Montana solar house

An Introduction to New Home Solar Design

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National Center for Appropriate Technology
Primary Author: Dale Horton, Architect
3040 Continental Drive, Butte, Montana 59702
Internet Address: www.ncat.org

Funded by the Montana Power Company Universal Systems Benefits Program

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Acknowledgments

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Montana solar house

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Prepared by the National Center for Appropriate Technology

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about 10 pages
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Passive house design-tools for calculating energy balances

Does energy-conscious design require sophisticated simulations?
This was indeed the case for the first Passive Houses that were completed in 1991. Calculating the energy balance of buildings with very low energy consumption is a demanding task and existing regulations and standards lack the required precision. Nevertheless, we have identified the critical factors for preparing reliable balances - with tools that are simple to use and with acceptable effort in terms of data input. The technique for designing functional passive houses has now been tried, tested and optimized in thousands of cases.

The Passive House Planning Package (PHPP)

is a clearly structured design tool that can be used directly by architects and designers.

Several thousand users have already experienced the reliability of the calculation results and the manageability of the tool.

The PHPP includes tools for

1. **calculating the U-values (metric reciprocal of R-values) of components with high thermal insulation**
2. **calculating energy balances**
3. **designing comfort ventilation**
4. **calculating the heat load (no heat load climate data contained yet for locations outside the Midwest U.S.)**
5. **summer comfort calculations**
6. **and many other useful tools for reliable design of passive houses**

First introduced in 1998, PHPP has been continually developed. At the core of the package are worksheets for heating energy balances (heating period or monthly technique), heat distribution and supply, electricity demand and primary energy demand.

New design modules have been added successively, e.g. calculation of window parameters, shading, heating load and summer performance.

The PHPP is continuously validated and refined based on measurements. As part of accompanying scientific research studies, measurements from more than 300 projects have so far been compared with calculation results. Of crucial significance was the project undertaken as part of the European Thermie program, during which housing developments were constructed according to passive house standards and scientifically accompanied at 14 different European locations ( ).

The PHPP energy balance module was shown to be able to describe the thermal building characteristics of passive houses surprisingly accurately. This applies particularly to the new technique for calculating the heating load, which was developed specifically for passive houses.

The following diagram shows the results of a comparison between measurements and PHPP calculations for different passive houses at different locations. It is interesting to note that in all cases, irrespective of the thermal insulation standard of the buildings, there is high (relative) scatter due to user behavior, but the calculations were in excellent agreement with the average measurement results.

Diagram: Comparison of PHPP calculation with consumption measurements in housing developments with low energy and passive houses

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file - How Solar Energy Works - 9 pages

How they work
How Solar Energy Works

Contents

Solar energy—power from the sun—is free and inexhaustible. This vast, clean energy resource represents a viable alternative to the fossil fuels that currently pollute our air and water, threaten our public health, and contribute to global warming. Failing to take advantage of such a widely available and low-impact resource would be a grave injustice to our children and all future generations.

in Clean Energy
Solar water heating
Up with the sun: Solar energy and agriculture
Environmental benefits of renewable energy
Energy 101: Take a tour

In the broadest sense, solar energy supports all life on Earth and is the basis for almost every form of energy we use. The sun makes plants grow, which can be burned as "biomass" fuel or, if left to rot in swamps and compressed underground for millions of years, in the form of coal and oil. Heat from the sun causes temperature differences between areas, producing wind that can power turbines. Water evaporates because of the sun, falls on high elevations, and rushes down to the sea, spinning hydroelectric turbines as it passes. But solar energy usually refers to ways the sun's energy can be used to directly generate heat, lighting, and electricity.

The Solar Resource

The amount of energy from the sun that falls on Earth's surface is enormous. All the energy stored in Earth's reserves of coal, oil, and natural gas is matched by the energy from just 20 days

Program Overview
Renewable Energy Basic
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file - Images - Rocky Mt. Christian
3 pages

Rocky Mountain Christian Church

Building Community in Boulder County

- **Get Informed**
  - About Us
  - Why The Expansion?
  - Community Involvement
  - Images
  - Frequent Questions
  - *Flyer-See More Details*
- **Get Involved**
  - Ways To Help
  - Write a Support Letter

Above: View from Quiet Retreat to the immediate west of RMCC. The arrow indicates the current location of the grade 6-8 modular buildings—the western-most edge of the expansion will not extend any further than these modular buildings.

Below: To provide a major buffer between RMCC and Quiet Retreat, the church will build a new landscaped berm with trees to block the view of RMCC buildings. The church's investment in larger-caliper trees are shown at time of installation.

Above: A view from the southwestern end of RMCC property on Niwot Road, looking east, with bike path in the foreground.

Below: An existing berm will feature new landscaping and trees to buffer the view from Niwot Road of church property on the other side. Bike path remains in the foreground.

Above: Current view from intersection of 95th street and Niwot Road.

Below: Increased landscaping and trees will screen and buffering views at the intersection,

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file - Solar Thermal and Photovoltaic Collector Spaper

Solar Thermal and Photovoltaic Collector Manufacturing Activities 2005

Figure F1. Total Solar Thermal Collector Shipments, 1996-2005

Figure F1 shows that shipments of solar thermal collectors increased by 13.7 percent to 16 million square feet between 2004 and 2005.

Figure F5. Phot

Figure F5 shows tha
percent to 134,465 p

(entire report also av
Photovoltaic Cells a

Overview

Since the beginning of 2005, U.S. energy prices have been generally increasing, in part due to hurricanes Katrina and Rita, and demand pressure on oil supplies from the Far East. This has increased interest in alternate energy sources, which include renewable energy sources such as solar.

The U.S. manufacture of both solar thermal collector and photovoltaic (PV) cells and modules continued to grow at a strong pace in 2005. This occurred despite the fact that prices for solar panels and PV cells and modules rose due to material cost increases. The solar industry has been able to absorb most of the rising material costs because it has become more flexible in its production methods and supply arrangements over the past years. It has recovered from the nationwide economic downturn in 2003, showing significant growth in 2004 and 2005.

Solar Thermal Collectors

Domestic shipments of solar thermal collectors rose 10.4 percent to 14.7 million square feet in 2005 (Table 29). There were 25 companies shipping solar collectors in 2005, one more than in 2004. Total shipments rose to 16 million square feet, a 13.7 percent increase over 2004 (Table 30 and Figure F1). Exports surged 67.4 percent, while imports increased 22.1 percent (Table 30).

Figure F1. Total Solar Thermal Collector Shipments, 1996-2005

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file - The Solar Envelope.htm
10 pages

The Solar Envelope

by

Ralph L. Knowles

Professor Emeritus of Architecture

University of Southern California

"Nothing is experienced by itself, but always in relation to its surroundings, the sequence of events leading up to it, the memory of past experiences."

Kevin Lynch, *The Image of the City*

Key Words: mama-plane; solar access; solar architecture; solar envelope; solar zoning; urban design.

INTRODUCTION

The sun is fundamental to all life. It is the source of our vision, our warmth, our energy, and the rhythm of our lives. Its movements inform our perceptions of time and space and our scale in the universe.

Assured access to the sun is thus important to the quality of our lives. Without access to the sun, our perceptions of the world and of ourselves are altered. Without the assurance of solar access, we face uncertainty and disorientation. We may lose our sense of who and where we are.

The concept of solar access is an abstraction generalized from particular observations. The natural world appears to abound with examples of arrangements based in some measure on exposure to the sun.

More to the point, observations of the modern built world reveal that we have not usually followed nature's example in this regard. Our cities are non-directional. Our buildings are undifferentiated by orientation to the sun. They stand static, unresponsive to the rhythms of their surroundings.

Solar access has, over the past twenty-five years, come into focus as a topic of discussion in the USA. Beginning in the 1970's, we looked at the sun primarily as a source of energy, a replacement for uncertain supplies of fossil fuel. More recently, with deterioration of the urban environment, emphasis has shifted more

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file - EERE Consumer's Guide to Energy Efficiency

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

A Consumer's Guide to Energy Efficiency and Renewable Energy

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Search

Search Help Ü More Search Options

Explore your options for saving energy and using renewable energy at home, at work, in your community, and while driving.

Your Home

Your Vehicle

Your Workplace

Photo of family of four in front of home.

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- Design & Remodeling
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- Electricity
  - Solar Electric Systems
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- Energy Audits
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Browse our online Energy Savers Booklet for tips to start saving energy and money.

Ahorro de Energía: Energy Savers in Español

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Introduction

On January 12, 2006, the California Public Utilities Commission (CPUC, or the Commission) approved the California Solar Initiative (CSI), an 11-year $3.2 billion incentive program which aims to install 3000 MW of new solar systems on-site at customers of the State's investor-owned utilities (IOUs). The CPUC portion of this program will cost $2.8 billion and target 2600 MW of solar technologies. The California Energy Commission (CEC) portion of the program will focus on the CEC's responsibility for statewide energy building codes. The CEC will seek to include solar systems in new home construction, calling upon a budget of $350 million with a target of 400 MW of new solar installations.

The CPUC Energy Division staff proposal below addresses the "Phase 1" program design and implementation for the

Large Scale Municipal and Commercial

Solar Pools

Sandia National Laboratories

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Links for Solar Water Heating

Solar Calculator

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QUICK QUALIFIER FOR THIRD PARTY SOLAR POOL FINANCING

You are a good candidate for this approach if you:

- Have large and/ or multiple swimming pools.
- Heat the pools.
- Heat enough pools that you have a critical mass of projects.
- Want to save money.
- Don't have the capital budget or enough of a capital budget to pay for the up-front cost of new energy equipment, even if it saves you money and has reasonably short pay-back time.

So if you can say yes or probably to these statements, then it would be worth your while to spend a few minutes checking out our ***"how-to" on this approach.*** It can get solar energy systems installed that actually save people money. You look like a hero. They look like a hero. Everybody wins.

We have designed this site to be simple, straightforward and to the point. This is not a comprehensive site for solar technology, financing, technology marketing, or several other issues that are relevant. When we discuss these things in the site, we will discuss them in only enough detail to get you to the objective – a deal done. But if you must, and want to drill down a bit into technique, we will give you a few references and resources that you can check to give you more detail.

So, to start –

(Introduction)

Quick Qualifier (You are Here)
Purpose of the Site

Who should be using this Site
Third Party Financing

(Getting Started)

Running the numbers
Overview of the Process
Developing an RFP ("Request for Proposal") Together
Sample RFP

(From RFP to Implementation Key Aspects of RFP)

Key Aspects of RFP
Sample RFP
Project Description
Proposal Evaluation Plan
Sources for Prospective Proposers

(Internet Resources)

-Solar Rating And Certification Corp. (SRCC).
-US DOE
-Florida Solar Energy Center (FSEC)
-National Renewable Energy Lab (NREL)
-Amercian Solar Energy Society (ASES)
-Sandia's Technology Assistance Program (TAP)
-Solar Energy Industries Association (SEIA)
-Interstate Renewable Energy Council (IREC)
-Million Solar Roofs (MSR)

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Contact Information: Greg Kolb
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Lisa Sena-Henderson
Last modified: May 4, 2007

HIGHLANDS AND ISLANDS OF SCOTLAND
HARNESSING NATURE'S POWER

Factsheet

Solar Photovoltaics

Image Courtesy of SgurrEnergy

Solar Photovoltaic cells (Solar PV for short) convert the energy contained in the sun's rays into DC electricity.

PV cells consist of a silicon based semiconductor. There are three principal types of cell:

- Monocrystalline (£3-4/Wp)
- Polycrystalline (£3-4/Wp)
- Amorphous Silicon (£1-2/Wp)

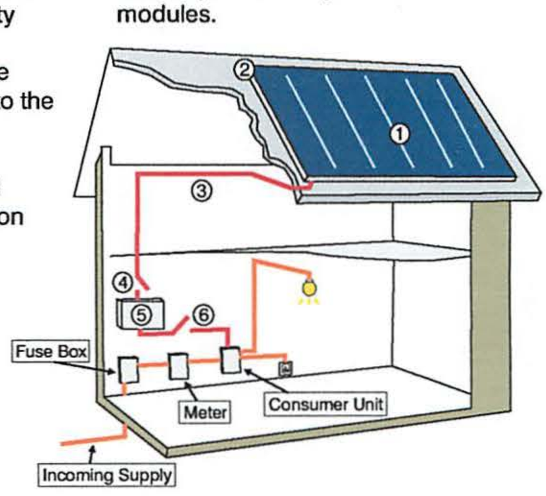
Cells are connected in series to form modules. When the silicon is exposed to light, an electrical charge is generated. The greater the intensity of light, the greater the level of electrical charge. Typical modules have a rated power output of around 75 - 120 Watts peak (Wp). A domestic system of 1.5 - 2 kWp may therefore comprise some 12 - 24 modules covering an area of 10-20m^2.

In a domestic installation PV modules are mounted onto an array and fixed to a building's roof. The electricity generated by them can then be converted to AC electricity for use within the property or sold back to the grid.

The components of a typical grid connected domestic PV installation are shown here.

1) PV Array
2) Roof Support Structure
3) DC and Earth Cable
4) DC Switch Disconnector
5) Inverter
6) AC Switch Disconnector

For a domestic installation suppliers will normally offer a 12 month warranty on the system, together with 2 years on the inverter and a performance warranty of 10 - 25 years on the modules.



If you require further information, please contact the renewable energy team at Highlands and Islands Enterprise
Tel: **01463 244350** Email: **renewables@hient.co.uk**

Solar Photovoltaics
Costs & Considerations

Costs
Typical domestic solar PV installations range in size from 1 to 2kWp and would cost from £7,000 to £12,000 fully installed.

At these prices PV is an expensive renewable energy generation method. Their application can look more viable if installed in an off grid area. Some PV products (e.g. solar tiles - shown below) also have the potential to replace traditional building materials therefore negating the cost associated with purchasing them.

Installation
PV systems should only be installed by accredited professionals. This is also likely to be a requirement to obtaining grant funding. A link to accredited installers located throughout the UK can be found in the 'Useful Links' section at the end of the factsheet

Stand Alone Systems
PV installations are well suited to off-grid applications, where a grid connection is not available or too expensive to obtain. In Scotland PV is often used to power telecommunications masts or road signs. They can also be used to provide power to caravans and boats. Such systems would normally use batteries to store the power in which case a suitable charging regulator would be required for protection.

If larger amounts of electricity are required PV can be combined with another stand alone source of power - e.g. a wind turbine or diesel generator to form a hybrid power supply system.

Connecting to the Grid
As well as generating electricity that can be consumed in your property, there may be times when your PV system produces more than you need. In this situation, any surplus electricity will be fed into the local network. It is the responsibility of the installer to contact the local Distribution Network Operator to advise that a new PV system is being connected in their area. It is also their responsibility to ensure your system is installed according to the existing electrical installation regulations (known as G83/1).

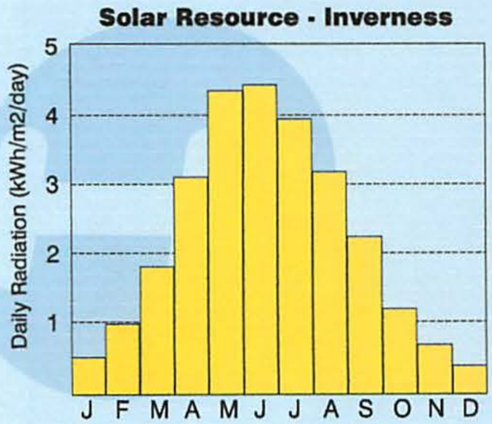
Being connected to the grid also has other benefits. As a renewable energy producer you should be eligible to accrue ROCs on the electricity you generate. ROCs can be traded thus improving the economics of your project. For small scale generators this can be a complex process. To remove this complication you may wish to investigate signing up with a green energy supplier who will take care of the whole ROC process and purchase the electricity you generate. Your PV supplier will be able to advise on which option suits you best. This will be dictated by factors such as how much excess electricity you generate.

Performance
The output of a PV system depends on a number of factors including orientation, pitch, shading and available solar resource (see foot of page).

The DTI state that an average grid connected PV system in the UK (unshaded, inclined and south facing) can be expected to generate around 750 kWh per kWp per year.
A 1.5-2kWp installation would therefore generate around half of a typical three bedroom home's electricity requirements.

Maintenance
The lack of moving parts within a PV system means that maintenance requirements are minimal. Arrays should be checked periodically to ensure they are clean and free from debris.

A PV array installed upon a caravan



Solar Resource in the Highlands and Islands

The power density of solar energy is made up of two components, the radiation in the direct beam from the sun, and diffuse radiation from the sky. Solar PV is able to harness both components. On a clear day diffuse energy may amount to 15-20% of the global irradiance whereas on a cloudy day it will be 100%. Global irradiance varies throughout the course of the day because the path length of the solar radiation through the atmosphere changes. For the same reason, there are variations with season and latitude. The total solar energy received in a day (known as the insolation or solar irradiation) can vary in the UK from around 0.5kWh/m^2 in the winter to 5kWh/m^2 in the summer. The graph opposite shows the typical solar resource available to Inverness throughout a year. This variability is an important aspect of any solar energy project as it will influence system design and economics.

If you know the Latitude and Longitude of your property you can calculate the solar resource available to it by following the link at the end of the factsheet.

Solar Photovoltaics
Is My Property Suitable?

Not all properties will be suitable for the installation of solar PV.

As virtually all domestic schemes will have the array mounted on the roof, the setting and orientation of the dwelling will have an effect on the performance of any installation.

Orientation & Tilt

Arrays should be oriented to maximize the level of daily and seasonal solar energy that they receive. The optimum orientation for a PV array in Scotland is due south.

Where this is not possible it should at least face within 45 degrees (east or west) of due south as per Figure 1.

As most arrays will be mounted on the roof of a property they will share the same tilt as that of the roof.

The optimum tilt for PV is between 30 and 40 degrees from horizontal. Should your roof have a tilt that is 20 degrees either side of optimum it will only suffer a reduced output of about 5%.

Overshading

Even a small degree of shading on part of the array can have a very significant impact on its overall output. This is because the cell with the lowest illumination determines the operating current of the series in which it is connected. Bearing in mind that the sun moves throughout the day the array should be positioned carefully so as to avoid all potential obstructions.

Planning Permission

PV arrays are generally integrated into the slope of a property's roof. This method of installation gives the collector the appearance of a rectangular glass skylight. In Scotland, such installations are generally regarded as permitted development and will not require planning permission.

There may be circumstances where permitted development status does not apply (installing upon a listed building or in a conservation area) therefore it would be prudent to first check with your local planning department.

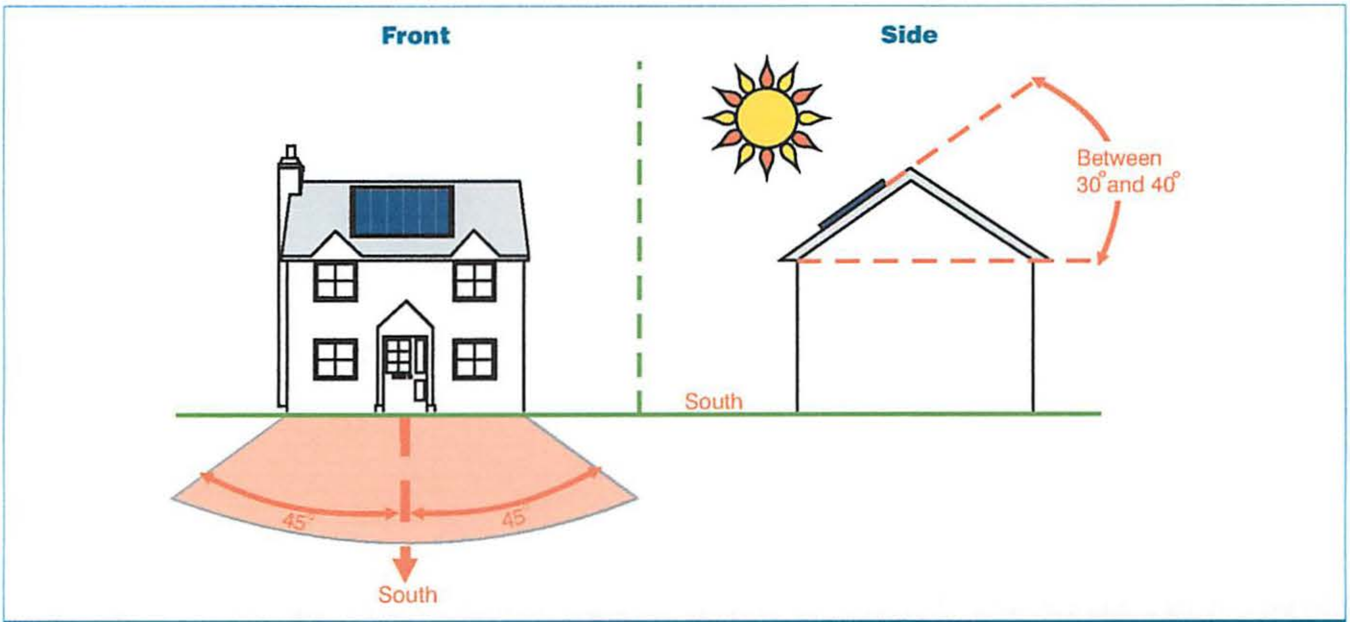


Figure 1: Optimum Orientation and Tilt of a Solar PV Array

Useful **Links**

The Energy Saving Trust - Solar PV
www.energysavingtrust.org.uk/generate_your_own_energy/types_of_renewables/solar_pv

British Photovoltaic Association
www.greenenergy.org.uk/pvuk2

Scottish Solar Energy Group
www.sseg.org.uk

NASA Surface Meteorology and Solar Energy Data - Calculate the solar resource at your property
http://eosweb.larc.nasa.gov/sse/RETScreen

A comprehensive list of accredited manufacturers and installers of PV equipment can be found here
www.lowcarbonbuildings.org.uk/info/installers