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What is the energy and carbon payback time for PV panels in the UK?

It is sometimes said that photovoltaic (PV) solar electric panels require more energy for their production than they every produce during their lifetime. This seems to be the kind of "urban myth" that is hard to eradicate. A PV system mounted in the UK will, under normal conditions, over its lifetime produce many times more energy than was required for its production.

Studies looking into this question typically conduct what's called a life cycle assessment (LCA), often known as "cradle-to-grave analysis", which looks into all the resources that go into the production, operation and disposal of a PV system (including "embodied energy" required for mining the raw materials and producing the panels) as well as the resources (electricity) produced by the system. The energy aspect of the LCA is often expressed in terms of the energy/carbon payback time, the time the system has to operate to produce the amount of energy (or carbon reductions) required for its production.

Different studies draw different "boundaries" of what should be included in the analysis (just the manufacturing of the panels, or also the structures the panels will be mounted on, or even a share of the total personal energy consumption of every labourer involved in the process?) and make different
assumptions about the operating conditions (will the PV system be installed in sunny California or in the UK?) and hence produce different results.

In a study published by the US Department of Energy, the payback time for PV panels was estimated to be 3.5 years under Californian sunshine conditions (1,700kWh per m^2 per year). As the UK receives only 700-900kWh of solar energy per m^2 per year, this would indicate that it takes around 7 years for PV panels in the UK to pay back their energy cost. However, this study is based on PV modules produced before 2004. The volume of PV modules produced globally increases year after year, and increasing volumes lead to greater energy efficiency in production.

A more recent study by researchers from the Netherlands and the USA (Fthenakis, Kim and Alsema, 2008), which analyses PV module production processes based on data from 2004-2006. They find that it takes 250kWh of electricity to produce $1m^2$ of crystalline silicon PV panel. Under typical UK conditions, $1m^2$ of PV panel will produce around 100kWh electricity per year, so it will take around 2.5 years to "pay back" the energy cost of the panel.

PV panels have an expected life of least 25-30 years (see *How long do PV panels last?*), so even under UK conditions a PV panel will, over its lifespan, produce many times more energy than was required to manufacture the panel.

Calculating carbon payback times introduces additional variables, especially the "carbon cost" of the electricity production replaced/avoided by the PV system: Carbon payback times are shorter in countries where electricity is primarily produced using coal power stations, and longer in countries where
grid electricity is already produced by low-carbon technologies. But generally payback times for carbon are similar to those for energy.

A 2006 report by the UK Parliamentary Office for Science and Technology, has calculated a "carbon footprint" of less than 60g per kWh of electricity from PV in the UK (and around 35g/kWh for PV in southern Europe), compared to 10 times as much for fossil fuels. More recent research by Fthenakis, Kim and Alsema, (2008) suggests that

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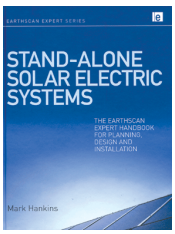

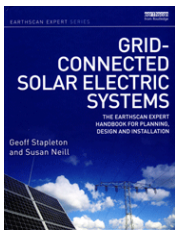

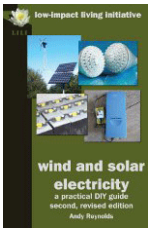

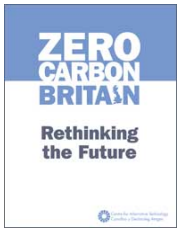

the total greenhouse gas emission (including CO2 and other gases) for electricity from PV panel is between 20 and 80g CO2-equivalent per kWh under UK conditions. This is ten times lower than the emissions for electricity from fossil fuels (UK grid average is around 500g/kWh, electricity from coal can be as high as 1000g/kWh).

Contacts

Energy Saving Trust - *http://www.est.org.uk/* - 0300 123 1234

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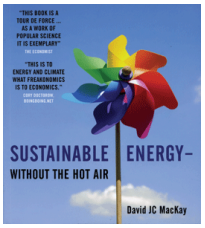

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