds value, then if only 1% is added to a property price then the system may be paid for. And, none of this takes into account the environmental savings on carbon emissions made by systems.

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