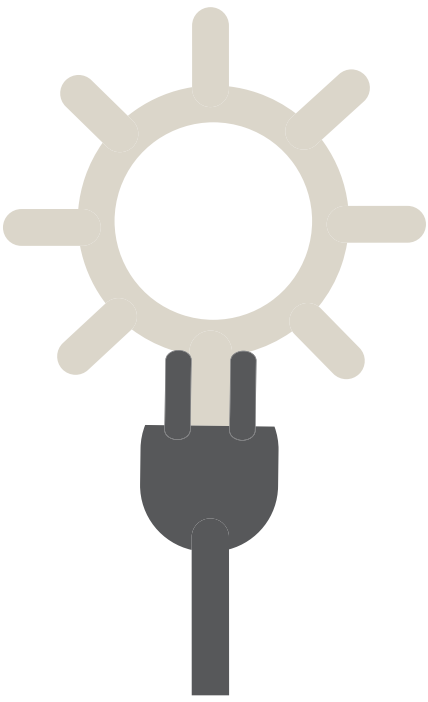
Choosing Solar Electricity

A guide to photovoltaic systems

Brian Goss



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Preface

Who should read this book?

Who should read this book? In short, anyone who wants to use solar photovoltaic (PV) to generate electricity and needs to know the pros and cons before talking to a professional solar installer. *Choosing Solar Electricity* is not intended as a comprehensive technical manual for designers or installers, although those considering installation as a business will find it a useful quick introduction to the subject. It doesn't cover design and installation issues exhaustively, but does give you the knowledge to feel confident enough to engage an installer. It also helps you understand how feed-in tariff incentives could make your investment in a solar PV system more than pay for itself. There are many books about solar PV technology and systems in print. Most make the assumption that the reader has a scientific background and a prior understanding of the principles of electricity; that they can easily understand concepts by looking at algebraic equations. My experience of teaching short courses about solar electricity has shown me that people interested in the subject come from a variety of backgrounds. Some may have qualifications in electrical and electronic engineering, whilst others have not studied science since the age of sixteen. And whilst some wish to pursue PV design and installation professionally, or have some involvement in design and installation, many may find that the safety and competency requirements for electrical work make DIY PV installation an unrealistic proposition. Instead they choose to have a system installed professionally. Homeowners, estate managers and building services managers who choose to have a system professionally installed will nonetheless want to understand what they're being offered and to make well informed design decisions that affect the aesthetics and performance of their new PV system.

How to use this book

Because the technical nature of solar PV can be daunting, I've tried to make things as simple as possible by providing easy to read break-out boxes for safety issues and technical boxes for those who want more in-depth technical explanations. You can choose to read the book without dipping into the technical boxes, but reading them will give you a greater depth of understanding. A professional solar PV installer will have a thorough knowledge of safety issues but as an operator of a PV system you will need to be aware of these too.

SAFETY

Expert advice should be sought before having a solar electric system installed. Check out Chapter Ten, 'Finding an installer'.

TECHNICAL

You'll find boxes like this one throughout the book. They have extra detail for the more technical reader; someone who has a greater interest in the system they're having installed. If you're not so technically inclined, don't worry, it's not necessary to know these technical details to own or run a PV system.

A step by step approach

Working out what you want from solar PV and what solar PV can give you requires a logical step by step approach. Going into it without a thorough understanding of your own requirements and the limitations and potential of solar power could cost a great deal of money. Installing any new power supply is an investment. You'll want to get a good return from the money you spend. Although solar panels have come down in cost and are more efficient than they once were, they are still a pricey option if you get it wrong. Your intended site might not even be suitable for solar, a fact best worked

out before you start spending money. The process of getting a PV system installed is outlined in the flowchart below – the various stages will be explained throughout the book.

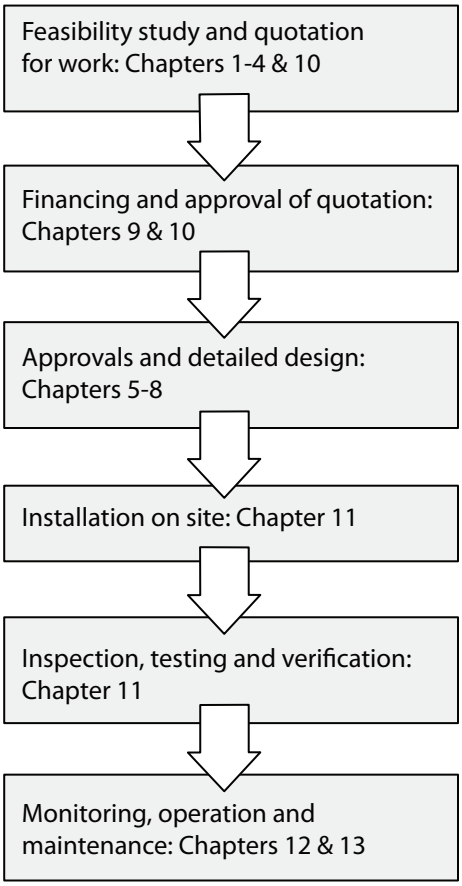

Fig. 1. Production flowchart.

Chapter One

Choosing renewables

Introduction

Although this book is about solar PV it is useful to know a little about the other renewable technologies and how solar PV compares – and can work in unison – with them. Many people chose to combine solar PV with other renewable technologies to provide a complete green solution to their heat and power needs. It is worth keeping this in mind when taking decisions about how much money you want to invest in PV. Choosing technologies carefully will help pay back your investment quicker.

Heat versus power

Generally speaking individual renewable energy technologies provide either heat or power (in the form of electricity). When we want to produce heat we turn to solar water heating, passive solar space heating, ground source heat pumps and wood burning stoves (pellets, wood chip or logs). When we want electricity we pick solar PV, hydro or wind. There are some renewable energy technologies that are designed to provide both heat and power. These are called combined heat and power (CHP) units and are generally used to meet the heat and power requirements of a large number of users – for example, a public or private office building, a university, a housing estate or a village. These systems are beyond the scope of this book.

How do I know which renewable energy system is right for me?

The most important issue when considering a renewable energy system is choosing the right technology for your situation, whether related to your site, the state of any existing technology you wish to replace, or the way you wish to use renewable energy.

The site

Any decision you take will be very site specific. Site requirements for solar PV systems – described in detail in Chapter Two – are very different to those of other renewable technologies. For example, a small wind turbine will produce minimal electricity if installed on a building within a large housing estate because such places usually have calm, irregular and turbulent winds, which is just about the opposite of what a wind turbine actually needs. To recoup installation costs a wind turbine needs strong, regular and consistent wind speeds, which is why wind farms are sited out at sea or on hilltops. Likewise, you shouldn't consider micro-hydro power (that is, domestic scale water power) if you don't live next to the kind of fast flowing streams typically found in hilly areas; or a ground source heat pump if your house sits on granite (unless you like playing with dynamite!).

Existing technology

It's very easy to get excited about buying a renewable energy system, but you should assess whether you really need one. For example, you might not want to convert to a wood pellet heating system if your gas boiler is only two years old. It will be performing very efficiently already. Likewise, if you are already connected to the grid you might be better spending your money on energy conservation measures and buying green electricity from a national energy supplier. On the other hand feed-in tariff incentives – with a guaranteed price

for every unit of electricity generated over a 25 year period – make solar PV a realistic investment opportunity in its own right (see Chapter Nine).

Appropriate use

Make sure the technology fits the use. Are you choosing solar because you want to reduce your carbon emissions, get a good return from a long term investment or because you need a backup in the event of power cuts? If it is the latter, note that most European grid-connected PV systems are not designed to operate during power cuts (since power cuts are very rare in most European countries). PV systems can be installed with battery backup, but this adds heavily to their cost and environmental impact (see Chapter Five). Hence for the backup of a utility supply that only fails for a few hours a year – if you really think you need one – a small UPS (uninterruptible power supply) or petrol generator often makes better financial and environmental sense.

Put energy conservation first

Near, if not at the top of your list of considerations should be whether renewable energy is your first priority at all! You will usually get a better return on your investment by installing basic insulation and energy efficiency measures if you haven't already done so. However, if your home or building has energy efficient heating and lighting and is well insulated already, then on-site renewable energy is a logical next step in your drive to reduce your energy consumption and cut your carbon emissions.

Choosing solar

Solar is a versatile energy resource and can be used in one of three different ways, although in this book we are concerned only with the third:

- To create so called 'passive' heat – where glass and careful design elements control the light and heat of the sun as it passes into a building.
- To heat water. Solar thermal collectors usually have water pumped through them, which is then heated by the sun. This hot water is used to heat water in a copper cylinder and supply domestic hot water (DHW).
- To produce electricity. Solar electricity, or photovoltaic (PV), modules convert light into electricity (*photo* = light, *voltaic* = electricity), which is fed directly into a building's electricity supply.

Although passive solar is an important component in architectural and building design, most people considering solar power have the two 'active' solar devices – solar thermal collectors or solar PV modules – in mind. Both are often called solar panels, but it is best to avoid this generic and potentially misleading term as it can cause confusion between water heating and the production of electricity.

Some people ask: 'Why can't we use electricity from solar PV to heat water?', or, 'Why have two separate systems?' Well, the answer is: technically you can have one system for both heating water and producing electricity, but it would be very inefficient and costly to do so. Much better to install a solar thermal collector and save the solar electricity for equipment which can't run off heat, like: power tools, computers, lights, televisions, and so on.

Why solar PV and not wind or hydro?

Solar PV can be used to provide power for homes, businesses, public buildings, holiday cottages, boats, schools, electric vehicles, remote devices… even satellites in orbit. Wind and hydro can do most of these things, too (except the satellites!), so why pick solar?

A major advantage of solar PV is that it is much less site-dependant than wind or hydro. You don't need a stream or an open windy plateau and, unlike a wind turbine, a solar PV array can be efficient when placed on an urban roof. The one issue you do need to be careful of is shading. A PV system will perform efficiently if it is placed with an open vista to the south, but not if it is heavily shaded by a large building or tall tree. Working out whether or not shading will stop your solar PV system being an economic proposition or make it slightly less efficient than it might otherwise be is your first priority. To do this you will need to calculate your solar resource. The next chapter shows you how.

Additional resources

It is beyond the scope of this book to offer a detailed comparison with other renewable energy technologies or show you how to use solar in conjunction with them. For this information, read *Off the Grid*, *Choosing Windpower* and *Going with the Flow* (all published by CAT: www.cat.org.uk). It is quite possible to design a system with all three power sources, but this scenario is more common in remote, off-grid locations. Furthermore, homes already connected to a utility electricity supply are more likely to use solar or wind power due to the remoteness of streams suitable for hydro schemes.