

Renovations that Reduce the Operating Costs of Single Family Homes in Hawai'i

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May 2011

Submitted towards the fulfillment of the requirements for the Doctor of Architecture Degree.

School of Architecture
University of Hawai'i

Doctorate Project Committee

Pu Miao, Chairperson
Michelle Teng
Phillip Barker

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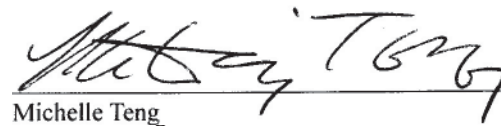
May 2011

We certify that we have read this Doctorate Project and that, in our opinion, it is satisfactory in scope and quality in fulfillment as a Doctorate Project for the degree of Doctor of Architecture in the School of Architecture, University of Hawai'i at Mānoa.

Doctorate Project Committee

 4/12/2011

Pu Miao, Chairperson



Michelle Teng



Phillip Barker

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Introduction

I wanted to do research in this area because I wanted to contribute something that was more than just a cool looking design. In my mind the best architectural designs are the ones that eloquently solve a problem. In these times it is important to be able address the amount of resources our buildings use. I want to create a knowledge base that will allow the owners of single family homes in Hawaii to improve their homes and save money on operating costs. This research focuses on specific methods and products that allow homeowners to save money. I know money can be a strong motivator which is why all of my research is aimed at methods which can save homeowners money. However, this is not the only value of this research. Along with saving money, people who use the methods in this book will become more aware of environmental issues. Whether they like it or not, by using the methods in this book they will be having a positive impact on the environment.

This research important because of how much money it can save the building occupants and what it can do for the quality of life of the users. It is also important because of the awareness it brings to the building users. I feel that the techniques in this book can be applied, in varying extents, to virtually any building and improve the way that it functions. This is why I find this research so valuable. It might be hard for me to justify a design decision that is based purely on aesthetics, but if I can tell a client that my design decision will save him or her x amount of dollars a year and improve their comfort I think my decision would be more justified.

Every design decision should have some kind of rationale behind it. Life cycle costs and the long term experience of building occupants should be the foremost function related design concerns of today's architects. It's not enough to just have short term goals in mind. If you own and manage a building for more than 25 years chances are you have paid as much in maintenance costs over that time period as you paid to buy the building initially.

Most single family homes in Hawaii have a higher occupancy rate than single family homes anywhere else in the nation except California (US Census). This means that every single family home that works inefficiently and uncomfortably is inflicting its damage on a greater number of people per home than almost anywhere else in the country. Here in Hawaii many will agree that we have the most opportunity for utilizing renewable energy and yet of all the states in the nation we are the most dependent on outside sources of energy. We have the highest prices of electricity in the nation and the highest average rental prices and housing prices in the nation.

Introduction

The largest costs in residential housing in Hawaii are usually for things related to human comfort. In Hawaii, air conditioning and hot water are not really necessities in a strong sense. The things we spend the most on in terms of house maintenance are things that we could choose to live without. This research is not about convincing people to live without, but to show people how to live comfortably without having to spend as much. If people were really worried about their energy bills they could just take cold showers. We could all go without AC in our homes if we really wanted. This is not the intention of my research, but it is important to remember how much money we spend on the ability to live comfortably. This book is about finding a way to reduce the price of your comfort. Some of this is about using what you already have in a different way, some of this is about using available products and design methods and some of this is simply about learning better habits.

It is hard to over state the value of good, energy efficient habits. This might seem a lot like the kind of thing kindergartners learn in school, but it is surprisingly important. Many LEED (energy efficient) buildings are not performing as well as the designers had intended and studies have shown that this is in large part due to the habits of the building users. The decision to turn off a light when you leave a room costs you nothing. It only takes a moment. Good habits are the most cost effective money saving method in this book.

How to Use This Book

This book is of course intended for people interested in learning and applying methods that reduce the operating costs and increase the comfort of single family homes in Hawaii. There are a wide variety of methods presented in this book. Each chapter has methods intended for large or small budgets as well as methods for do-it-yourself projects and those that require professional products or services. Whenever possible, information on product pricing or square foot cost is given. The first three chapters in this book give important background information on Real Estate Considerations , Building Permits and Tax Incentives. The rest of the chapters in this book are organized by building **surfaces** and building **systems**. Building **systems** are covered in the Water Heating, Lights, and AC chapters. Building **surfaces** are covered in the Roof, Walls and Windows chapters.

At the beginning of each chapter there is some general background information that you should know before proceeding to the methods within the chapter. Look for the big title:

BACKGROUND INFO

Many of the methods in this book should be applicable to your home, but due to the varying nature of homes and environmental differences throughout parts of Hawaii, some methods will, or will not be useful to you. Each chapter has points along the way where the savings, comfort value of the method are discussed. Look for the big dollar symbol and smiley face to find out if a particular method will save you money or increase the comfort of your home based on your homes particular situation.



At the beginning of each chapter there is a glossary of words that will help you understand the methods in the chapter. Look for the big book to get acquainted with the new terms.



Some pieces of information are particularly critical regarding safety, functionality and the ability to qualify for tax incentives. To find this critical information look for the big exclamation mark.

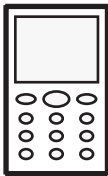


How to Use This Book

Throughout the chapters there are helpful rules of thumb. To find these look for the big thumb.



At the end of each chapter there is a list of phone numbers of important contacts related to the methods in that chapter. To find these look for the big cell phone.



Real Estate Considerations

Many of the methods presented in this book can be performed without a building permit. However, there are also many methods in this book that either require a building permit, or require a moderate amount of Do-It-Your-Self skill. It is important to understand when a building permit is required and when a contractor is required. Just because a contractor is not required does not necessarily mean it is a good idea to do a project yourself.

Permits and licensed contractors are a way of maintaining the health safety and welfare of the public. Aside from safety, it is important to consider that any non-permitted alterations you made to your home may devalue your home and make it more difficult to sell. It is also important to remember that many of the rebates you can earn for making energy efficient upgrades to your home must meet code and in some cases be installed by a licensed contractor.

If you make modifications to your home without building permits you will have to disclose these to potential buyers when you sell your home and this can make your house seem less desirable.¹ See the next chapter for more information on when a building permit is required.

¹(no author), Abe Lee Realty, "Hawaii Real Estate Disclosures and Standard Forms," <http://www.abeleerealty.com/HawaiiRealEstateInformation/Disclosures.asp> (accessed 2-19-2011).

Building Permits

These are government forms provided to help homeowners apply for building permits. For more information and forms go to the State Department of Planning and Permitting website. <http://www.honoluluodpp.org/PermitInfo/> or <http://honoluluodpp.org/downloadpdf/construction/bldperm2.htm>

BUILDING PERMITS ARE REQUIRED:

1. To erect, construct, alter, remove, or demolish any building or structure (including fences, retaining walls and swimming pools).
2. For any electrical or plumbing work.
3. To construct or alter any sidewalk, curb or driveway in public rights-of-way.

A sign permit is required to install, construct, alter, relocate, or reconstruct any sign. A temporary permit is required to erect any tent or similar structure to be used for religious or commercial purposes, such as rallies, festivals or carnivals.

BUILDING PERMITS ARE NOT REQUIRED FOR:

1. Curbs, planter boxes, retaining walls and fences which are not more than 30" in height
2. Individual residential television and radio antennas excluding dish-type antennas.
3. Painting, cabinet work and floor covering.
4. Tool and storage sheds not exceeding 120 square feet as accessories to dwellings.
5. Repairs using similar or same materials for the purpose of maintenance and which are not more than \$1,000 in valuation in any 12-month period, and do not affect any electrical or plumbing installations.

Refer to section 18-3.1, Chapter 18, Revised Ordinances of Honolulu, 1990, for complete listing of items not requiring permits

INFORMATION TO BE PROVIDED ON PLANS:

1. On plot plan, show lot dimensions, location of driveway, location of proposed work, distance from property lines and other buildings, easements and other pertinent information.

Plans should be drawn preferably to scale with sufficient information and details to clearly show the nature and extent of work.

2. On floor plan, indicate the use of rooms, room dimensions, location and sizes of windows, exits, etc.
3. On framing plans or typical section view, show sizes and spacing beams, floor joists, rafters, etc., and ceiling heights.
4. On outside or exterior elevation views, show height of building.
5. Give address and/or tax map key of where the work is to be done, and the name and address of owner.

ELECTRICAL AND PLUMBING WORK:

All electrical and plumbing work shall be performed by licensed electrical/plumbing contractors.

Henery Eng, *Do you need a building permit?*,

(Honolulu hawaii: Department of Planning and Permitting, 2008),
<http://honoluluodpp.org/downloadpdf/CONSTRUCTION/bpinfo.pdf> (accessed 2-22-2011).

Building Permits

WHERE TO APPLY:

Building Permit Center
Frank F. Fasi Municipal Building
650 South King Street (ground floor)
Phone: 768-8220

Building Permit Center - Kapolei Hale
1000 Uluohia Street (ground floor)
Phone: 768-3126

OFFICE HOURS: 7:45 a.m. - 4:30 p.m.,
Monday thru Friday (except holidays).

ARCHITECT'S OR ENGINEER'S SEAL:

Plans must be properly stamped and signed by an architect or structural engineer when

(1) work on one storied buildings exceed \$40,000, (2) work on two-storied buildings exceed \$35,000, or (3) the principal structural members are of reinforced concrete or structural steel. Plans for retaining walls five feet or more in height must be properly stamped and signed by an architect, structural engineer, or civil engineer. See Chapter 464 of the Hawaii Revised Statutes for additional data.

FURTHER INFORMATION:

For some construction projects, in addition to a building permit, you may need permits or approvals from the following city agencies:

- a. **Civil Engineering Branch** (Ph: 768-8219)
Review involves drainage, grading and projects adjacent to streams and drainage easements.
- b. **Wastewater Branch** (Ph: 768-8212)
Review for sewer availability and adequacy and for projects adjacent to existing sewer easements.
- c. **Zoning Plan Review Branch** (Ph: 768-8252)
Information for specific zoning regulations.
- d. **Board of Water Supply** (Ph: 748-5460)
Review for water use and adequacy.

Owner-builders should contact the State Department of Commerce and Consumer Affairs at 586-2700 for further information.

Additional information is available at the Department of Planning and Permitting website: www.honoluluodpp.org

A word of caution: since this booklet is a general guide and necessarily brief, please consult each agency for additional details and for the latest amendments and changes.

Henery Eng, *Do you need a building permit?*,
(Honolulu hawaii: Department of Planning and Permitting, 2008),
<http://honoluluodpp.org/downloadpdf/CONSTRUCTION/bpinfo.pdf>
(accessed 2-22-2011).

Building Permits

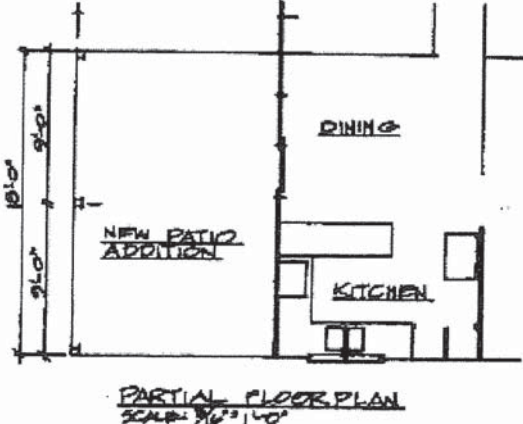
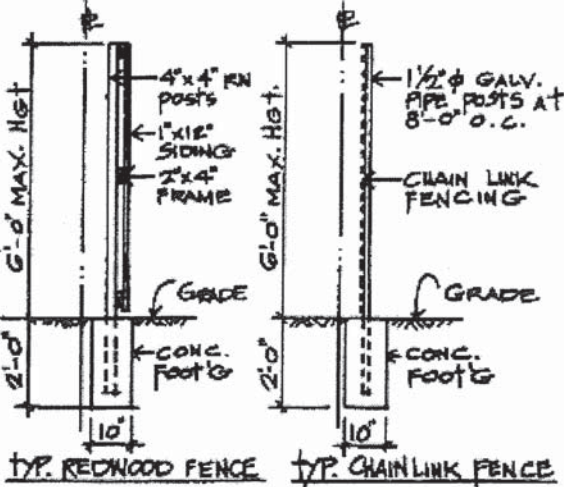
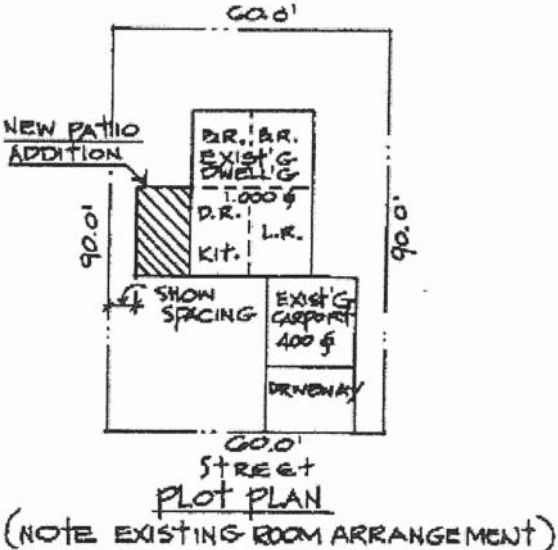
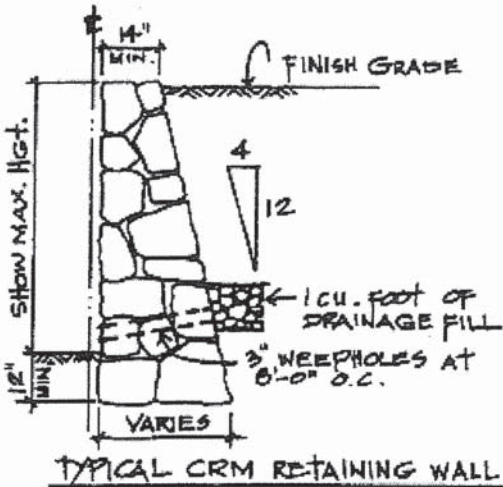
WHAT TO BRING:

Four (4) sets of plans.

PERMIT FEE:

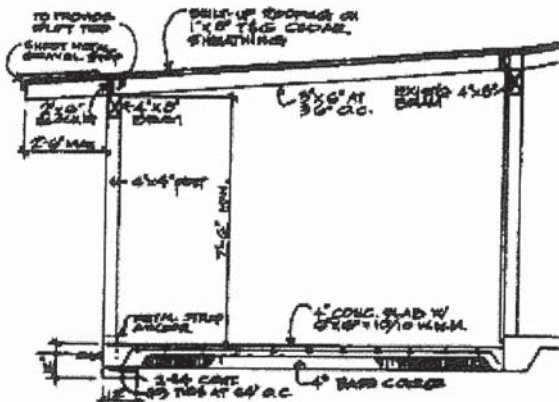
The minimum fee is \$18 for work up to \$500 in value. This fee increases as the value of work being done increases.

EXAMPLES OF TYPICAL FENCES AND RETAINING WALL

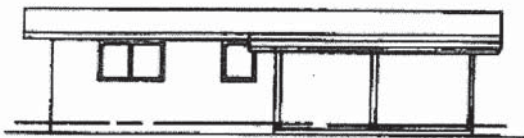


Henery Eng, *Do you need a building permit?*, (Honolulu hawaii: Department of Planning and Permitting, 2008), <http://honoluluodpp.org/downloadpdf/CONSTRUCTION/bpinfo.pdf> (accessed 2-22-2011).

Building Permits



TYPICAL CROSS SECTION
SCALE: 3/8" = 1'-0"

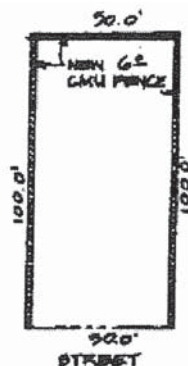


LEFT ELEVATION
SCALE: 3/8" = 1'-0"

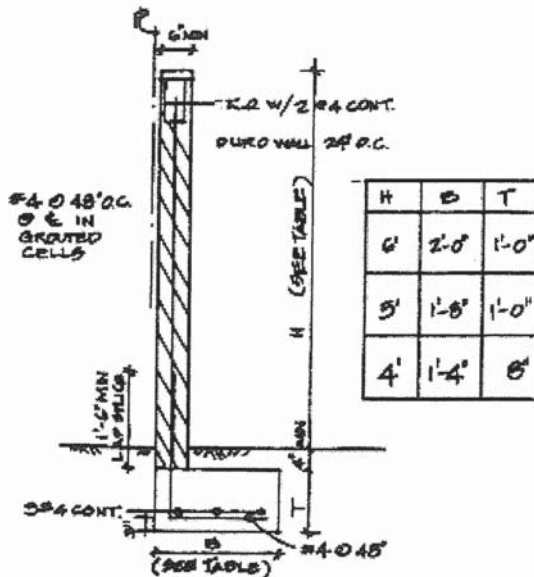
SAMPLE ONLY

NEW PATIO ADDITION FOR
MR. & MRS. JOHN A. DOE
125 MAIN ST. HONOLULU, HI
TAX MAP KEY: 1-2-3-4

PLOT PLAN



HOLLOW TILE FENCE WALL



Henery Eng, *Do you need a building permit?*,
(Honolulu hawaii: Department of Planning and Permitting, 2008),
<http://honoluluodpp.org/downloadpdf/CONSTRUCTION/bpinfo.pdf>
(accessed 2-22-2011).

Building Permits

Department of Planning & Permitting • City and County of Honolulu
BUILDING PERMIT WORKSHEET

Application Index No. **A**
 Please Print - Use Ink

APPLICANT FILL IN AREA BELOW					Zone	Sec	Plot	Parcel	Lot No.	Lot Area	Sq. Ft.	
Owner					Estimated Market Value of Work \$							
Owner's Address					WORK WILL		ADD		DELETE			
Construction Site Address					Residential Units	Total		Total				
Plan Maker					Hotel Rooms	Rooms		Rooms				
Address					NATURE OF WORK							
Contractor					1 <input type="checkbox"/> New Building	6 <input type="checkbox"/> Repair	11 <input type="checkbox"/> Plumbing					
Address					2 <input type="checkbox"/> Foundation Only	7 <input type="checkbox"/> Demolition	12 <input type="checkbox"/> Fire Sprinkler					
Electrical Contractor					3 <input type="checkbox"/> Shell Only	8 <input type="checkbox"/> Fence	13 <input type="checkbox"/> Air Conditioning					
Address					4 <input type="checkbox"/> Addition	9 <input type="checkbox"/> Retaining Wall	14 <input type="checkbox"/> Solar					
Address					5 <input type="checkbox"/> Alteration	10 <input type="checkbox"/> Electrical	15 <input type="checkbox"/> Other					
Address					SIDEWALK, CURB, AND DROP DRIVEWAY							
Address					<input type="checkbox"/> Construct	<input type="checkbox"/> Conc.	<input type="checkbox"/> A.C.	EXISTING				
Address					<input type="checkbox"/> Reconstruct	<input type="checkbox"/> Lava Rock	<input type="checkbox"/> Conc.	CURBING				
Address					<input type="checkbox"/> LINEAL FEET of _____	<input type="checkbox"/> R.C.	<input type="checkbox"/> A.C.	DRIVEWAY				
Address					Please notify this office at least 24 hours before starting work. Phone 523-4276.							
DESCRIPTION OF WORK TO BE DONE												
SEWAGE DISPOSAL METHOD												
1 <input type="checkbox"/> Public Sewer 2 <input type="checkbox"/> New Aerobic Unit 3 <input type="checkbox"/> Not Applicable 4 <input type="checkbox"/> Private Sewage Treatment Plant 5 <input type="checkbox"/> Septic Tank 6 <input type="checkbox"/> Cesspool 6 <input type="checkbox"/> Other (Specify) _____												
Signature (Owner or Agent)										Date		
Proposed Use:										Floor Level:		
If Agent, Print Name										Agent's Tel. No.		

DPP-25 (REV. 1/01)

Henery Eng, *Do you need a building permit?*,
 (Honolulu hawaii: Department of Planning and Permitting, 2008),
<http://honoluluodpp.org/downloadpdf/CONSTRUCTION/bpinfo.pdf>
 (accessed 2-22-2011).

Building Permits

In addition to filling out a paper copy of a building permit application you are now also required to fill out an online version to help the planning department streamline its operations. When you fill out the online building permit application you will be given an IBP number. Remember to have this number with you because it will be one of the first things you are asked for when you get to the building permit desks. Below is a quote from the Honolulu City and County Department of Planning and Permitting web site.

“In order to facilitate a smoother transition to the International Building & Residential Code, we are “REQUIRING” that all Building Permit submittals have an Internet Building Permit Application created. You may access this online site thru the link at:

<http://dppweb.honolulu.gov/DPPWeb/default.asp?PossePresentationId=600>.

The permit center has 2 computers available to the public to submit an Internet Building Permit Application. Due to the limited number of computers, customers with internet access are encouraged to complete the online application before coming to the permit center. To create an Internet Building Permit Application, please carefully read all instructions and fill out the information accordingly. After proper completion, write down the Internet Building Permit (IBP) number. It should look similar to this example: 2007/IBP0750 To complete the application process, submit the IBP number with your plans at the permit center. If you have any questions or require assistance, please ask the receptionist at the counter located in front of the entrance doors of the permit center or call the Permit Issuance Branch at 768-8257.²”

² City and County of Honolulu Department of Planning and Permitting, *Internet building permit application*, <http://honolulu.dpp.org/WhatsNew/process0905072.pdf> (accessed 2-22-2011).

Tax Rebates

There are a number of methods in this book that could save you money and increase the comfort of your home and many of these methods are also capable of earning tax rebates. It is important that before you start any method that you examine the related tax forms provided. These forms are updated each year and are easily available online if you simply search the name of the form. Forms often ask for things like cost of product, cost of installation, energy efficiency ratings, capacity of the product, energy consumption of the product etc. Always keep receipts of products you think might qualify and always keep information related to the capacity and energy efficiency of the products. It is also important to remember that these tax rebates are generally only good for the year in which a product was purchased or installed.

It is also important to know about the requirements that have to be met in order to qualify for federal tax credits related to energy efficient products or improvements to your home. State and federal requirements differ. The federal tax rebate forms expect your home improvements to live up to the standards of the IECC. Often new building permits will require energy calculations for chapter 32 of Honolulu's Land Use Ordinances and these are largely based on the IECC.

The IECC is the **International Energy Conservation Code**. To keep updated check online at the IECC web site. This is the link that lays out the specific federal requirements based on Hawaii's climate. Different regions in the United States have to meet requirements based on their designated climate zones. In Hawaii we are in climate zone 1.

<http://energycode.pnl.gov/EnergyCodeReqs/?state=Hawaii>

Below are the IECC required values for Hawaii's climate zone (climate zone 1) Consider these performance values when you are choosing products for the methods in this book.

Ceiling R-value	30
Wood Frame Wall R-value	13
Mass Wall R-value (i)	3/4
Floor R-value	13
Basement Wall R-value (c)	0

Tax Rebates

Slab R-value d, Depth	0
Crawlspace Wall R-value c	0
Fenestration U-Factor b	1.2
Skylight U-Factor b	0.75
Glazed fenestration SHGC b, e	0.30

Notes about the above values:

a. R-values are minimums. U-factors and SHGC are maximums. R-19 batts compressed into a nominal 2x6 framing cavity such that the R-value is reduced by R-1 or more shall be marked with the compressed batt R-value in addition to the full thickness R-value.

b. The fenestration U-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

c. "15/19" means R-15 continuous insulated sheathing on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. "10/13" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

d. R-5 shall be added to the required slab edge R-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in zones 1 through 3 for heated slabs.

e. There are no SHGC requirements in the Marine zone.

f. Basement Wall Insulation is not required in warm-humid locations.

g. Or insulation sufficient to fill the framing cavity. R-19 is minimum.

h. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

i. The second R-value applies when more than half the insulation is on the interior of the wall.

j. For impact rated fenestration complying with Section R301.2.1.2 of the International Residential Code or Section 1608.1.2 of the International Building code, the maximum U-factor shall be 0.75 in Zone 2 and 0.65 in Zone 3.³

³ (no author), *Residential Prescriptive Requirements*, 2009 International Energy Conservation Code (IECC), <http://energycode.pnl.gov/EnergyCodeReqs/?state=Hawaii> (accessed 2-22-2011).



What will qualify for tax credits?

If you want to know more about the qualifications for tax credits, visit the U.S Department of Energy website: www.energysavers.gov . If you go to the specific URL: http://www.energysavers.gov/financial/70010.html#products_2011 you will find constantly updated lists of products that will qualify for tax credits. You will also find links that help you download the most updated tax forms and detailed and up to date explanations of how to claim your tax credits.⁴

Public Opinion Regarding Alternative Energy Tax Incentives

American's today are apparently quite interested in Tax Incentives:

“With Republicans in control of the House of Representatives and Democrats in control of the Senate, it would appear the proposals with the best chances of passing are those that generate strong bipartisan support. **That is clearly the case for a bill that would provide incentives for increased use of alternative energy.**”

While there is strong bipartisan sentiment for overhauling the federal tax code, Republicans and Democrats would likely have very different ideas on how to handle an overhaul, making the odds of passing such legislation unclear.

Though there is less bipartisan agreement on increased oil and gas exploration or a speedier withdrawal from Afghanistan, there may be enough that Congress could pass legislation on these issues if it decides to pursue them.”⁵

See the following page for the results of a recent Gallup poll:

4 (no author), U.S. Department of Energy, “Energy savers, Tax Credits for Energy Efficiency”, <http://www.energysavers.gov/financial/70010.html#taxcredit> (accessed 2-23-2011).

5 Jeffrey M. Jones, “In U.S., Alternative Energy Bill Does Best Among 8 Proposals,” Gallup, Tuesday march 29, <http://www.gallup.com/poll/145880/Alternative-Energy-Bill-Best-Among-Eight-Proposals.aspx> (accessed 3-29-2011).

Tax Rebates

In U.S., Alternative Energy Bill Does Best Among Eight Proposals

Two-thirds favor expanded drilling and exploration for oil and gas

by Jeffrey M. Jones

PRINCETON, NJ – Of eight actions Congress could take this year, Americans most favor an energy bill that provides incentives for using alternative energy (83%), an overhaul of the federal tax code (76%), and speeding up withdrawal of U.S. troops from Afghanistan (72%).

Next, I'm going to read a list of actions Congress could take this year. Please say whether you strongly favor, favor, oppose, or strongly oppose Congress doing each of the following this year. How about -- [RANDOM ORDER]?

	Total % favor	Total % oppose
Pass an energy bill that provides incentives for using solar and other alternative energy sources	83	15
Pass a bill to overhaul the federal tax code	76	14
Speed up the withdrawal of U.S. troops from Afghanistan	72	25
Pass an energy bill that expands drilling and exploration for oil and gas	65	33
Approve a free-trade agreement with South Korea	53	35
Pass stronger gun control laws	49	50
Take steps to deny automatic citizenship to children born in the U.S. whose parents are illegal immigrants	44	54
Pass a bill to give some illegal immigrants living in the U.S. a path to legal status	43	55

USA Today/Gallup, Jan. 14-16, 2011

Public opinion about energy tax incentives

<http://www.gallup.com/poll/145880/Alternative-Energy-Bill-Best-Among-Eight-Proposals.aspx>

Tax Rebates

Due to Hawaii's dependency on outside oil for electricity, the number of rebates, and the dollars they can amount to, has increased in recent years. In fact, in a recent legislative session, lawmakers in Hawaii made it clear that we need to get serious about reducing our energy dependency. The state has decided that any new residence built in Hawaii beginning January 2010 must have solar water heaters, or similar energy saving heater on the roof.

“Senate Bill # 644 “BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:

...Accordingly, the purpose of this Act is to increase the use of renewable energy to protect our environment, reduce pollution, make housing more affordable, and enhance Hawaii's local economy by:

(1) Requiring the installation of solar water heater systems, comparable renewable energy systems, or demand gas water heaters in all new residential development projects constructed after January 1, 2010;...”⁶

5695 Residential Energy Efficiency Property Credit

Following is the tax form from 2010 that you would fill out to claim rebates on devices that you installed in or on your home to make your home more energy efficient. This form is intended for residences within the United States and is not specific to Hawaii. **This is the form you would fill out after installing a solar water heater, photovoltaic system, adding a reflective roof coating, installing wall or attic insulation, having a qualifying window film applied to your windows etc. Notice that many of the possible energy credits are methods from chapters in this book.** In the instructions sections of these forms it gives clear decisions on what qualifies and who qualifies. This particular tax form is specifically aimed at homes not businesses. **It is also important that the products you installed were installed in 2010 and that they meet IECC (discussed earlier in the chapter) and other performance standards (listed in the tax forms).**

⁶ SB 644, http://www.capitol.hawaii.gov/session2008/Bills/SB644_CD1_.htm (accessed 11-18-09).

Tax Rebates

Form **5695**
 Department of the Treasury
 Internal Revenue Service

Residential Energy Credits

▶ See instructions.
 ▶ Attach to Form 1040 or Form 1040NR.

OMB No. 1545-0074
2010
 Attachment
 Sequence No. **158**

Name(s) shown on return

Your social security number

Part I Nonbusiness Energy Property Credit (See instructions before completing this part.)

1 Were the qualified energy efficiency improvements or residential energy property costs for your main home located in the United States? (see instructions) ▶	1	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<i>Caution: If you checked the "No" box, you cannot claim the nonbusiness energy property credit. Do not complete Part I.</i>			
2 Qualified energy efficiency improvements (see instructions).			
a Insulation material or system specifically and primarily designed to reduce the heat loss or gain of your home	2a		
b Exterior windows (including certain storm windows) and skylights	2b		
c Exterior doors (including certain storm doors)	2c		
d Metal roof with appropriate pigmented coatings or asphalt roof with appropriate cooling granules that are specifically and primarily designed to reduce the heat gain of your home, and the roof meets or exceeds the Energy Star program requirements in effect at the time of purchase or installation	2d		
3 Residential energy property costs (see instructions).			
a Energy-efficient building property	3a		
b Qualified natural gas, propane, or oil furnace or hot water boiler	3b		
c Advanced main air circulating fan used in a natural gas, propane, or oil furnace	3c		
4 Add lines 2a through 3c	4		
5 Multiply line 4 by 30% (.30)	5		
6 Maximum credit amount. (If you jointly occupied the home, see instructions)	6	\$ 1,500	
7 Enter the amount, if any, from your 2009 Form 5695, line 11. Otherwise enter -0-	7		
8 Subtract line 7 from line 6	8		
9 Enter the smaller of line 5 or line 8	9		
10 Limitation based on tax liability. Enter the amount from the Credit Limit Worksheet (see instructions)	10		
11 Nonbusiness energy property credit. Enter the smaller of line 9 or line 10. Also include this amount on Form 1040, line 52, or Form 1040NR, line 49	11		

For Paperwork Reduction Act Notice, see your tax return instructions. Cat. No. 13540P Form **5695** (2010)

<http://www.irs.gov/pub/irs-pdf/f5695.pdf>

Tax Rebates

Part II Residential Energy Efficient Property Credit (See instructions before completing this part.)

Note. Skip lines 12 through 21 if you only have a **credit carryforward from 2009.**

12	Qualified solar electric property costs	12		
13	Qualified solar water heating property costs	13		
14	Qualified small wind energy property costs	14		
15	Qualified geothermal heat pump property costs	15		
16	Add lines 12 through 15	16		
17	Multiply line 16 by 30% (.30)	17		
18	Qualified fuel cell property costs	18		
19	Multiply line 18 by 30% (.30)	19		
20	Kilowatt capacity of property on line 18 above ▶ _____ x \$1,000	20		
21	Enter the smaller of line 19 or line 20	21		
22	Credit carryforward from 2009. Enter the amount, if any, from your 2009 Form 5695, line 28	22		
23	Add lines 17, 21, and 22	23		
24	Enter the amount from Form 1040, line 46, or Form 1040NR, line 44	24		
25	<p>1040 filers: Enter the total, if any, of your credits from Form 1040, lines 47 through 50; line 11 of this form; line 12 of the Line 11 worksheet in Pub. 972 (see instructions); Form 8396, line 9; Form 8859, line 3; Form 8834, line 22; Form 8910, line 21; Form 8936, line 14; and Schedule R, line 22.</p> <p>1040NR filers: Enter the amount, if any, from Form 1040NR, lines 45 through 47; line 11 of this form; line 12 of the Line 11 worksheet in Pub. 972 (see instructions); Form 8396, line 9; Form 8859, line 3; Form 8834, line 22; Form 8910, line 21; and Form 8936, line 14.</p>	25		
26	Subtract line 25 from line 24. If zero or less, enter -0- here and on line 27	26		
27	Residential energy efficient property credit. Enter the smaller of line 23 or line 26. Also include this amount on Form 1040, line 52, or Form 1040NR, line 49	27		
28	Credit carryforward to 2011. If line 27 is less than line 23, subtract line 27 from line 23	28		

General Instructions

Section references are to the Internal Revenue Code.

What's New

Nonbusiness energy property credit. The nonbusiness energy property (NBEP) credit has been extended for property placed in service in 2011. However, any NBEP credit for which you might be eligible for NBEP improvements in 2011 may be limited, or you may be allowed no NBEP credit at all for 2011 NBEP improvements. For 2011 NBEP improvements, the maximum NBEP credit allowed is \$500 reduced (but not below zero) by the total of your NBEP credits for 2006 through 2010. In addition, the credit allowed for windows for 2011 is limited to \$200 reduced (but not below zero) by the total of your credits for windows from 2006 through 2010.

Purpose of Form

Use Form 5695 to figure and take your residential energy credits. The residential energy credits are:

- The nonbusiness energy property credit, and
- The residential energy efficient property credit.

Also use Form 5695 to take any residential energy efficient property credit carryforward from 2009 or to carry the unused portion of the credit to 2011.

Who Can Take the Credits

You may be able to take the credits if you made energy saving improvements to your home located in the United States in 2010.

Home. A home is where you lived in 2010 and can include a house, houseboat, mobile home, cooperative apartment, condominium, and a manufactured home that conforms to Federal Manufactured Home Construction and Safety Standards.

You must reduce the basis of your home by the amount of any credits allowed.

Main home. Your main home is generally the home where you live most of the time. A temporary absence due to special circumstances, such as illness, education, business, military service, or vacation, will not change your main home.

Costs. For purposes of both credits, costs are treated as being paid when the original installation of the item is completed, or in the case of costs connected with the reconstruction of your home, when your original use of the reconstructed home begins. For purposes of the residential energy efficient property credit only, costs connected with the construction of a home are treated as being paid when your original use of the constructed home begins. If less than 80% of the use of an item is for nonbusiness purposes, only that portion of the costs that is allocable to the nonbusiness use can be used to determine either credit.



The nonbusiness energy property credit is only available for existing homes. Only the residential energy efficient property credit is available for both existing homes and homes being constructed.

Association or cooperative costs. If you are a member of a condominium management association for a condominium you own or a tenant-stockholder in a cooperative housing corporation, you are treated as having paid your proportionate share of any costs of such association or corporation.



If you received a subsidy from a public utility for the purchase or installation of an energy conservation product and that subsidy was not included in your gross income, you must reduce your cost for the product by the amount of that subsidy before you compute your credit. This rule also applies if a third party (such as a contractor) receives the subsidy on your behalf.

Nonbusiness Energy Property Credit

You may be able to take a credit of 30% of the costs paid or incurred in 2010 for any qualified energy efficiency improvements and any residential energy property. The credit is limited to a total of \$1,500 over tax years 2009 and 2010.

Qualified energy efficiency improvements. Qualified energy efficiency improvements are the following building envelope components installed on or in your main home that you owned during 2010 located in the

United States if the original use of the component begins with you and the component can be expected to remain in use at least 5 years.

- Any insulation material or system that is specifically and primarily designed to reduce heat loss or gain of a home when installed in or on such a home.
- Exterior windows (including certain storm windows) and skylights.
- Exterior doors (including certain storm doors).
- Any metal roof with appropriate pigmented coatings or asphalt roof with appropriate cooling granules that are specifically and primarily designed to reduce the heat gain of your home, and the roof meets or exceeds the Energy Star program requirements in effect at the time of purchase or installation.

For purposes of figuring the credit, do not include amounts paid for the onsite preparation, assembly, or original installation of the building envelope component.



To qualify for the credit, qualified energy efficiency improvements must meet certain energy efficiency requirements. See Lines 2a Through 2d on page 4 for details.

Residential energy property costs. Residential energy property costs are costs of new qualified energy property that is installed on or in connection with your main home that you owned during 2010 located in the United States. Include any labor costs properly allocable to the onsite preparation, assembly, or original installation of the energy property. Qualified residential energy property is any of the following.

- Certain electric heat pump water heaters; electric heat pumps; central air conditioners; natural gas, propane, or oil water heaters; and stoves that use biomass fuel.
- Qualified natural gas, propane, or oil furnaces and qualified natural gas, propane, or oil hot water boilers.
- Certain advanced main air circulating fans used in natural gas, propane, or oil furnaces.



To qualify for the credit, qualified residential energy property must meet certain energy efficiency requirements. See Lines 3a Through 3c that begins on page 4 for details.

Joint ownership of qualified property. If you and a neighbor shared the cost of qualifying property to benefit each of your main homes, both of you can take the nonbusiness energy property credit. You figure your credit on the part of the cost you paid. The limit on the amount of the credit applies to each of you separately.

Married taxpayers with more than one home. If both you and your spouse owned and lived apart in separate main homes, the limit on the amount of the credit applies to each of you separately. If you are filing separate returns, both of you would complete a separate Form 5695. If you are filing a joint return, figure your nonbusiness energy property credit as follows.

1. Complete Part I of a separate Form 5695 for each main home through line 5.
2. Figure the amount to be entered on line 5 of both forms (but not more than \$1,500 for each form) and enter the combined amount on line 5 of one of the forms.
3. On line 6 of the form with the combined amount on line 5, cross out the preprinted \$1,500 and enter \$3,000.
4. On the dotted line to the left of line 6, enter "More than one main home." Then, complete the rest of this form.
5. Attach both forms to your return.

Joint occupancy. If you owned your home jointly with someone other than your spouse, each owner must complete his or her own Form 5695. Your credit is limited to the smaller of:

1. The amount you paid, or
2. \$1,500 multiplied by a fraction. The numerator is the amount you paid and the denominator is the total amount paid by you and all other owners.

These rules do not apply to married individuals filing a joint return.

<http://www.irs.gov/pub/irs-pdf/f5695.pdf>

Residential Energy Efficient Property Credit

You may be able to take a credit of 30% of your costs of qualified solar electric property, solar water heating property, small wind energy property, geothermal heat pump property, and fuel cell property. Include any labor costs properly allocable to the onsite preparation, assembly, or original installation of the residential energy efficient property and for piping or wiring to interconnect such property to the home. The credit amount for costs paid for qualified fuel cell property is limited to \$500 for each one-half kilowatt of capacity of the property.

Qualified solar electric property costs. Qualified solar electric property costs are costs for property that uses solar energy to generate electricity for use in your home located in the United States. This includes costs relating to a solar panel or other property installed as a roof or a portion of a roof. The home does not have to be your main home.

Qualified solar water heating property costs. Qualified solar water heating property costs are costs for property to heat water for use in your home located in the United States if at least half of the energy used by the solar water heating property for such purpose is derived from the sun. This includes costs relating to a solar panel or other property installed as a roof or a portion of a roof. To qualify for the credit, the property must be certified for performance by the nonprofit Solar Rating Certification Corporation or a comparable entity endorsed by the government of the state in which the property is installed. The home does not have to be your main home.

Qualified small wind energy property costs. Qualified small wind energy property costs are costs for property that uses a wind turbine to generate electricity for use in connection with your home located in the United States. The home does not have to be your main home.

Qualified geothermal heat pump property costs. Qualified geothermal heat pump property costs are costs for qualified geothermal heat pump property installed on or in connection with your home located in the United States. Qualified geothermal heat pump property is any equipment that uses the ground or ground water as a thermal energy source to heat your home or as a thermal energy sink to cool your home. To qualify for the credit, the geothermal heat pump property must meet the requirements of the Energy Star program that are in effect at the time of purchase. The home does not have to be your main home.

Qualified fuel cell property costs. Qualified fuel cell property costs are costs for qualified fuel cell property installed on or in connection with your main home located in the United States. Qualified fuel cell property is an integrated system comprised of a fuel cell stack assembly and associated balance of plant components that converts a fuel into electricity using electrochemical means. To qualify for the credit, the fuel cell property must have a nameplate capacity of at least one-half kilowatt of electricity using an electrochemical process and an electricity-only generation efficiency greater than 30%.



Costs allocable to a swimming pool, hot tub, or any other energy storage medium which has a function other than the function of such storage do not qualify for the residential energy efficiency credit.

Joint occupancy. If you occupied your home jointly with someone other than your spouse, each occupant must complete his or her own Form 5695. To figure the credit, the maximum qualifying costs that can be taken into account by all occupants for qualified fuel cell property costs is \$1,667 for each one-half kilowatt of capacity of the property. The amount allocable to you for qualified fuel cell property costs is the lesser of:

1. The amount you paid, or
2. The maximum qualifying cost of the property multiplied by a fraction. The numerator is the amount you paid and the denominator is the total amount paid by you and all other occupants.

These rules do not apply to married individuals filing a joint return.

Example. Taxpayer A owns a house with Taxpayer B where they both reside. In 2010, they installed qualified fuel cell property at a cost of \$20,000 with a kilowatt capacity of 5. Taxpayer A paid \$12,000 towards the cost of the property and Taxpayer B paid the remaining \$8,000. The amount to be allocated is \$16,670 (\$1,667 x 10 (kilowatt capacity x 2)). The amount of cost allocable to Taxpayer A is \$10,002 (\$16,670 x \$12,000/\$20,000). The amount of cost allocable to Taxpayer B is \$6,668 (\$16,670 x \$8,000/\$20,000).

<http://www.irs.gov/pub/irs-pdf/f5695.pdf>

Specific Instructions

Part I

Lines 2a Through 2d

Nonbusiness Energy Property Credit

Before you begin Part I:

Figure the amount of any credit for the elderly or the disabled you are claiming.

Line 1

To qualify for the credit, any qualified energy efficiency improvements or residential energy property costs must have been for your main home located in the United States. See *Main home* on page 3. If you check the "No" box, you cannot take the nonbusiness energy property credit.

Note. Unless otherwise noted, any references to the International Energy Conservation Code (IECC) are treated as references to the 2001 Supplement of the 2000 IECC, the 2004 Supplement of the 2003 IECC, or the 2009 IECC. However, a reference to the 2009 IECC is a reference only to the 2009 International Energy Conservation Code.



Do not include on lines 2a through 2d any amounts paid for the onsite preparation, assembly, or original installation of the components.

Line 2a. Enter the amounts you paid for any insulation material or system (including any vapor retarder or seal to limit infiltration) that is specifically and primarily designed to reduce the heat loss or gain of your home when installed in or on such home and meets the prescriptive criteria established by the 2009 IECC as in effect (with supplements) on February 17, 2009.



A component is not specifically and primarily designed to reduce the heat loss or gain of your home if it provides structural support or a finished surface (such as drywall or siding) or its principal purpose is to serve any function unrelated to the reduction of heat loss or gain.

Line 2b. Enter the amounts you paid for exterior windows (including any storm windows installed with such exterior windows) and skylights that meet the prescriptive criteria established by the IECC for such components and have a U-factor of 0.30 or less and a solar heat gain coefficient (SHGC) of 0.30 or less.

Line 2c. Enter the amounts you paid for exterior doors that meet the prescriptive criteria established by the IECC for such components and have a U-factor of 0.30 or less and an SHGC of 0.30 or less.

Line 2d. Enter the amounts you paid for a metal roof with the appropriate pigmented coatings or an asphalt roof with the appropriate cooling granules that are specifically and primarily designed to reduce the heat gain of your home, and the roof meets or exceeds the Energy Star program requirements in effect at the time of purchase or installation.

Manufacturer's certification. For purposes of taking the credit, you can rely on a manufacturer's certification in writing that a building envelope component is an eligible building envelope component. Do not attach the certification to your return. Keep it for your records.

Lines 3a Through 3c



Also include on lines 3a through 3c any labor costs properly allocable to the onsite preparation, assembly, or original installation of the property.

Line 3a. Enter the amounts you paid for energy-efficient building property. Energy-efficient building property is any of the following.

- An electric heat pump water heater that yields an energy factor of at least 2.0 in the standard Department of Energy test procedure.
- An electric heat pump that achieves the highest efficiency tier established by the Consortium for Energy Efficiency (CEE) as in effect on January 1, 2009.
- A central air conditioner that achieves the highest efficiency tier that has been established by the CEE as in effect on January 1, 2009.

- A natural gas, propane, or oil water heater that has an energy factor of at least 0.82 or a thermal efficiency of at least 90%.
- A stove that uses the burning of biomass fuel to heat your home or heat water for your home that has a thermal efficiency rating of at least 75% as measured by using a lower heating value. Biomass fuel is any plant-derived fuel available on a renewable or recurring basis, including agricultural crops and trees, wood and wood waste and residues (including wood pellets), plants (including aquatic plants), grasses, residues, and fibers.

Line 3b. Enter the amounts you paid for a natural gas or propane furnace that achieves an annual fuel utilization efficiency rate of at least 95 and for a natural gas, propane, or oil hot water boiler or oil furnace that achieves an annual fuel utilization efficiency rate of at least 90.

Line 3c. Enter the amounts you paid for an advanced main air circulating fan used in a natural gas, propane, or oil furnace that has an annual electricity use of no more than 2% of the total annual energy use of the furnace (as determined in the standard Department of Energy test procedures).

Manufacturer's certification. For purposes of taking the credit, you can rely on a manufacturer's certification in writing that a product is qualified residential energy property. Do not attach the certification to your return. Keep it for your records.

Line 6

If the rules on page 3 for joint occupancy apply, cross out the preprinted \$1,500 on line 6 and enter on line 6 the smaller of:

1. The amount on line 4, or
2. \$1,500 multiplied by a fraction. The numerator is the amount on line 4. The denominator is the total amount from line 4 for all owners.

For more details, see *Joint occupancy* on page 3.

Line 10

Complete the worksheet below to figure the amount to enter on line 10.

Credit Limit Worksheet—Line 10

1. Enter the amount from Form 1040, line 46, or Form 1040NR, line 44	1. _____
2. Enter the total, if any, of your credits from Form 1040, lines 47 through 50, and Schedule R, line 22; or Form 1040NR, lines 45 through 47	2. _____
3. Subtract line 2 from line 1. Also enter this amount on Form 5695, line 10. If zero or less, stop ; you cannot take the nonbusiness energy property credit	3. _____

Part II

Residential Energy Efficient Property Credit

Before you begin Part II:

Figure the amount of any of the following credits you are claiming.

- Credit for the elderly or the disabled.
- Mortgage interest credit.
- District of Columbia first-time homebuyer credit.
- Alternative motor vehicle credit.
- Qualified plug-in electric vehicle credit.
- Qualified plug-in electric drive motor vehicle credit.



Also include on lines 12 through 15, and 18, any labor costs properly allocable to the onsite preparation, assembly, or original installation of the property and for piping or wiring to interconnect such property to the home.

Line 12

Enter the amounts you paid for qualified solar electric property. See *Qualified solar electric property costs* on page 4.

Line 13

Enter the amounts you paid for qualified solar water heating property. See *Qualified solar water heating property costs* on page 4.

Line 14

Enter the amounts you paid for qualified small wind energy property. See *Qualified small wind energy property costs* on page 4.

Line 15

Enter the amounts you paid for qualified geothermal heat pump property. See *Qualified geothermal heat pump property costs* on page 4.

Line 18

Enter the amounts you paid for qualified fuel cell property. See *Qualified fuel cell property costs* on page 4.

Line 25

If you are claiming the child tax credit for 2010, include on this line the amount from line 12 of the Line 11 Worksheet in Pub. 972.



If you are not claiming the child tax credit for 2010, you do not need Pub. 972.

Manufacturer's certification. For purposes of taking the credit, you can rely on the manufacturer's certification in writing that a product is qualifying property for the credit. Do not attach the certification to your return. Keep it for your records.

Line 28

If you cannot use all of the credit because of the tax liability limit (line 26 is less than line 23), you can carry the unused portion of the credit to 2011.

File this form even if you cannot use any of your credit in 2010.

Tax Rebates

High Efficiency Water Heater Rebate Application

Following is the rebate form for 2010 that you would fill out to claim rebates on devices that you installed in or on your home to make your home more energy efficient. This form is intended for residences within the State of Hawaii. **There are many important pieces of information that have to be filled out on this form so be sure to keep your receipts if you purchase a new water heating product. Capacity and efficiency ratings are important values to remember before you purchase as these numbers effect your rebate! It is a good idea to look carefully at this form before you use any of the methods in the water heating chapter.**

Tax Rebates

High Efficiency Electric Hot Water Heater Incentive Application Hawaii Energy – Effective January 2010 or while funding last



Hawaii Energy

For Residential Utility Applicants (not for newly constructed homes).
This Program is available for and funded by the Residential Electric Utility Applicants of Hawaii, Lanai, Maui, Molokai and Oahu and is administered under the direction of the Hawaii Public Utilities Commission.
Applications must be filled out completely and legibly and **submitted within six (6) months** of invoice or sales receipt date. Please allow 6 – 8 weeks for processing.

Step 1. Fill Out Applicant Utility Account and Payee Information

Electric Account Number: _____ - _____	<input type="checkbox"/> Owner Occupant	<input type="checkbox"/> Landlord	<input type="checkbox"/> Tenant
Account Holder's Name listed on Electric Bill (Check will be made out to this name or qualified other Payee): _____			
Address where the Appliance is installed or the Central Air Conditioning Maintenance was done: _____			Apt / Unit #: _____
City: _____	State: HI	Zip: _____	
Daytime Phone: (____) _____ - _____	Alternate Phone: (____) _____ - _____	Island: _____	
Email: _____			

Other Payee (Complete ONLY if Utility Account Holder is not receiving funds, i.e., appliance installed on military base, condo/AOAO or rental unit.)

Other Payee must be the: <input type="checkbox"/> Property Owner living in a multi-family complex <input type="checkbox"/> Landlord <input type="checkbox"/> Property Management Company <input type="checkbox"/> Tenant			
Name of Other Payee: First, Last (Check will be made out to) _____			
Address: (Check will be mailed to this address) _____			Apt / Unit #: _____
City: _____	State: _____	Zip: _____	
Daytime Phone: (____) _____ - _____	Alternate Phone: (____) _____ - _____	_____	
Email: _____			

Step 2. Check the item you are applying for and fill in the needed information

Previous Water Heater Type: (only Applicants replacing electric water heaters are eligible for rebate) <input type="checkbox"/> Electric <input type="checkbox"/> Gas <input type="checkbox"/> Other New Water Heater Gallons: _____ Make: _____ Model #: _____ Serial #: _____	Dwelling Type: <input type="checkbox"/> Single-Family <input type="checkbox"/> Single-Family (2-3-4 Plex) <input type="checkbox"/> Multi-Family Residence Is Occupied Year-Round: <input type="checkbox"/> Yes <input type="checkbox"/> No Purchase Date: _____ Date of Installation: _____ Rebate Amount: (see chart) _____	High Efficiency Water Heater Rebate Chart		
		Gallons	EF*	Rebate Amount
		35 or less	0.94	\$40
		36-45	0.93	\$40
		46-64	0.92	\$50
		65	0.91	\$50
		66 or greater	0.88	\$70
		Heat Pump	-	\$175
<small>* EF ratings are minimum based on most recent GAMA certified efficiency ratings.</small>				

Step 3. Attach original receipts listing the make and model number

Step 4. Sign Agreement Clause (make sure you have read the Terms and Conditions on back of this form)

I have read, understand, and agree to the Terms and Conditions of this Rebate Application as detailed on the front and back of this Agreement.

Electric Account Holder's Signature: _____ Date: _____

Mail Completed and Signed Application with **Original** Sales Receipts (photocopies not accepted) to:
(Please include a self-addressed stamped envelope if you would like your receipts returned.)

Hawaii Energy Efficiency Program
P.O. Box 3920, Honolulu, HI 96812-3920
Phone: 808-537-5577

Tax Rebates

FOR OFFICIAL USE ONLY: DE _____ QC _____ # _____

Hawaii Energy Efficiency Program Terms and Conditions

- 1) **Rebates/Incentives:**
Subject to these Terms and Conditions, the Hawaii Energy Efficiency Program (the Program) will pay rebates for qualifying high efficiency appliances and equipment.
- 2) **Eligibility:**
 - a) An **"Applicant"** is a residential scheduled account holder of an electric utility on the islands of Hawaii, Lanai, Maui, Molokai, and Oahu that contribute into the Public Benefit Fund where the electricity-saving Energy Efficiency Measure has been installed. Incentives are awarded only to an eligible Account Holder. The Account Holder can reassign the incentive payment to another Payee designated in the "Other Payee" section. Applicants are ultimately responsible for the compliance with these Terms and Conditions.
 - b) **"Qualifying Water Heaters"** are those electricity-saving items that are identified in the program applications and associated materials. All equipment must be new, meet Program specification requirements, and be fully operable prior to incentive payment.
 - c) Incomplete applications or missing supporting documents will be returned.
 - d) Rebate Application must be received within six (6) months of installation.
- 3) **Installation Verification and Data Collection:**
 - a) The Program may conduct an inspection to verify pre-installation conditions or confirm installation prior to incentive payment, at anytime after receipt of applications and up to up to five (5) years after payment of incentives.
 - b) The Applicant must provide reasonable access to the facility, the equipment, and related documentation and data.
 - c) The Program may install metering devices on equipment for Program data collection, measurement, and verification purposes.
- 4) **Compliance:**
The Applicant is responsible to abide by all applicable laws, rules, and regulations, and to comply with all federal, state, and local codes.
- 5) **Program Availability:**
Rebates are available on a first-come, first-served basis subject to the availability of funds. Program availability, Program terms, and equipment eligibility may change without notice at the discretion of the Program.
- 6) **Publicity:**
The Program reserves the right to publicize participation in the Program for promotional purposes unless the Applicant submits a written request to the Program.
- 7) **Disclaimers:**
 - a) The Program is not responsible for any tax liability imposed on the Applicant as a result of the payment of rebates.
 - b) The Program does not expressly or implicitly warrant the performance of installed equipment, the quality of any contractor's work, or that the equipment will result in any energy or cost savings.
 - c) The Program is not responsible for the proper disposal or recycling of any waste generated as a result of this project.
 - d) The Program does not endorse any particular market provider, manufacturer, product, labor or system design by offering this program.
 - e) The Program does not guarantee that funding will be available for payment of rebates until this application is approved. Submission of the application does not warrant payment under any circumstances should the application not be approved or funding not be available.
- 8) **Indemnification and Limits of Liability:**
 - a) Applicant shall hold harmless the Program and the Program's agents, contractors, employees, officers and directors from any and all liability, claims, loss, damage, death or injury including reasonable attorneys' fees and costs, arising out of or relating to the installation, use and maintenance of the equipment, designs, practices, or methods involved in this Applicant's project.
 - b) In no event shall either the Program, or any other indemnified party be liable for any punitive, exemplary, special, indirect, incidental or consequential damages (including, but not limited to, lost profits, lost business opportunities, loss of use or equipment down time, and loss of or corruption to data) arising out of or relating to this Agreement, regardless of the legal theory under which such damages are sought.
- 9) **Entire Agreement:**
The entire agreement between the Applicant and the Program is composed of an approved, fully-executed application, these Terms and Conditions, and, as applicable, pre-installation approval letters, invoices, receipts and any and all such other documentation as required.

Hawaii Energy Efficiency Program • P.O. Box 3920 • Honolulu, HI 96812-3920 • Phone: 808-537-5577


http://www.hawaiienergy.com/media/assets/2010ResHighEffWaterHeatingApplication_000.pdf

Tax Rebates

Energy Star Appliance Incentive Application

Following is the rebate form for 2010 that you would fill out to claim rebates on devices that you installed in or on your home to make your home more energy efficient. This form is intended for residences within the State of Hawaii. There are many important pieces of information that have to be filled out on this form so be sure to keep your receipts and keep the information regarding the efficiency rating and capacity of your product. **It is a good idea to look carefully at this form and the energy star web site before you use any of the methods in the**

Tax Rebates

Energy Solutions for the Home ENERGY STAR® Appliance Incentive Application Hawaii Energy – Effective March 1, 2010 or while funding last	 Hawaii Energy
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For Residential Utility Customers (not for newly constructed homes). Effective from March 1, 2010 or while funding lasts. This Program is available for and funded by the Residential Electric Utility Customers of Hawaii, Lanai, Maui, Molokai and Oahu and is administered under the direction of the Hawaii Public Utilities Commission.

Applications must be filled out completely and legibly and **submitted within six (6) months** of invoice or sales receipt date. Please allow 6 – 8 weeks for processing.

Step 1. Fill Out Applicant Utility Account and Payee Information

Electric Account Number: _____		<input type="checkbox"/> Owner Occupant <input type="checkbox"/> Landlord <input type="checkbox"/> Tenant	
Account Holder's Name listed on Electric Bill (Check will be made out to this name or qualified other Payee): _____			
Address where the Appliance is installed or the Central Air Conditioning Maintenance was done: _____			Apt / Unit #: _____
City: _____		State: HI	Zip: _____
Daytime Phone: (____) _____ - _____		Alternate Phone: (____) _____ - _____	
Email: _____			

Other Payee (Complete ONLY if Utility Account Holder is not receiving funds, i.e., appliance installed on military base, condo/AOAO or rental unit.)

Other Payee must be the: <input type="checkbox"/> Property Owner living in a multi-family complex <input type="checkbox"/> Landlord <input type="checkbox"/> Property Management Company <input type="checkbox"/> Tenant			
Name of Other Payee: First, Last (Check will be made out to) _____			
Address: (Check will be mailed to this address) _____			Apt / Unit #: _____
City: _____		State: _____	Zip: _____
Daytime Phone: (____) _____ - _____		Alternate Phone: (____) _____ - _____	
Email: _____			

Step 2. Check the item you are applying for and fill in the needed information

Select one of these: <input type="checkbox"/> Ceiling Fan - \$40 <input type="checkbox"/> Clothes Washer - \$50 <input type="checkbox"/> Dishwasher - \$50 <input type="checkbox"/> Refrigerator - \$50 <input type="checkbox"/> Window A/C - \$75 <input type="checkbox"/> Ductless Split Air Conditioner - \$110 <input type="checkbox"/> Central Air Conditioning Maintenance - \$50* <small>(see back page for details)</small>	Installation Date: _____ Brand: _____ Model #: _____ Serial #: _____ Quantity: _____ x Rebate Amount (from left) _____ = Total Rebate _____ Store Names & Location: _____ Purchase Date: _____
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Step 3. Attach original receipts listing the make and model number

Step 4. Sign Agreement Clause (make sure you have read the Terms and Conditions on back of this form)

I have read, understand, and **agree to the Terms and Conditions** of this Rebate Application as detailed on the front and back of this Agreement.

Electric Account Holder's Signature: _____ Date: _____

Rebates are not guaranteed, available on a first-come, first-served basis and subject to the availability of funds without notice.

Mail Completed and Signed Application with **Original** Sales Receipts (photocopies not accepted) to:
 (Please include a self-addressed stamped envelope if you would like your receipts returned. Please allow 6 – 8 weeks for processing.)

Hawaii Energy
 P.O. Box 3920, Honolulu, HI 96812-3920
 Phone: 808-537-5577 or 877-231-8222

FOR OFFICIAL USE ONLY: DE _____ QC _____ # _____



Hawaii Energy

ENERGY STAR® Appliance Incentive Application

ENERGY STAR® Appliance Information

Ceiling fans, clothes washers, dishwashers, refrigerators, and window air conditioners must be ENERGY STAR® rated to qualify for a rebate. To qualify for rebate, the **brand** and **model** must be **LISTED** on the ENERGY STAR® website. A list of qualifying units can be found at www.energystar.gov. All appliances must be new to qualify for a rebate. Follow manufacturer installation requirements to ensure proper operation.

Ductless split air conditioners (sometimes called mini-splits) **brand** and **model** that qualify for rebates must be **LISTED** as ENERGY STAR® on the Consortium for Energy Efficiency website at <http://www.ceedirectory.org/ceedirectory/pages/cee/ceeSearchMain.aspx> or call 808-537-5577 for help finding qualifying models. Installation work must be by a Hawaii Energy registered C52 Air Conditioner Contractor to qualify for a rebate. The sales receipt must show the Ductless split air conditioner brand or manufacturer, model number and the date of installation.

*Central Air Conditioning Maintenance Information

A \$50 central air conditioner maintenance rebate is given when maintenance is provided by a Hawaii Energy registered C52 contractor. To receive a rebate, you must include a full cost invoice on the contractor's letterhead and the Contractor's Air Conditioner Maintenance Checklist (filled in by the contractor). The invoice must state "Central A/C Maintenance." Central Air Conditioning Maintenance rebates are limited to one per 12-month period per address. Ductless split air conditioners and Window Air Conditioners maintenance are not eligible for this rebate.

Hawaii Energy Terms and Conditions

- 1) **Rebates/Incentives:**
Subject to these Terms and Conditions, the Hawaii Energy (the Program) will pay rebates for qualifying high efficiency appliances and equipment.
- 2) **Eligibility:**
 - a) An **"Applicant"** is a residential scheduled account holder of an electric utility on the islands of Hawaii, Lanai, Maui, Molokai, and Oahu that contribute into the Public Benefit Fund where the electricity-saving Energy Efficiency Measure has been installed. Incentives are awarded only to an eligible Account Holder. The Account Holder can reassign the incentive payment to another Payee designated in the "Other Payee" section. Applicants are ultimately responsible for the compliance with these Terms and Conditions.
 - b) **"Qualifying Appliances"** are those electricity-saving items that are identified in the program applications and associated materials. All equipment must be new, meet Program specification requirements, and be fully operable prior to incentive payment.
 - c) Incomplete applications or missing supporting documents will be returned.
 - d) Rebate Application must be received within six (6) months of installation.
 - e) Applications for newly constructed homes or new homes purchased with appliances or air conditioners do not qualify.
- 3) **Installation Verification and Data Collection:**
 - a) The Program may conduct an inspection to verify pre-installation conditions or confirm installation prior to incentive payment, at any time after receipt of applications and up to up to five (5) years after payment of incentives.
 - b) The Applicant must provide reasonable access to the facility, the equipment, and related documentation and data.
 - c) The Program may install metering devices on equipment for Program data collection, measurement, and verification purposes.
- 4) **Compliance:**
The Applicant is responsible to abide by all applicable laws, rules, and regulations, and to comply with all federal, state, and local codes. Incentive Program participants receiving \$600 or more in combined rebates will be issued an IRS Form 1099 unless exemptions apply. Social Security numbers may be requested a later date and are held in confidence under terms of the Privacy Act.
- 5) **Program Availability:**
Rebates are available on a first-come, first-served basis subject to the availability of funds. Program availability, Program terms, and equipment eligibility may change without notice at the discretion of the Program.
- 6) **Publicity:**
The Program reserves the right to publicize participation in the Program for promotional purposes unless the Applicant submits a written request to the Program.
- 7) **Disclaimers:**
 - a) The Program is not responsible for any tax liability imposed on the Customer as a result of the payment of rebates.
 - b) The Program does not expressly or implicitly warrant the performance of installed equipment, the quality of any contractor's work, or that the equipment will result in any energy or cost savings.
 - c) The Program is not responsible for the proper disposal or recycling of any waste generated as a result of this project.
 - d) The Program does not endorse any particular market provider, manufacturer, product, labor or system design by offering this program.
 - e) The Program does not guarantee that funding will be available for payment of rebates until this application is approved. Submission of the application does not warrant payment under any circumstances should the application not be approved or funding not is available.
- 8) **Indemnification and Limits of Liability:**
 - a) Customer shall hold harmless the Program and the Program's agents, contractors, employees, officers and directors from any and all liability, claims, loss, damage, death or injury including reasonable attorneys' fees and costs, arising out of or relating to the installation, use and maintenance of the equipment, designs, practices, or methods involved in this Customer's project.
 - b) In no event shall either the Program, or any other indemnified party be liable for any punitive, exemplary, special, indirect, incidental or consequential damages (including, but not limited to, lost profits, lost business opportunities, loss of use or equipment down time, and loss of or corruption to data) arising out of or relating to this Agreement, regardless of the legal theory under which such damages are sought.
- 9) **Entire Agreement:**
The entire agreement between the Customer and the Program is composed of an approved, fully-executed application, these Terms and Conditions, and, as applicable, pre-installation approval letters, invoices, receipts and any and all such other documentation as required.

Hawaii Energy • P.O. Box 3920 • Honolulu, HI 96812-3920 • Phone: 808-537-5577 or 877-231-8222

http://www.hawaiienergy.com/media/assets/2010ResENERGYSTARApplication_000.pdf

Tax Rebates

Air Conditioning chapter.

N-334 Renewable Energy Technologies Income Tax Credit

Following is the rebate form for 2008 that you would fill out to claim rebates on devices that you installed in or on your home to make your home more energy efficient. This form is intended for residences and commercial buildings within the State of Hawaii. There are many important pieces of information that have to be filled out on this form so be sure to keep your receipts if you purchase a new product. It is a good idea to look carefully at this form before you look at any of the chapters.

Tax Rebates

FORM N-342 (REV. 2010)	STATE OF HAWAII – DEPARTMENT OF TAXATION RENEWABLE ENERGY TECHNOLOGIES INCOME TAX CREDIT (FOR SYSTEMS INSTALLED AND PLACED IN SERVICE ON OR AFTER JULY 1, 2009) Or fiscal year beginning _____, 2010, and ending _____, 20____	TAX YEAR 2010
--------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------

ATTACH THIS SCHEDULE TO YOUR FORM F-1, N-11, N-13, N-15, N-30, N-40, OR N-70NP

Name _____	SSN or FEIN _____
------------	-------------------

Note: Use a separate form for each eligible system.
Note: For a carryover of the credit for systems installed and placed in service before July 1, 2009, see Form N-323.
Note: Multiple owners of a single system are entitled to a single tax credit. (See separate instructions.)

COMPUTATION OF TAX CREDIT

Note: If you are claiming the Ethanol Facility Tax Credit, no other credit can be claimed.
Note: You cannot claim this credit for a solar water heating system that is required for new single-family residential property constructed on or after January 1, 2010. You also cannot claim this credit for a wind-powered energy system that is used as a substitute for the required solar water heating system.
Note: If you are only claiming your distributive share of a tax credit distributed from an S corporation, a partnership, an estate, or a trust (Form N-342A), skip lines 1 through 39 and begin on line 40.

SOLAR ENERGY SYSTEM	Enter date system was installed and placed in service > ____/____/____	
1. Enter your total cost of the qualified solar energy system installed and placed in service in Hawaii (See instructions if there are multiple owners of the system.).....	1	
2. Enter the amount of consumer incentive premiums, costs used for other credits, and utility rebate, if any, received for the qualifying solar energy system.....	2	
3. Actual cost of the solar energy system. (Subtract line 2 from line 1 and enter result.).....	3	
4. Is this solar energy system primarily used to heat water for household use? <input type="checkbox"/> Yes. Go to line 5. <input type="checkbox"/> No. Go to line 15.		
SYSTEM PRIMARILY USED TO HEAT WATER FOR HOUSEHOLD USE (lines 5 - 14)		
5. Enter the portion of line 3 that is installed and placed in service in Hawaii on single-family residential property.....	5	
6. Enter 35% of line 5 or \$2,250, whichever is less.....	6	
7. Enter the portion of line 3 that is installed and placed in service in Hawaii on multi-family residential property.....	7	
8. Divide the total square feet of your unit by the total square feet of all units in the multi-family residential property. Enter the decimal (rounded to 2 decimal places). (See instructions.).....	8	
9. Actual per unit cost of the solar energy system. (Multiply line 7 by line 8 and enter result.).....	9	
10. Enter 35% of line 9 or \$350, whichever is less.....	10	
11. Multiply line 10 by the number of units you own to which the allocated unit cost on line 9 is applicable. (Number of units you own _____).....	11	
12. Enter the portion of line 3 that is installed and placed in service in Hawaii on commercial property.....	12	
13. Enter 35% of line 12 or \$250,000, whichever is less.....	13	
14. Add lines 6, 11, and 13, and enter result (but not less than zero).....	14	
SYSTEM NOT PRIMARILY USED TO HEAT WATER FOR HOUSEHOLD USE (lines 15 - 26)		
15. Enter the portion of line 3 that is installed and placed in service in Hawaii on single-family residential property.....	15	
16. Enter 35% of line 15 or \$5,000, whichever is less.....	16	
17. Was this system used as a substitute for a solar water heating system that is required for new single-family residential property constructed on or after January 1, 2010? <input type="checkbox"/> Yes. Enter 35% of line 15 or \$2,250, whichever is less. <input type="checkbox"/> No. Enter zero.....	17	
18. Line 16 minus line 17.....	18	
19. Enter the portion of line 3 that is installed and placed in service in Hawaii on multi-family residential property.....	19	
20. Divide the total square feet of your unit by the total square feet of all units in the multi-family residential property. Enter the decimal (rounded to 2 decimal places). (See instructions.).....	20	
21. Actual per unit cost of the solar energy system. (Multiply line 19 by line 20 and enter result.).....	21	
22. Enter 35% of line 21 or \$350, whichever is less.....	22	
23. Multiply line 22 by the number of units you own to which the allocated unit cost on line 21 is applicable. (Number of units you own _____).....	23	

(Continued on back)
FORM N-342

Tax Rebates

Form N-342
(REV. 2010)

Page 2

24. Enter the portion of line 3 that is installed and placed in service in Hawaii on commercial property.....	24		
25. Enter 35% of line 24 or \$500,000, whichever is less.....		25	
26. Add lines 18, 23, and 25, and enter result (but not less than zero).....		26	
WIND-POWERED ENERGY SYSTEM Enter date system was installed and placed in service > ___/___/___			
27. Enter your total cost of the qualified wind-powered energy system installed and placed in service in Hawaii (See instructions if there are multiple owners of the system.).....	27		
28. Enter the amount of consumer incentive premiums, costs used for other credits, and utility rebate, if any, received for the qualifying wind-powered energy system.....	28		
29. Actual cost of the wind-powered energy system (Subtract line 28 from line 27 and enter result.).....	29		
30. Enter the portion of line 29 that is installed and placed in service in Hawaii on single-family residential property.....	30		
31. Enter 20% of line 30 or \$1,500, whichever is less.....		31	
32. Enter the portion of line 29 that is installed and placed in service in Hawaii on multi-family residential property.....	32		
33. Divide the total square feet of your unit by the total square feet of all units in the multi-family residential property. Enter the decimal (rounded to 2 decimal places). (See instructions.).....	33		
34. Actual per unit cost of the wind-powered energy system. (Multiply line 32 by line 33 and enter result.).....	34		
35. Enter 20% of line 34 or \$200, whichever is less.....	35		
36. Multiply line 35 by the number of units you own to which the allocated unit cost on line 34 is applicable. (Number of units you own _____).....		36	
37. Enter the portion of line 29 that is installed and placed in service in Hawaii on commercial property.....	37		
38. Enter 20% of line 37 or \$500,000, whichever is less.....		38	
39. Add lines 31, 36, and 38, and enter result (but not less than zero).....		39	
DISTRIBUTIVE SHARE OF TAX CREDIT			
40. Distributive share of solar energy tax credit from attached Form N-342A.....		40	
41. Distributive share of wind-powered energy tax credit from attached Form N-342A.....		41	
REFUNDABLE TAX CREDIT			
42. If you are making an irrevocable election to treat the tax credit as refundable, check the appropriate box. Otherwise, go to line 47. <input type="checkbox"/> a. I elect to treat the tax credit for a solar energy system as refundable. The amount of the tax credit will be reduced by 30%. <input type="checkbox"/> b. I elect to treat the tax credit for a solar energy system or a wind-powered energy system as refundable. ALL of my income is exempt under a public retirement system or received in the form of a pension for past services, or my adjusted gross income is \$20,000 or less (\$40,000 or less if filing jointly).			
43. If you checked the box on line 42(a), enter the amount from line 14, 26, or 40.....		43	
44. Multiply line 43 by 30% (.30).....		44	
45. Line 43 minus line 44. This is your refundable renewable energy technologies income tax credit. Enter this amount, rounded to the nearest dollar for individual taxpayers, on the appropriate line on Schedule CR; Form N-13; Form N-40, Schedule F; or Form F-1, Schedule I; whichever is applicable.....		45	
46. If you checked the box on line 42(b), enter the amount from line 14, 26, 39, 40, or 41. This is your refundable renewable energy technologies income tax credit. Enter this amount, rounded to the nearest dollar for individual taxpayers, on the appropriate line on Schedule CR; Form N-13; Form N-40, Schedule F; or Form F-1, Schedule I; whichever is applicable.....		46	
NONREFUNDABLE TAX CREDIT Do not complete this section if you claimed the refundable tax credit.			
47. Enter the amount from line 14, 26, 39, 40, or 41.....		47	
Adjusted tax liability			
48. a. Individuals — Enter the amount from Form N-11, line 34; Form N-13, line 23; or Form N-15, line 50..... b. Corporations — Enter the amount from Form N-30, line 13..... c. Other filers — Enter the amount from Form F-1, line 71; Form N-40, Schedule G, line 3; or Form N-70NP, line 18.....		48	
49. If you are claiming other nonrefundable credits, including the nonrefundable renewable energy technologies income tax credit for another system, complete the credit worksheet in the instructions and enter the total here.....		49	
50. Line 48 minus line 49. This represents your tax liability, as adjusted. If the result is zero or less than zero, enter zero.....		50	
51. Total credit allowed — Enter the smaller of line 47 or line 50. This is your nonrefundable renewable energy technologies income tax credit allowable for the year. Enter this amount, rounded to the nearest dollar for individual taxpayers, on the appropriate line on Schedule CR; Form N-13; Form N-40, Schedule E; or Form F-1, Schedule H; whichever is applicable.....		51	
52. Line 47 minus line 51. This represents your carryover of unused credit. The amount of any unused tax credit may be carried over and used as a credit against your tax liability in subsequent years until exhausted.....		52	

FORM N-342



BTU - This is the common indication of an air conditioner's cooling capacity. BTU stands for British Thermal Unit. 1 BTU is the amount of heat needed to heat 1 pound of water one degree Fahrenheit at 65 degrees Fahrenheit and at one standard atmosphere. Generally the cooling capacity of air conditioners is given in BTUs per hour or BTU/H.⁷ **As a general rule of thumb you should have about 45 BTU/H per square foot of floor space.** This means a 12' x 12' bedroom should have an air conditioner with a BTU/H rating of about 6,480 ($12 \times 12 = 144$, $144 \times 45 = 6,480$).

EER - This is a rating system used to evaluate small air conditioners. EER stands for energy efficiency ratio, sometimes called the seasonal energy efficiency ratio (SEER). All air conditioners manufactured after October 2000 are required to be EER 9.7 or higher. The higher the EER number the more efficient the AC unit. The number indicates cooling capacity (British Thermal Units per hour divided by the amount of watts of power consumed). An example of how the EER number is derived would be: a 10,000 BTU/hour AC unit divided by the 1,000 watts it consumes = 10 ($10,000/1,000=10$). So the EER for this unit would be 10. As a rule of thumb any model with an EER over 10.0 is very energy efficient and an EER of 14.0 would be even more efficient.⁸

⁷ Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, Energy Tips & Choices: A Guide to an Energy-Efficient Home

(Honolulu, Hawaii: no publisher, no date), pg 25

⁸ Ibid pg 27

BACKGROUND INFO

This chapter focuses on air conditioning and the considerations for how to get the most comfort for your money. There are many considerations you will want to factor into your decision of whether or not to use the methods in this chapter. There are several kinds of air conditioning commonly used in homes in Hawaii and this chapter will cover window units, split systems central ac and methods of natural ventilation to reduce the need to air condition.

“Air conditioning has increased energy use, especially during the last 30 or so years. More homeowners are installing and using air conditioners, and many new homes are being built with air conditioners already installed.”⁹



Whenever possible try to find ways to naturally ventilate the spaces in your home. There are situations when air conditioning is necessary but it is important to do this intelligently. In many cases you can keep spaces in your home cool and comfortable without air conditioning for most if not all times of the day. When it becomes necessary to air condition a space consider the other methods in this book that reduce heat gain which will allow your air conditioner to run more efficiently. **Many of the methods in the roof and windows chapters will help reduce the amount of energy your air conditioner uses to cool a space.** The difference between the utility bills for an air conditioned home and one that uses natural ventilation are significant. An air conditioned home can pay up to twice as much for its electric bill. This is a strong incentive to reduce or eliminate your need to air condition rooms within your home.¹⁰

“Typical utility bills are \$90 per month. The cost jumps up to more than \$200 per month for air conditioned homes. Savings of \$30 to \$50 per month are feasible.”¹¹

“Various areas, or zones, within the home have different cooling needs due to differing activities and thermal exposures. For example, the cooling requirements for a bedroom on the north side of a house would be very different from those of a busy kitchen with a wide western exposure. Separate controls for each

⁹ Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*, (Honolulu, Hawaii: no publisher, no date), pg 23

<http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09).

¹⁰ (no author), *Hawaii Homeowner's Guide to Energy, Comfort & Value*,

(Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2002), pg 4

<http://hawaii.gov/dbedt/info/energy/publications/hhog.pdf> (accessed 4-12-2009).

¹¹ Ibid

zone increase the efficiency of the overall system, which increases comfort and decreases operating costs.”¹²

Intuitively many people might think that a bigger air conditioner will do a better job cooling their room. Unfortunately this is rarely true. There are many problems that having an oversized air conditioner can cause and later in the chapter there is a section devoted to picking an AC unit properly sized for your needs.¹³

See the windows chapter for more information regarding window design options. Some of these include, exterior shading, interior shading, window coatings, films and tints. Choosing the right kind of window to match with air conditioned spaces and naturally ventilated spaces is also vital for maximizing energy efficiency and maximizing user comfort. Certain window types such as typical louvered jealousies that are common in Hawaii should not be used as windows in a room that is air conditioned. This type of window is great for natural ventilation, but allows serious air infiltration even when the window is fully closed. For more information on reducing air infiltration to improve the efficiency of your air conditioner see the infiltration section of the roof chapter.¹⁴ There are many strategies to improve the efficiency of the air conditioning within your home that should be considered. The cheapest thing to do is to make sure to seal off all the places where air infiltration is possible. There is more information on this in the natural ventilation section of this chapter.¹⁵

In the chapters on walls and roofs I present several examples of passive cooling strategies and locally available products for properly executing these passive strategies. Basically you want to make sure the building envelope is properly insulated and isolated from the outside heat. This way if you choose to air condition your home, your AC unit will not have to work as hard and you will save on the cost of your electric bill. See the walls, roof and windows chapters to get more detailed information.¹⁶

Before you go out and choose an air conditioner it is important to understand some things about the way AC models are rated and sized for applications. A great resource to help you choose a proper air conditioner for your specific situation is the HECO web site. If you look up www.heco.com and then look under residential services you will find a link called air conditioning sizing. Click on this link and there is a simple step by step guide for helping you choose an AC unit of the right size to cool your space.

¹² James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes*, (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 83

¹³ Ibid

¹⁴ Ibid

¹⁵ Ibid, pg 81

¹⁶ Ibid pg 82

AC

This guide even asks you about the conditions of the room you will be cooling, for example a high heat room on the south side of the home or a low heat room on the north side. It also asks you how long the unit will probably be run each day and gives you an estimated monthly bill based on the efficiency rating of the unit you purchase and the Hawaiian island you live on. To give an idea of how it works here are two examples. One is of an example of what it would take to cool a well insulated north facing room with properly shaded windows. The other is an example of what it would be like to air condition a south facing room that is not well insulated and has windows that take a lot of heat gain from the sun¹⁷.

A well insulated bedroom (12'x12' with an 8' ceiling) on the north side of the home with well shaded windows would require a 4540-5540 BTU air conditioner. If this air conditioner is run for 6 hours each day it will run an average of 180 hours a month. If the unit has an EER rating of 8 it will cost \$30-38 per month. If the unit has an EER rating of 10 it will cost \$25-30 per month and if it has an EER rating of 11 it will cost \$23-28 per month. (for island of Oahu)

A poorly insulated bedroom (12'x12' with an 8' ceiling) on the south side of the home with windows that take a lot of solar heat gain requires a 6700-7700 BTU air conditioner. If this is run for 6 hours each day it will run an average of 180 hours a month. If the unit has an EER rating of 8 it will cost \$45-52 per month. If the unit has an EER rating of 10 it will cost \$36-42 per month and if it has an EER rating of 11 it will cost \$33-38 per month. (for island of Oahu)

This is a powerful tool for homeowners to not only choose the kind of AC unit that is appropriate for them, but it also allows you to see how much you can save each month by using a high efficiency AC unit and combining this with the methods in this book that reduce heat gain.

¹⁷Heco, "Air Conditioning Sizing,"
<http://www.heco.com/portal/site/heco>
(accessed 2-16-2011).

AC

Air conditioners typically express their capacity in the form of BTUs. “Thermal energy is measured in terms of British thermal units (BTUs). A British thermal unit is defined as the amount of heat required to heat one pound of water one degree Fahrenheit at 65 F and at one standard atmosphere.”¹⁸



A good rough rule of thumb is that you generally need about 45 BTUs per square foot. So as in the example above a 12' x 12' room needs roughly 6480 BTUs of cooling power. Always choose the smallest air conditioner that will do the job. The right sized air conditioner will lower the temperature and dehumidify the space as well.¹⁹ If you choose an oversized air conditioner it will cost more initially and it will cost more to operate. An AC unite that is too large will have Frequent on/off cycling to adjust the temperature in the room and this can cause wear and tear on the unit. An oversized air conditioner may not remove moisture as effectively as a properly sized unit because it cools too quickly and this can lead to moisture problems.²⁰



The decision to properly maintain your air conditioning system is what will save you money in the long run. “With regular maintenance, an air conditioner can retain up to 95% of its efficiency. If not properly maintained, an air conditioner can lose 5% of its operating efficiency every year.”²¹ Failing to properly maintain your system will lead to higher maintenance costs and a shorter life span for your system.

When you buy any large appliance like a refrigerator, water heater, range, dryer or air conditioner you will find a large yellow sticker on the product. This sticker is required by the government to inform consumers about how much it will cost them to operate the product. This sticker will often let you know if you are buying a high efficiency product (high EER rating) as well as your cost of operation compared to other efficiency ratings. This sticker comes up with an estimated

¹⁸ William T. Meyer, *Energy economics and Building Design* (New York: McGraw Hill Book Copany, 1983), pg 10

¹⁹ Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*,

(Honolulu, Hawaii: no publisher, no date),

<http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09). pg 26

²⁰ Ibid, pg 27

²¹ Ibid

yearly electrical cost but this is almost always incorrect for Hawaii. The yellow stickers use the national average electricity price per kilowatt hour which is usually around 12 cents per kilowatt hour.



On Oahu the price is currently 21.53 cents per kilowatt hour²² Make sure to look at the HECO web site for current electricity costs to better estimate your yearly cost. As this is being written HECO is in the process of implementing a three tiered cost system that rewards customers who use less electricity with lower prices per kilowatt hour. Visit HECO.com to read more about the new cost scale.

Remember, how often you use the unit and where in the house it is being used and how well you have used the other methods in this book to reduce heat gain are all important factors that effect the cost of running an air conditioner.

²²Hawaiian Electric Company, residential services,
<http://www.heco.com/portal/site/heco/menuitem.508576f78baa14340b4c0610c510b1ca/?vgnextoid=692e5e658e0fc010VgnVCM1000008119fea9RCRD&vgnnextchannel=10629349798b4110VgnVCM1000005c011bacRCRD&vgnextfmt=default&vgnextrefresh=1&level=0&ct=article>
(accessed 2-16-2011).

Lists key features of the appliance you're looking at and the similar models that make up the cost range below.

U.S. Government Federal law prohibits removal of this label before consumer purchase.

ENERGYGUIDE

Refrigerator-Freezer

- Automatic Defrost
- Side-Mounted Freezer
- Through-the-Door Ice

XYZ Corporation
Model ABC-L
Capacity: 23 Cubic Feet

Estimated Yearly Operating Cost

\$67


\$57 ————— \$74

Cost Range of Similar Models

630 kWh
Estimated Yearly Electricity Use

Your cost will depend on your utility rates and use.

- Cost range based only on models of similar capacity with automatic defrost, side-mounted freezer, and through-the-door ice.
- Estimated operating cost based on a 2007 national average electricity cost of 10.65 cents per kWh.
- For more information, visit www.ftc.gov/appliances.



The maker, model, and size tell you exactly what product this label describes.

What you might pay to run the appliance for a year, based on its electricity use and the national average cost of energy. The cost appears on labels for all models and brands, so you can compare energy use just like you would price or other features.

The cost range helps you compare the energy use of different models by showing you the range of operating costs for models with similar features.

An estimate of how much electricity the appliance uses in a year based on typical use. Multiply this by your local electricity rate on your utility bill to better judge what your actual operating cost might be.

If you see the ENERGY STAR logo, it means the product is better for the environment because it uses less energy than standard models.

<http://www.ftc.gov/bcp/edu/resources/images/REA14-energylabels.jpg>

AC| Window Mounted

Window mounted air conditioners are a very common air conditioner type. There are many pros and cons that should be considered when you are considering purchasing a window mounted air conditioner. Window mounted AC units are nice because they are easy for homeowners to install on their own so there is typically no installation cost. Window mounted AC units can be fairly efficient when they are properly sized for the rooms they are cooling. Window mounted AC units are also nice because they allow you the flexibility of cooling selected rooms within your home while naturally ventilating others.

However, there are some downsides to window mounted AC units. Window mounted AC systems are only preferable when you are cooling a fairly small room within your home.²³ They are not the most efficient kind of air conditioning for larger spaces and they are often noisy. Window mounted AC units are particularly susceptible to air infiltration. You want to do a careful job of sealing up the air spaces where your AC unit meets the window frame. Weather stripping or caulking are inexpensive ways to solve this problem. For more detailed information on this subject see the air infiltration section of the roof chapter.

If your AC system is in the hot sun all day it will use more energy to perform its task. Whenever possible place your air conditioning system in a place that is shaded from direct sunlight. Having some kind of louvered shade, shade tree, or placing your AC unit on the north side of your building are all possible ways to do this.²⁴ Make sure that this shading device does not impede the AC units ability to vent hot air.

²³ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes*, (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 81

²⁴ *Ibid*, pg 87

AC| Window Mounted



Example of a window mounted AC unit ideal for a 12' x 12' room. It costs about \$330 at The Home Depot and has an EER rating of 10.7. According to the HECO web site this kind of air conditioner would cost \$25-42 a month if it was run 6 hours a day. The variation in price is due to how well the room you are cooling mitigates heat.

http://www.homedepot.com/h_d1/N-5yc1v/R-202073173/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



Example of a home made window mount to seal the connection between the air conditioner and the window frame.

<http://www.instructables.com/image/F11Q942FWEGKCKF/Mounting-a-Standard-Air-Conditioner-in-a-Sliding-WV.jpg>



Example of a home made device that shades the AC unit while allowing it to vent.

<http://www.instructables.com/image/F2YAQDBGBUH9J33/Shade-Screen-for-Air-Conditioner-Condenser.jpg>



Example of a home made device that shades the AC unit while allowing it to vent.

http://image.dhgate.com/upload/spider/b/102/127/b_5fex3z127102_0.jpg

AC | Portable

Portable air conditioners are a fairly common air conditioning type and they have many advantages and disadvantages that should be considered before you choose to purchase one. Portable AC units are ideal for cooling relatively small spaces like bedrooms but there are some with the capacity to cool larger spaces like living rooms. Because this AC unit is portable and generally has wheels built into the bottom, it is easy to move from room to room. It is important to note that these units are generally fairly heavy and will not be as easy to move up and down stairs. It is also important to consider that some of the portable AC models require you to drain a condensation trap that gets filled with water as the unit runs. **This water might spill all over your floor if you tip the model sideways while carrying it up or down stairs!** Newer models no longer have this problem and it is a good feature to look for when purchasing a product.²⁵

A drawback to portable AC units is that you have to set up the exhaust space for the hot air to leave the room. Most portable air conditioners come with kits that are intended to make this easier. However, window designs vary. Often people find themselves building their own special fitting that allows the hot air to exhaust while keeping the cool air in. Often hardware stores sell small pieces of a 1/4" or 1/2" thick plywood in small sizes like 2' x 4'. You can get a piece like this and cut it to fit the window frame of the window you wish to exhaust through. Be sure to look at the air infiltration section in the roof chapter to familiarize your self with ways to seal up the room you are air conditioning.²⁶



Example of a portable air conditioner available at The Home Depot for about \$380. It has an EER of 12.44 and is rated at 12,000 BTU/H. This model would be ideal for a large bedroom or any room with about 266 SF of floor space.
http://www.homedepot.com/h_d1/N-5yc1v/R-202105048/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053

²⁵ Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*, (Honolulu, Hawaii: no publisher, no date), <http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09). pg 25
²⁶ Ibid

AC | Portable



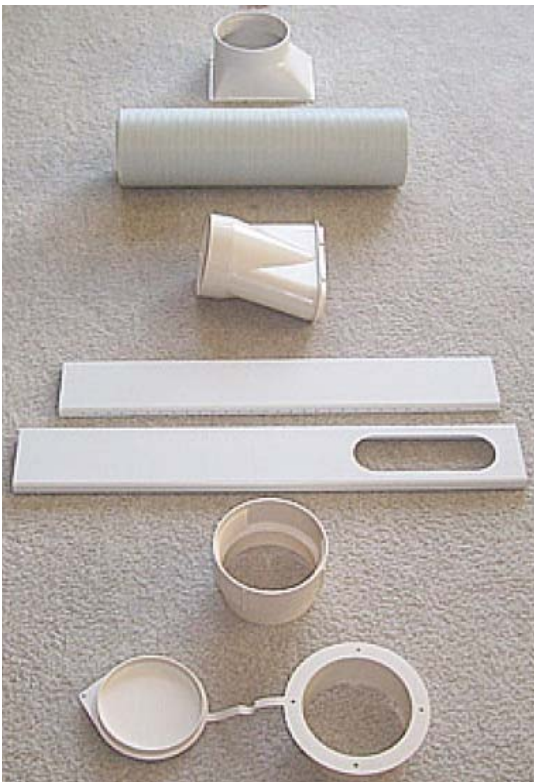
Portable air conditioners come with window adapters that work with many window types.

<http://www.yourstoreimages.com/1659/full/royal-air-conditioner-14.jpg>



Example of how the window adapter kits that come with portable air conditioners don't always fit.

<http://www.unplggd.com/uimages/unplggd/071510exhaust.jpg>



Example of portable air conditioner window adapter kit

<http://factoidz.com/images/user/ac-vent-assembly.jpg>



Example of a home made window adapter made of plywood, clothes dryer exhaust vent parts and painted white.

<http://www.thegoodhuman.com/wp-content/uploads/2009/06/duct.jpg>

AC | Split System

Split system air conditioners have many advantages over other types of air conditioners. They are highly efficient, depending on the model you choose. You may find EER ratings that are much higher than those for window mounted or portable ac units. The Mr.Slim split system air conditioner by Mitsubishi has models with EER ratings that range from 14 up to 22 or higher (this is as much as twice as efficient as the other air conditioners discussed in this chapter)²⁷. Split systems keep the noisy part of the air conditioner outside in a place of your choosing. Unlike central air conditioning split systems don't use air ducts. Instead split systems use thin pipes that send coolant between the compressor unit and the fan unit inside the house. The pipes used to run this fluid are typically around 1" in diameter or less, which makes them unobtrusive, flexible and easy when it comes to installations²⁸. The fluid that runs through the pipes loses less heat as it travels than the air in the ducts of a central air conditioning system which is another reason split systems are so much more efficient.

Generally split systems are intended for cooling larger spaces, or multiple spaces within your home. You can have one compressor unit outside your home that is running multiple fan units on the inside of your home. In 2006, the U.S. Department of Energy requires all new central and large split systems to have an SEER of 13 or better.²⁹



Generally split systems must be installed by a contractor and you should shop around and compare prices. A permit is also required upon installation, however the contractor should take care of this. Most contractors give free estimates. When calling or e-mailing to ask for an estimate be sure to have information regarding the square footage of the space you want cooled.

For example: AMV, a contractor listed in the contacts section, will install a split system for a 288 square foot living room for about \$3,300-3,400 plus an additional \$90 for permitting fees. If you want to also air condition two bedrooms (12'x12' or 144 SF each) you would have 288 square feet of bedroom space plus the 288 square foot living room = 576 total square feet. AMV would install a split system for these three rooms for about \$6,000.

²⁷www.mrslim.com

²⁸ Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*, (Honolulu, Hawaii: no publisher, no date),

<http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09). pg 26

²⁹ Ibid pg 27

AC | Split System



As you can see, this kind of air conditioner has a much higher up front cost, but if you use air conditioning regularly for a significant part of your home it is likely that you will save money in the long run with a split system. If you are only going to cool one bedroom or you only plan to use the AC sporadically this might not be the best option for you. For smaller applications or for more sporadic use you are better served by a portable AC unit or a window mounted unit.



Example of the fan unit which would be installed on an interior wall inside the home.

www.mrslim.com

Example of the compressor unit which would be installed on the exterior of your home, ideally on the north side or in a shaded location.

www.mrslim.com



Example of how split systems could be utilized throughout a home.

www.mrslim.com

AC | Natural Ventilation

This chapter is devoted to mechanical means to increase the comfort of your home. However, there are many cases where ideally you want to naturally ventilate your home. One of the biggest reasons to naturally ventilate as much of your home as possible is that it costs \$0 to operate naturally ventilated windows! While there may be some parts of your home that you ultimately choose to air condition, you will greatly reduce your operating costs if you can naturally ventilate most of your home. Even if you can't naturally ventilate your home during the hotter hours of the day, you can still turn off the AC and naturally ventilate your home during the cooler hours.

This can be a problem if you don't have windows that seal well. Traditional jalousies are a common window type in Hawaii and they are great for natural ventilation but terrible for air conditioned spaces. The great thing about jalousies is that they are highly operable and allow for adjustable wind flow. They are usually pretty good at keeping out rain but not so good for keeping out burglars. Jalousie windows allow large mounts of air to leak in and out even when they are fully closed. This means that the cold air from your air conditioner will be leaking out and warm air from outside could potentially be leaking into your home. Because jalousie windows are single pane windows they also easily conduct heat from outside to the inside making your air conditioner work harder. In order to allow a room to be flexible and be air conditioned in the hot hours of the day and naturally ventilated in the cooler hours you need windows that can seal well and that also have good U-factors (see windows chapter glossary)³⁰. The U-factor is an indication of the rate of heat flow through a window. The lower the U-factor the less heat is able to flow from the outside of the window to the inside. Windows that are constructed of double and triple paned glass will have a much lower U-Factor. A U-factor of .30 or less is required for windows to qualify for form 5695 in the tax rebates section of this book. Consider this and read through the rebates chapter before you purchase any windows.

If you really like the high level of ventilation you get from jalousie windows you might consider replacing your traditional jalousies with Breezway Jalousies. Breezway Jalousies allow half as much air infiltration as traditional jalousie windows.³¹ Yet when they are open they allow for 75% or more of the window surface to be effective at allowing air flow.³² Despite the better sealing ability of the Breezway windows, you might be better off using these only in non-air

30 James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes*, (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 54

31 (no author), Breezway, "Energy Efficient Louvre Windows," http://www.breezway.com.au/louvres_energy_efficiency.htm (accessed 3-21-2011).

32 James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes*, (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 54

AC | Natural Ventilation



Traditional Jalousie windows

<http://www.sturdi-built.com/images/Jalousie%20window.jpg>



Breezway jalousies seal 2 x better than traditional jalousies (rated at .34 cfm)

http://www.breezway.com/hawaii/louvres_windows_systems.htm

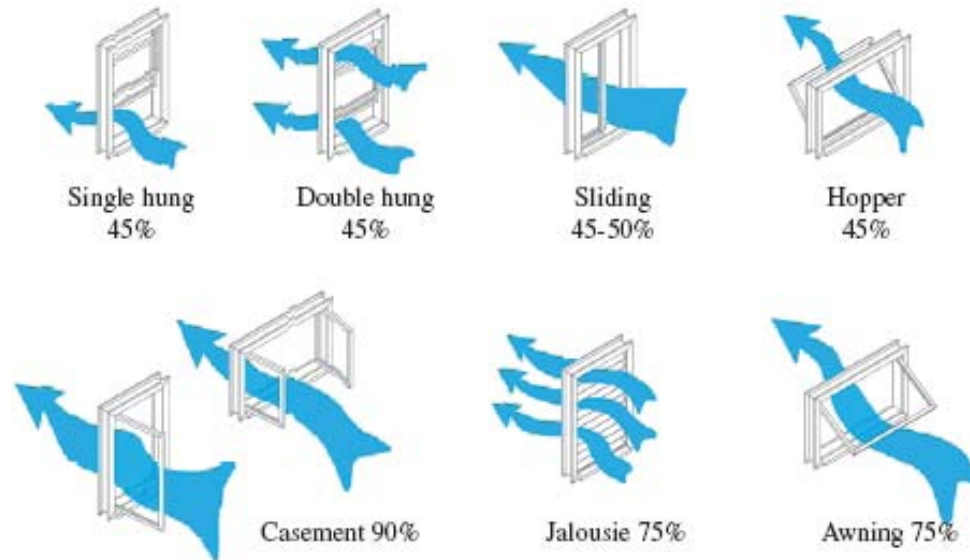
conditioned spaces. If you are trying to seriously create spaces in your home that can be air conditioned in the hot hours of the day and naturally ventilated in the cooler hours you will need to replace your jalousie windows. You want windows that reduce the amount of air infiltration that can get through your windows and really reduce the amount of conductive heat that gets through your windows. In order to do this you will want to choose a double or triple paned insulated window. There are many types of window that can do this. Slider and double hung windows are two good examples that typically have double or triple paned glass and some of the more expensive models allow you to choose a low-E specification (see windows chapter).

These only allow about 45% of the window surface to be effective at allowing air flow when the window is open which is much less than the 75% you get with jalousies. However, the sacrifice in air flow will be worth it when you consider that your air conditioner will not have to work as hard to cool the room with slider or double hung windows.³³ Another important consideration is insulation properties of the material that the window frame is made of. Wood and Vinyl are the best options in terms of frames that insulate well. Aluminum is very durable but unless it is specifically designed with thermal breaks an aluminum frame is not a good insulator.³⁴

³³ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes*, (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 54

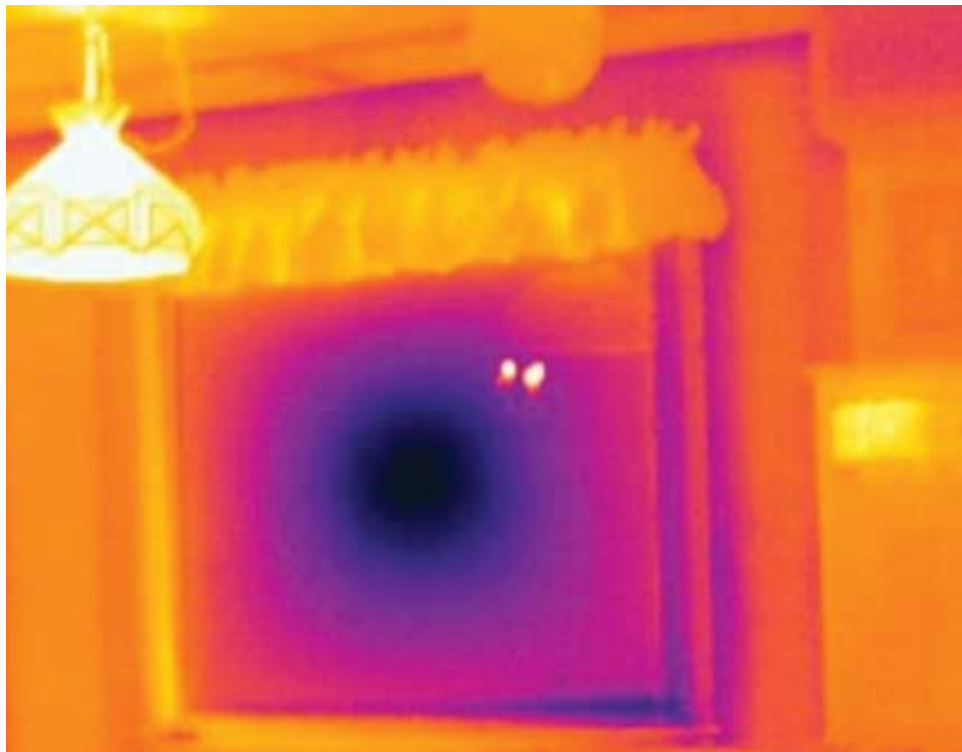
³⁴ (no author), Lower My Energy Bill, "Window Efficiency and Frame Material," <http://www.lower-my-energybill.com/window-efficiency.html> (accessed 4-17-2011).

AC | Natural Ventilation



Effective open areas for different window types

James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes*, (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 54



Infrared thermal Image indicating temperature difference between the surface of a window and the rest of a room. This large difference indicates a window with a high U-Factor allowing lots of heat transfer.

http://www.thermalimagingscan.com/system/files/userfiles/images/IR_0517.jpg

AC | Natural Ventilation

To properly replace your windows follow the manufacturers instructions. Generally you should be able to find windows that can fit into the places where your old jalousies were. In some cases you will have to modify the size of the window frame by either shrinking or enlarging it. This can be a fairly simple project for the experienced do-it-yourselfer but less experienced home owners might want to hire a handyman or small project contractor. For those interested in installing their own slider or double hung windows see the diagram in the following page. If you are trying to install this window in the wall of an air conditioned space it is pivotal that you properly seal the spaces where the window meets the building (see air infiltration section in the roof chapter).



Slider window 32" x 22" about \$90 at
The Home Depot

http://www.homedepot.com/Vinyl/Doors-Windows-Windows/TAFCO-WINDOWS/h_d1/N-5yc1vZaq1wZ1z13hnaZ53q/R-100671878/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



Double hung window 24" x 36" about
\$90 at The Home Depot

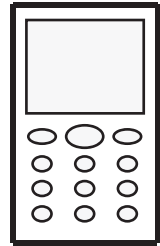
http://www.homedepot.com/webapp/wcs/stores/servlet/Navigation?storeId=10051&N=500324+4294940950&langId=-1&catalogId=10053&cm_sp=e589fbdd-b01b-4aee-b026-cfce4a269e32



How to install vinyl windows, Diagram

http://2.bp.blogspot.com/_zQDMW7O9D_8/TTyjH4g6OAI/AAAAAAAAAKU/4GTUm4sFgVo/s1600/install.jpg

AC | Contacts



Home Improvement Stores:

The Home Depot	808 521-7355
City Mill	808 533-3811
True Value	808 949-7936
Sears	808 247-8211

Windows:

Breezway Hawaii	808 292-4811
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AC Contractors:

Air Masters Inc	808 848-2473
AMV Air Conditioning Inc	808 845-3149
Air Systems	808 422-6333
Cool Zone Inc	808 947-0055
Progressive Air Conditioning	808 839-0770



Energy Factor (EF) - The Energy Factor tells you how efficient the water heater is based on the amount of energy it uses and the amount of hot water it can heat. The higher the EF number is, the more efficient the water heater. For example, a tankless gas water heater has to have an EF of .82 or more to be energy star rated.³⁵

Solar Fraction (SF) - Solar Fraction relates specifically to solar water heating systems. The SF is an indication of how much of your hot water needs are provided by solar energy. The higher the SF is, the more efficient the solar water heater. For example, in Hawaii solar water heaters can often take care of 90 to 100% of a families hot water needs. This would be a solar Fraction of .9 to 1.0.³⁶

First-Hour Rating (FHR) - The first-hour rating is how much hot water in gallons water heater with a storage tank can provide per hour (starting with a tank full of hot water).³⁷

Gallons per Minute (GPM) - Gallons per Minute is the amount of heated water a tankless water heater can supply in gallons per minute over a 77°F temperature rise.³⁸

Temperature Rise - This is the temperature difference between the cold water that goes into your heater and the heated water that comes out. If you want a shower of 110°F and you live in Kaneohe where the cold water might be 70°F, then you need a 40°F temperature rise ($70+40=110$).³⁹ The temperature rise is particularly important when you are planning on using a on demand water heater.

³⁵ (no author), Energy Star, "Residential Water Heaters Key Product Criteria," http://www.energystar.gov/index.cfm?c=water_heat.pr_crit_water_heaters (accessed 3-20-2011).

³⁶ Ibid

³⁷ Ibid

³⁸ Ibid

³⁹ Ibid

BACKGROUND INFO

This chapter will help you gain a better understanding about residential water heaters. It is likely that you currently have a traditional electric resistance water heater. While these have gotten much more efficient in recent years it is a good idea to explore what you could be doing to pay less for your hot water. Depending on your situation the best idea might be to buy a new and different kind of water heater, or it might simply be to make the heater you are currently using run more efficiently. This chapter will help you make informed decisions about which product to choose. This chapter will also help you know how to improve the efficiency of your current hot water system if you don't have the budget for a new heater.



Before you consider anything else it is important to remind yourself that no matter what kind of water heater you use, the more hot water you use the more energy has to be used to heat the water. Your water use habits will often be more important in the long run than any highly efficient heater or special cost saving method in this chapter. This chapter can save money in varying ways for just about any home type. If you use hot water in your home then you have a chance to either save money and/or maximise the efficiency of your hot water system. If you are currently using a solar hot water heater then you are probably spending as little as possible on hot water. However, you can still make your system more efficient and prevent yourself from running out of hot water with methods in this chapter.

To help you understand the impact your water use habits have on your electric bill and water bill here is a per person water use chart. Keep in mind this chart includes hot and cold water.



Bathroom sink: 5 gallons per day per person
Kitchen sink: 5-15 gallons per day per person
Shower: 20 gallons per day per person
Bath: 40 gallons per day per person
Washing machine: 30-50 gallons per day per load⁴⁰

⁴⁰ Walter T. Grondzik, and Alisson G. Kwok, and John S. Reynolds, and Benjamin Stein, *Mechanical and Electrical Equipment for Buildings* (Hoboken, New Jersey: John Wiley & Sons, Inc., 2006), pg 1038

Water Heater

If you use hot water for your washing machine this can also be a significant draw on your hot water heater.⁴¹ If you plan on buying a new water heater you must be able to figure out the capacity you will need. To do this you have to estimate your hot water requirements. Much of the water you use during the week is (or could be) cold. Typically a family of four in Hawaii uses about 80 gallons of hot water per day. You will get the most efficient use of your system when it is sized to meet 110% of the household's projected demand.⁴²

If you don't have a four person family, the rule of thumb is about 15 to 20 gallons of hot water a day for each person in your family. If you have a dishwasher or washing machine that uses hot water you should add 5 gallons more per person to your tally. You will want to increase or decrease this number a bit based upon your known habits. For example if some people in your family like cold showers, or if someone in your family loves long hot showers you will want to adjust your calculations accordingly.⁴³

Selecting the correct tank size is important so that you don't waste money, but also so that you have enough for your needs. You don't want to spend more up front than you need to and you also don't want to be constantly heating more water than you use. On the other hand you don't want to get stuck taking an undesired cold shower. Remember to buy a heater that can handle 110% of your estimated hot water needs.⁴⁴ According to HECO a typical family of four or five needs a 40 gallon conventional water heater.⁴⁵

There are many options when it comes to choosing a hot water heater. As with many other situations in life, the more you can spend up front, the more you can save in the long run. Hawaii is ideal for Solar hot water, and though it is more expensive up front, it will likely pay for its self within four years.

41 James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 62

42 Ibid

43 (no author), *Have Some Energy On The House, Solar: Questions and Answers on Solar Water Heating* (Honolulu, Hawaii: Department of Business, Economic Development & Tourism, 2003), pg 13 <http://hawaii.gov/dbedt/info/energy/publications/HaveEnergyOnHouse03.pdf> (accessed 10-13-09).

44 James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 62

45 Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home* (Honolulu, Hawaii: no publisher, no date), pg 45 <http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09).

Water Heater



Water Heater Comparison

	Type of water heater	Installed cost	Energy cost per-year (family of 4)
BEST	Solar	\$2,000	\$55
BETTER	Heat Pump	\$1,000	\$220
FAIR	Gas	\$400	\$370
POOR	Electric Resistance	\$350	\$520⁴⁶

Everyone's situation is different. Not everyone can afford to install a solar hot water system and not everyone is in the right location to make it viable. Some people are already getting gas service and others would have to pay to get service set up at their home. These are all things that should be considered when you choose a hot water heater.⁴⁷

Another type of water heater that has been growing in popularity is the on-demand water heater or tankless water heater. This kind of water heater only heats the water when you start using it. This means there is no storage tank hence the name, tankless. These heaters use either electricity or gas and can be very efficient. One of the main reasons on-demand heaters can save money is that there is no tank that has to be kept warm and there is no waste due to heat loss. However, because they have to heat the water instantly, they often have a fairly low flow rate (measured in gallons per minute) which might be a problem if you have a large family and you all take showers at the same time of day. Older homes in Hawaii may only have around 110 amps of service. If you are using an electric on-demand water heater you may have to upgrade your electrical service from HECO upward of 200 amps as electric on-demand heaters generally require 240 volts and high amperage.⁴⁸

It is important to choose a system based on your household's demand for hot water. Each system has its advantages and disadvantages and it is important to choose one that maximizes the benefit for your particular location. Knowing that

46 (no author), *Hawaii Homeowner's Guide to Energy, Comfort & Value* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2002), pg 4

<http://hawaii.gov/dbedt/info/energy/publications/hhog.pdf> (accessed 4-12-2009).

47 (no author), "Consumers Guide to Gas Water Heaters,"

<http://www.hawaiigas.com/consumerguides/oahu.html> (accessed 3-26-2011).

48 Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*

(Honolulu, Hawaii: no publisher, no date), pg 45

<http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09).

Water Heater

you might have a large draw of hot water for lots of people taking showers means a tankless water heater might not be ideal.

If your house is under a large tree or does not receive much sun you might not be able to make use of a solar hot water system. If you chose to use a traditional hot water heater (electric resistance), consider the ways to maximize its efficiency. Adding a heat pump to your traditional water heater is ideal here in Hawaii because of our warm climate. A heat pump works like an air conditioner except that it takes the heat out of the air and uses it to heat your water.⁴⁹ You might also find that you can save money by using point of use heaters. Below is a chart explaining how various water heaters can qualify for the Energy Star rating.

ENERGY STAR Criteria

A water heater model must meet all of the identified criteria to be labeled as ENERGY STAR.

High-Efficiency Gas Storage				
ENERGY STAR Criteria	Energy Factor	First-Hour Rating	Warranty	Safety
Gas Storage (Ending 8/31/2010)	EF \geq 0.62	FHR \geq 67 gallons per hour	Warranty \geq 6 years on sealed system	ANSI Z21.10.1/CSA 4.1
Gas Storage (Beginning 9/1/2010)	EF \geq 0.67	FHR \geq 67 gallons per hour	Warranty \geq 6 years on sealed system	ANSI Z21.10.1/CSA 4.1

Gas Condensing				
ENERGY STAR Criteria	Energy Factor	First-Hour Rating	Warranty	Safety
Gas Condensing	EF \geq 0.8	FHR \geq 67 gallons per hour	Warranty \geq 8 years on sealed system	ANSI Z21.10.1/CSA 4.1

Heat Pump Water Heaters				
ENERGY STAR Criteria	Energy Factor	First-Hour Rating	Warranty	Safety
Heat Pump Water Heaters	EF \geq 2.0	FHR \geq 50 gallons per hour	Warranty \geq 6 years on sealed system	UL 174 & UL 1995

Whole-Home Gas Tankless				
ENERGY STAR Criteria	Energy Factor	Gallons-Per-Minute	Warranty	Safety
Whole-Home Gas Tankless	EF \geq 0.82	GPM \geq 2.5 over a 77° F rise	Warranty \geq 10 years on heat exchanger and 5 years on parts	ANSI Z21.10.3/CSA 4.3

Solar Water Heaters			
ENERGY STAR Criteria	Solar Fraction	Warranty	Safety
Solar Water Heaters	SF \geq 0.5	Warranty \geq 10 years on solar collector, 6 years on storage tank, 2 years on controls and 1 year for piping and parts	OG-300 Certification from the SRCC

Energy Star water heater chart

http://www.energystar.gov/index.cfm?c=water_heat.pr_crit_water_heaters

49 Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*

(Honolulu, Hawaii: no publisher, no date), pg 45

<http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09).

Water Heater

Before considering a new water heater, try to find ways to make your existing plumbing more efficient for hot water. There are several ways you can do this. You can insulate your pipes, lower the flow rates of your water fixtures, fix leaks and improve your water use habits. These are especially good considerations if you don't have the cash to go out and buy a new heater. These methods are low investment and they help you start saving money instantly.

"When you decrease the amount of hot water used in the home, you reduce the amount of energy used to heat the water. Aerators in faucets and low-flow shower heads can cut hot water requirements by 50%. Install bathroom faucets that use no more than 2 gallons per minute (gpm). Other sink faucets and shower heads should use no more than 2.5 gpm."⁵⁰ Low flow fixtures reduce the rate of flow (gallons per minute) but they actually increase the water pressure which is often desirable. "Water heating typically accounts for up to 40% of utility bills in non-air conditioned homes." There are many ways to improve the efficiency of your homes heated water system. Plumbing fixtures that conserve water, correctly sized water heater and careful maintenance are some of the most effective methods⁵¹.

Hot water leaks are a frequent cause of unusually high increases in energy costs. A hot water leak could potentially increase your monthly energy by as much as 200%. "A leaking hot water faucet wastes both water and up to 400 kWh per year."⁵² Turn off all your water fixtures and then go look at your water meter. Often this is on the edge of your property near the street under a cast iron access panel (roughly 9" x 14"). If you see the numbers on the meter running you have either forgotten to turn something off, or you have a leak. As a result of a leak you may have warm water running from the cold water tap; warm or hot water spots in the floor; or you might notice that your hot water runs out very fast. See the Board of Water Supply's website (<http://www.hbws.org/cssweb/display.cfm?sid=1091>) for tips on detecting leaks.⁵³

50 James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 62

51 Ibid, pg 61

52 Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*

(Honolulu, Hawaii: no publisher, no date), pg 46

<http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09).

53 Ibid

Water Heater

One simple way to reduce your hot water energy bill is to turn down the temperature on your hot water heater thermostat. This will be covered in greater detail in the section on traditional hot water heaters. It is important not to go too far with this method. If you try to adjust the thermostat in your water heater and set it too low you might cause people within the home to actually use more water to make up for the lack of heat. This will end up costing you more. A good temperature range to set the thermostat at is 120-125 degrees F. any more than this and you will likely waste energy making the water hotter than it needs to be.⁵⁴

Any pipes that carry hot water would benefit from insulation. In many houses the water fixtures that are farther from the heater tend to take awhile to receive hot water. If you are one of those people who has to run the shower for a minute before you get in because of the hot water lag, you would also benefit from insulating your hot water pipes. Many houses in Hawaii are built of single wall construction. In these houses you can often access much of the exposed piping in the crawl space under the house. It is easy to find which pipes are the hot water pipes. Simply run hot water through the fixture that the pipes lead to and carefully feel which one heats up. You could also start insulating at the exit pipe on your hot water heater and follow it along. You can buy foam insulation at about \$2 per 6' section and cover your hot water pipes with it. Not only will this reduce the water you might otherwise waste waiting for your shower to heat up, you will also save on your electric bill.⁵⁵

54 Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*

(Honolulu, Hawaii: no publisher, no date), pg 47

<http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09).

55 (no author), *Have Some Energy On The House, Solar: Questions and Answers*

on Solar Water Heating (Honolulu, Hawaii: Department of Business, Economic Development & Tourism, 2003), pg 15

<http://hawaii.gov/dbedt/info/energy/publications/HaveEnergyOnHouse03.pdf> (accessed 10-13-09).



Water pipe insulation less than \$2 for 6 feet at The Home Depot

http://www.homedepot.com/Plumbing-Pipe-Insulation/h_d1/N-5yc1vZbuy9/R-100539941/h_d2/ProductDisplay?langId=1&storeId=10051&catalogId=10053

Water Heater



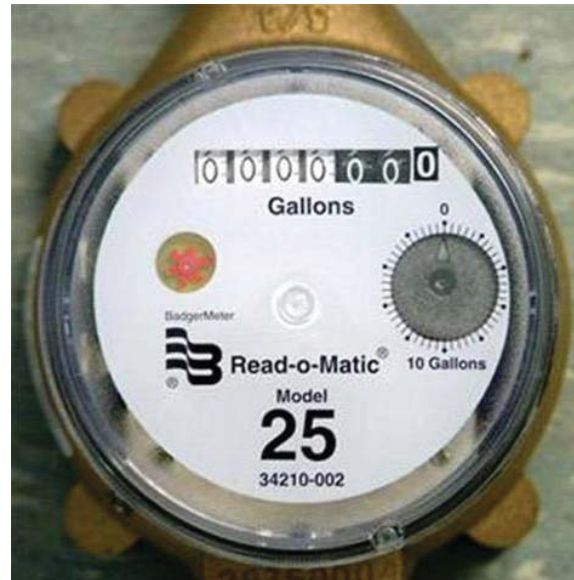
Sink with an after market aerator attached

http://www.takeashower.com/images/Large_Aerator_Sink-side.jpg



Where is your water meter? Usually at the edge of your property near the street under a cast iron access panel.

<http://blog.airdye.com/goodforwater/wp-content/uploads/2009/06/water-meter-reader.jpg>



Your water meter, if the dials are turning when you have all the fixtures in your home shut off then you have a leak.

<http://www.savewatersavemoney.co.uk/control/image/large/save-water-water-meter-1.jpg>

Water Heater| Electric Conventional

Conventional electric water heaters are the most common type of water heater used in Hawaii because they are the cheapest in terms of up front cost. However, these heaters are the least efficient kind of water heater. A conventional, electric water heater contains an electric heating element that heats the water in the storage tank. The heating element is controlled by a thermostat. When the water in the storage tank reaches the thermostat's preset temperature, the heating element turns off. Because some heat is constantly being lost through the walls of the storage tank, the heating element must periodically turn on to maintain the temperature. The amount of heat loss is determined by the heater's efficiency factor (EF). The higher the EF rating the lower the heat loss.

Most people in Hawaii still use a traditional electrical resistance water heater. If you have money to upgrade to another heater type it is worth considering. Even newer models of conventional electric water heaters are much more efficient than those made before 1998. There are also a number of inexpensive and simple ways to make your existing water heater more efficient.

A good way to improve the efficiency of any hot water system that uses a storage tank is to insulate the storage tank. This is quite cheap and not difficult to do. There are special insulation products specifically made for hot water storage tanks but its nearly as easy to simply rap a roll of fiberglass batt insulation around your storage tank and fasten it there with duct tape.⁵⁶ If you need to figure out how much insulation to buy simply measure the height and circumference of your tank. Keep in mind that insulation generally comes in 15" or 23" widths. You will want to make sure to leave the thermostat uncovered so that you can access it in the future. Do this by cutting a small hole in the insulation to fit around the thermostat.

Often a simple and inexpensive method to reduce your bill is to adjust the thermostat on your water heater. Often a water heater will be preset to 140 degrees but 120 degrees is often plenty of heat especially if you have properly insulated your hot water pipes and are using aerated water fixtures as mentioned earlier in the chapter. One exception for this method is if you are using a dishwasher that does not have its own heating element. Check the owners manual for your dishwasher to see what temperature is required.⁵⁷

⁵⁶ (no author), *Have Some Energy On The House, Solar: Questions and Answers on Solar Water Heating* (Honolulu, Hawaii: Department of Business, Economic Development & Tourism, 2003), pg 14 <http://hawaii.gov/dbedt/info/energy/publications/HaveEnergyOnHouse03.pdf> (accessed 10-13-09).

⁵⁷ Ibid, pg 30

Water Heater| Electric Conventional

“To adjust the setting on your water heater, turn off the electricity to the water heater at the circuit breaker panel. Remove the thermostat(s) access panel(s) and push the insulation aside with a screwdriver. Most heaters have two thermostats to adjust: one for the upper heating element and one for the lower heating element. Use the screwdriver to turn the indicator to the desired temperature. Replace the insulation and access panel(s). Turn the electricity back on at the circuit breaker panel.”⁵⁸

You might also consider a timer for your water heater. These are relatively cheap compared with installing a new system and depending on your hot water use habits could save you money. It is important to consider your water use habits before you chose to use a timer. Today’s more efficient water heaters use the most energy to heat up cold water, but after that they are only on for small amounts of time during the day to maintain the temperature.⁵⁹ If you set your water heater to only be on for a small period of time, say right before you take your shower in the morning you could save money, if not a timer is not worth your time.

58 Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*

(Honolulu, Hawaii: no publisher, no date), pg 47

<http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09).

59 (no author), *Have Some Energy On The House, Solar: Questions and Answers*

on Solar Water Heating (Honolulu, Hawaii: Department of Business, Economic Development & Tourism, 2003), pg 30

<http://hawaii.gov/dbedt/info/energy/publications/HaveEnergyOnHouse03.pdf> (accessed 10-13-09).

Water Heater| Electric Conventional



Electric 30 gal 240 volt water heater,
about \$350 at The Home Depot
http://www.homedepot.com/Plumbing-Water-Heaters/GE/h_d1/N-5yc1vZbqlyZlo/R-100128723/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



Fiberglass batt insulation: Roughly \$16 to cover 50 square feet at The Home Depot

http://www.homedepot.com/Building-Materials-Insulation-Fiberglass/h_d1/N-5yc1vZbay7/h_d2/Navigation?langId=-1&storeId=10051&catalogId=10053&Nu=P_PARENT_ID&storeId=10051&catalogId=10053&langId=-1



Adjusting water heater thermostat
<http://yourhowtopartner.com/wp-content/uploads/2010/03/Water-Heater-Temp-Setting-1-copy1-300x281.jpg>

Water Heater| Gas

If you have gas service at your home from The Gas Company you might consider one of two common gas powered water heaters. If you don't you will have to consider the start up cost of having gas provided to your home. If your home is in an area that would benefit from solar water heating you might skip over this method rather than go through the trouble and expense of setting up propane or natural gas service and look at the solar method. Both of these are more efficient than a conventional electric resistance heater and both of them are more expensive in terms of initial cost.⁶⁰



However, both of these are **likely to save you 30%** off what you might be paying while using a conventional electric resistance water heater. This savings can make either of these a worthwhile investment if you have the cash and the existing gas service.⁶¹



If you already have gas service to your home and you are looking to make a minimal upgrade from your conventional electric resistance water heater, a gas tank storage water heater is a good choice. It is not that much more (about \$100-\$200 more) than a conventional electric heater, but it will save you about 30% off your yearly water bill. While an on demand/tankless gas water heater is also 30% more efficient than a conventional electric water heater, it costs considerably more (\$500-\$600 more). The tankless is nice because you don't lose efficiency by heat lost during storage in a water tank, and you can free up space by getting rid of the tank. However, if you are going to spend \$1,000 or more on a water heater you may as well get a solar water heater installed (assuming you are in a permissible location). While a solar hot water system for a family of 4 might initially cost \$4,000-\$6,000, you can get a federal tax rebate of 30% and a state tax rebate of 35% which could reduce the price to something more like \$1,500. For more information see the tax rebates chapter and the solar water section in this chapter. Remember that once a solar water heater is in place it is providing hot water for free!

⁶⁰ Walter T. Grondzik, and Alisson G. Kwok, and John S. Reynolds, and Benjamin Stein, *Mechanical and Electrical Equipment for Buildings*

(Hoboken, New Jersey: John Wiley & Sons, Inc., 2006), pg 917-930

⁶¹ (no author), Energy Star, "How It Works-Gas Condensing Water Heaters,"

http://www.energystar.gov/index.cfm?c=gas_cond.pr_how_it_works (accessed 3-20-2011).

Water Heater| Gas



40 gallon gas water heater with storage tank about \$500 at The Home Depot

http://www.homedepot.com/h_d1/N-5yc1v/R-100013742/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



Gas Tankless/on-demand water heater rated at 8.4 gallons per minute is about \$1,100 The Home Depot

http://www.homedepot.com/h_d1/N-5yc1v/R-202514575/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053

Water Heater|Electric Point-of-Use

Point-of-use water heaters are a good idea for homes that have long stretches of plumbing. If you have one water heater supplying hot water to your entire home you often have to turn on the water and wait awhile for the hot water to get to the fixture. This means that you will be wasting water while you run the tap and wait for the hot water to arrive. Even if you insulate your pipes you will experience this problem to varying degrees. Point-of-use water heaters can eliminate this problem because they can be installed right under your sink or right next to your shower. This means that when you turn on the hot water you don't have to wait for the hot water to arrive it is there almost instantly.⁶²



You can potentially replace your large water heater with multiple point-of-use water heaters. This depends on your water use habits and the specific situation of your homes design. If you have several bathrooms that are far apart from each other and a kitchen that is far from your bathrooms then multiple point of use water heaters might be a good consideration. The most important thing to consider with point of use water heaters is their gallons per minute capacity. Point-of-use water heaters are commonly described in terms of their gallons per minute capacity. Depending on what kind of fixture your point-of-use water heater is serving it will need a certain capacity rating.⁶³

For Example, if you have a bathroom sink with an aerator you will have a much lower gallons per minute need than a bathroom sink without an aerator. When you purchase an aerator you will find an indication of its flow rate on the product. This is often tabled on the aerator its self. See the table at the end of this section for an indication of the typical flow rates of various water fixtures. As you will see, a shower will probably need a larger point-of-use heater than a bathroom sink. You also have to consider your own habits. If you like long hot showers then this method might not be for you. If you use an average amount of hot water and your home has several far spaced hot water use locations you might be able to eliminate your large water heater and simply install 2 or 3 point-of-use water heaters.⁶⁴

62 (no author), The Home Depot, "Point of Use water Heaters and Recirculating Pumps", http://www.homedepot.com/Point-of-Use-Water-Heaters/h_d1/NCC-1701/h_d2/ContentView?pn=KH_BG_AP_WH_Point_of_Use&storeId=10051&langId=-1&catalogId=10053 (accessed 3-19-2011).

63 Ibid

64 Walter T. Grondzik, and Alisson G. Kwok, and John S. Reynolds, and Benjamin Stein, *Mechanical and Electrical Equipment for Buildings* (Hoboken, New Jersey: John Wiley & Sons, Inc., 2006), pg 917-930

Water Heater|Electric Point-of-Use

Small point-of-use water heaters can be simple to install as many of them simply need a 120V receptacle that you would use for any other small appliance. Most of the smaller models can fit easily in the cabinet under a sink. Larger models might be trickier to fit into sink cabinets and some may need to be wired into your homes wiring.



It is also important to hook up the plumbing for the pressure relief valve (see image on next page). Most water heaters that have tanks have a pressure relief valve that protects you and the tank from explosion if the tank experiences excessive pressure. If this should happen water will escape out of the tank through this valve. You want to connect a pipe to this valve and exit this pipe somewhere either outside or under your home where you don't mind having hot water drained. If you don't connect an escape pipe to your pressure relief valve you might end up with hot water all over your floor!

Water Heater|Electric Point-of-Use



2.5 gallon point-of-use 120 volt water heater about \$250 at The Home Depot
http://www.homedepot.com/Plumbing-Water-Heaters-Point-Of-Use/GE/h_d1/N-5yc1vZbqo7Zlo/R-100094732/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



Pressure Relief Valve

http://www.homedepot.com/Point-of-Use-Water-Heaters/h_d1/NCC-1701/h_d2/ContentView?pn=KH_BG_AP_WH_Point_of_Use&storeId=10051&langId=-1&catalogId=10053

Average Flow Rates in Gallons per Minute (gpm)	
Fixture/Appliance	Flow Rate
Bathtub	2.0 - 4.0
Shower	1.5 - 3.0
Bathroom Faucet	0.5
Kitchen Faucet	1.0 - 1.5
Dishwasher	1.0 - 3.0
Clothes Washer	1.5 - 3.0

Flow Rates Chart

http://www.homedepot.com/Point-of-Use-Water-Heaters/h_d1/NCC-1701/h_d2/ContentView?pn=KH_BG_AP_WH_Point_of_Use&storeId=10051&langId=-1&catalogId=10053

Water Heater|Electric Tankless/On-Demand

On Demand or tankless water heaters (also called instantaneous water heaters) have similar benefits and applications as point-of-use water heaters (see point-of-use section). Most on-demand water heaters are suitable for point-of-use type applications rather than for replacing a large single heater. If you have many people in your home you will probably not want to buy a single large on demand water heater to replace your old conventional electric heater. This is because on-demand heaters use high voltage and high amperage to quickly raise the temperature of your water from say, 70 degrees to 110 degrees. In this case there is a temperature rise of 40 degrees. If you have two showers going at the same time and someone washing dishes in the kitchen this might be too much for most on-demand water heaters. Often it makes more sense to install several small heaters at the points where they are needed. Similar to point-of-use water heaters they can be installed in the cabinets under your bathroom or kitchen sink.⁶⁵

It is important to understand temperature rise when purchasing an on-demand water heater. The higher the temperature rise, the lower your flow rate will be. For example if you buy a small capacity on-demand water heater it might be able to provide 4 gallons per minute when it has to perform a 45 degree temperature rise. This same heater might only be able to provide .8 gallons per minute if it has to raise the temperature of the water 77 degrees. Luckily if you live in Hawaii there is probably a fairly small temperature rise from the temperature of your cold water entering the on-demand heater to the temperature you want when you take a shower. You should also consider flow rates of different fixtures in your home (see the point-of-use section flow rate chart).⁶⁶

You might be able to plug some on-demand water heaters into 120V outlets but most have higher voltage and amperage requirements and may require the help of an electrician to install.

⁶⁵ Walter T. Grondzik, and Alisson G. Kwok, and John S. Reynolds, and Benjamin Stein, *Mechanical and Electrical Equipment for Buildings*

(Hoboken, New Jersey: John Wiley & Sons, Inc., 2006), pg 917-930

⁶⁶ (no author), "Tankless Water Heater Buying Guide," <http://www.tanklesswaterheaterguide.com/> (access 3-18-2011).

Water Heater|Electric Tankless/On-Demand



On-demand electric water heater

http://www.homedepot.com/webapp/wcs/stores/servlet/ProductDisplay?storeId=10051&productId=202514587&langId=-1&catalogId=10053&MERCH=REC-_-search-1-_-NA-_-202514587-_-N&locStoreNum=1701



On-Demand water heater under a sink

http://salestores.storehost.us/stores/images/images_747/RP3P1.jpg

Water Heater| Heat Pump

Heat pump water heaters (or air source heat pump water heaters) are highly efficient but cost 2 to 3 times as much as a conventional water heater. However, it should be considered that a heat pump water heater is also 2 to 3 times more efficient than a conventional water heater.⁶⁷ Heat pump water heaters are a great choice if you are in the right situation. For a heat pump to work properly you need to store it in a place that is protected from the elements and also has a lot of ventilation. If you are not in a good location to use solar but you have \$1,600 to invest then you should seriously consider a heat pump water heater.⁶⁸

According to the U.S. Department of Energy “Heat pump water heaters use electricity to move heat from one place to another instead of generating heat directly. Therefore, **they can be two to three times more energy efficient than conventional electric resistance water heaters.** To move the heat, heat pumps work like a refrigerator in reverse.”⁶⁹

“Hawaii is an ideal location to operate heat pumps because a heat pump water heater generally should be installed in locations that remain in the 40°–90°F range year-round and provide at least 1,000 cubic feet (28.3 cubic meters) of air space around the water heater.⁷⁰ Heat pump water heaters take in hot air and send out cool air that can be channeled into a room or just outside. If you have the opportunity, install them in a place that has a lot of heat. Heat pump water heaters don’t run efficiently in cold temperatures.⁷¹

You can sometimes buy heat pumps that are intended to be added on to conventional water heaters. You can also buy heat pump water heaters that come combined with a water storage tank. Contractors who install heat pumps will advertise that this kind of water heater (with the right set up) can dump cool air into a space in your home.

67 (no author), “Energy Star, Water Heater, Heat Pump,” http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=WHH (accessed 3-20-2011).

68 (no author) U.S. Department of Energy, Energy Savers, “Heat Pump Water Heaters”, http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12840 (accessed 3-21-2011).

69 Ibid

70 Ibid

71 Walter T. Grondzik, and Alisson G. Kwok, and John S. Reynolds, and Benjamin Stein, *Mechanical and Electrical Equipment for Buildings*

(Hoboken, New Jersey: John Wiley & Sons, Inc., 2006), pg 917-930

Water Heater| Heat Pump



50 Gallon heat pump water heater, this energy star compliant model is about \$1,600 at The Home Depot

http://www.homedepot.com/h_d1/N-5yc1v/R-202065074/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053

Water Heater| Solar

Solar water heaters make use of the sun's energy to heat water. Solar water heaters initially cost more, but the cost of operating one is lower because the sun's energy provides most of the heat. Electricity might have to be used to operate pumps and to supply backup heat when there is cloudy weather for extended periods of time.⁷²

It is likely that \$1 of every \$3 in your electric bill is used to heat water. And your total bill keeps going up because conventional energy costs keep going up.” Solar is ideal specifically in Hawaii because of our sunny climate. Solar energy is free and aside from the initial cost (which can be offset by rebates and tax credits) there is minimal maintenance for solar water heating systems.⁷³ Using the state income tax forms for renewable energy tax credits (see tax incentive chapter) you can take 30% off the cost of a solar water heater with the federal tax rebate and 35% off with the state tax rebate. A typical solar hot water system costs about \$4,000. After tax rebates are accounted for a \$4,000 solar water system can be whittled down to \$1,700.⁷⁴ **The money you save over the course of 4 years will be more than the price of the solar hot water system.**⁷⁵



Depending on your particular location, solar water may be an ideal cost saver for you. “Choosing a solar water heater over a conventional water heater can reduce water heating costs by 80% to 90%”⁷⁶

72 Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*

(Honolulu, Hawaii: no publisher, no date), pg 45

<http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09).

73 (no author), *Have Some Energy On The House, Solar: Questions and Answers on Solar Water Heating* (Honolulu, Hawaii: Department of Business, Economic Development & Tourism, 2003), pg 5

<http://hawaii.gov/dbedt/info/energy/publications/HaveEnergyOnHouse03.pdf> (accessed 10-13-09).

74 Ibid, pg 8

75 James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes*

(Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 61

76 Ibid

Water Heater | Solar



Solar Hot Water Heater collectors on a roof
http://vikingsolarsolutions.com/images/solar_hot_water3_eiww.jpg



Home Made Solar Water Heater collector
<http://www.watertubeboiler.org/wp-content/uploads/2011/01/solar-hot-water-heater.jpg>



In most cases solar hot water will prove to be a good investment. However, there are certainly situations where it is not worth your time and money. If you live in a place that does not get enough sunshine, if you don't have any taxable assets (to deduct the state and federal tax rebates from), if you don't use much hot water or if you don't have a good place to install a solar water heater this method might not be worth your time and money.⁷⁷

It is important to know if your roof has effective sunlight on it for enough hours during the day to heat water properly. The majority of houses in Hawaii are well suited for solar water heaters.⁷⁸ If you are not sure if your home is ideally situated for solar call a contractor listed at the end of the chapter or go online to: <http://www.getsolar.com/hawaii-solar-power-panel-installation-professionals.php>

There are many sites like this which take some information about your homes location and specific situation (average electric bill, roof type, number of family members etc). These web sites send your info out to multiple contractors who can reply to you by phone or e-mail. Solar contractors will usually be more than willing to visit your home and help you through the process. Most contractors take care of the permits required to have solar water heaters installed as well.

“Electrically heated water costs -- at 21¢ per kWh – about \$21 a month per person on Oahu. Thus, a family of four pays about \$1,008 a year for water heating. Solar water heating can provide about 90 percent of a family's water heating needs, saving about \$907 of the annual water heating cost for a family of four.”⁷⁹ Often a family of four in Hawaii will use between 80 and 120 gallons of hot water a day. Keep this in mind when you are discussing storage tank sizes with a contractor.⁸⁰

⁷⁷ (no author), *Have Some Energy On The House, Solar: Questions and Answers on Solar Water Heating* (Honolulu, Hawaii: Department of Business, Economic Development & Tourism, 2003), pg 7 <http://hawaii.gov/dbedt/info/energy/publications/HaveEnergyOnHouse03.pdf> (accessed 10-13-09).

⁷⁸ Ibid, pg 8

⁷⁹ Ibid, pg 10

⁸⁰ Ibid, pg 13

Water Heater| Solar

Just to give you an idea of how important solar hot water is and will be in Hawaii, here is an excerpt from a bill that was recently passed into law.

S.B. NO. 644 A BILL FOR AN ACT
RELATING TO ENERGY RESOURCES.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:

“§196- Solar water heater system required for new single-family residential construction. (a) On or after January 1, 2010, no building permit shall be issued for a single-family dwelling that does not include a solar water heater system that meets the standards established pursuant to section 269- . . . unless the energy resources coordinator approves a variance. ⁸¹ _

You can have a licensed contractor (who might also be a solar water heater dealer) install your solar hot water heater or you could install it yourself and have a licensed plumber and licensed electrician do the final hook up into your homes plumbing and electrical systems. These contractors must have a solar specialty contractors licence. This is important if you want to qualify for the rebates (remember to look at the tax forms in the tax rebates chapter before starting a solar project).



While thorough instructions on how to build your own solar water heater is beyond the scope of this book, you can easily find a variety of ideas online or at the library. Be careful as even home made solar water heaters can heat water that reaches temperatures higher than 160 degrees Fahrenheit which is more than enough to burn you!

Some good materials to consider include:

Copper or aluminum collector plates

Fiberglass batt or polystyrene foam insulation.

Dark matt colored paint on the collector plates to increase the heat absorption.

Low iron tempered glass for the cover.⁸²

⁸¹ (no author), “SB No. 644,” *Solar Energy Devices; Water Heating; Residential; Tax Credit*, http://www.capitol.hawaii.gov/session2008/Bills/SB644_CD1_.htm (accessed 11-18-09).

⁸² (no author), *Have Some Energy On The House, Solar: Questions and Answers on Solar Water Heating* (Honolulu, Hawaii: Department of Business, Economic Development & Tourism, 2003), pg 16 <http://hawaii.gov/dbedt/info/energy/publications/HaveEnergyOnHouse03.pdf> (accessed 10-13-09).

How Much Collection Space is Needed?



Generally your contractor should be able to figure this out for you. If you are a do-it-yourselfer than you should calculate 1/2 square foot (6" x 6") of solar collector surface for every gallon of water you need per day. If you want to make a more conservative estimate (if you can afford the extra collector space, or if you live in a less sunny area) calculate 3/4 square foot of solar collector for every gallon of hot water per day that you will need.⁸³

For example: a family of 4 will often need 80-100 gallons of hot water per day. To be conservative in our estimate we would find that the family needs 75 square feet of solar collector on their roof. (100 x 3/4 = 75).⁸⁴



Remember, if you are a do-it-yourselfer and you build your own solar water heater, it might work well but you can't take advantage of the tax rebates. Remember that if you do anything to your plumbing or electrical systems you must have the work done by a licensed contractor (see building permits chapter).⁸⁵ If you plan to install your own system and have a licensed plumber and electrician do the final hook up be sure they are solar specialty contractors and be sure to purchase a qualifying solar water heater (see www.energystar.com for a list of qualifying solar water products).

⁸³ Walter T. Grondzik, and Alisson G. Kwok, and John S. Reynolds, and Benjamin Stein, *Mechanical and Electrical Equipment for Buildings*

(Hoboken, New Jersey: John Wiley & Sons, Inc., 2006), pg 933-939

⁸⁴ (no author), *Have Some Energy On The House, Solar: Questions and Answers on Solar Water Heating* (Honolulu, Hawaii: Department of Business, Economic Development & Tourism, 2003), pg 15 <http://hawaii.gov/dbedt/info/energy/publications/HaveEnergyOnHouse03.pdf> (accessed 10-13-09).

⁸⁵ Ibid, pg 26

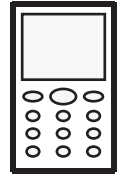


To check that a contractor is properly licensed call the Consumer Resource Center of the DCCA at 587-3222 or 587-3295. You can also call the State Department of Commerce and Consumer Affairs (DCCA): 587- 3222 or 587-3295.

It is also important to consider any warranty you may have on your roof before having a solar water heater installed. The Federal Trade Commission has good publications on warranty information: 1-877-382-4357; or www.ftc.gov.⁸⁶

⁸⁶ (no author), *Have Some Energy On The House, Solar: Questions and Answers on Solar Water Heating* (Honolulu, Hawaii: Department of Business, Economic Development & Tourism, 2003), pg 24 <http://hawaii.gov/dbedt/info/energy/publications/HaveEnergyOnHouse03.pdf> (accessed 10-13-09).

Water Heater | Contacts



Home Improvement Stores:

The Home Depot	808 521-7355
City Mill	808 533-3811
True Value	808 949-7936
Sears	808 247-8211

Tax Credits:

Department of Taxation	808 587-4242.
Neighbor Islanders	1-800-222-3229

Solar Contacts:

Hawaii Solar Energy Association	808 521-9085
Hawaiian Electric Company (Oahu):	808 947-6937
HECO (island of Hawaii):	808 969-0127
Kauai Island Utility Cooperative:	808 246-8284
(Maui, Molokai and Lanai):	1-888-632-6786

Is the installer is properly licensed?:

Consumer Resource Center 587-3222 or 587-3295.⁸⁷

FTC warranty info: 1-877-382-4357; or go online to www.ftc.gov).

“State law provides consumers with an implied warranty. An implied warranty means that the product you buy will do what it is designed to do. That is, a solar water heating system, for example, must be able to provide hot water through the use of solar energy.”⁸⁸ “The State Department of Commerce and Consumer Affairs (DCCA) licenses and regulates contractors. It will also investigate complaints against licensed contractors. If a contractor is licensed, it means he has met the State’s professional and financial requirements. You, the consumer, are ensured of legal recourse if the contractor’s work proves unsatisfactory. If the installer is not licensed, your contract with the installed may be voided. If you wish to verify a contractor’s license number, or if you want to know if complaints have been lodged against a specific contractor, check with DCCA.”⁸⁹

⁸⁷ (no author), *Have Some Energy On The House, Solar: Questions and Answers on Solar Water Heating* (Honolulu, Hawaii: Department of Business, Economic Development & Tourism, 2003), pg 19 <http://hawaii.gov/dbedt/info/energy/publications/HaveEnergyOnHouse03.pdf> (accessed 10-13-09).

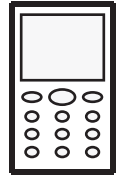
⁸⁸ Ibid, pg 24

⁸⁹ Ibid, pg 26

Water Heater | Contacts

DCCA

808 587- 3222



State Offices:

Department of Commerce and
Consumer Affairs

808 587-3222

Consumer Resource Center-
www.state.hi.us/dcca

808 587-1234

Better Business Bureau

808 536-6956



Kelvin - This is the color temperature of the light emitted by a bulb. Often shown on packaging as K. Most people tend to be comfortable with a color in the range of 2,300 - 3,000 K.⁹⁰ The Kelvin color temperature value is derived from the temperature required to make a heated body emit a given color.⁹¹ There is not a relationship between the operating temperature of a bulb and the color temperature you see on today's light bulbs.

Correlated Color Temperature (CCT) - This is an alternate to the Kelvin color temperature chart. The Kelvin color temperatures were originally intended for light sources that gave off heat. The CCT color chart was used for bulbs that did not give off much heat (LEDs and Fluorescents) as a way to compare their color to incandescent light bulb light.⁹²

Lumen - This is a measure of photometric power. In simple terms this is a measure of how bright a bulb is. 900 Lumens is brighter than 500 lumens. Typical light bulbs will produce something between 500-900 lumens⁹³

Watt - This is the unit of electric power. The higher the wattage of a bulb the more electricity it uses to emit light.⁹⁴ Efficient light bulbs can produce 500 or more lumens with less than 20 watts of electricity.⁹⁵ A higher number for watts indicates a higher energy draw.

90 (no author), *A Compact Fluorescent Truth*, New Energy Choices.org, <http://www.newenergychoices.org/uploads/CFL%20article.pdf> (accessed 2-27-2011).

91 Walter T. Grondzik, and Alisson G. Kwok, and John S. Reynolds, and Benjamin Stein, *Mechanical and Electrical Equipment for Buildings* (Hoboken, New Jersey: John Wiley & Sons, Inc., 2006), pg 506

92 Ibid

93 Ibid, pg 463

94 Ibid, pg 1154

95 (no author), *Hawaii Homeowner's Guide to Energy, Comfort & Value* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2002), pg 7

BACKGROUND INFO

Energy use for lighting has increased dramatically in the last few years primarily due to the gradual increase in home sizes throughout Hawaii. This is a great incentive to reduce the amount of money you spend to properly light your home⁹⁶ This Chapter focuses on typical light bulbs that most homeowners will be able to use in their homes. Most people are familiar with the traditional incandescent light bulb and it is still widely used in single family homes throughout Hawaii. “Incandescent lights, which include halogen lights, are NOT energy efficient, but are the most familiar type of light bulb used in almost all homes and are most commonly found in retail stores around the island. The reason this type of lighting is inefficient is because only 10% of the electricity is actually used to produce light, the remaining 90% produces heat.”⁹⁷ There has been a growing awareness of other light bulb types and it is worth understanding the pros and cons of the light bulbs available to you.

Recently there has been a growing awareness of compact fluorescent light bulbs or CFLs and LEDs or Light Emitting Diode light bulbs. These two light bulb types have developed a lot in recent years and there has been a great deal of progress made in the quality of these two lighting technologies. Fluorescent lighting has long had the stigma of being cold and unpleasant when compared with traditional incandescent light. LED lighting has suffered from a similar criticism and LED lights manufacturers have long struggled to make LEDs that create consistent pleasant white light. Both of these light types have also had issues with the ability of the bulbs to work properly with dimmer switches. In recent years the quality of the available CFL and LED products has vastly improved and there are now highly efficient pleasant colored and dimmable CFL and LED bulbs readily available.

LEDs and CFLs still cost more per bulb than incandescents but the price is coming down all the time and generally these products will pay for themselves within a year of use when compared to incandescent bulbs. It should also be noted that CFLs and LEDs last 10 to 20 times longer than incandescent bulbs. This means they are well suited for hard to reach lighting fixtures. Another plus is that CFLs and LEDs do not emit as much heat as incandescent bulbs.⁹⁸ This could potentially mean less money would be required to cool a room light by LEDs or CFLs. It is important to pay attention to Energy Star labels on light bulb products. There

⁹⁶ Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*

(Honolulu, Hawaii: no publisher, no date), pg 36

⁹⁷ Ibid, pg 37

⁹⁸ (no author), *Hawaii Homeowner's Guide to Energy, Comfort & Value* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2002), pg 7

<http://hawaii.gov/dbedt/info/energy/publications/hhog.pdf> (accessed 4-12-2009).

Lights

are still plenty of cheaper lower quality LEDs and CFLs out there that are unlikely to perform satisfactorily. If you want to be sure that the product you are purchasing will run effectively and efficiently look for the Blue Energy Star label. This label means that the product has met the government requirements for efficiency and lighting quality product longevity as well as many other criteria. To get a better idea of how light bulbs are awarded the Energy Star label go the web site at www.energystar.gov.

“Compact fluorescent lamps (CFLs) are energy efficient. Compact fluorescents typically use 66% less energy than standard incandescent light bulbs and can last as long as three to four times longer. This makes them perfect for areas that are hard to reach or for light fixtures used most often. They’re also great for those lights you want to run for hours at a time for safety while you’re away. Save money with lower electricity costs and less frequent bulb replacements. Changing just one 100-watt bulb to a CFL equivalent, based on three hours of use per day, can save 81 kWh and \$24* per year.”⁹⁹

LEDs that qualify for the Energy Star rating use at least 75% less energy than incandescent light bulbs. They last a minimum of 25,000 hours which is about 22 years of average use. They must be guaranteed by a three year (or more) warranty and many of them are dimmable. Like CFLs LEDs emit very little heat and have the potential to reduce air conditioning costs.¹⁰⁰

“Energy Star qualified CFLs use about 75 percent less energy than standard incandescent bulbs, last up to 10 times longer, and produce about 75 percent less heat, so they’re safer to operate and can cut energy costs associated with home cooling.”¹⁰¹

There is mercury used in CFL bulbs but it is not currently considered to be a safety problem because the amount of mercury in a compact fluorescent light bulb is typically about 5 milligrams or less.¹⁰² This is about the size of the ball on a ball point pen. You are not exposed to the mercury while the bulb is operating or while the bulb is intact. Only when the bulb is broken is there a chance of exposure and a small amount of exposure at that.

99 Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home* (Honolulu, Hawaii: no publisher, no date), pg 37

100 Ibid

101 Ibid, pg 38

102 Ibid, pg 33

Lights

LEDs have been efficient and long lasting as indicator lights in electronics for years, but using LEDs to create stable white light for general lighting presents new challenges. Recently there have been large improvements in LED design.

To qualify for the ENERGY STAR rating, LED lighting products must pass several tests. Energy star qualifying LEDs must have a brightness that is equal to, or greater than incandescent or fluorescent lights and the light that LEDs produce must be evenly distributed. LED light output also has to remain constant over time. LED color quality must remain high and the shade of light an LED produces must remain consistent over time. The efficiency of an LED must be as good or better than fluorescent lighting. The LED light must come on instantly when its turned on. There should be no flicker when the LED is dimmed and there should be no off-state power draw (which means the fixture does not use power when it is turned off). There are many low quality LED products out there. To insure that you get the most for your money choose ENERGY STAR qualified LED fixtures.¹⁰³



If you are at a store trying to figure out which bulbs are most efficient, look at the lumens and the watts ratings. Watts indicates the amount of electricity used to power the bulb. Lumens indicates the brightness or amount of light emitted from the bulb. If you divide the lumens number by the watt number you will get an idea of how many lumens (amount of brightness) you get for each watt. This tells you how efficient the bulb is.¹⁰⁴ For example a 60 watt incandescent bulb that produces 800 Lumens gets about 13.333 Lumens per watt. A 14 watt CFL that produces 800 Lumens gets about 57.142 Lumens per watt. In this case the CFL is much more efficient.

¹⁰³ (no author), Energy Star, "Why Choose ENERGY STAR Qualified LED Lighting?," (accessed 2-26-2-11).

http://www.energystar.gov/index.cfm?c=ssl.pr_why_es_res

¹⁰⁴ (no author), *Hawaii Homeowner's Guide to Energy, Comfort & Value* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2002), pg 7

<http://hawaii.gov/dbedt/info/energy/publications/hhog.pdf> (accessed 4-12-2009).

Lights



If you are trying to figure out how to replace an incandescent bulb with a CFL or LED simply divide the watts of the bulb you are replacing by four and buy the nearest wattage CFL or LED.¹⁰⁵ For example if you had a 60 watt incandescent that burned out you could replace it with a CFL or LED rated at approximately 15 watts.







One simple and inexpensive retrofit idea to consider is that white colored ceilings and walls increase light levels even if you don't change your light bulbs¹⁰⁶ If you have dark walls or ceilings a new paint job with a lighter color might make a big difference.

¹⁰⁵ Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*

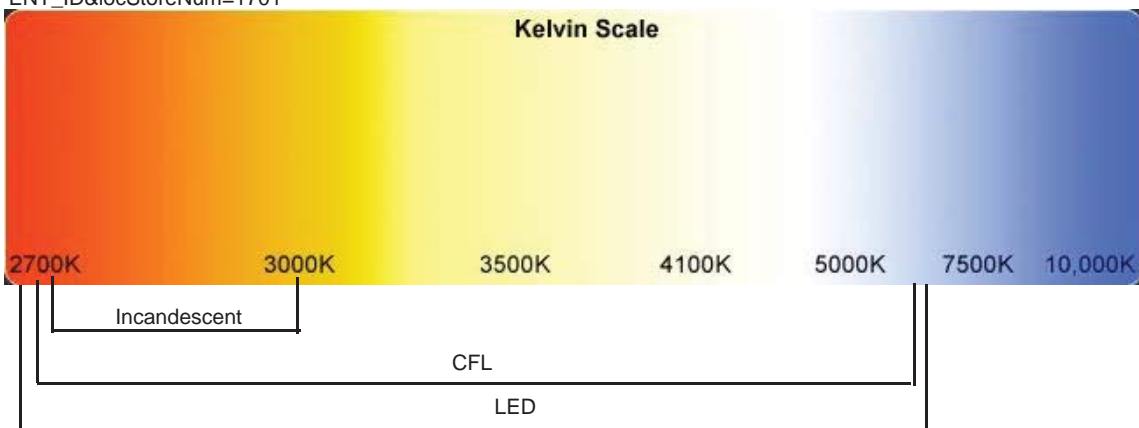
(Honolulu, Hawaii: no publisher, no date), pg 38

¹⁰⁶ (no author), *Hawaii Homeowner's Guide to Energy, Comfort & Value* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2002), pg 8
<http://hawaii.gov/dbedt/info/energy/publications/hhog.pdf> (accessed 4-12-2009).

Lights

Light Bulb Comparison						
						
FEATURES	Incandescent	Fluorescent	CFL	HID	LED	Halogen
Rated Avg. Life	750-1000	20,000	10,000	20,000	45,000	3,000
Life Span	Low	Long	Long	Long	Very Long	Medium
Watts	3 – 500	4 – 215	3 – 120	35 – 1500	2.5 – 16	5 – 500
Cost to Operate	High	Low	Low	Lowest	Low	Medium
Price of Product	Low	Medium	Medium	High	High	Medium
Lumens per Watt (LPW)	15	60 – 100	60	Up to 120	45	25
Color Temperature (in Kelvin)	2700K	3000K – 6500K	2700K – 6500K	1700K – 6500K	2700K – 6500K	3000K

http://www.homedepot.com/webapp/wcs/stores/servlet/Navigation?storeId=10051&categoryId=542154&langId=-1&catalogId=10053&navFlow=3&searchRedirect=light%20bulbs&cm_sp=searchredirect-_Light_Bulbs-_x-_x&Nu=P_PARENT_ID&locStoreNum=1701



Example of the color range of incandescents, CFLs and LEDs. Notice that LEDs and CFLs are now capable of the warmer light colors in the same range as incandescent light bulbs. However, there are many LEDs and CFLs that are rated at much cooler “harsher” colors so be careful to look at the color temperature listed on the bulbs package.

<http://www.tunerdomes.com/images/kelvin00.jpg>

Lights| Bulb Types

Below are some locally available light bulb types. Included with each bulb is a description of its possible area of use (indoor/outdoor), its lifespan in hours, its color temperature (see chart in introduction), its brightness (lumens), its wattage, warranty info and price.



Example of LED indoor/outdoor bulb. This one has a 5 year warranty and is dimmable. Its about \$45 at The Home Depot. It produces 725 lumens at 15 watts which is highly efficient. Color temperature is 3,000 K. Lifespan is 50,000 hours.



Example of LED indoor bulb. This one has a 5 year warranty and is dimmable. Its about \$19 at The Home Depot. It produces 429 lumens at 8.6 watts which is highly efficient. Color temperature is 3,032 K. Lifespan is 50,000 hours



Example of CFL indoor/outdoor bulb. This one has a 7 year warranty and is not dimmable. It's about \$5 for two at The Home Depot. It produces 800 lumens at 14 watts which is highly efficient. Color temperature is 2,700 K. Lifespan is 8,000 hours.



This is the Energy Star label. This certifies that a product has met high standards for efficiency and quality.
<http://www.energystar.gov>



Example of CFL indoor bulb. This one has a 9 year warranty and is not dimmable. Its about \$18 for a 12 pack at The Home Depot. It produces 550 lumens at 9 watts which is highly efficient. Color temperature is 2,700 K. Lifespan is 10,000 hours.

All product data is from manufacturer specifications

(no author), The Home Depot, "Light Bulbs,"

http://www.homedepot.com/webapp/wcs/stores/servlet/Navigation?storeId=10051&categoryID=542154&langId=-1&catalogId=10053&navFlow=3&searchRedirect=light%20bulbs&cm_sp=searchredirect-_Light_Bulbs_-_x_-_x&Nu=P_PAR-ENT_ID&locStoreNum=1701
 (accessed 3-21-2011).

Lights| Controls

There are certain parts of the home that will benefit from specialized lighting controls. Some of the basic control types include: motion sensors, occupancy sensors, timers and photo-sensors.

Occupancy sensors can detect sound (ultrasonic) or body heat (infrared) depending on the type of sensor. These specialized controls can allow you to turn off lights and fans when the sensor determines that a room has been empty for a given time period (for example 10 minutes). It is important that these sensors are placed according to product directions to allow the sensors to detect people within a space.¹⁰⁷ Motion sensors work in much the same way as occupancy sensors, turning on lights if motion is detected. Many new models of electrical controls allow multiple options when it comes to sensitivity and duration. This allows you to use these flexibly in different locations. Most of these products also have manual override switches.



To get the most efficiency out of your controls the best locations for switches that sense occupants are in low foot traffic areas like bathrooms, garage, laundry rooms and attic spaces. Depending on your habits it might also be useful over the kitchen sink.¹⁰⁸ You want to avoid using these types of controls in places like hallways that get constant foot traffic. If you are using CFL or Fluorescent light bulbs you may shorten their life span by constantly turning them on and off.

It is important to choose a high enough amperage rating of dimmer switches that will be used on larger light fixtures with multiple bulbs. You should also be careful about using dimmer switches on fans as using the wrong switch can burn out a fan motor. Read product information carefully before buying.

Most of these control switches are simple to install for a moderately experienced do-it-yourselfer. **If for any reason you feel uncomfortable about this procedure stop and hire an electrician!** You first make sure that you have turned off the electrical breaker for the switch you are working on. Then you can unscrew the existing switch and pull it a little ways from the wall exposing the “hot” (black wire) “neutral” (white wire) and ground (green or exposed copper wire). You can generally replace a common light switch by simply connecting the black white and ground wire to the appropriate connection point on the switch. These will be labeled on the product you buy.

¹⁰⁷ (no author), U.S. Department of Energy, “Energy Savers-Lighting Controls”, http://www.energysavers.gov/your_home/lighting_daylighting/index.cfm/mytopic=12180 (accessed 3-29-2011).

¹⁰⁸ Taryn Fiol, Unplggd, “Do Motion-sensor Lights Save Energy and Money?”, October 5, 2009 <http://www.unplggd.com/unplggd/bloggging/do-motionsensor-lights-save-energey-and-money-097641> (accessed 3-29-2011).

Lights | Controls



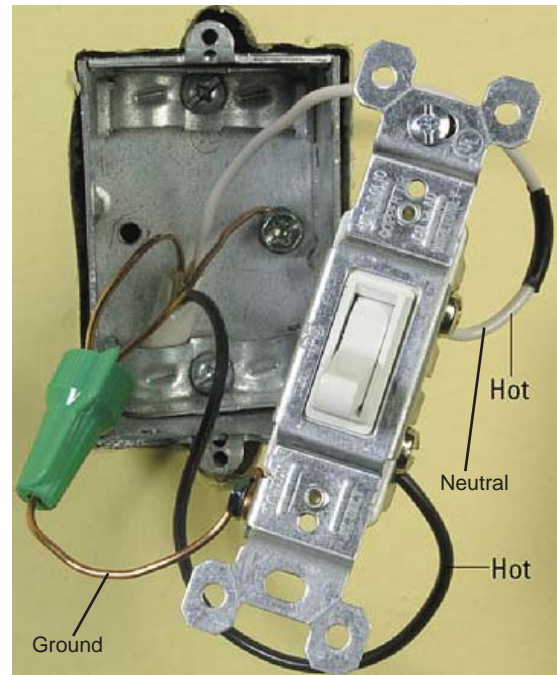
Motion detector type-occupancy sensor \$50 at The Home Depot
http://www.homedepot.com/Electrical-Dimmers-Switches-Motion-Sensors/h_d1/N-5yc1vZbojf/R-100671798/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



Dimmer/motion sensor \$35 at The Home Depot
http://www.homedepot.com/Electrical-Dimmers-Switches-Motion-Sensors/h_d1/N-5yc1vZbojf/R-202065253/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



Digital Timer about \$25 at The Home Depot
http://www.homedepot.com/Electrical-Home-Automation-Security-Home-Automation-Dimmers-Lighting-Controls/h_d1/N-5yc1vZbmir/R-100685863/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



Wiring a common light switch
http://images.meredith.com/diy/images/2009/03/p_SCW_090_03a.jpg



Photovoltaic Panels

<http://www.solarpowerninja.com/wp-content/uploads/2009/01/solar-panels.jpg>

Photovoltaic panel usage in Hawaii has gone up dramatically in recent years. This is partly due to the gradual decrease in the price of installing a system and the gradual increase in the efficiency of installing a photovoltaic-pv system. There has also been an increase in the number of companies that install and maintain pv systems in Hawaii. One final important factor is that Hawaiian electric company now allows for “net metering” to take place.

If you look on the HECO web site you will find a detailed explanation of net metering. “According to Hawaii state law (Hawaii Revised Statutes (HRS) Section 269-101 - 269-111), all residential and commercial utility customers who own and operate an eligible renewable energy generation system up to a generating capacity of 100 kW and intend to connect to utility grid, must register their systems with their utility by executing a NEM agreement. The executed agreement allows the NEM customer to connect their renewable generator to the utility grid, allowing it to export surplus electricity into the grid, and to receive credits at full retail value which can be used to offset electricity purchases over a 12-month period.¹⁰⁹”

“NEM customers are billed for net energy purchased, which is determined by subtracting the excess energy exported to the utility grid from the total energy supplied by the utility. Here is the formula:

$$\text{Energy Supplied by the utility (kWh)} - \text{Excess Energy exported to the utility (kWh)} \\ = \text{Net Energy Billed to the Customer (kWh)}^{110}$$

¹⁰⁹ (no author), Hawaiian Electric Company, “Net Energy Metering In Hawaii,” <http://www.heco.com/portal/site/heco/menuitem.8e4610c1e23714340b4c0610c510b1ca/?vgnextoid=db7bf2b154da9010VgnVCM10000053011bacRCD&vgnnextfmt=default> (accessed 3-22-2011).

¹¹⁰ Ibid

Lights| Photovoltaic

For more detailed information about PV requirements visit the HECO website:
www.heco.com

In order to install a PV panel system on your home you must obtain a building permit (see building permit chapter) from the Honolulu department of planning and permitting. You must also have the wiring installed by a licensed electrician.

There are two common ways to set up a PV system. You can set up your PV system so that when it generates electricity the electricity is stored in batteries to be used when the sun is no longer out. You can also set up your system to use electricity when you are producing it from the sun, and when you are not using electricity your PV panels are feeding electricity back into HECO's grid (net metering). When you are net metering you get paid the same amount of money for the electricity you put into the grid as you pay for the electricity you take out of the grid.

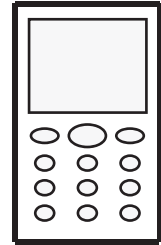
It is possible to be an owner builder and install a PV system on your own, get a permit and have licensed professionals sign off on your work. While a very experienced do-it-yourselfer could save a lot of money on the installation of a PV system by doing it themselves, there is a high technical learning curve for this kind of project and as well as a fairly involved process of getting permits. The number of companies that specialize in net metering in Hawaii has increased dramatically and they are getting more and more sophisticated. For this and other reasons, most people will find that hiring a contractor is the best route for having a PV system installed.

You can go to the web site of a company like: Sun Energy Solutions, Bonterra, or Sunetric Hawaii and you will find information on financing, expected payback times, sizing estimation programs and State and Federal rebates. These companies have streamlined the process for anyone interested in PV systems. Most of these companies also have open houses on the weekends so you can go visit a home that actually has a system installed on it.

Lights | Contacts

Home Improvement Stores:

The Home Depot	808 521-7355
City Mill	808 533-3811
True Value	808 949-7936
Sears	808 247-8211



Photovoltaic Contacts:

Sunitric www.sunetric.com	808 262-6600
Bonterra www.bonterrasolar.com	808 548-7657
Sun Energy Solutions www.sunenergyhi.com	808 587-8312



Radiant Barrier - Radiant barriers come in a variety of forms. In general a radiant barrier is any product which blocks a significant amount of radiant heat from entering your home. This reflective ability is measured in emissivity or reflectivity. The most effective radiant barriers will have a low emissivity, example: .01 and a high reflectivity example: 97%.

VOC - (volatile organic compounds) In short this is what you smell after you use certain paints or install certain kinds of carpet. A low VOC product is intended to be safer to the people applying the product and safer for the inhabitants of the space after the application. Using a low VOC product is also considered more environmentally friendly.

Emissivity - In this book emissivity is used to measure the effectiveness of radiant barriers to block the sun's radiation. A radiant barrier with a low emissivity is desirable.

Reflectivity - In this book reflectivity is used to measure the effectiveness of radiant barriers to reflect the sun's radiation. A radiant barrier with a high reflectivity is desirable.

R - Value - R - values in this book are associated with various forms of insulation and their ability to slow the transfer of conductive heat (heat transferred by direct contact). A higher R-value means that the insulation is better at stopping the transfer of conductive heat. The R-values of insulation are also higher when the insulation is thicker. R-values are also an indication of the amount of air space trapped within an insulating product. R-values are also the reciprocal of U-Factors which tend to be specific to windows.

Kerf- a notch or slot generally created by cutting a material with a saw blade or router. Often Kerfs can be decorative, but many of them are functional and are deliberately cut to a size that will allow some other building element to fit into the kerf slot. In this chapter kerfs are discussed with regard to weather stripping. There are various shapes of extruded vinyl weather stripping pre-made to fit into kerfs. It is important to consider not only the width of the kerf, but also the depth when choosing extruded vinyl weather stripping.

BACKGROUND INFO

This chapter focuses on reducing the heat that gets into your home through the roof. The basic methods to reduce heat gain through the roof are: adding insulation, adding radiant barriers, applying reflective coatings, sealing up air infiltration and venting the attic space. If your house is already shaded by a large tree or building then you will want to factor that into your decision of whether or not to use the methods in this chapter.¹¹¹

Heat can be transferred in three ways. Conduction, convection and radiation. Conduction is heat that transfers through direct contact. Convection is heat that transfers through a carrier fluid such as air or water. Radiation needs neither direct contact, nor a carrier fluid and travels as visible and invisible light. In Hawaii the air temperature tends to be quite mild and therefore we don't have to worry much about heat that is transferred by convection. However, we do have to worry about radiant heat from the sun, and conductive heat from things the sun has heated up. To a lesser extent appliances and human bodies in your home produce heat.

According to the *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes*: "The roof is the greatest source of heat gain for homes in Hawaii, receiving about 1,700 BTU per sq.ft. per day. Solar radiation coming through the roof can account for a third of the heat build-up in a house. A roof can reach temperatures of 150 F, even when the ambient outdoor temperature is only 80 F." The best way to reduce heat gain in your home is to focus on reducing the heat gain through the roof. There are a number of ways to do this.¹¹²



Using the methods in this chapter will reduce the amount of heat that reaches the inhabitants of the home. If your home has air conditioned spaces, using these methods will allow the air conditioner to use less energy to cool those spaces. If your house is naturally ventilated you will not save money on your electric bill, but you will increase the comfort of your home by lowering the inside temperature.

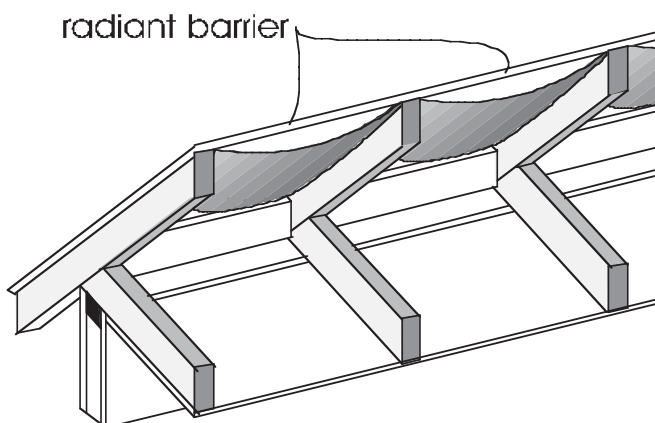
¹¹¹ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 31

¹¹² Ibid

Roof

You will also potentially increase the value of your home to anyone who might want to buy your home down the road. If you are currently using air conditioning, these methods, in combination with other methods in this book, can help you reduce the number of spaces you need to air condition, or possibly allow you to naturally ventilate your home.

Roof | Radiant Barrier



Roof diagram showing radiant barrier location
<http://hawaii.gov/dbedt/info/energy/publications/roofinsulation.pdf> (accessed 11-20-09)



Radiant Barrier \$15 at The Home Depot

http://www.homedepot.com/h_d1/N-5yc1vZ1xk1/R-100020855/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053 (accessed 10-30-09)

There are many radiant barrier products available at hardware stores and building supply stores throughout Hawaii. One example (image above right) is Reflectix. Like many other radiant barrier products Reflectix comes in rolls of varying lengths and widths. Typical widths are 16 and 18 inches because radiant barriers are commonly installed between studs and rafters. Some products come in 4 foot rolls and these are often intended for installation before the roof deck is built. Reflectix like many other radiant barriers has folding tabs that allow you to staple it between rafters (image above left). In retrofits radiant barriers are typically cut to the correct length and stapled onto decking or between framing members. You can buy this kind of radiant barrier (18" x 25') for around \$15.00 per roll at local hardware stores.¹¹³

There are some important product specifications to look out for when purchasing radiant barriers. The two main things you should look for are the **Emissivity** and the **Reflectivity**. Not all products will list both of these values. If you don't see an Emissivity or Reflectivity value then you might not be looking at a radiant barrier! The Reflectix brand of radiant barrier has a reflectivity value of 97%. A high reflective value above the 90% range is important to look for when you choose a product. Conversely, a good emissivity value will be around 0.1 or less. As always, remember that to be effective **the shiny face of the radiant barrier must face an air space** of at least 3/4 of an inch.¹¹⁴

¹¹³ (no author), "Reflectix 24 In. x 25 Ft. Staple Tab Insulation," The Home Depot, http://www.homedepot.com/h_d1/N-5yc1vZ1xk1/R-100020855/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053 (accessed 9-26-09).

¹¹⁴ (no author), *Ceiling Insulation for Your Home* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, no date), <http://hawaii.gov/dbedt/info/energy/publications/roofinsulation.pdf> (accessed 11-29-09).

Roof | Radiant Barrier

There are other product qualities to look for when you search for a radiant barrier. Many products will tell you if they contain any formaldehyde or carcinogens and if they are energy star compliant. Many also list how resistant they are to pests, moisture and fire. You will not typically see R-values associated with radiant barriers. This is because radiant barriers have traditionally not been intended to stop the flow of conductive heat, only radiant heat. However, there are some radiant barrier products which contain air bubbles or other insulating materials that can give the product an R-value. Radiant barrier products that contain R-values are sometimes labeled as **Reflective Insulation** products. A reflective insulation product is basically two layers of radiant barrier that sandwich some kind of insulating material. The shiny surfaces of this material should still face some kind of air space to be effective¹¹⁵



E-Barrier being painted onto attic surfaces

<http://www.sherwin-williams.com/pdf/products/ebarrier.pdf> (accessed 9-29-09)

Some radiant barriers can be painted on. The name used by Reflective Insulation Manufacturers Association to describe these products is: Interior Radiation Control Coatings. These paint on products effectively reduce the emissivity of the material they are applied to. As long as the painted side has an air space, the painted material will act as a radiant barrier. The Reflective Insulation Manufacturers Association defines Interior Radiation Control Coatings as having the ability to reduce the emissivity of a non porous building material by 0.24 or lower.¹¹⁶

E-Barrier (images above) is one kind of paint-on radiant barrier product produced by Sherwin-Williams. Paint-on radiant barriers are good because they can be applied to irregular surfaces. You don't have to worry about measuring and cutting pieces and stapling them into place. The paint on radiant barrier is also good because it will not trap moisture the way other radiant barriers might and it claims to be a fully breathable paint. E-Barrier can be applied with paint rollers in the same way you apply regular latex paint.¹¹⁷

¹¹⁵ Reflective Insulation Manufacturers Association, *Understanding and Using Reflective Insulation: Radiant Barriers and Radiation Control Coatings*

(Phoenix, Arizona: RIMA, 2002), pg 10

<http://www.reflectixinc.com/images/uploads/allpdfs/t18%20rima%20booklet.pdf> (accessed 11-28-09).

¹¹⁶ Ibid, pg 14

¹¹⁷ (no author), Sherman-Williams, *E-Barrier*, pg 2-3

<http://www.sherwin-williams.com/pdf/products/ebarrier.pdf> (accessed 9-25-09).

Roof | Radiant Barrier

No primer is required and one coat should be sufficient. If there are any leaks in your roof they will be easier to spot than if you had a typical type of radiant barrier. This product happens to be latex based which means that any mistakes you make can be cleaned up with water rather than paint thinner. Despite all of these advantages, E-Barrier has its shortcomings and they are important to consider. The emissivity value of the E-Barrier is about 20% less than what you might expect from a typical roll form radiant barrier like the one shown earlier in the chapter. This means that it will not be quite as effective as more traditional radiant barriers. If you live in a particularly sunny part of the island, or if you have a dark colored roof you might want to stick with a more traditional radiant barrier like the one mentioned earlier in this chapter.¹¹⁸



When dealing with radiant barriers remember:

If it has no labeled emissive or reflective value it may not be a radiant barrier. The shiny side must face an air space (minimum 3/4 inch). As a general rule of thumb, less shiny = less effective.



Remember that radiant barriers will only save you money if you are currently air conditioning your home. Radiant barriers can make your home more comfortable to live in by reducing heat gain even if you don't use AC. However, if you don't use AC and you want to save money on maintaining your home then this method may not be your first priority.


¹¹⁸ (no author), Sherman-Williams, *E-Barrier*, pg 2-3
<http://www.sherwin-williams.com/pdf/products/ebARRIER.pdf> (accessed 9-25-09).

Roof | Reflective Coatings

Reflective coatings are an ideal retrofit method for both reducing heat gain and patching leaks. There are several locally available reflective coating products and they have pros and cons that should be considered. Most of these products can be purchased by do-it-yourselfers or installed by contractors.

Hawaiian SunGuard is a locally available roof coating that can be applied to a variety of roof types including metal standing seam, asphalt shingle and even plywood. This product comes in 5 gallon buckets and requires a primer coat and two finish coats. The SunGuard Primer is about \$160 for 5 gallons and the SunGuard finished coating costs about \$165 for 5 gallons. The coverage ability of this product averages about 300 square feet per gallon. Hawaiian SunGuard can be applied to any flat roof and most sloped surfaces; including asphalt shingle, aluminum shingle and even plywood.

The Hawaiian SunGuard is a good product for increasing the lifespan of your roof, reducing and patching leaks and reducing heat gain through the roof. The product does not have to be white and can be tinted to custom colors, however, lighter colors reflect heat better. One of the important factors that helps this product work so well are the suspended ceramic particles within the paint. The product can reduce roof temperatures by more than 60 degrees in the heat of the day and reduce ceiling temperatures by more than 16 degrees!

	Brown Shingle Roof	Hawaiian SunGuard	Difference
Roof Temp	150.2°	88.8°	61.4°
Ceiling Temp	99.1°	82.2°	16.9°



Hawaiian SunGuard Installed

SunGuard Temp

Brown Shingle Roof

Hawaiian SunGuard reflective properties

<http://www.hawaiiansunguard.com/projects.php>

Before applying Hawaiian SunGuard you have to clean off the roof surface. This can be done with a push broom. However, if you have a lot of mold etc on your roof you may want to use a pressure washer to blast off any mold or loose debris on your roof. Once the roof has dried and you are sure it will not rain soon you can apply the primer to the roof using a paint roller. Once the primer has dried

Roof | Reflective Coatings

for 2 hours you can coat over this with the regular Hawaiian SunGuard Coating. It will usually take two to three coatings of Hawaiian SunGuard to build up enough thickness. For more detailed instructions visit <http://www.hawaiiansunguard.com/installation.php> or call Hawaiian SunGuard: 591-1900.

Leakmaster is one local contractor that applies Hawaiian SunGuard to residential roofs (see contacts at the end of the chapter).

Applying Hawaiian SunGuard is a good method to use if you want to reduce the amount of money you pay for air conditioning. The amount of heat that gets into the living spaces of your home will be reduced and this means your air conditioner will not have to work as hard to cool living spaces. Using this and other methods in this book you might potentially be able to reduce or eliminate your need to air condition which would save you money further. If you don't have air conditioning then you will not see any savings by using this method. However, you will find that the interior temperature of your home is cooler and more comfortable.

Below are coverage rates for Hawaiian SunGuard. This will give you an idea of what it would cost to do your roof. On the following page are some Hawaiian SunGuard products and Prices.



	FABRIC	PRIMER	ROOF REPAIR PUTTY	COATING
Reflectivity Coat	as needed	300 sq. ft. / gal	as needed	2-3 gallons / 100 sq. ft.
Metal Roofs	over joints	500 sq. ft. / gal	seams & screws	3 gallons / 100 sq. ft.
Asphalt / Composition Shingles	optional	300 sq. ft. / gal	as needed	4-5 gallons / 100 sq. ft.
Flat Roofs	full-fabric	300 sq. ft. / gal	as needed	4-5 gallons / 100 sq. ft.
Pitch and Gravel (tar)	full-fabric	300 sq. ft. / gal	as needed	5 gallons / 100 sq. ft. (after scraping smooth)

<http://www.hawaiiansunguard.com/products.php>

Roof | Reflective Coatings



Hawaiian SunGuard CoolFab: High-tensile reinforcing fabric that can be embedded in the foundation coat of Hawaiian SunGuard to create a fully-adhered waterproof membrane.

[Download MSDS](#)

[\\$32.03 \(4" x 300 ft.\)](#)
[\\$47.25 \(6" x 300 ft.\)](#)
[\\$92.58 \(12" x 300 ft.\)](#)
[\\$118.13 \(20" x 300 ft.\)](#)
[\\$195.85 \(40" x 324 ft. = approx. 1000 sq. ft.\)](#)

Walking Deck Fabric Mesh
[\\$19.88 \(4" x 180 ft.\)](#)
[\\$201.75 \(40" x 180 ft.\)](#)



Hawaiian SunGuard Epoxy Primer: A clear, flexible, water-based primer and conditioner that creates an excellent adhesion layer between roof substrate and foundation coat. Available in one or five gallon containers.

[Download MSDS](#)

[\\$35.03 \(1 gallon\)](#)
[\\$159.83 \(5 gallons\)](#)



Hawaiian SunGuard Roof Coating: Ceramic-titanium elastomeric roof coating specially engineered to withstand high-UV attack, heavy wind, rain, and chemical exposure.

[View Color Samples](#)

[Download MSDS](#)

[\\$164.20 \(5 gallons\)](#)

<http://www.hawaiiansunguard.com/products.php>



There are many important things to consider when working on your roof. The first is safety. Working on the roof presents a hazard of falling which could cause severe injury or death. If you are not comfortable with the safety hazards then hire a professional. Roofs get very hot in the day time and proper clothing and foot wear is required. In addition to the hazard of falling there is also a hazard of dehydration as well as the potential to get scraped and cut on the rough roofing materials. Whenever you walk on your roof you run the risk of damaging the roofing materials. Your roof is a very expensive part of your home and it protects all of your other investments inside. If your roof is not worked on properly you can have water leaks that can cause costly damage. The source of a water leak is not always simple to find. Be very careful if you ever have to walk on your

Roof | Reflective Coatings

roof as older roofing shingles become brittle and fragile with age. If you do choose to take on this project on your own choose a nice day to do your work. Keep in mind that if it starts raining you will want a tarp to cover your work should you be unable to finish in one day. When in doubt call a professional to have the work done.

With this in mind, There are many locally available products that are intended to perform as both a water proofing layer and a reflective coating to reduce heat gain. Products Similar to Hawaiian SunGuard are Tropical Roofshield and White lava. Both of these are available in Hawaii and their installation method is very similar to that of Hawaiian SunGuard. For more information on White Lava and Tropical Roofshield call All Weather Surfaces at: (808) 487-3043 or visit: <http://www.allweathersurfaces.com/> to see an instructive do-it yourself video.



Tropical Roofshield \$157 for 5 gallons
<http://www.allweathersurfaces.com/products/tropical-roof-shield>



White Lava \$125 for 5 gallons
<http://www.allweathersurfaces.com/products/white-lava>

Roof | Infiltration

An important consideration before you start any insulation project is to properly seal up any air leaks in your home¹¹⁹. Although this is a chapter on roofs, it is important to discuss air infiltration before insulation, as any project involving insulation must first resolve air infiltration problems.



Remember that air infiltration is a primary concern only if you are air conditioning spaces in your home. Sealing up air leaks can drastically reduce your electric bill. “Lack of draft proofing can account for 10-30% of your total energy expenditure”. A better sealed room will require less energy to keep cool. Reducing air infiltration between the attic space and the living spaces will increase comfort whether you air condition your home or not. However, if you do not air condition any parts of your home this method may not be worth your time and money.

Air infiltration in or out of your home is a large concern particularly if you air condition any part of your home. Statistically the average home has roughly 2 square feet of cumulative air leak space¹²⁰. This cumulative space includes the small gaps surrounding your doors, possible gaps around your window frames and gaps along your walls where they meet the floor and ceiling. Generally it is important to consider the leaks that occur along the skin of the building as this is where air can either leak in or out. However, it is also important to consider the air that can travel between your living spaces and the attic above. Ideally your attic space can act as a buffer from the hot roof above. Sealing up the leaks between the living space and the attic space can mean a real yearly savings in air conditioning costs. Doors, windows and the attic access door are good places to start sealing up air infiltration¹²¹

Different locations will benefit from different sealing methods and products. Doors and windows require the most care and precision because they are opened and closed on a daily basis. Weather stripping comes in many forms and should be carefully chosen to meet the needs of your specific situation. Some doors have larger or smaller gaps and some doors open over smooth hard surfaces while some open over irregular surfaces like carpet. The door sweep, or weather stripping chosen for the bottom of the door will generally be chosen based upon the material the door swings over. Some weather stripping for the bottom of doors is made of a bristle material, some are made of vinyl plastic flaps

119 Leon Glicksman and Juintow Lin, *Sustainable Urban Housing In China: Principles and case studies for low-energy design*

(Springer Dordrecht, The Netherlands, 2006), pg 57

120 Edward Harland, *Eco-Renovation: The Ecological Home Improvement Guide*

(Post Mills, Vermont: Chelsea Green Publishing Co., 1993), pg 49

121 Ibid, pg 52

Roof | Infiltration

while some are made of compressible foam or rubber. Some of these are attached with screws, some have adhesive sticky backs and some have channels that must be first screwed in place and then the weather stripping can be slid in place. Many forms of weather stripping are intended to slide into a kerf in the door or door frame.

A very important consideration is the size of the gap that must be sealed. You want the door to seal tightly but you don't want the seal to make the door difficult to close. As an example, if you stand on the side of the door that you would have to push to open the door and you look at the sides and top of the door you will see a small gap. Measure this gap to determine the thickness of weather stripping you will need. You don't need expensive tools to do this. Simply take a piece of paper and fold it in half several times until the thickness of your folded paper barely squeezes into the gap. Take this folded paper with you to the hardware store and either compare it directly with the available weather stripping, or borrow one of the measuring tapes in the hardware store to measure the thickness of your folded piece of paper. You want to choose weather stripping that is slightly thicker than your gap but not twice as thick.

For example: if your gap turns out to be 1/4" thick then 3/8" thick weather stripping should work well. This way the weather stripping will compress but it will not be so thick that your door is hard to shut.

You also want to make sure that the weather stripping on the bottom of the door is actually making contact with the threshold of the door when the door is closed or it is not functioning as a seal. Exterior doors should have some kind of drip edge to keep potential rain water from leaking onto the inside floor. It is simple enough to seal up most other gaps with an acrylic, latex, polyurethane, or silicone-based sealant. These are relatively cheap and you will find that one tube of this sealant can go a long way. If you are working in an area where you might make a mess or you are concerned about your ability to perform this carefully choose a latex based caulking. These are easily cleaned up with a wet rag while the product is still wet.¹²²

¹²² (no author), *Hawaii Homeowner's Guide to Energy, Comfort & Value*, (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2002), pg 15

Roof | Infiltration



Examples of extruded vinyl weather stripping. One end is intended to fit into a kerf. The other end compresses to create a seal.

http://www.google.com/imgres?imgurl=http://www.re-view.biz/imgWstrip3.jpg&imgrefurl=http://www.re-view.biz/weatherstripping.html&usq=__VZPtaSIUcj1c5wVfCK4e1_Hf49E=&h=267&w=275&sz=9&hl=en&start=12&zoom=1&um=1&itbs=1&tbnid=gjqpSh-R16_iTM:&tbnh=111&tbnw=114&prev=/images%3Fq%3Dweather%2Bstripping%26um%3D1%26hl%3Den%26sa%3DN%26rlz%3D1T4ADFA_enUS347US352%26tbs%3Disch:1&ei=MbxRTZWrHJO4sAOu5pTBBg



Example of installing a vinyl insert type weather stripping into a kerf on the top of a door frame.

http://www.midwestmanufacturing.com/Midwest-Manufacturing/web/img/howto/weatherstrip_system/ht-wssystem-03.jpg



Example of installing self stick adhesive backed weather stripping to the bottom of a window

<http://static.howstuffworks.com/gif/how-to-install-weatherstripping-1.jpg>



Example of installing adhesive backed weather stripping on sides of a door frame

http://www.mbmgreen.com/images/mbm_weatherstripping.jpg

Roof | Infiltration



Diagram of a door sweep in relation to the door and threshold.

<http://www.azubuild.com/images/wthrstrp4.jpg>



Example of a vinyl door sweep/door bottom weather stripping intended to be fastened on the inside with screws. Available at The Home Depot for about \$11

http://www.homedepot.com/Tools-Hardware-Hardware-Fasteners-Weather-Stripping/h_d1/N-5yc1vZard7/R-100081954/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



Example of an aluminum door sweep/door bottom with a rubber insert intended to be fastened on the outside with screws. This is intended for exterior doors as it also has a drip cap. Available at The Home Depot for about \$8

http://www.homedepot.com/webapp/wcs/stores/servlet/ProductDisplay?storeId=10051&productId=100008291&langId=-1&catalogId=10053&MERCH=REC-_product-1-_100081954-_100008291-_N&locStoreNum=1701

Roof | Infiltration



Caulking gun for use with 10oz tubes
about \$2-5 at The Home Depot

http://www.homedepot.com/h_d1/N-5yc1v/R-202036529/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



Example of acrylic latex caulking. A 10 oz tube will allow you to cover 55 linear feet of cracks. Easy to clean mistakes with water and a rag while its wet.

About \$2 at The Home Depot

http://www.homedepot.com/h_d1/N-5yc1v/R-100078928/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



Example of compressible foam weather stripping with a self stick adhesive backing. About \$5 at The Home Depot for a 10' length

http://www.homedepot.com/Tools-Hardware-Hardware-Fasteners-Weather-Stripping/h_d1/N-5yc1vZard7/R-100047977/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053

Roof | Insulation

Insulation is a good way to stop conductive heat. This is the kind of heat that transfers from one object to another by direct contact. However, there are many kinds of heat invading your house. **It is important to remember that hot air rises, but conductive and radiant heat can travel in any direction.** In Hawaii it is important to mitigate conductive heat, and radiant heat which was covered in the radiant barrier section. Insulation and radiant barriers are very effective when used in concert.¹²³

There are many types of insulation that can be used in your home. Typically insulation can be found in three basic forms. Batting, rigid boards and blown-in/loose fill. Batting is typically some form of fiberglass, rigid foam is commonly made of polystyrene and blown-in/loose fill insulation can be made of fiber glass as well as cellulose. These are typical materials but there are many variations.¹²⁴ Each type of insulation has its advantages and disadvantages. Fiberglass batting is usually the cheapest insulation per square foot and is easy for the average home owner to install. Rigid foam insulation can be useful in situations where you want to be able to trim the insulation to a very exact size and in situations where the insulation must maintain a specific dimension. Blown in or loose fill insulation is great for retrofitting spaces that are difficult to access.

The materials that various kinds of insulation are made of can be arranged into three categories. These three categories are: Organic, inorganic and synthetic-organic. Organic insulation can come in the form of lambs wool, cellulose or other natural materials. While these are perhaps the most environmentally friendly, they must be treated to resist fire and insects/vermin. Inorganic products are generally made of some form of glass or rock fiber (silicone or calcium).



It is important to remember that just because a product is made from a natural material does not mean it is healthy for human handling. Asbestos is a naturally occurring substance that was used for years in building insulation but it can cause mesothelioma and other health complications. Synthetic organic insulators are commonly made from feedstock and derived from various polymers¹²⁵.

¹²³ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 34

¹²⁴ Sue Roaf, Manuel Fuentes, Stephanie Thomas, *Ecohouse 2: A Design Guide* (Architectural Press, Burlington MA, 2003), pg 75

¹²⁵ Peter F. Smith, *Architecture In A Climate of Change: A Guide to Sustainable Design* (Architectural Press: Jordan Hill Oxford, 2001), pg 59-60

Roof | Insulation

Because fiberglass batting is generally the cheapest per square foot and the simplest to install it will be the primary type of insulation for this method¹²⁶.

“Insulation slows the transfer of heat from warm to cooler areas. When used in a roof assembly, insulation can substantially reduce heat gain through a roof.” Insulation can be effective when installed either between the roof rafters or between the beams above the ceiling. Later in this chapter there is a basic guide to installing insulation. An minimum R-value of 19 is recommended in typical Hawaii residential roof construction but R-30 would be ideal.”¹²⁷

An R-value is a number given to express the ability a given material has at reducing the flow of conductive heat. The higher the number attached to an R-value the higher its ability to slow heat transfer. Often the R-value is a combination of the material used and the thickness of the material when it is installed. It is important to remember that insulation that has been crushed or squeezed into a small space will not have its advertised R-value. Proper space must be allowed particularly for blown-in and batt type insulation. This is because air space within the insulation is a large part of what the R-value is derived from. Insulation that is wet from a leaky roof will not insulate well and will also lend its self to the growth of mold.

“Heat conducted through the roof heats the ceiling, which in turn radiates to the interior surfaces and occupants. R-19 insulation can reduce ceiling temperatures by more than 15° F. (not including the impact of radiant barriers). People are particularly sensitive to heat from overhead sources, and this reduction in real surface temperatures can make a room feel 9° F cooler.”¹²⁸

In the following pages there are examples of how to install some locally available forms of insulation and important things to consider.

126 Sue Roaf, Manuel Fuentes, Stephanie Thomas, *Ecohouse 2: A Design Guide* (Architectural Press, Burlington MA, 2003), pg 75

127 James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 33

128 Ibid



This method will only save you money if you are currently air conditioning your home. By reducing the amount of heat that reaches the cooled living spaces in your home this method allows you to use less energy to keep your spaces cool. This method will increase the comfort of the living spaces in your home by keeping the living spaces cooler even if you don't use air conditioning, however it will not save you money on your electric bill. Consider this before you invest time and money in this method.

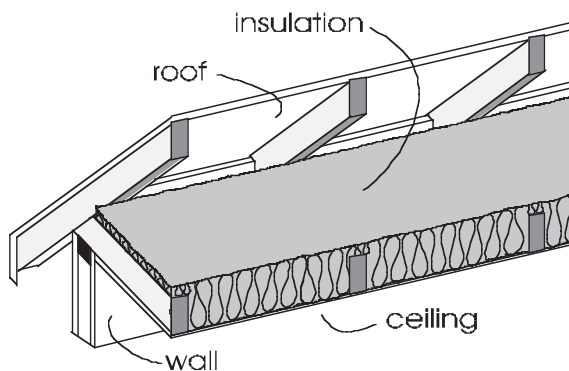


Diagram of where insulation can be installed relative to the roof deck and ceiling

<http://hawaii.gov/dbedt/info/energy/publications/roofinsulation.pdf>



Typical package of fiberglass batt insulation. This one comes with a kraft paper back and is intended for rafters spaced 16" apart. Roughly \$16 to cover 50 square feet.

<http://www.homedepot.com/Building-Materials-Insulation-Fiberglass-Rolls/h>

Mineral fiber/fiberglass batts are typically the easiest form of insulation to install and the cheapest per square foot. Batt is particularly good when you have an easy to access place that you plan on putting the insulation. Batt is not good for places that are hard to reach, or for places that are already sealed up. In these situations blown in loose fill insulation is more handy. Batt is locally available at many hardware stores and other building supply stores in Hawaii. Measure the spacing in your attic joists before you buy your batting. Batt is made to fit between common framing spacings like 16 or 24 inches from center to center of joists. This means that batt type insulation commonly comes in 15" and 23" widths¹²⁹.

Typically you want a minimum insulating value of R-19 or higher. If you have a dark roof an insulating value of R-30 is good. Remember a higher R-value may mean that the insulation is thicker so keep this in mind if you have a tight space to install. Make sure to choose a product with a kraft paper backing if you plan

¹²⁹ Edward Harland, *Eco-Renovation: The Ecological Home Improvement Guide* (Post Mills, Vermont: Chelsea Green Publishing Co., 1993), pg 57

on stapling the batting to a vertical surface like a wall. This craft paper backing is unnecessary for applications where you are laying the batting down on the top of the ceiling.



Always be careful to leave to least 3” of air space between electrical fixtures and the insulation. Chimneys are less common in Hawaii, but if you are installing insulation near a chimney give it at least a 3” air space as well.¹³⁰

If you squish the thicker insulation it no longer has the value that it is labeled with. It is also important to remember that you do not want to cut off the flow of air from your soffit vents which are discussed later in this chapter. A good way to insure that your insulation does not block the vent space is with a rafter vent product similar to Raft-R-Mate product shown in this chapter.

Installing insulation is fairly straight forward and requires only scissors/razor blade for occasional trimming. When installing batt type insulation you should wear the appropriate gear. The materials insulation is made of have gotten safer over the years, but products still carry warnings about irritation and health issues caused by exposure. Avoid skin contact with the material¹³¹. Wear long sleeved clothes and cover as much of your skin as possible. Wear gloves, eye protection and a respirator as well. All this gear can get hot and uncomfortable especially if you are working in a hot place like the attic. Remember to stay properly hydrated and consider planning your attic work for earlier or later in the day when it will be cooler.

In situations where you cannot access parts of your attic you should consider blown-in type insulation. This can be more costly because typically you have to hire a contractor to bring their equipment to your home and perform the process. Blown-in insulation will tend to cost more per square foot because it requires labor and the use of specialized equipment. Blown-in insulation can be messy if you need to frequently access your attic and it is also susceptible to shifting and settling which can reduce its effectiveness. However, properly installed it is very effective.

¹³⁰ Owens Corning, “Homeowner’s Guide to Insulating,” (Toledo, Ohio, 2006).

<http://www.owenscorning.com/around/insulation/fallpromo/HomeownersGuideToInsulating.pdf> (accessed 11-27-09).

¹³¹ Peter F. Smith, *Architecture In A Climate of Change: A Guide to Sustainable Design* (Architectural Press: Jordan Hill Oxford, 2001), pg 60

Roof | Insulation

Below are instructions from Owens Corning, a fiberglass insulation manufacturer. These are general guidelines and more detailed instructions are free to download as a PDF at <http://www.owenscorning.com/around/insulation/fallpromo/HomeownersGuideToInsulating.pdf>



1. Lay temporary flooring (using plank or plywood pieces) across joists and hang a temporary work light. To make sure the soffit vents aren't blocked, install attic vents or baffles like Owens Corning *raft-R-mate* Attic Rafter Vents, which assure unobstructed airflow from the soffit to the attic.



2. Begin laying faced or unfaced PINK FIBERGLAS Insulation at outer edge of attic and work toward center. The vapor retarder should be facing down toward the warm-in-winter side of the ceiling. In Gulf Coast states and Florida, local building codes may not call for an interior vapor retarder.



3. Lay insulation in long runs first, and use leftovers for shorter spaces. Ends of insulation should be cut to fit snugly around cross bracing. Insulation should extend far enough to cover exterior walls but should not block flow of air from soffit vents. If needed, install a baffle wherever there is a soffit vent to assure airflow. To complete the ventilation process, add roof vents.

<http://www.owenscorning.com/around/insulation/fallpromo/Homeowners-GuideToInsulating.pdf>

Roof | Insulation



4. Insulation must be kept 3" away from recessed lighting fixtures unless fixtures are marked "I.C." (Insulated Ceiling)—designed for direct insulation contact. Insulation placed over an unrated fixture may cause the fixture to overheat and perhaps start a fire. The insulation should always be installed at least 3" away from any metal chimneys, gas water heater flues or other heat-producing devices.



5. Fill the spaces between a masonry chimney and wood framing with a noncombustible material such as unfaced PINK FIBERGLAS Insulation, which will not burn.

NOTE: Do not leave faced insulation exposed. The facings on kraft-faced insulation will burn and must be installed in substantial contact with an approved interior finish as soon as the insulation has been installed. Facing must be installed in substantial contact with an approved ceiling, floor or wall material. Keep open flame and other heat sources away from facing. Do not place insulation within 3" of a light fixture or similar electrical device unless device is labeled for contact with insulation. Use only unfaced insulation between wood framing and masonry chimneys. Do not use insulation in spaces around metal chimneys, fireplaces or flues. Unfaced insulation is considered noncombustible by model building codes. Flame Spread 25 products are flame-spread rated and can be left exposed where codes allow. See package for warnings, fire hazard and instructions, or call 1-800-GET-PINK.

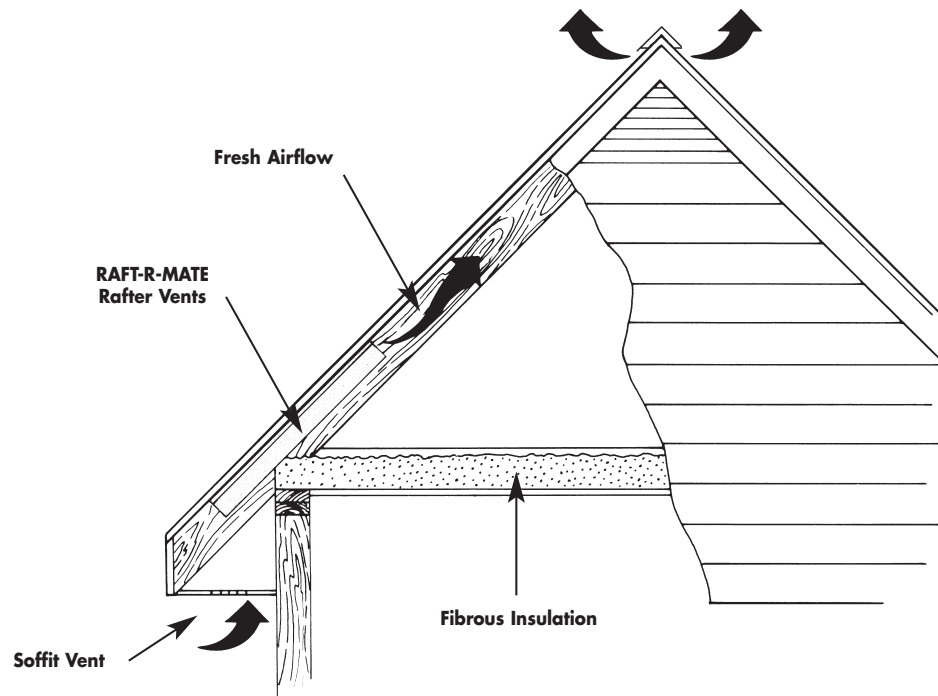
<http://www.owenscorning.com/around/insulation/fallpromo/Homeowners-GuideToInsulating.pdf>

Roof | Insulation

Homes in Hawaii are built so that the attic is allowed to ventilate along the eaves and gables. As a basic minimum ventilation requirement you want 1 square foot of ventilation space for every 300 square feet of attic ceiling space. Often when you install insulation you run into a potential problem of blocking off soffit ventilation space with the insulation. You can avoid blocking soffit vents by installing a spacer which fits between the rafters of the roof and allows the air to pass between the roof deck and the spacer. One available product for this is Raft-R-Mate.

This kind of spacer is only needed in places where you have soffit vents. If you chose to use the paint on radiant barrier described in the chapter you will want to paint on the radiant barrier prior to installing this type of product. If you choose to use other types of radiant barrier, depending on the product, you will want to install the radiant barrier before installing the rafter vents as it is common to staple the radiant barrier directly onto the underside of the roof deck¹³².

The diagrams and instructions on the following page include a manufacturers instructions on installing attic vents to allow air to properly flow through the soffit vents.



Section drawing of an attic showing the location of rafter vents properly installed

<http://secure.owenscorning.net/Portal/uploads/document/20031130/23502-B%20RAFT-R-MATE%20ATTI C%20VENTS%20DATA%20SHEET.pdf>

¹³² John P. Holmes, *Home Improvement 1-2-3* (Des Moines, Iowa: Meredith Publishing Group, 2003), 422-441

Roof | Insulation

This is a product intended to allow eve vents to operate properly even when the attic has been insulated with batting. This product only needs to be used where there are vents. This particular product is 22 1/2"x48" and constructed of polystyrene. It can be snapped in half length wise (or cut with a utility knife) to fit between rafters spaced more closely. A staple gun is sufficient to fasten the Raft-R-Mate into place. Only one Raft-R-Mate is required for each vent opening. It is critical to install the Raft-R-Mate so that it allows air to move from the vent and up between the Raft-R-Mate and the roof deck (see manufacturers diagrams).

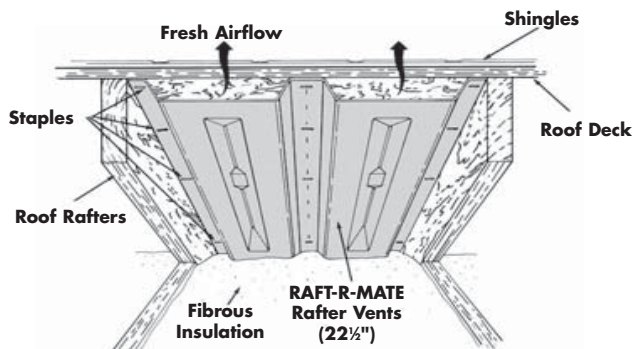


Diagram of rafter vent installed between joists spaced at 24" from center to center

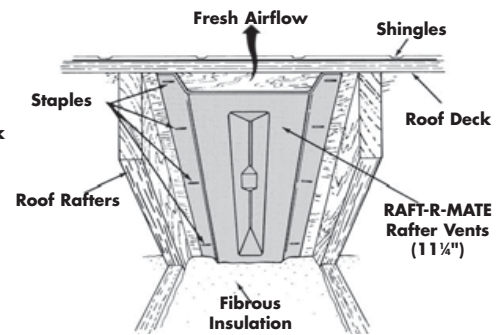


Diagram of rafter vent installed between joists spaced at 16" from center to center

<http://secure.owenscorning.net/Portal/uploads/document/20031130/23502-B%20RAFT-R-MATE%20ATTIC%20VENTS%20DATA%20SHEET.pdf>

Remember the main function of this product is to keep a space between insulation and the air vent. The Raft-R-Mate only needs to be long enough to separate the insulation from the air vents and reach above the height of the insulation batts to allow the air from the vents to flow freely upwards into the attic space. Because the insulation will likely be much less than 48" in height it is possible to cut the Raft-R-Mate in half and get twice as many vents addressed with half the cost. This method is not something the manufacturer suggests, but it will work fine in most situations and will cut the cost of protecting your vents air flow in half. A utility knife is sufficient to cut the Raft-R-Mate in half, but be careful not to crush the polystyrene as you will be cutting across and uneven surface.¹³³ In addition to insulation and radiant barriers, good ventilation will remove the heat that accumulates in your attic and also reduce moisture problems.¹³⁴

¹³³ Owens Corning, "Raft-R-Mate Attic Rafter Vents,"

<http://secure.owenscorning.net/Portal/uploads/document/20031130/23502-B%20RAFT-R-MATE%20ATTIC%20VENTS%20DATA%20SHEET.pdf>

(accessed 11-27-09).

¹³⁴ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes*

(Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 36

Roof | Insulation

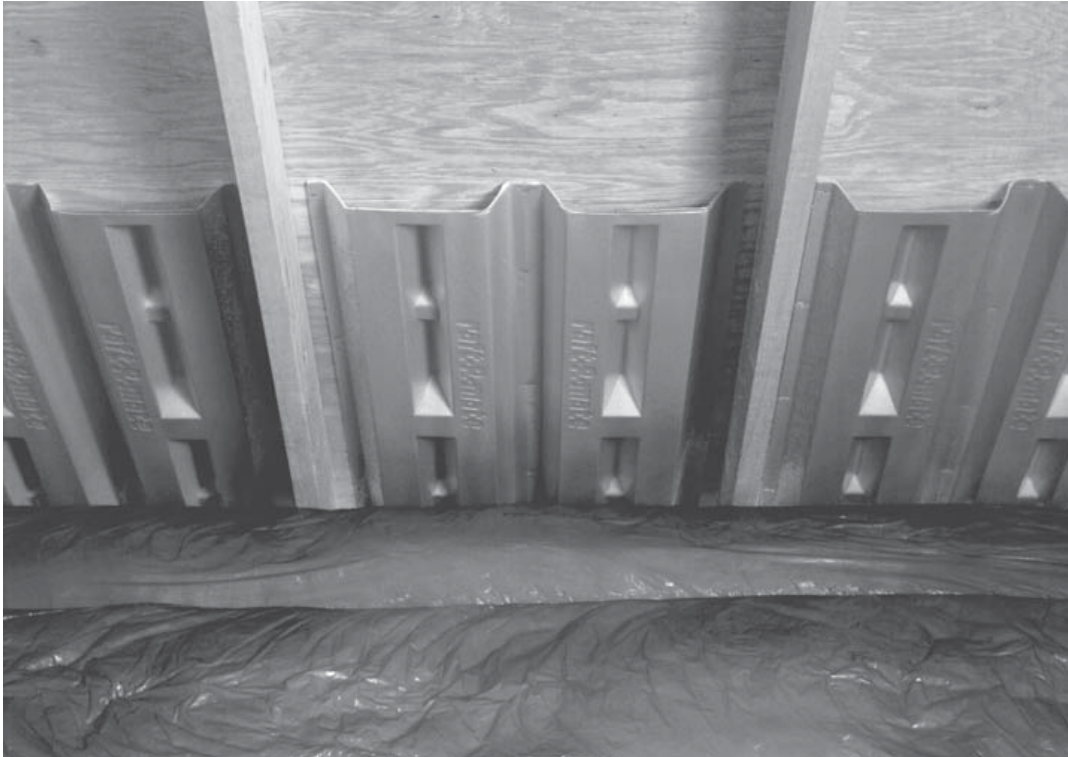


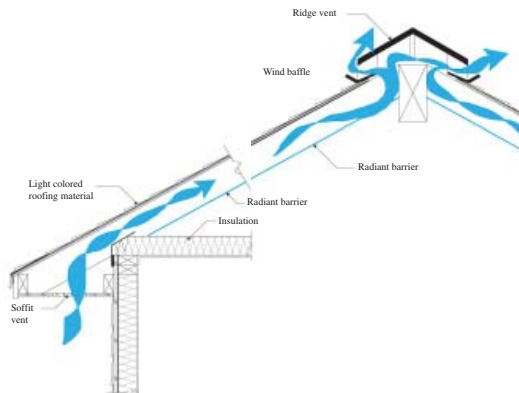
Photo of installed rafter vents with batt type insulation below

<http://secure.owenscorning.net/Portal/uploads/document/20031130/23502-B%20RAFT-R-MATE%20ATTIC%20VENT%20DATA%20SHEET.pdf>

Roof | Ventilation

This chapter will cover active and passive venting. Active ventilation requires a source of electricity to run a fan that forces air to move out of the attic space. Passive ventilation requires no electricity and is very low maintenance. There are two passive vent types that are readily available and fairly simple to install. These are ridge vents, and gable vents.

Both ridge vents and gable vents use air pressure and/or heat differentials to move air through your attic. An air pressure differential moves air through your attic as high pressure on the inside of your attic is drawn out through the vents into the low pressure air outside¹³⁵. Air can also move due to heat differentials which typically occur when hot air from inside the attic is drawn upwards and out through the vents. It is important to properly protect against rain and insect infiltration when installing your ridge vents.¹³⁶



Section Diagram of a house roof using soffit vents and ridge vents combined with radiant barriers and Insulation

James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 37



Section Diagram of a roof ridge vent showing how air can move up and out through the vent while at the same time keeping the roof water tight

Ridge vents vary somewhat depending on the manufacturer but there are some

¹³⁵ Edward Harland, *Eco-Renovation: The Ecological Home Improvement Guide* (Post Mills, Vermont: Chelsea Green Publishing Co., 1993), pg 49

¹³⁶ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes*

(Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 36

Roof | Ventilation

important general considerations. Some ridge vents come in large rolls that can simply be rolled out on your roof and cut to the desired length. Other ridge vents come in 4' sections that are to be nailed one after the other. You should add up the amount of ventilation space that your gable and soffit vents account for. Generally you want to have an equal amount of ventilation space in your ridge vents as you have in your soffit vents.

Most ridge vents have baffles that keep the rain out and many are able to keep most insects out as well. These are important considerations when choosing a product. The air gap on either side of the roof ridge should be about 3/4". When you are nailing the ridge vent down make sure you are not crushing the vent as it will not function properly. Your roof gets hot in the daytime and many materials expand when they are hot. Make sure that if you are using ridge vents that come in short sections to leave 1/8" expansion gap between the panels to allow for expansion.¹³⁷

On the following pages are manufacturers instructions for the VenturiVent ridge vent product. This as well as other products covered in this chapter can be purchased at locations listed in the contacts section at the end of this chapter. Before proceeding to the installation instructions please carefully read the paragraph below.



There are many important things to consider when working on your roof. The first is safety. Working on the roof presents a hazard of falling which could cause sever injury or death. If you are not comfortable with the safety hazards then hire a professional. Roofs get very hot in the day time and proper clothing and foot wear is required. In addition to the hazard of falling there is also a hazard of dehydration as well as the potential to get scraped and cut on the rough roofing materials. Whenever you walk on your roof you run the risk of damaging the roofing materials. Your roof is a very expensive part of your home and it protects all of your other investments inside. If your roof is not worked on properly you can have water leaks that can cause costly damage. The source of a water leak is not always simple to find. Be very careful if you ever have to walk on your roof as older roofing shingles become brittle and fragile with age. If you do choose to take on this project on your own, choose a nice day to do your work. Keep in mind that if it starts raining you will want a tarp to cover

137 James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes*

(Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 37

Roof | Ventilation

your work should you be unable to finish in one day. When in doubt call a professional to have the work done. There are several roofing companies listed at the end of the chapter in the contacts section who install roof vents. Generally this costs about \$25-60 per linear foot of roof vent.



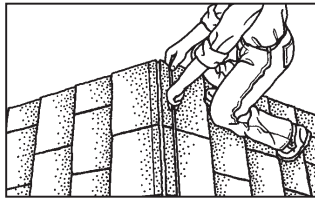
Keep in mind that this project will only save you money if you are currently air conditioning your home. If you are not using AC this method will likely increase the comfort of the living spaces in your home. Consider this before you choose this method as your money and time may be better spent on other methods. This method is relatively cheap if you are capable of doing it on your own. Ridge vents are roughly \$4 a linear foot (see contacts at end of chapter for products) while hiring a contractor to install ridge vents can be between \$25-60 a linear foot. Make sure to call around for free estimates as prices vary a lot.

VENTURIVENT PLUS™ Installation Instructions

VenturiVent Plus fits roofs with 3/12 to 16/12 pitches.
Intake vents that equal or exceed the total net free area of the ridge venting must be installed.
VenturiVent Plus is designed for residential applications.

IMPORTANT NOTES

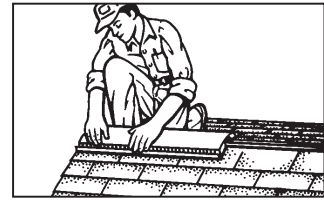
1. When using standard flat 3 tab shingles, it is unnecessary to caulk under flange of the vent.
2. Before applying vent to dimensional or architectural shingles on new construction, leave felt long at ridge and fold back under vent (see drawings on other side). – OR – caulk between low areas of shingle and flange of vent, making sure you don't plug drain holes.
3. When applying vents to shakes, fold felt as shown in drawings on other side.
4. When installing vent in cold weather, leave a 1/8" gap between vent sections to allow for expansion in hot weather.
5. See instructions below for cutting slot.
6. When installing vent on roofs with different ridge heights and a common attic, be sure to vent the high ridge only.
7. For best appearance, run VenturiVent Plus from end to end to give the roof a more even, attractive appearance.



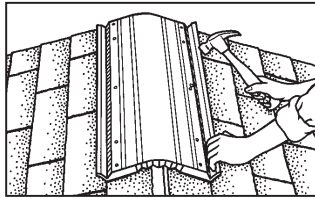
1. On existing roofs, remove cap shingles. Mark slot width at both ends of ridge. Use slot guides imprinted on vent and refer to drawings below. Snap chalk line on both sides of ridge.



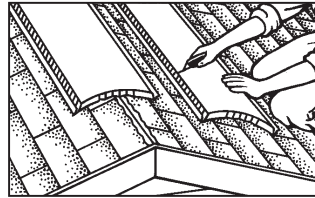
2. Cut slot (plumb cut, if possible). Refer to drawings below for slot dimensions. Remove debris from slot.



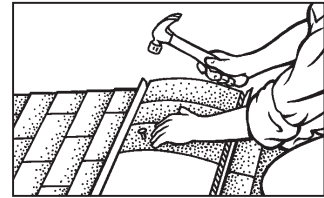
3. Center vent over slot. End should be flush with end of roof. Make sure vent's support walls sit flat on the roof.



4. Pre-fasten first section using roofing nails through pre-drilled nail holes. Continue to pre-fasten remaining sections, making sure support walls are flat on the roof.



5. Use utility knife to cut final section to length. End of final section should be flush with end of roof. Pre-fasten final section.



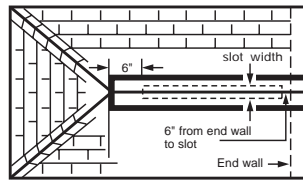
6. Nail cap shingles in place using roofing nails long enough to penetrate roof sheathing. Use nail holes provided on vent.

INSTRUCTIONS FOR CUTTING SLOTS

----- indicates slot width ——— indicates vent run - - - - indicates end wall

Hip and Gable Roofs

Cut slot 3/4" on either side of ridge centerline or from ridge board and to within 6" of end wall or hip intersection.



Hip end Fig. 1 Gable end

"L" and "T" Shaped Roofs

Cut slot, as per Figure 1 and run VenturiVent Plus across long ridge. On short ridge, cut slot to within 12" of junction point and run VenturiVent Plus from end of roof to butt against crossing VenturiVent Plus.

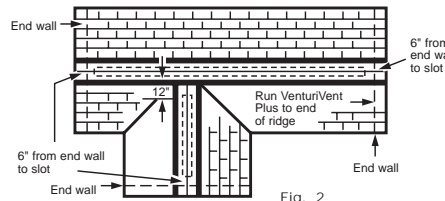


Fig. 2

Chimneys

Cut slots to within 12" of chimney. Run VenturiVent Plus from end of roof to butt against chimney.

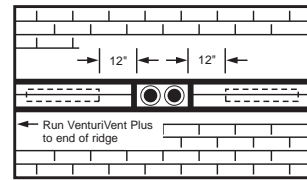


Fig. 3

NOTE: Air Vent's written warranty for this product shall not apply in any instance in which the product was not installed in accordance with the instructions contained herein.

<http://www.airvent.com/pdf/installation/VenturiVentPlus-install.pdf>

VENTURIVENT PLUS™ Installation Instructions

VenturiVent Plus fits roofs with 3/12 to 16/12 pitches. VenturiVent Plus provides 18" net free area per lineal foot.

Dimensions remain the same for all roof pitch configurations. See below for special conditions of steep pitch roofs and truss type construction.

Thanks for choosing VenturiVent Plus!

This product is engineered to provide the best, most efficient ventilation system available. When properly installed, VenturiVent Plus will:

- Help prevent the premature deterioration of shingles and other roofing materials caused by inadequate ventilation.
- Meet typical roof shingle warranty ventilation requirements.
- Help prevent attic heat build-up and ice dams by continuously moving air along undersheath of roof.

Install adequate intake vents

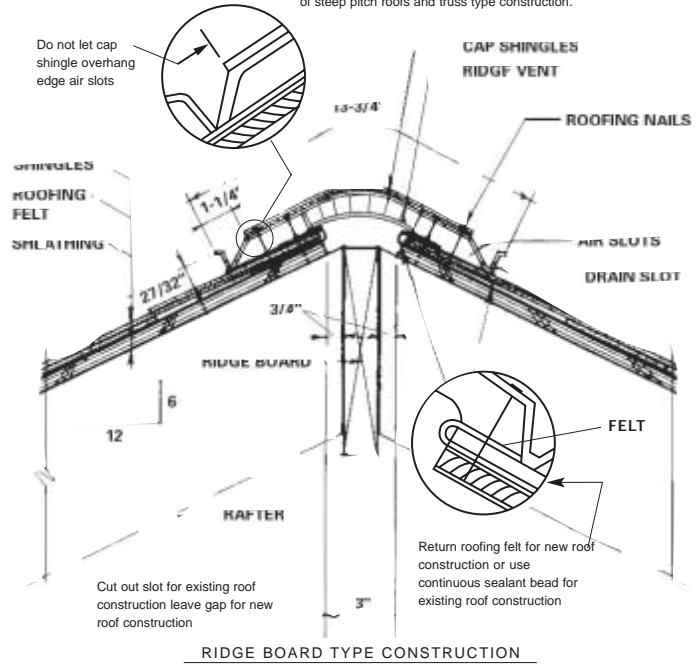
VenturiVent Plus is designed to exhaust moisture-laden air from the attic. To achieve optimum ventilation efficiency, existing roof vents, turbine vents and gable vents should be removed or plugged, and intake ventilation must be installed at the soffit or eave. Products such as Air Vent's Continuous Soffit Vent, Drip Edge Vent or Undereave Vent provide the necessary intake ventilation for optimum performance of VenturiVent Plus. These vents are available from your Air Vent distributor. Or call us for the name of a distributor in your area.

VenturiVent Plus is a snap to install!

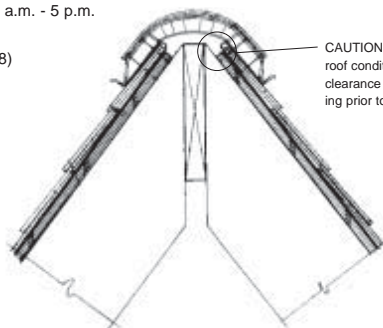
Just follow these simple instructions. If you have any questions or require special installation assistance, call our toll-free number from 8 a.m. - 5 p.m. (C.S.T.) Mon. - Fri.:
1-800-AIR-VENT (247-8368)

Tools needed for installation

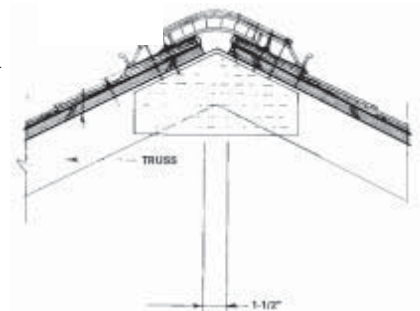
- Hammer
- Utility knife
- Chalk line
- Roofing nails
- Tape measure
- Circular saw



RIDGE BOARD TYPE CONSTRUCTION



STEEP PITCH ROOF (16/12)



TRUSS TYPE CONSTRUCTION

Highest quality co-polymer remains sturdy, nailable, and flexible, in all climates.

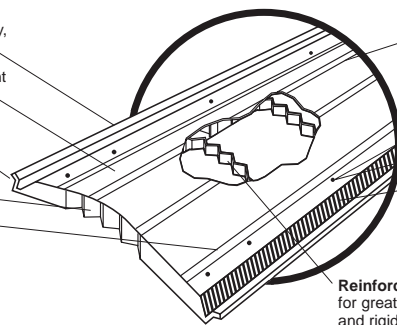
Cap shingles install easily, making the vent virtually invisible.

External wind baffle creates negative air pressure above the vent and helps pull air out of the attic.

Built in end plug seals the end.

High gloss nailing lines for accurate, fast cap shingle nailing.

(See other side for additional installation instructions)



Imprinted slot guides for proper slot opening and alignment.

Nail bosses, reinforced nail holes designed to prevent over nailing.

Nail holes located at 16" and 24" centers.

Air slots have 18 sq. inches free vent area per lineal foot.

Reinforced ribs for greater stability and rigidity.

AIR VENT INC.
3000 W. Commerce St., Dallas, TX 75212

<http://www.airvent.com/pdf/installation/VenturiVentPlus-install.pdf>

Roof | Ventilation

It is also important to consider active ventilation methods. Unlike passive ventilation which relies on heat differentials and pressure differentials, active ventilation typically uses an electrically powered fan to pull air out of your attic. These fans are typically thermostatically controlled and are powered by the electricity in your home, or by photovoltaic panels. Thermostatically controlled fans have a thermostat that lets the fan know when the attic has reached a given temperature which tells the fan to turn on and run until the temperature drops below a certain level. This keeps the fan running only when the roof needs to be cooled and allows it to work without anyone having to think about it.

The Products discussed in the active ventilation section require the same careful considerations as those in the passive ventilation section. Many of these products can be installed by homeowners. This requires a great deal of care. Here again are the same important considerations



There are many important things to consider when working on your roof. The first is safety. Working on the roof presents a hazard of falling which could cause severe injury or death. If you are not comfortable with the safety hazards then hire a professional. Roofs get very hot in the day time and proper clothing and foot wear is required. In addition to the hazard of falling there is also a hazard of dehydration as well as the potential to get scraped and cut on the rough roofing materials. Whenever you walk on your roof you run the risk of damaging the roofing materials. Your roof is a very expensive part of your home and it protects all of your other investments inside. If your roof is not worked on properly you can have water leaks that can cause costly damage. The source of a water leak is not always simple to find. Be very careful if you ever have to walk on your roof as older roofing shingles become brittle and fragile with age. If you do choose to take on this project on your own, choose a nice day to do your work. Keep in mind that if it starts raining you will want a tarp to cover your work should you be unable to finish in one day. When in doubt call a professional to have the work done. There are several roofing companies listed at the end of the chapter in the contacts section who install roof vents.

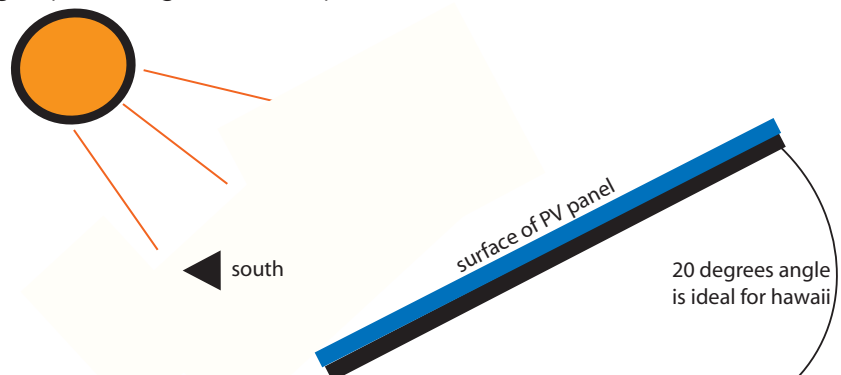
There are readily available products that can be installed by homeowners or contractors. In the following pages examples of active ventilation products are explained. The Gable Solar Fan is powered by solar energy so it costs nothing to maintain and it automatically switches on when your attic reaches a high enough

Roof | Ventilation

temperature. It requires minimal installation. However, it is important to do a careful and thorough job to avoid water leaks. Another product is a simple attic fan which does the same thing, however it requires electricity from your house every time it switches on. Both fans are thermostatically controlled so they are only on when they need to be. It is cheaper up front to buy the conventional electric fan. However, it will be more expensive in the long run than the solar fan. Solar powered fans can also qualify for state tax credits (in some cases including the installed cost) if they meet certain criteria. For more information on how to qualify for these tax credits look at the sample tax forms in the tax rebates chapter.



Just because the solar fan costs nothing to operate does not immediately make it the right choice. This method will not save you money if you don't have air conditioning. However, it will likely make your home more comfortable and for about \$400 you can install a product that will require no electricity to operate. It is also important to consider your homes individual location situation. The solar panel will not be as effective if you have a huge tree over your house, or if you place it on a part of the roof that is facing north. It is important to look at your own individual situation to decide which method will serve you best. **For the solar fan to be most effective it must be installed so that the photovoltaic panel is facing south, at a 20 degree angle.** The farther the panels direction deviates from this, the less effective it becomes. Installed with the solar panel facing the right direction it can be very effective. Some of the criteria for collecting tax rebates for renewable energy products require that your photovoltaic panels is facing within so many degrees of south and within so many degrees of the 20 angle (see diagram below).¹³⁸

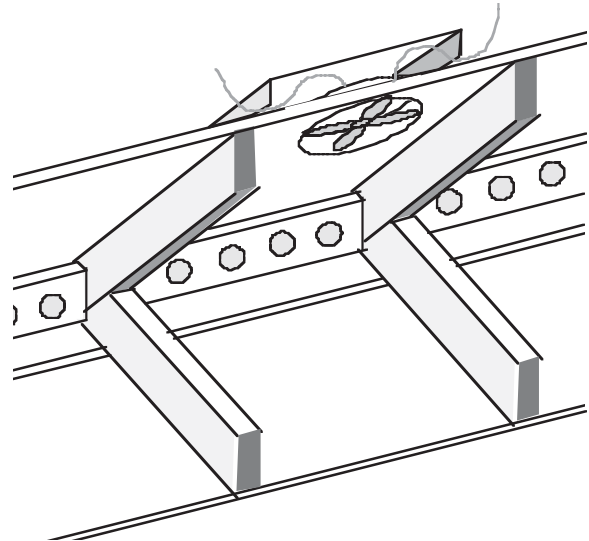


¹³⁸ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 37

Roof | Ventilation

Solar-powered fans use energy from the sun and add no cost to your electric bill to draw out hot air and reduce attic temperature by as much as 40°. These fans work hardest when the sun is strongest. Solar powered attic fans qualify for rebates (see the rebates chapter).¹³⁹

Natural Light, a company that sells Solar Attic Fans, claims their product is fairly simple for home owners to install. The fan is shipped fully operational in a discreet unit. “No electrical wiring, no expensive electrician or permits are needed. Detailed installation instructions are provided with each unit.”¹⁴⁰ Products from this site can also be installed even if you have no attic and the ceiling is the underside of your roof. Open beam ceilings will simply have a return vent that allows the hot air that accumulates at the ceiling level to be sucked out through the vent.¹⁴¹ In the next two pages there are installation instructions from the manufacturers of two types of attic ventilation fans.



Example of solar powered fan from Costco. Uses no money to operate. Costs about \$340
<http://reviews.costco.com/2070/11328759/u-s-sunlight-solar-powered-attic-ventilator-reviews/reviews.htm>

Diagram of an attic fan installed on a roof
<http://hawaii.gov/dbedt/info/energy/publications/roofinsulation.pdf>

¹³⁹ Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home*

(Honolulu, Hawaii: no publisher, no date), pg 22

<http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09).

¹⁴⁰ (no author), Natural Light Energy Systems, “Installation: As Easy as 123,”

http://www.solaratticfan.com/pages/saf_installation.html (accessed 11-12-09).

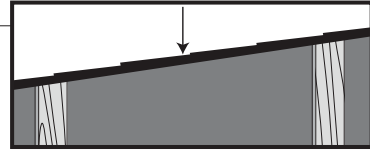
¹⁴¹ Ibid

Installation Pointers

When determining location of the unit, try to place the solar attic fan on the south side of the roof, also consider potential problems such as objects shading the unit during certain times of the day. The unit should also be centered on the roof and the center of the unit should be about 2 feet down from the roof ridge.

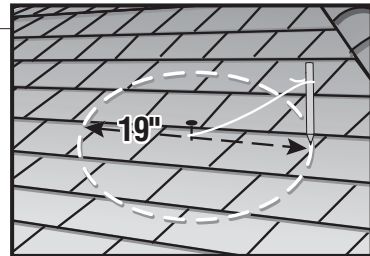
Step 1

Choose location for solar vent unit, south exposure is best. If a southern exposure is not feasible for your installation, the fan can be installed on any other exposure and the solar panel adjusted to capture maximum sunlight.



Step 2

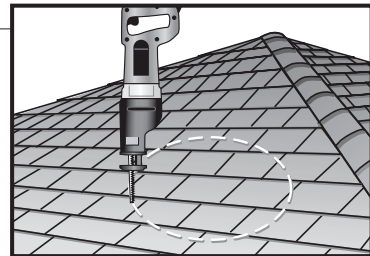
Hammer a nail at the center of the location chosen between rafters for the solar attic fan unit. The center of the unit should be about 2 feet down from the ridge. Attach a string to the nail. Measure 9.5" of string and attach a marking pen to the string, **see diagram**. Scribe a 19" circle onto the roof shingles or use the template created earlier.



Step 3

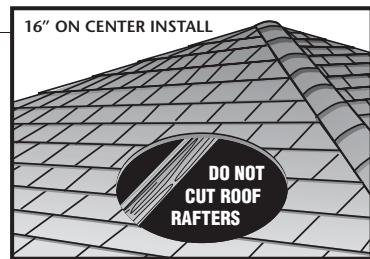
With a reciprocating saw, cut the diameter of the hole.

IMPORTANT: The solar attic fan must be installed between the roof rafters or over a roof rafter. **DO NOT CUT THROUGH ANY FRAMING MEMBER.**



Step 4

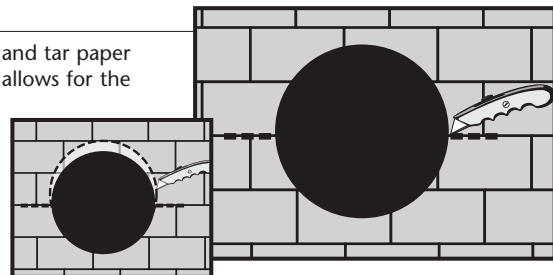
Roof rafters are generally 16" or 24" on center. On 16" on center construction, the installer can either cut a 14" hole between the rafters or cut a 19" hole with the roof rafter running through the cut hole - **do not cut the rafter** (see diagram). On 24" on center construction, center the fan between the rafters. **NEVER CUT THROUGH ANY ROOF RAFTERS. LEAVE ALL FRAMING MEMBERS IN PLACE.** Only remove roof sheathing.



Step 5

With a razor knife, cut a four inch slit through the shingles and tar paper at the three and nine o'clock position of the flashing. This allows for the foot print of the flashing to be inserted under the shingles.

NOTE: If a 14" hole was cut instead of a 19" hole in Step 3, additional shingles may also need to be removed on the high side towards the ridge to allow the flashing to slide over the hole (see inset illustration).

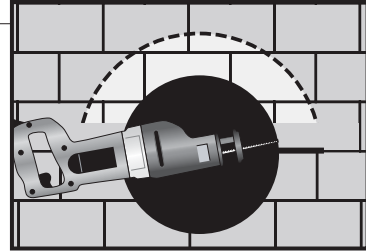


(no author), Natural Light Energy Systems, "Installation: As Easy as 123," http://www.solaratticfan.com/pages/saf_installation.html (accessed 11-12-09).

Roof | Ventilation

Step 6

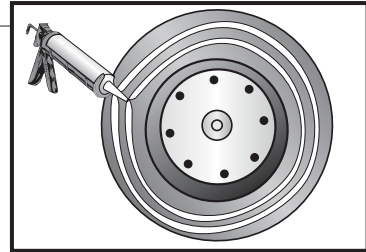
Insert the reciprocating saw blade sideways at the three o'clock position and commence cutting the roofing nails up and around to the nine o'clock position. This process removes the nails that will prevent the flashing foot print from sliding up underneath the shingles.



Step 7

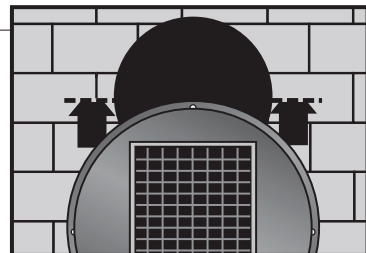
Caulk **underside** of flashing with the provided caulking material. Two concentric rings of caulking material is sufficient.

NOTE: Installation on tile roofs will require the use of a skirt.



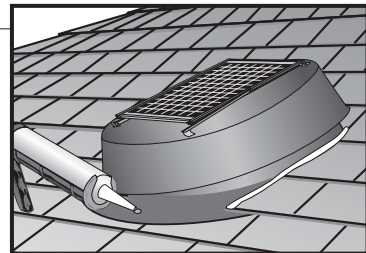
Step 8

Taking care not to smear caulk on the exposed shingles, slide flashing under tar paper and shingles and force flashing up until the shingles come in contact with the raised portion of the flashing. The bottom side of the flashing will be on top of the shingles. Secure flashing with four Phillips head screws at the 3:00, 6:00, 9:00 and 12:00 positions. The 3:00 and 9:00 positions screws should go under the shingles. The 6:00 and 12:00 position screws should go on top of the shingles.



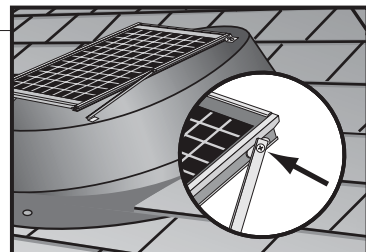
Step 9

At the 6:00 and 12:00 positions, caulk over the screw head, since it will be exposed to the weather. Use remaining caulk to seal the areas where the 4" slits were made and around the area where the shingles meet with the raised area of the flashing.



Step 10

Loosen, but do not remove, the screw on the clip/screw assembly located on each side of the solar panel bracket. Adjust the solar panel to the position it will collect the most sunlight throughout the day. Tighten screws at the desired position.



(no author), Natural Light Energy Systems, "Installation: As Easy as 123," http://www.solaratticfan.com/pages/saf_installation.html (accessed 11-12-09).



Example of a gable mounted fan (see opposite page) view from inside the attic

(no author), Natural Light Energy Systems, "Installation: As Easy as 123," http://www.solaratticfan.com/pages/saf_installation.html (accessed 11-12-09).

Roof | Ventilation

IMPORTANT: Please take the time to read through the ENTIRE instructions prior to starting any work.

Precautions

1. Ensure normal safety precautions are taken when using tools, ladder and walking on roofs.
2. Do not cut any structural members in the house.
3. Install only in dry weather.

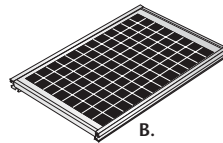
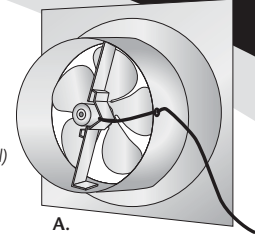
Tools Required

- Power Drill
- Phillips Screwdriver
- Caulking Gun
- Ladder
- Electrical Tape
- 1/4" Masonry Bit (for tile roofs)

Gable Fan Installation Kit:

- A. Gable Fan
- B. Solar Panel
- C. (2) L-Brackets
- D. Caulk
- E. Power Cable Adapter
- F. (14) Wood Screws (around shroud)
- G. (4) Machine Screws (shingle roofs)
- H. (4) Self-Tapping Screws (L-bracket to panel)
- I. (4) Anchors (tile roofs)

NOTE: Use I & G screws for tile installs



Installation Pointers

When determining location of the solar panel, consider potential problems such as objects shading the unit during certain times of the day (southern exposure is recommended). To ensure proper ventilation, install the Gable Solar Fan so that it covers the entire gable opening.

Step 1 Choose location to install the gable fan. The fan must be installed between studs in the gable area. For proper ventilation, the fan unit must cover the entire gable opening. If the gable opening is larger than the fan unit shroud, the excess opening must be blocked. **DO NOT CUT ANY WOOD FRAMING.** From inside the attic, position the gable fan (with the motor facing the attic) to the desired location and secure the shroud with the provided wood screws (see Figure 1).

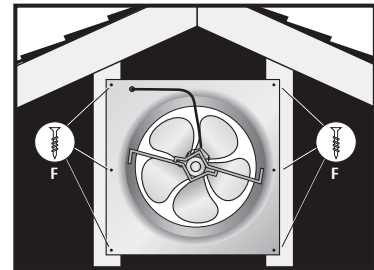


Figure 1 (view from inside attic)

Step 2 Locate area to install the solar panel on the roof where it will gather the most amount of sunlight (southern exposure is recommended). Attach the L-brackets to the long sides of the solar panel with the self-tapping (H) screws into the pre-drilled holes on the panel frame. Attach solar panel to roof using the provided wood screws (see Figure 2). Caulk around the wood screws to prevent leaks. **FOR TILE ROOFS:** Pre-drill hole in tile to accommodate the anchors provided (I). Tap anchors into holes and secure L-bracket using provided screws (see inset).

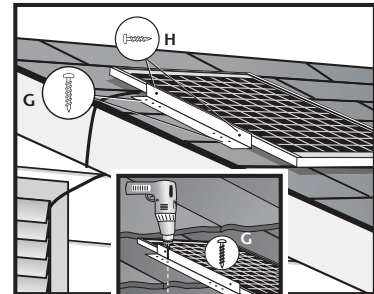


Figure 2

Step 3 Use one of the following two options for routing the power cable from the fan to the solar panel:

OPTION 1: Route the power cable from the fan unit through the gable vent and along the outside of the house up to the roof.

OPTION 2: Drill a small hole next to the solar panel on the roof. Route the power cable from the fan unit through the attic and up through the hole. Caulk around hole to prevent leaking.

Step 4 Connect the power cable from the fan unit to the power cable from the solar panel. Connect the black wire to the black wire and the red wire to the red wire (see Figure 3). If the power cables do not reach, use the provided adapter cable. If wire connections are located outside of the attic space, wrap the connections with electrical tape to prevent water infiltration. Secure any loose wires using wire staples (not provided).

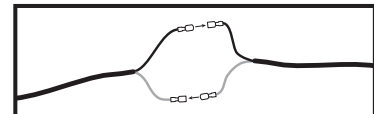
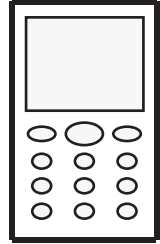


Figure 3

(no author), Natural Light Energy Systems. "Installation: As Easy as 123," http://www.solaratticfan.com/pages/saf_installation.html (accessed 11-12-09).

Roof | Contacts



Home Improvement Stores:

The Home Depot	808 521-7355
City Mill	808 533-3811
True Value	808 949-7936

Radiant Barrier Paint Contacts:

Sherwin-Williams	808 842-4000
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Insulation Contacts:

Aloha Insulation	808 377-5564
A's Insulation	808 839-8065

Roofing Contacts:

Rainbow Roof Maintenance	808 842-0488
Tropical Roofing and Rain Gutters	808 847-0030
David's Custom Roofing & Painting Inc	808 833-1633
United Roofing LLC	808 428-7947
Cool Roof Hawaii	808 792-6132
Aloha Roofing Inc	808 538-7663
LeakMaster	808 591-1900
Hawaiian SunGuard	808 591-1900
ABC Supply Inc	808 836-8077
RSI	808 847-2077



Radiant Barrier - Radiant barriers come in a variety of forms. In general a radiant barrier is any product which blocks a significant amount of radiant heat from entering your home. This reflective ability is measured in emissivity or reflectivity. The most effective radiant barriers will have a low emissivity example: .01 and a high reflectivity example: 97%.

VOC - (volatile organic compounds) In short this is what you smell after you use certain paints or install certain kinds of carpet. A low VOC product is intended to be safer to the people applying the product and safer for the inhabitants of the space after the application. Using a low VOC product is also considered more environmentally friendly.

R - Value - R -values in this book are associated with various forms of insulation and their ability to slow the transfer of conductive heat (heat transferred by direct contact). A higher R-value means that the insulation is better at stopping the transfer of conductive heat. The R-values of insulation are also higher when the insulation is thicker. R-values are also an indication of the amount of air space trapped within an insulating product. R- values are also the reciprocal of U-values which you will find in the windows chapter.

BACKGROUND INFO

This chapter focuses on reducing the heat that gets into your home through the exterior facing walls. The basic methods to reduce heat gain through the walls are adding insulation and increasing the reflectivity of the exterior of your walls. If your house is already shaded by a large tree or building then you will want to factor that into your decision of whether or not to use the methods in this chapter.¹⁴²

Heat can be transferred in three ways. Conduction, convection and radiation. Conduction is heat that transfers through direct contact. Convection is heat that transfers through a carrier fluid such as air or water. Radiation needs neither direct contact, nor a carrier fluid and travels as visible and invisible light. In Hawaii the air temperature tends to be quite mild and therefore we don't have to worry much about heat that is transferred by convection. However, we do have to worry about radiant heat from the sun, and conductive heat from things the sun has heated up. To a lesser extent appliances and human bodies in your home produce heat.



Insulation and suspended particle paint will reduce the amount of heat that reaches the inhabitants of your home. If your home has air conditioned spaces, using these methods will allow the air conditioner to use less energy to cool those spaces. If your house is naturally ventilated you will not save money on your electric bill, but you will increase the comfort of your home by lowering the inside temperature. You will also potentially increase the value of your home to anyone who might want to buy your home down the road. If you are currently using air conditioning, these methods, in combination with other methods in this book, can help you reduce the number of spaces you need to air condition, or possibly allow you to naturally ventilate your home.

It is important to remember that the average home in Hawaii has much more wall square footage than floor or roof square footage. Depending on the context of your home you may have a significant amount of wall surface area exposed to sunlight each day. This can be one of the largest contributing factors to heat gain in your home. The goal of this chapter is to prevent the various forms of heat from reaching the inside of your home.

¹⁴² James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 31

Walls | Insulation

There is much more information on insulation in the roof chapter so it would be a good idea to read that chapter to understand more about insulation. The ability of a particular type of insulation to resist heat transfer is called its “R-Value”. The higher the material’s R-value, the better it is at resisting the transfer of heat.

“In Hawaii, un-shaded walls are exposed to high levels of solar radiation. During the winter months, south facing walls can receive over 1,300 Btu/sq.ft./day. During the summer, east and west walls receive nearly 1,000 Btu/sq.ft./day. If this heat is allowed to re-radiate into interior spaces, it can create discomfort in the home.” Recommended methods for reducing heat gain through walls include painting your walls with a light color, insulating your walls and using radiant barriers.¹⁴³ “Insulation and radiant barriers can significantly reduce heat buildup in the home.”¹⁴⁴

The methods in this book can be used on new homes but are focused on retrofits for existing homes. Generally it would not be cost effective to rip your exterior facing walls apart and install insulation and radiant barriers. Many older homes in Hawaii are single wall construction and don’t have any wall cavity for insulation or radiant barriers. The methods chosen for this chapter are intended to be useful to people in varying situations.

If your home is built of single wall construction you don’t have a wall cavity to fill with insulation and/or a radiant barrier. There are many ways you could retrofit your exterior single walls to allow them to be insulated. You could add studs to the inside of your wall, fill the spaces between the studs with insulation and radiant barriers (similar to methods in the roof chapter). You could then cover the studs with drywall as a finish material. You could also install rigid foam insulation directly to the inside of your exterior facing walls and then cover this with drywall. Both of these methods are problematic because they slightly reduce the square footage of your room. These methods will also likely require you to alter your electrical outlets and extend the molding surrounding your windows to take care of the increased wall thickness.

These are good methods if you are serious about reducing heat gain. However, if you have single wall construction and you don’t want to take on insulating your walls you can significantly reduce heat gain with the reflective coating described in this chapter.

¹⁴³ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes*, (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 23

¹⁴⁴ Ibid, pg 27

Walls | Insulation

If you have stud wall construction then you can benefit from both insulation and reflective coatings. Remember, that these methods will not save money if you are not currently air conditioning your home. These methods will decrease the amount of heat that gets into your home through the exterior walls and this could make your indoor temperatures much more comfortable.

If you already have stud wall construction, check to see if you have insulation in your exterior walls. One way to do this is to remove light switch cover plates or electrical outlet plates. **Before you do this be sure to switch off your electric breakers.** Between the finished wall material and the electrical outlet box there is usually a small gap. Look into this gap with a flashlight and search for insulation. Before concluding that there is or is not insulation in your exterior walls it is best to check behind several light switches or electrical outlets.

If you find that there is no insulation there are two basic ways to insulate your exterior walls. You could rip out all of your interior drywall (very messy and costly) and install radiant barriers and insulation (see roof chapter). This is generally not a good idea unless you are already in the process of a large renovation. Remember again that unless you are air conditioning your home insulation will not save you any money! A much less invasive method of insulating exterior walls is to hire a contractor to drill small holes between the studs in the wall on either the inside or outside of your home and spray insulation into the wall cavities through the holes. In many places on the mainland you can buy loose fill insulation rent the blower equipment to do this yourself. Currently this option is not available in Hawaii.

Two local contractors are Spray Foam Hawaii and Aloha Insulation (see contacts at the end of the chapter). Both of these companies will install insulation in existing walls. Prices for installing insulation in existing walls vary a lot depending on individual situations. A large part of the expense is actually drilling and patching all of the holes that have to be created. If you have an existing base board along the walls you want to have insulated it might be cheaper because the base board could be removed allowing holes to be drilled. If you have fire blocking it means you have to drill holes in the top and bottom of the wall and this could complicate things further and increase the price. These contractors will send someone to look at your house and give you an estimate.

Walls | Suspended Particle Paint

Many older homes in Hawaii are built of single wall construction. This means that the walls are not constructed with metal or wooden studs. This also means that there is no wall cavity where insulation can be installed. These older single wall construction homes were not originally intended to be air conditioned. 30 years ago the number of homes in Hawaii that used air conditioning was much lower¹⁴⁵. However, today many people want to air condition their homes and many of the homes being air conditioned are built of single wall construction. To insulate the walls of these homes would be costly and potentially reduce the square footage of the home. Exterior walls absorb large amounts of heat during the hottest part of the day and air conditioners in single wall construction homes have to work harder to cool the spaces within¹⁴⁶.

Most people are familiar with the idea that lighter colors reflect more light. This is true and it is an important consideration when considering the color of the exterior of your home or the color of your roof. One simple and fairly cheap method of reducing heat gain on exterior walls is to paint them a lighter color. However, if you are like many people you may want to choose a color other than white for your homes exterior.

Cool Wall is an acrylic based (clean up with water) locally available product intended to reflect heat and radiation from the sun keeping the inside of your home cooler. It comes in satin and semi gloss and can be tinted to custom colors (lighter colors reflect better). Its low VOC so its not as harmful to the environment or the person applying the paint. Cool Wall is intended to be painted on the exterior walls of Hawaii homes. It has been shown by the American Society for Testing Materials to reduce the surface temperature of exterior walls by as much as 40 degrees Fahrenheit compared to typical acrylic paint!¹⁴⁷

Installation is the same as for any other acrylic based paint. You first clean the wall surface by scraping off any old paint. You may have to take safety precautions as some older homes have paint that contains lead. You can buy kits at hardware stores to detect if your paint contains lead. If this is the case with your home wear long sleeved clothing, eye protection and a respirator when cleaning the exterior of the building. One good method for cleaning the exterior would be to close all of the windows and then wash the building with a pressure washer. You can rent a pressure washer for \$60 dollars a day from Hawaii Rent-All (see

145 Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home* (Honolulu, Hawaii: no publisher, no date), pg 23

<http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09).

146 James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001) pg 82

147 (no author), TexCote, Architectural and Protective Coatings, "Cool Wall Super Cote"

<http://allweathersurfaces.com/wp-content/themes/aws-theme/product-data/cool-wall-supercote-data.pdf> (accessed 3-22-2011).

Walls | Suspended Particle Paint

contacts list at the end of the chapter). Once the exterior walls are clean and dry you can paint on the Cool Wall primer which is about \$133 for 5 gallons. The primer will cover about 150 square feet per gallon. You should let the primer dry for 24 hours and then paint on the Cool Wall Coat. Wait 24 hours and then add the final coat. For further information visit: <http://www.allweathersurfaces.com/> or call (808) 487-3043.

Walls | Suspended Particle Paint



Single wall construction typical of older homes in Hawaii

<http://www.localpropertyindex.com:81/lpi-images/33/16979/lpiimg8489936.jpg>



Cool Wall \$215 for 5 gallons
<http://www.allweathersurfaces.com/products/cool-wall>



Paint roller, about \$3 at The Home Depot can be screwed onto broom handle

http://www.homedepot.com/h_d1/N-5yc1v/R-100001737/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



paint roller covers, about \$10 for three at The Home Depot

http://www.homedepot.com/h_d1/N-5yc1v/R-202046301/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053



Paint Roller Tray, about \$7 at The Home Depot

http://www.homedepot.com/h_d1/N-5yc1v/R-100656816/h_d2/ProductDisplay?langId=-1&storeId=10051&catalogId=10053

Walls | Suspended Particle Paint

TECHNICAL DATA

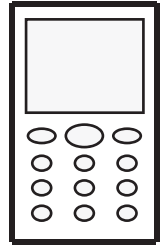
Table 1 Applicable Standards American Society for Testing Materials (ASTM)

<u>Test Method</u>	<u>Property</u>	<u>Result</u>
ASTM D2565-99-T-1, C # 4	Accelerated Weathering	5000 Hours, Passed
ASTM B117	Salt Spray Resistance	100 Hours - Passed
ASTM D714	Blistering Resistance	100 Hours - Passed
ASTM D610	Rusting Resistance	100 Hours - Passed
ASTM D968	Abrasion Resistance	825 liters falling sand
ASTM D3273/D3274	Mold & Mildew Resistance	28 Days- Rating 10, No growth
ASTM D6940	Wind Driven Rain Resistance	Passed
ASTM C67/D2794	Freeze-Thaw Resistance	50 cycles - Passed
ASTM D4585	Humidity Resistance	100 Hours - Passed
ASTM E96	Permeability	Passed
ASTM C1305	Crack Bridging	No cracks, separation or loss of film
ASTM D 4803-97	Total Solar Reflectance	Surface wall temperature reduced up to 40 degrees Fahrenheit depending on color and geographical location as compared to commercial acrylic paint.

Technical Data Showing Cool Walls effectiveness at reflecting heat

<http://allweathersurfaces.com/wp-content/themes/aws-theme/product-data/cool-wall-supercote-data.pdf>

Wall | Contacts



Home Improvement Stores:

The Home Depot	808 521-7355
City Mill	808 533-3811
True Value	808 949-7936
Hawaiian Rent-All	808 949-3961

Suspended Particle Paint Contacts:

All Weather Surfaces	808 487-3043
Cool Roof Hawaii	808 792-6132

Insulation Contacts:

Aloha Insulation	808 377-5564
A's Insulation	808 839-8065
Honsador Lumber	808 206-8234
Hawaii Insulation Inc	808 621-6562
Island Insulation Co.	808 851-7373
Spray Foam Hawaii	808 242-9202



Low-E - Low-E stands for low emissivity. This is an indication of how much radiant heat a particular product transmits. In this chapter tinting/window films are discussed and among the important qualities a tint/film possesses is its ability to reduce the amount of radiant heat that passes through windows.

Near Infrared Radiation- radiant heat from the sun that is not visible to the human eye. This is the heat you feel when you stand in the sunlight.

Far Infrared Radiation- radiant heat that comes out of hot objects for example the heat radiating out of your roof after it is heated by the sun.

SHGF/SHGC- solar heat gain factor or solar heat gain coefficient. This is the indication of how much near infrared light is allowed to pass through your windows. This number is often expressed as a percentage or decimal. .1 or 100% means all the near infrared light gets through your windows and .0 or 0% means none of the light gets through (there are currently no films this effective). In Hawaii get the lowest SHGF or SHGC possible for example .30 or 30%. A SHGC of .30 or less is required to qualify for the tax rebate listed on tax form 5695 in the rebates section of this book.

VLT- visible light transmissivity. This is the indication of the amount of visible light that window tint/film allows to pass through the window. This number is often expressed as a percentage or decimal. .1 or 100% means all the light gets through and .0 or 0% means all the light is reflected. In Hawaii a VLT of 70% is desirable.

UV - ultraviolet light from the sun that can sun burn you or fade the colors of things left exposed to the sun.

U-factor, this is the insulating value used for windows. Most other parts of a buildings skin are given R-values (see roof chapter glossary). An R-value is an expression of a building materials ability to resist heat flow and a U-factor is a measure of a materials ability to transmit heat. A U-factor is the reciprocal of an R-value. If you want to convert between R-values and U-factors, divide 1 by the U-factor number. For example a 0.25 U-factor equals a R-value of 4 ($1/0.25 = 4$).¹⁴⁷ If you purchase new windows they must have a U-factor of 1.2 or less in order to qualify for the tax rebates listed on form 5695 located in the rebates section of this book.

¹⁴⁷ (no author), Efficient Windows Collaborative, "U-factor," <http://www.efficientwindows.org/ufactor.cfm> (accessed 2-22-2011).

BACKGROUND INFO

This chapter focuses on reducing the heat that gets into your home through windows. The basic methods to reduce heat gain through the window are adding exterior shading devices, interior shading devices and/or films/tinting. If your house is already shaded by a large tree or building then you will want to factor that into your decision of whether or not to use the methods in this chapter.¹⁴⁸

As mentioned in the Roof chapter: Heat can be transferred in three ways. Conduction, convection and radiation. Conduction is heat that transfers through direct contact. Convection is heat that transfers through a carrier fluid such as air or water. Radiation needs neither direct contact, nor a carrier fluid and travels as visible and invisible light. In Hawaii the air temperature tends to be quite mild and therefore we don't have to worry much about heat that is transferred by convection. However, we do have to worry about radiant heat from the sun, and conductive heat from things the sun has heated up. To a lesser extent appliances and human bodies in your home produce heat. Remember, when dealing with windows there are three factors to consider. These are: reflection, absorption and transmission. How your windows are treated will affect these factors. Windows will naturally reflect a certain amount of the sun's light and radiant heat but some of the visible light and radiant heat will get through the windows. Some visible light that gets transmitted through the windows to the inside and will increase visibility but radiant heat also gets through and will increase the inside temperature. Finally, the objects in your house that the radiant heat contacts, including the window will absorb and reradiate heat¹⁴⁹.

The methods in this chapter will allow visible light to transmit through your windows while increasing the amount of radiant heat that is reflected and reducing the amount of radiant heat absorbed.

¹⁴⁸ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 31

¹⁴⁹ Peter F. Smith, *Eco Refurbishment: A Guide to Saving and Producing Energy in the Home* (Burlington, MA: Architectural Press, 2004), pg 56



The methods in this chapter will reduce the amount of heat that reaches the inhabitants of your home. If your home has air conditioned spaces, using these methods will allow the air conditioner to use less energy to cool those spaces. If your house is naturally ventilated you will not save money on your electric bill, but you will increase the comfort of your home by lowering the inside temperature. You will also potentially increase the value of your home to anyone who might want to buy your home down the road. If you are currently using air conditioning, these methods, in combination with other methods in this book, can help you reduce the number of spaces you need to air condition, or possibly allow you to naturally ventilate your home.¹⁵⁰ For more on natural ventilation see natural ventilation section in the AC chapter.

¹⁵⁰ Hawaiian Electric Company, Inc., Education & Consumer Affairs Division, *Energy Tips & Choices: A Guide to an Energy-Efficient Home* (Honolulu, Hawaii: no publisher, no date), pg 22
<http://www.heco.com/vcmcontent/StaticFiles/pdf/Energy-Tips-&-Choices-2008-Web.pdf> (accessed 9-15-09).

Windows | Exterior Shading Devices

Having some form of exterior shading device over your windows is an ideal way to stop radiant heat from getting into your home and the most effective method of reducing the heat gain through your windows¹⁵¹. There are many ways to do this and this method presents many advantages and disadvantages that should be noted. This method should be considered primarily for windows that are commonly in direct sunlight for lengthy periods of the day. Which windows are in the strongest sunlight will vary throughout the day and year. Typically the morning sun will beat down on a homes east facing windows and in the afternoon the south western windows will be hit. In Hawaii the sun gets higher in the sky at mid day in the summer than in the winter. Some windows that are not affected in one season will be affected in the other. You will want to consider these extremes when considering which windows to address with this method.¹⁵² On east and west facing windows vertical shading devices are most effective and on south facing windows horizontal shading devices are most effective. You will generally not need to put any shading devices on the windows on the north side of your home¹⁵³.



It should also be noted that of all the methods in this chapter, properly executed exterior shading devices are the most effective method for reducing radiant heat gain through windows.¹⁵⁴ Exterior shading devices are potentially the most inexpensive as well.

Exterior shading devices can be relatively inexpensive and quick to install. There are a number of ways to shade exterior windows allowing flexibility of choice. Often exterior shading devices can allow greater privacy as views out of treated windows remain relatively unobstructed but views in from outside are typically hindered. A draw back of this method is that, depending on how it is carried out it can interfere with the aesthetic appearance of your home and some methods reduce potential air flow and visibility of your windows. The cheapest exterior shading devices are also inoperable.

151 Kent Royle, Cliff Terry, *Hawaiian Design: Strategies for Energy Efficient Architecture* (Department of business and economic development energy division: 1990), pg C20

152 James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 41-54

153 Kent Royle, Cliff Terry, *Hawaiian Design: Strategies for Energy Efficient Architecture* (Department of business and economic development energy division: 1990), pg C21

154 Department of Business, Economic Development and Tourism, *Guide to Resource-Efficient Building in Hawaii* (Honolulu, Hawaii 2000), pg III-28

Windows | Exterior Shading Devices



Later in this chapter interior shading devices such as window blinds will be discussed. While these are an aesthetically pleasing and mechanically adjustable shading method, even the best interior shading devices are typically less than half as effective as exterior shading devices.¹⁵⁵

¹⁵⁵ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 42

Windows | Exterior Shading Devices



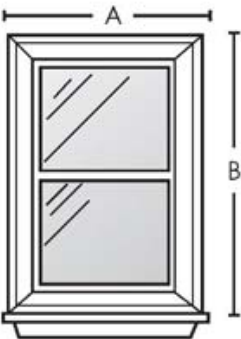
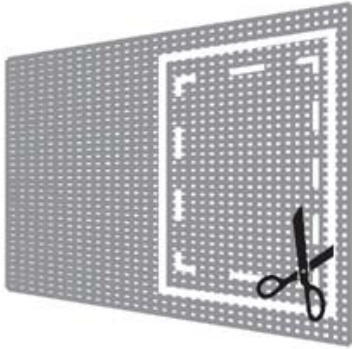

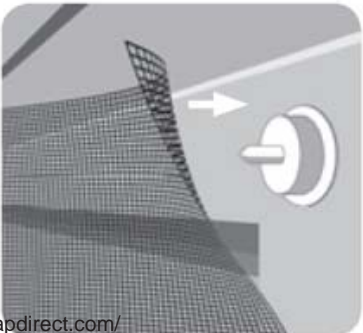
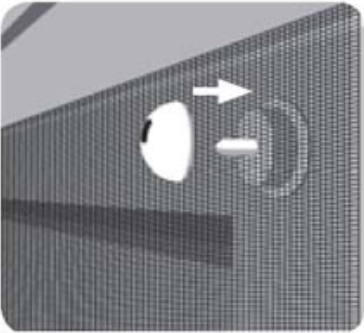
A sky light treated with the EZ-Snap system



Exterior and interior views showing the visibility from the inside and privacy from outside views

<http://www.ezsnapdirect.com/>

One way to create an exterior shading device for your windows is to apply a screen type material to the exterior face of the window. One company has created its own system for doing this. The product is called E-Z Snap. It involves sticking adhesive backed fasteners or optional screw type fasteners around the perimeter of a window, cutting the shading fabric to slightly offset the windows size and fastening the fabric to the exterior face of the window with the EZ-Snap fasteners. Below are the manufactures instructions.

1. Take Measurements 
2. Cut Fabric 
3. Studs & Pins 
4. Fabric Placement 
5. Cap Placement 

<http://www.ezsnapdirect.com/>

Windows | Exterior Shading Devices

Another low cost method of creating an exterior shading device is to build something rigid on the exterior of your window. If you are a do-it-yourself type this is a fairly simple project. You can build an external shading device with supplies from your local hardware store. There are endless examples of exterior shading devices on the web and with a little surfing you are sure to find something that matches your home and suits your tastes.

The Size of the exterior shading device is critical to its performance. For west and east facing shading devices a vertical shade is typically the best option. For south facing windows a horizontal shade is the most effective. The south face of your home is the side that generally receives the most heat during the day and probably the first place to consider for this method¹⁵⁶.



Remember, if you have something like a large tree or existing building already shading the south face of your home this method is not the best place to spend your time and money.

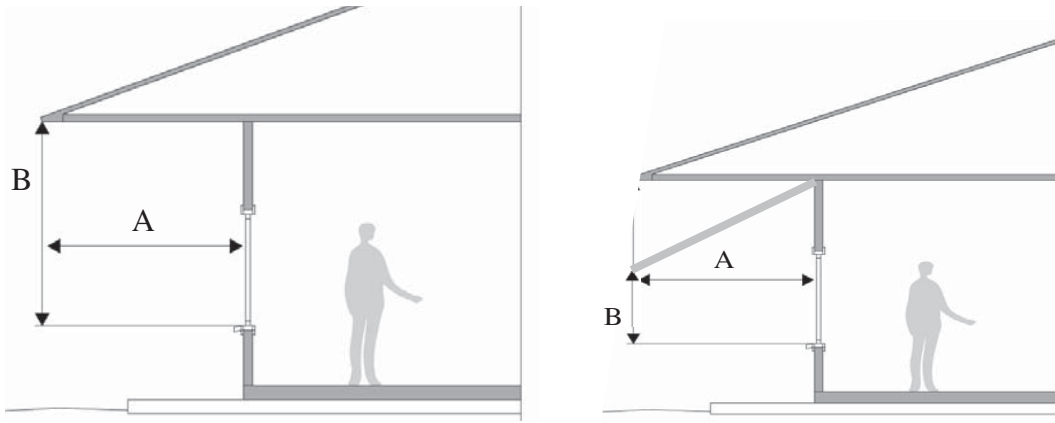
¹⁵⁶ Kent Royle, Cliff Terry, *Hawaiian Design: Strategies for Energy Efficient Architecture* (Department of business and economic development energy division: 1990), pg C22

Windows | Exterior Shading Devices



Typically for the best shading you want the shade device to be as far away from the face of the window as the base of the window is from the shading device. See the diagram below left. If the distance A is less than half the distance of B then the window will be inadequately shaded. If the distance A is equal to distance B then the window will be fully and properly shaded. If the distance A is more than the distance of B then your shading device is projecting unnecessarily far. Ideally the shading device will have a distance of A that is half of, or equal to distance B. For example, if you had a window that was 3' high measured from the bottom of the glass farthest from the shading device to the inside edge of your shading device (distance B), then ideally you would want a shading device that projected 1'-6" to 3' out from the face of your window (distance A).¹⁵⁷

The diagram below right is an indication of how a slanted shading device would be measured.



Shading diagrams

James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 42

¹⁵⁷ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 42

Windows | Exterior Shading Devices



The window of an east facing room that is not air conditioned and not used in the morning may not be a good candidate for a shading device as time and money would be better spent elsewhere.

The method used to determine the required size of a vertical shading device for an east or west facing window is similar to the method used for a south facing window. These windows will be most effected by sunlight early in the morning and late in the day, and this should be considered.



The diagram below right is a plan drawing (view from above) showing a window in relation to a vertical shading device. If the distance A is less than half the distance of B then the window will be inadequately shaded. If the distance B is equal to distance A then the window will be fully and properly shaded. If the distance B is less than the distance of A then your shading device is projecting unnecessarily far. Ideally the shading device will have a distance of A that is half of, or equal to distance B. For example, if you had a window that was 3' wide measured from the side of the glass farthest from the shading device to the inside edge of your shading device (distance B), then ideally you would want a shading device that projected 1'-6" to 3' out from the face of your window (distance A).¹⁵⁸

Depending on how much effort you are willing to put into your exterior shading device project it can create an aesthetic addition to your home, or simply be functional.

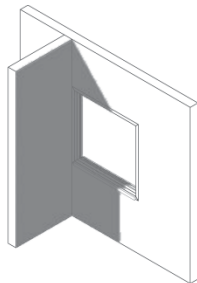
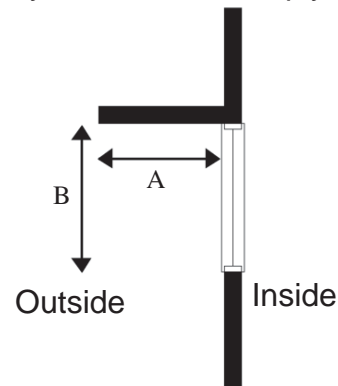


Diagram of a vertical shading device used for an east or west facing window



¹⁵⁸ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 42

Windows | Exterior Shading Devices



A rigid exterior shading device
<http://justshutters.co.nz/attachments/Image/Awning.jpg>



A rigid exterior shading device
<http://www.comingunmoored.com/wp-content/uploads/2009/07/AC2-300x225.jpg>

There are many variations on exterior shading devices. Some like the example in the above left image leave the outside view largely unobstructed, but are less effective at blocking the sun late in the day. Others like the example in the above right image block much more of the view out, but are much more effective at blocking the sun throughout the day. The example above right also offers more privacy¹⁵⁹.

If you are not the do-it-yourself type there are still plenty of options. Hunter Douglass and Sunburst Window Shutters are just a few companies that serve Hawaii's window shades needs. Look for the contact numbers of these and others at the end of the chapter. The below left image is an example of an operable exterior shading device that works much like the blinds you commonly find on the interior of your home, but are more than twice as effective at blocking heat because they block the heat before it reaches the windows. The below right image is an example of a more economic version of an operable exterior shading device. It is 4' x 6' and you could buy it at target for about \$30.



Operable exterior shading device
http://1.bp.blogspot.com/_0oxi4MU6XOk/SpKpghf-AOI/AAAAAAAAANG/Ncy1mmWtYjQ/s400/Hella+Exterior+Blinds.jpg



Out door blinds, about \$30 at Target
http://www.target.com/s?keywords=outdoor_blinds&LNM=Outdoor%20blinds&CPNG=_XS000000

¹⁵⁹ Kent Royle, Cliff Terry, *Hawaiian Design: Strategies for Energy Efficient Architecture* (Department of business and economic development energy division: 1990), pg C20

Windows | Interior Shading Devices

This method is likely familiar to most home owners. There are many forms of interior shading devices and they come in a wide variety of styles and price ranges. This method is as simple as measuring your window and then going to a local home improvement or interior design store to purchase a product that fits the window and meets your aesthetic needs. Interior shading devices are desirable because they are typically operable and allow the user to choose the amount of light that is blocked, and at the same time choose the level of privacy.



The downside to this method is that it is less than half as effective as an exterior shading device. This is something you may want to consider particularly if you air condition your home. Once light and radiant heat from the sun have passed through your window it's already inside of your home¹⁶⁰. Even if the window shades stop the light and heat from penetrating further into the home, the shades will heat up and eventually warm the air around them. Ideally light and radiant heat are blocked before they manage to get into the home.

Despite limitations, many people choose interior shading devices for reasons of aesthetics and cost. Most of us are already quite familiar with these devices but there are some worthwhile considerations. While interior shading devices may all seem like variations of the same idea, different designs offer different benefits.

Look carefully at the examples on the next page and notice that some devices retract from top to bottom, some from bottom to top and some from side to side. The flexibility of choosing which part of a window to shade and which part to leave unobstructed can be important. Avoiding glare on your TV or computer screen, or the ability to read comfortably may be affected by your choice of interior shading device. If you want to let light in through the top of your window late in the day, but you also want to shade the lower half of the window you may want a Roman style blind. If you want to let direct light in through one side of a window but not the other vertical blinds are most effective. Windows situated in different locations within your home will benefit from varying shading options.

There are also some brands of windows such as Pella that sell blinds sealed within two panes of glass so dust won't gather on them. Some of these devices are made of more durable materials than others and some are more easy to clean than others. Product utility, price and aesthetic quality vary greatly and with the above considerations you can find a design that meets your specific needs.

160 Kent Royle, Cliff Terry, *Hawaiian Design: Strategies for Energy Efficient Architecture* (Department of business and economic development energy division: 1990), pg C20

Windows | Interior Shading Devices



Roman Blinds offer flexibility retracting from top or bottom
<http://www.shadesco.com/images/d.jpg>



Vertical Blinds offer variable shading/privacy and retract to one side
http://www.decor-master.com/images/vertical_blinds.jpg



Pleated Blinds offer one level of shade and generally retract upwards, there are some that have two shade levels and some that retract from side to side
<http://www.poshblinds.co.uk/assets/images/pleated3.jpeg>



Venetian Blinds offer variable shading/privacy and retract upwards
<http://miniswindowblinds.com/wp-content/uploads/2009/02/venetian-blinds.gif>

Windows | Tinting

This method allows clear visibility while at the same time reducing the amount of radiant heat from the sun that gets into your home. If you have typical clear glass windows a large amount of the sun's light (both visible and infrared) pass through the glass while some is reflected. The visible light is nice because it lights your home without any cost. The infrared light comes from the sun in the form of near IR (or infrared) which passes easily through your windows. Once the heat is absorbed by objects on the inside of your home the near IR is reradiated out as far infrared or far IR. The far IR is not easily able to get back out through the windows of your home and remains trapped inside heating up the inside spaces.¹⁶¹

In order to reduce the infrared radiation from getting through your windows you can use special window tints or films. **Not all tints/films do the same thing!** There are a variety of tints and their specifications are very important when choosing a product. Typically in Hawaii you want to have a fairly high amount of visible light getting through your windows, and as little radiant heat (infrared light) getting through as possible. Different companies describe these qualities differently in their product specifications so be careful!¹⁶².



Remember to ask for a product with a visible light transmissivity or VLT somewhere around .7 or 70%. This means that nearly all the visible light from the sun will get through the window lowering the amount of electricity you will need to light your home in the day time. Many tints and films block all or mostly all UV light. UV or ultra violet is the light that can sunburn you and fade the color of your home furnishings. The other important number to ask for when choosing a tint/film is the SHGF or SHGC. These are two names for the same thing. Often called the solar heat gain coefficient or solar heat gain factor. Different companies label this with different names but it is important to remember that this is a number indicating that amount of radiant heat that gets in through your window. Typically you want the lowest SHGC or SHGF available, often something like .30 or 30%¹⁶³. Occasionally you will hear about a windows U-factor. This is the windows insulating value and is not affected by the tinting.

¹⁶¹ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 41

¹⁶² Peter F. Smith, *Eco Refurbishment: A Guide to Saving and Producing Energy in the Home* (Burlington, MA: Architectural Press, 2004), pg 56

¹⁶³ Kent Royle, Cliff Terry, *Hawaiian Design: Strategies for Energy Efficient Architecture* (Department of business and economic development energy division: 1990), pg G38

Windows | Tinting

These films are constantly getting better and better at protecting from radiant heat. Often values are labeled in a variety of ways so be sure to ask the product provider about radiant heat as this is what has the biggest effect on how much heat gets in through the window. Another form of performance tint/film is low-e glazing. This is specifically designed to meet the SHGF, VLT and UV specifications of a client. Low-e means low emissivity, meaning this product controls the amount of infrared heat of varying fields that passes through your windows. Low-e glazing can be designed to block the near infrared from the sun from getting into your home while allowing the far infrared from inside your home to get out. A good low-e films designed for Hawaii will also allow a great deal of visible light to pass through your windows. While low-e films are a good way to reduce the radiant heat that gets into your home, it is important to remember that even the best low-e tinting is typically only 2/3 to 1/2 as effective at reducing radiant heat gain when compared to a well designed exterior shading device¹⁶⁴



This method will only save you money on your electric bill if you use it on windows that are getting lots of sunlight and also connected to air conditioned spaces. It is also worth considering that if you currently air condition many spaces in your home, you may be able to reduce the need to air condition or eliminate it by using the methods in this chapter and other methods in the book. It is also perfectly valid to use tinting or low-e films to simply keep your non-air conditioned home at a more comfortable temperature while reducing the need to use electric lights during the day.

While it is completely possible to buy rolls of tint and do tint jobs yourself, it is usually a better idea to hire a professional to do this. Tinting is a tricky procedure that requires some specialized tools and a great deal of care. Windows are immaculately cleaned before they are tinted and a great deal of experience is generally required to be able to avoid wrinkles or bubbles. To insure effective and attractive results it is recommended to choose a qualified professional to have your home tinted.

¹⁶⁴ James Furuhashi, and Kathleen O'Brien, and Nick Huddleston, and Stephen Meder, *Field Guide for Energy Performance, Comfort and Value in Hawaii Homes* (Honolulu, Hawaii: U.S. Department of Energy and Department of Business, Economic Development & Tourism, 2001), pg 42

Windows | Tinting

The tint installer will also be able to answer your questions and help you choose a high quality product with a high VLT (70%) a low SHGF/SHGC (30% or less) and good UV protection. **Keep in mind that the SHGC is part of the criteria for whether or not your windows qualify for certain tax rebates (see form 5695 in the Tax Rebates chapter).**¹⁶⁵

One local company (T & T Tinting) charges about \$9.50 a square foot (installed cost) for films that offer variable VLT, SHGF and UV values. Less effective tints/films are about \$5 per square foot.



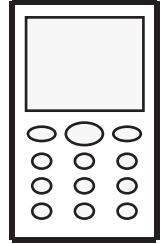
Not all tints and films are the same!
<http://www.seattlewindowtinting.com/images/window-film.jpg>



Professional tint installation is recommended
<http://tntinting.com/node/99>

¹⁶⁵ (no author), Efficient Windows Collaborative, "U-factor," <http://www.efficientwindows.org/ufactor.cfm> (accessed 2-22-2011).

Windows | Contacts



Hardware Stores:

The Home Depot	808-521-7355
City Mill	808-533-3811
True Value	808-949-7936

Window Shades:

Sunburst Window Shutters	808 851-7200
Hunter Douglass	808 964-2580
Sky Shades Hawaii	808 879-9600
EZ-Snap -	1-877-439-7627

Tint:

Al's Tinting	808 484-5093
Tint Factory	808 479-4531
Auto Trim Hawaii	808 306-3175
Custom Glass Tinting	808 593-9566
Elite Glass Tinting	808 596-2300
First Class Tint	808 941-6968
Midnight Tinting	808 479-9488
Pacific Window Tinting	808 536-9399
Alaka'i Window Laminates	808 847-2255

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