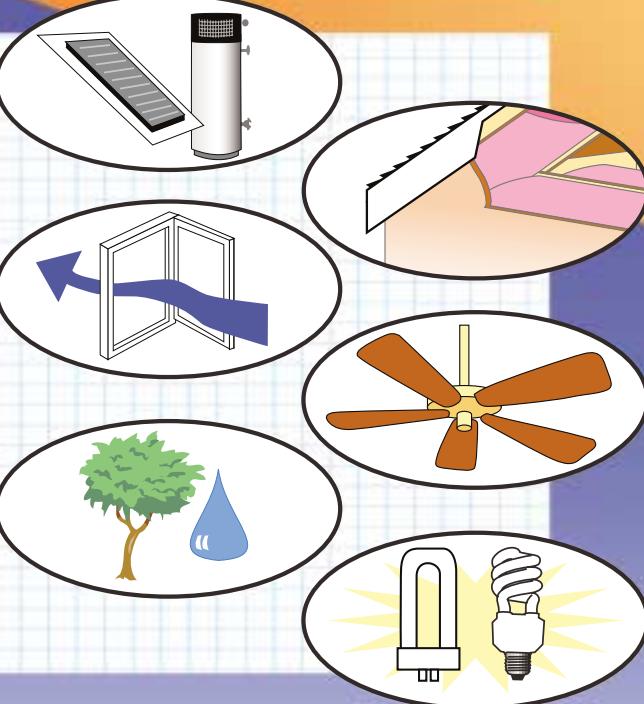


Hawaii Homeowner's  
Guide to

# ENERGY, COMFORT & VALUE

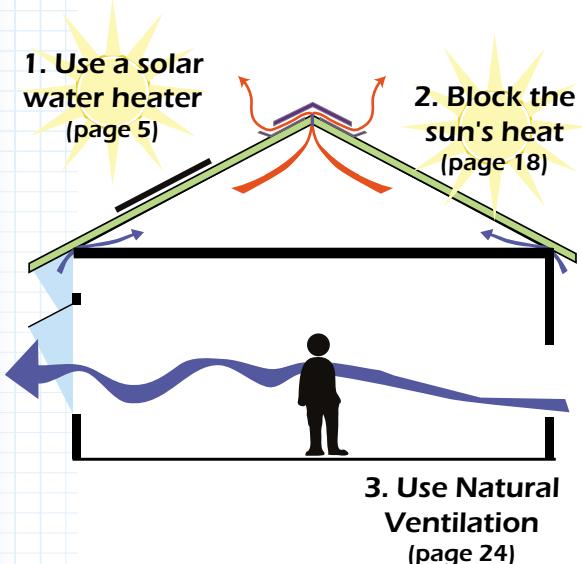


# Creating a High Performance Home

This guide provides tips to help you make your home more:

- Comfortable
- Affordable to operate
- Healthy
- Easy on the environment
- Valuable
- Durable

## The "Three Big Bang" Techniques of a High Performance Home:



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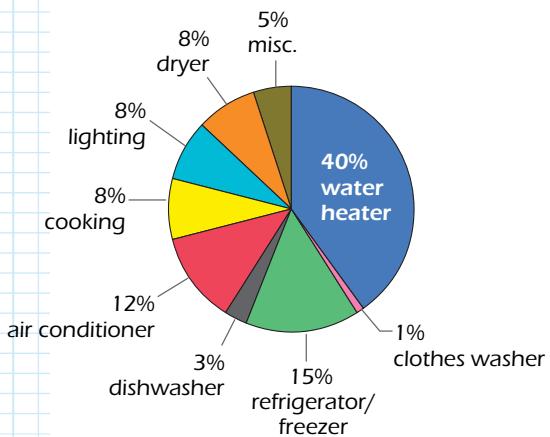
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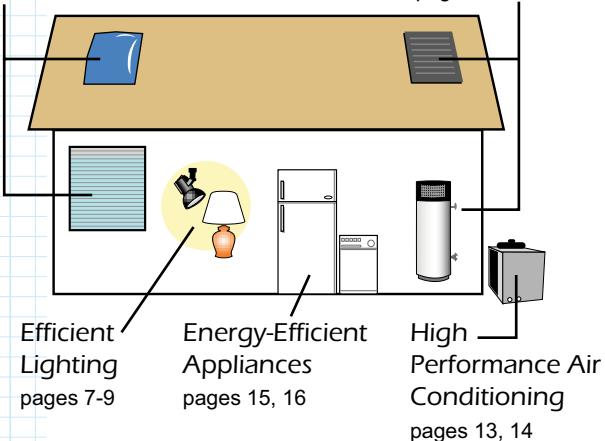
# Energy-Efficient Homes

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. This pie chart shows electrical energy use for a typical family of four in Hawaii. Source: Hawaiian Electric Company, Inc.



## Energy Cost Reduction Strategies

Daylighting  
pages 10-12



## Avoid the Need for Air Conditioning

Air conditioning is expensive to install and operate. Save money and still be comfortable by following the Comfortable Homes strategies described later. The Cool Roofs recommendations are especially important. Save about \$18,000 in cost for central systems and \$400 per year in energy costs by avoiding air conditioning. Air conditioning can also be a source of mold and mildew.

# Water Heating

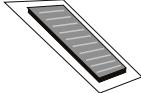
(Big Bang Technique #1)

The best opportunity to cut your utility bill

A utility-approved solar water heater is the most important energy savings step for a Hawaii home. Conventional water heating is a big expense. It accounts for about 40% of the utility bill in a Hawaii house. A solar system isn't cheap, but much of the installation cost can be offset by state tax credits and utility rebates, and may help you qualify for an Energy Star® Mortgage.\*

## Types of water heaters

### BEST



Solar

Saves 80% - 90% of water heating costs. Energy savings can pay back the installation cost in less than 4 years.

### BETTER



Heat pump

Works like an air conditioner in reverse, heating water and cooling air. Look for a coefficient of performance (COP) of 2.7 or better.

### FAIR



Gas

Some savings, requires gas service. Consider a high efficiency model with an energy factor (EF) of 0.65 or higher.

### POOR



Electric Resistance

Most common but most expensive to use. Check the Energy Guide label and buy the most energy efficient water heater.

## Costs

Type of water heater	Installed cost (for average size system)	Energy cost per year (for average family of four)
<b>BEST</b> Solar	\$2,000+	\$55
<b>BETTER</b> Heat Pump	\$1,000+	\$220
<b>FAIR</b> Gas	\$400	\$370
<b>POOR</b> Electric Resistance	\$350	\$520

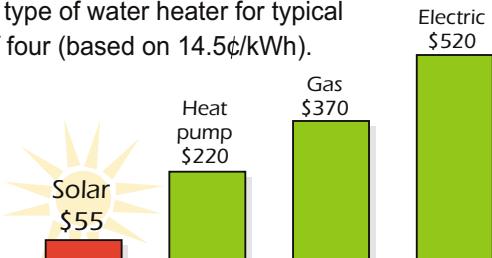
\*Does your new home qualify for an Energy Star® Mortgage?

A utility-approved solar water heater is all that is needed for a non-air conditioned Hawaii home! Call the utilities listed on the back page for more information.

## ■ Water Heating

(Big Bang Technique #1)

Comparison of cost per year  
for each type of water heater for typical  
family of four (based on 14.5¢/kWh).



## Tips & Techniques

- Get a State of Hawaii tax credit for solar and heat pump water heating systems. In 2002, the savings are 35% for solar systems.\*
- Call your utility company when planning your solar system. Utility incentives may be available for efficient water heating systems, further reducing the cost. Utilities may also provide lists of qualified contractors.
- Insulate hot water pipes with at least ½" foam or 1" fiberglass insulation.
- Set the thermostat for 120°F or less.
- Plan for solar water heating in the future (if not possible at present) by providing hot water pipe stubs.
- Install water-conserving fixtures like low-flow showerheads and aerators in faucets.
- Consider horizontal-axis (front-loading) washing machines that use much less water.

## Cost

- A typical solar system costs about \$4,000, but the cost to the homeowner can be much less due to tax credits and utility incentives.\*

## Savings

- Savings range from \$400 to \$600 per year compared to an electric water heater (based on 14.5¢/kWh).

\*See the Additional Resources section on the back of this brochure for places to find latest information on tax credits, utility rebates, Energy Star® Mortgages, and other incentives.

# Lighting

## A cost effective investment

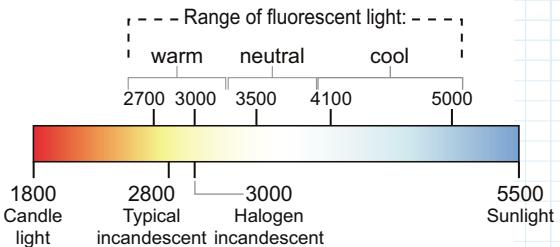
An efficient lighting system uses fluorescent lamps as the primary light source and may selectively use incandescent (also halogen, a type of incandescent) for accent lighting and for applications where the light is usually off (like exterior lights on motion sensor controls).

Modern fluorescent lighting can provide excellent color rendering and be free of flicker and hum. And start up is nearly instantaneous with electronic instant-start and rapid-start ballasts. Fluorescent lighting costs more initially but pays for itself. Remember that fluorescent lamps last 10 to 20 times longer than incandescents, saving energy all the while, so the lifetime cost is much lower. Plus, fluorescent lights do not emit as much heat as incandescents.

## Explaining lighting terms

### Color Appearance

Correlated Color Temperature (CCT) refers to the apparent color of a light source. Warmer colors have lower CCT, cooler colors have higher CCT. Fluorescent lamps cover a wide range. The best choice is a matter of personal preference.



### Color Rendering

Color Rendering Index (CRI) tells how well a light source shows colors. A higher value (up to 100) generally means more accurate colors. For fluorescent lamps, choose a CRI of 70 or higher for most uses and consider a CRI of 80 or more for applications like bathroom vanity lights.

### Lumens & Efficacy

Lumens describe a quantity of light. Efficacy is expressed in lumens per watt; bulbs that use fewer watts to produce the same amount of light have higher efficacy.

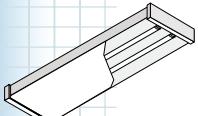
4-ft. T-8 Flourescent	Compact Flourescent Lamp (CFL)	Standard Incandescent
32 watts	13 watts	60 watts
3,000 lumens	800 lumens	800 lumens
90 lumens per watt	55 lumens per watt	13 lumens per watt
<b>BEST</b>	<b>BETTER</b>	<b>POOR</b>

### Ballasts

Ballasts are devices that control both the voltage needed to start a fluorescent bulb and the current required during bulb operation. Electronic ballasts are more efficient than magnetic ballasts, run cooler, and eliminate flicker and humming. Electronic ballasts may not be available for small fluorescent lamps like 9 or 13 watt CFLs.

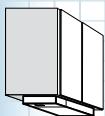
## ■ Efficient Electric Lighting

Full-Size, Surface Mount or Recessed, Ceiling



- Two 4-ft. tubes with electronic ballast (60 watts).
- Excellent for kitchen and large bathrooms (especially using lamps with CRI above 80).
- Illuminates up to about 100 square feet.

- Equal to four 90-watt incandescent (360 watts). Save about \$50 per year (based on three hour per day operation, 14.5 ¢ per kWh).
- Clear prismatic acrylic lens distributes light better than simple diffuser, with less glare.



### Under Cabinet

- T5 and twintube CFL work well (look hard for CRI >80).
- Great to eliminate dark counters in kitchen or office.



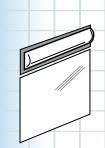
### Recessed Can

- 26 watt compact fluorescent instead of 100 watt incandescent.
- For kitchen, bathroom, living room. Anywhere to provide more dramatic down light; good optical designs have low glare.
- Saves about \$12 per year.
- Electronic ballasts (or electronic starters in small CFLs) start lamps flicker-free.
- Best to buy fixtures specifically designed for pin-based CFLs.



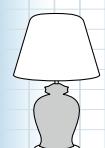
### Bathroom

- One four-foot T8 lamp (32 watts) in pleasing fixture instead of three 40-watt incandescents; select 3500 K, 85 CRI lamp for most flattering look.
- Use over mirror in bathroom, or a 17-watt (2 ft.) T8 luminaire along each side of the mirror.



### Ceiling Mount

- Two 26-watt CFLs instead of two 100-watt incandescents save about \$24 per year.
- Use in bedroom, kitchen, living room, or utility rooms.
- Different sizes are available.



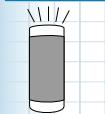
### Table Lamp

- Look for specially designed table lamps using CFLs, some with dimming controls.
- Many existing table lamps can take screw-base CFLs; a few CFLs dim or operate with three-way switches.
- For living rooms, bedrooms, office.



### Floor Lamp

- CFL floor lamps are available to replace traditional halogen incandescent torchieres; most dim or switch for a selectable light level.
- For living room and bedroom; CFL torchieres are much cooler and safer than halogen.



### Wall Sconce

- Look for CFL fixtures.



### Low Voltage Halogen Spotlights

- Use sparingly to highlight art work or accent design features
- Buy quality bulbs for good performance
- Unless you need the flexibility of dimming, use lower power lamps if you need less light. Dimming makes lamps yellowish and less efficient.

## ■ Efficient Electric Lighting

### Tips & Techniques

#### What to Look for in Fluorescent Lights:

- CRI of 80 or greater for good color rendering.
- Electronic ballast for energy savings.
- CCT of 3,000K or less for a warm look, 3,500K for neutral color, and 4,100K or higher for cool appearance. To match the yellowish color of typical incandescent lamps, many CFLs have a CCT of 2,700K.
- For long tubes choose T-8 (1" diameter) bulbs with electronic ballasts instead of T-12 (1.5" diameter).

#### Other tips:

- Conserve energy with controls like timers, occupancy sensors, and photo sensors.
- Use halogen lamps sparingly for accent lighting. They are not very efficient and can even be dangerously hot in some fixtures like torchieres. A CFL torchiere may save enough energy in its first year of use to pay back the entire extra cost of the better technology.
- A few CFLs can use typical residential dimmers, but read each CFL package carefully! Most CFLs CANNOT operate properly with dimmers, and could cause a fire.
- Most other types of fluorescent lamps can also dim, but the proper ballasts and controllers are expensive. If you buy a dimming ballast, use the controls and lamps the ballast manufacturer recommends.
- White colored ceilings and walls increase light levels.

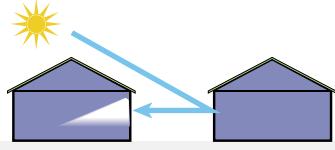
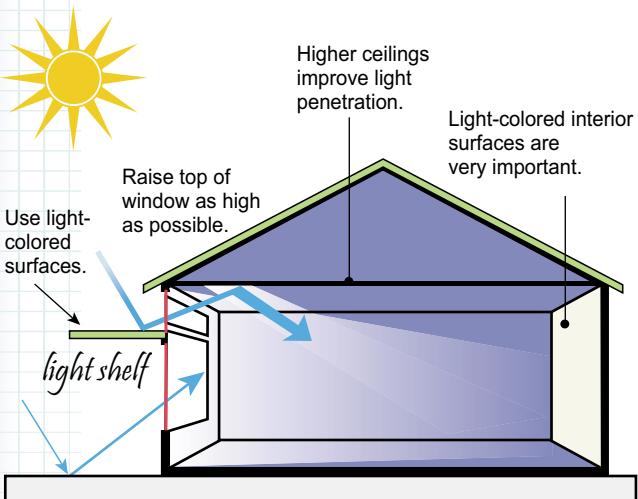
# Daylighting

## The other solar energy system

Sunlight connects us to the outdoors and natural rhythms. It can reduce electricity bills, too. The trick to using daylight in Hawaii is to get enough light without too much heat.

### Daylight and windows

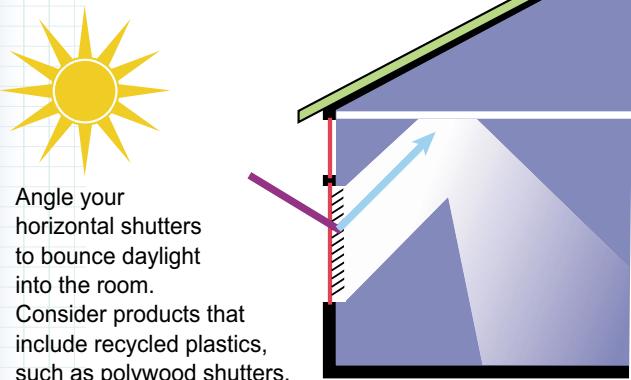
Windows are usually a home's main source of daylight. Try to block direct sunlight and bounce light onto the ceiling.



Daylight can also reflect off adjacent walls.

### Shutters

Use horizontal shutters if exterior shades are not feasible.



## Daylighting

### Skylights

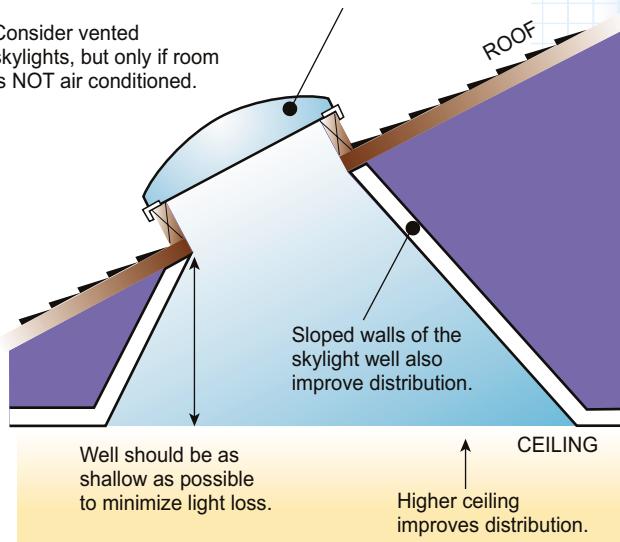
Skylights can provide very pleasant light, making a room feel bright and airy. Follow these tips to get good light distribution without creating excessive heat and glare.

#### Skylight Features

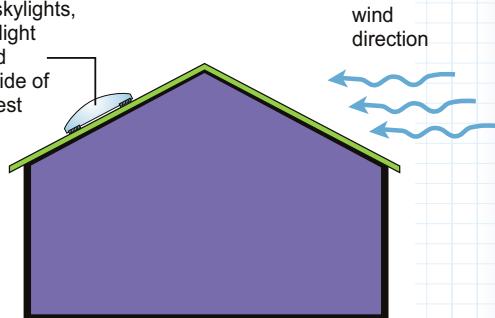


Clear prismatic or white diffuse skylights provide best light distribution.

Consider vented skylights, but only if room is NOT air conditioned.



With vented skylights, place the skylight in the leeward (downwind) side of the roof for best performance.



Use this table as a rough guide to select skylight size.

#### Skylight size

#### Floor area covered (square feet)

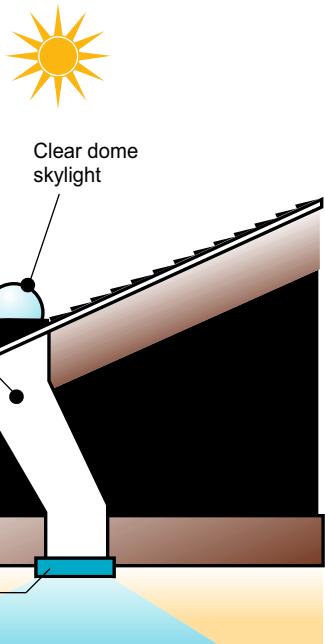
1.5' x 1.5' (2.2 sq. ft.)	50 - 110
2' x 2' (4 sq. ft.)	100 - 200
2' x 3' (6 sq. ft.)	150 - 300
2' x 4' (8 sq. ft.)	200 - 400

## ■ Daylighting

Tubular skylights are often less expensive to install and can help brighten spaces that might otherwise be difficult to daylight.

### Tubular Skylights

- 8" tube serves up to about 100 square feet.
- 13" tube serves up to about 150 square feet.



### Tips & Techniques

- Light-colored interior finishes are critical for good light distribution. A white ceiling is recommended.
- Minimize area of east- or west-facing windows or use polywood shutters.
- Blue or green glass transmits more visible light than gray or bronze tints (see Cool Windows section).
- Rooms with higher ceilings and narrow floor plans are easier to daylight.
- Consider several smaller skylights instead of one larger skylight for better light distribution.

### Cost

- \$100 - \$200 plus installation

### Savings

- Save up to \$50 per year in lighting electricity cost for each skylight.

## High Performance Air-Conditioning

### Bigger is not always better

In terms of energy, economy, and health, it is best **NOT** to air condition your home. However, if you live in a dusty or noisy area, you might want AC. In that case:

- Follow the recommendations for Cool Roofs, Walls, and Windows (to minimize your AC use).
- Compare Energy Guide labels.
- Seal air leaks in the home and ducts.
- Choose an AC unit that is not too big, but just the right size.

### Not Too Big!

Smaller AC units run more efficiently and usually provide better comfort and air quality. They don't cycle on and off as much, and they remove more moisture from the air, reducing the risk of mold and mildew growth.

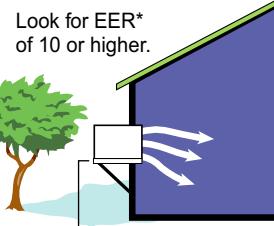
### How much AC do I need?

Floor area (in square feet)	Capacity (Btu/hr.)
150 - 250	5,000
200 - 300	6,000
250 - 350	7,000
300 - 400	8,000
350 - 450	9,000
400 - 550	10,000
500 - 650	12,000
575 - 800	14,000
750 - 1000	18,000

Applies to window or ductless split system AC. Consult contractor for central AC size.

### Window Air Conditioner

Performs most efficiently in a shaded location, like on the north side of a home.



Install on a level surface

### Ductless Split System AC

Consider units with multi-speed fans & compressors for better overall performance.



\* Energy Efficiency Ratio    \*\*Seasonal Energy Efficiency Ratio

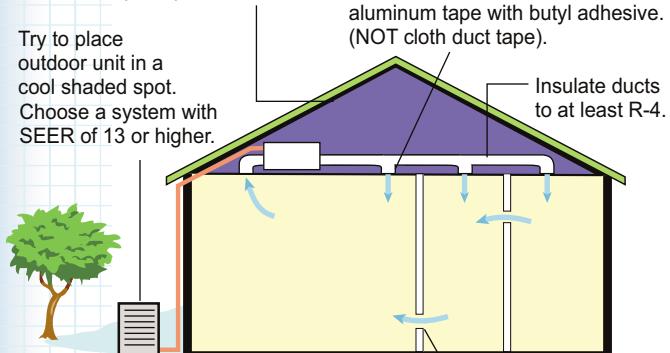
## ■ High Performance AC

### Central AC System

Install a radiant barrier or insulation under the roof to help keep ducts cool.

Try to place outdoor unit in a cool shaded spot. Choose a system with SEER of 13 or higher.

Mechanically fasten (with screws or nylon straps) and seal all connections with mastic or aluminum tape with butyl adhesive. (NOT cloth duct tape).



A multi-speed fan and compressor provide better comfort and efficiency. Provide return vents or transfer grilles for each room with a supply vent.

If using a pre-insulated flexible duct, stretch it to its full length, and don't allow sharp turns. Otherwise airflow drops dramatically.

### Tips & Techniques

- Before installing AC check the recommendations for Cool Roofs, Walls, Windows, and Natural Ventilation. Do not air condition your home unless absolutely necessary.
- Seal joints in walls, floors and ceilings. Use acrylic latex, polyurethane, or silicone-based sealants.
- Choose high-quality, low air leakage windows and doors or seal them with weatherstripping.
- Provide a drain for condensed water from the cooling coil. Always empty the drain pan to prevent mold growth.
- Make sure that AC systems are easily accessible for maintenance.
- Hire a contractor to periodically clean coils and check refrigerant charge.

### Cost

- Electricity cost for a window AC is \$0.20 to \$0.40 per hour and can add up quickly. A typical central AC costs in the range of \$0.60 to \$1.00 per hour. Annual AC costs are \$300 to \$500.

### Savings

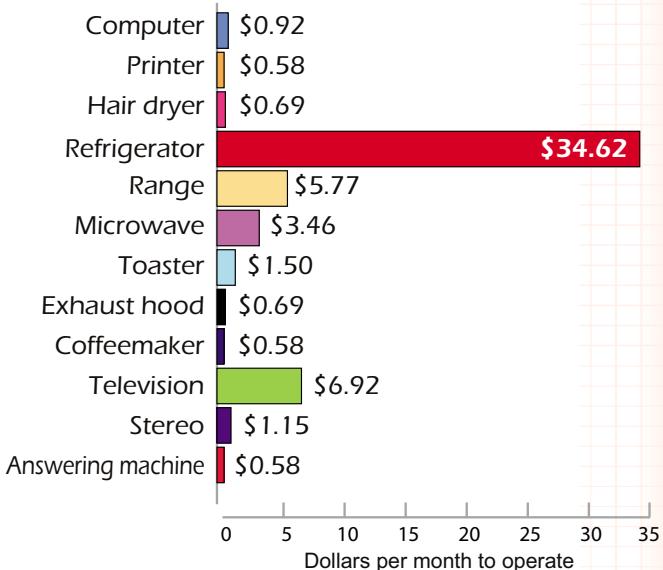
- Proper sizing and installation saves 20% to 30% or more on AC costs.

## Energy-Efficient Appliances

### The savings add up!

Over the life of most household appliances, their operation costs will far exceed the original purchase price. Energy-efficient appliances may initially cost more than standard appliances, but cost much less to operate.

Average monthly energy costs for common household appliances (based on utility rate of 14.5¢ per kilowatt hour of electricity):



### Look for energy efficiency labels on new appliances

Read the Energy Guide labels to compare energy costs. Appliances with the ENERGY STAR and Green Seal labels are efficient choices.



## ■ Energy-Efficient Appliances

### Refrigerators

- ✓ Compare Energy Guide labels for savings.
- ✓ Buy the right size - 14 to 17 cubic feet for 3 to 4 occupants.
- ✓ Choose a model with top or bottom freezer rather than side-by-side.
- ✓ Avoid models with ice makers and through-door water dispensers.
- ✓ Look for separate controls for the freezer and refrigerator compartments.
- ✓ Provide 3" of air space around coils for them to operate efficiently.
- ✓ Place refrigerator away from heat sources such as stoves, ranges, and dishwashers.
- ✓ Set temperatures at about 36°-38°F in the refrigerator and 0°-5°F in the freezer.

### Laundry Equipment

- ✓ Use a clothes line to replace electric or gas clothes dryers.
- ✓ Use a horizontal-axis, front loading washing machine to save water and water heating energy.
- ✓ If you must use a dryer, select one with moisture sensors and cooldown cycles.
- ✓ Clean dryer filter often, vent clothes dryer directly to the outside of the home.

### Cooking Appliances

- ✓ Consider induction or halogen cooktops instead of electric burners.
- ✓ Install a range hood to vent heat and humidity.
- ✓ Use microwave and toaster ovens rather than a full-size electric oven.
- ✓ Install self-cleaning ovens; they have better insulation.
- ✓ Use a convection oven instead of a standard electric oven.
- ✓ Select ovens with windows so that you don't need to open the oven to look at what's cooking.

### Dishwashers

- ✓ Install dishwashers with built-in booster heater so you can lower the water heater temperature setpoint.
- ✓ Select a unit with an energy-saving wash cycle.
- ✓ Use the air-drying cycle to save energy.
- ✓ Regularly clean the filter at the bottom of the dishwasher.

# Comfortable Homes

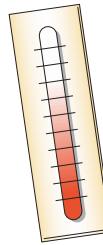
There's more than  
one way to keep cool

A comfortable Hawaii home uses a combination of strategies to keep cool. In most cases, air conditioning is unnecessary with proper attention to comfort design.

The keys to Hawaiian comfort:

### Air Temperature

Keep the sun's heat out and stay cooler.



- Cool Roof (page 18)
- Cool Window (page 21)  
(let the view in and keep the sun out)
- Cool Wall (page 23)

### Air Movement

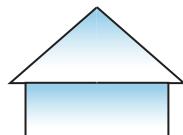
A gentle breeze increases the rate of evaporation from your skin and helps you feel much cooler.



- Natural Ventilation (page 24)
- Ceiling Fans (page 26)
- Site Planning (page 27)

### Radiant Temperature

Cooler indoor surfaces help you feel comfortable.



- Cool Roof (page 18)
- Cool Wall (page 23)

# Cool Roofs

(Big Bang Technique #2)

To cool your home,  
start at the top

A cool roof is essential for a comfortable home. A roof's second most important job in Hawaii, after keeping out the rain, is to keep out the sun. A roof that blocks the sun's heat keeps the home cooler and much more comfortable. If your home has air-conditioning, a cool roof will eliminate or reduce its use, cutting your electricity bills. Eliminating air conditioning will save up to \$18,000 for the cost of a new system and about \$400 a year in electricity.

## Tips & Techniques

- Ventilate the attic, especially when using a radiant barrier. A baffled ridge vent and large soffit vents are recommended (see page 20).
- If a ridge vent is not feasible, use a solar powered vent fan in combination with eave or soffit vents.
- Avoid compressing insulation as that will reduce its effectiveness. Keep attic vents clear if installing insulation.
- Consider encapsulated products if choosing fiberglass insulation to reduce the chance of contact with fibers.
- As an alternative to fiberglass, consider blown-in insulation made from recycled paper and treated with fire and pest retardant.
- Install a white roof to keep the roof surface 20° - 40°F cooler.

## Cost

- \$0.50 - \$2.00 per square foot.

## Savings

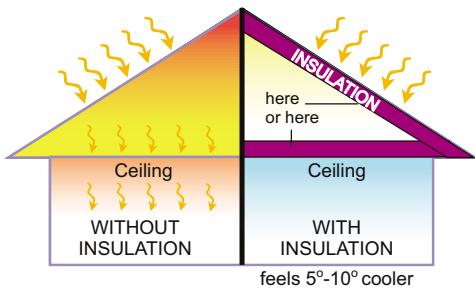
- \$360 - \$450 per year in reduced air conditioning costs for an average-sized house.

## Cool Roofs

(Big Bang Technique #2)

How insulation keeps you cool:

By blocking heat on the roof from getting into the attic, the ceiling and the rest of the house stay cool and comfortable.



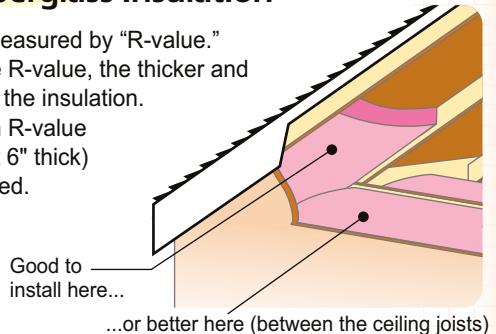
Cool roof options:

### R-19 Fiberglass Insulation

Insulation is measured by "R-value."

The higher the R-value, the thicker and more effective the insulation.

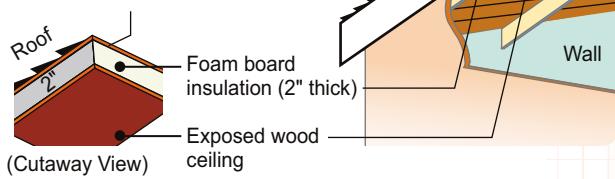
For Hawaii, an R-value of R-19 (about 6" thick) is recommended.



### Foam Board Insulation

Foam board insulation works well for open beam ceilings. A thickness of 2" is recommended.

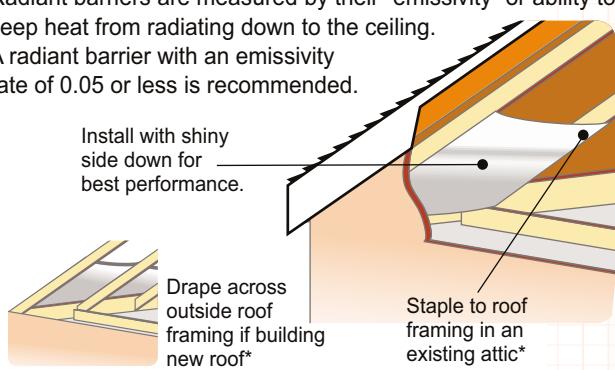
May need wood sheet on top of foam board on which to nail roof shingles.



### Radiant Barrier

Radiant barriers are measured by their "emissivity" or ability to keep heat from radiating down to the ceiling.

A radiant barrier with an emissivity rate of 0.05 or less is recommended.



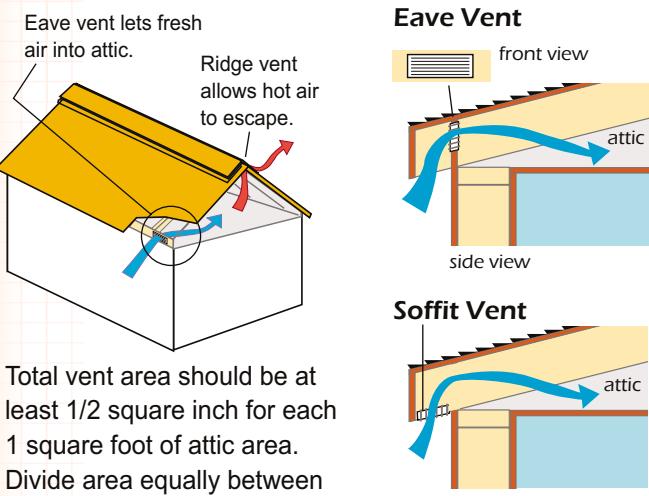
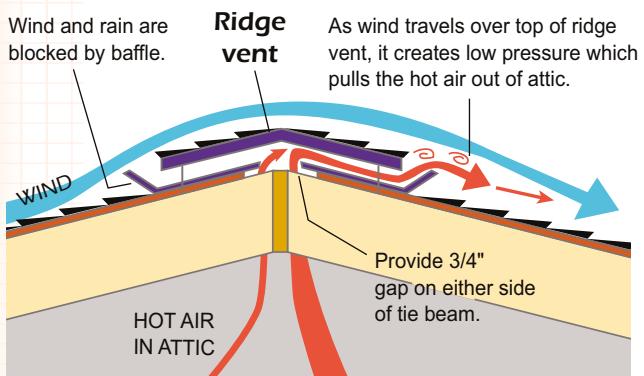
## Cool Roofs (Big Bang Technique #2)

### Attic Ventilation

For homes with attics, good ventilation is recommended when a radiant barrier is installed. And ventilation is also helpful even when the attic floor is insulated.

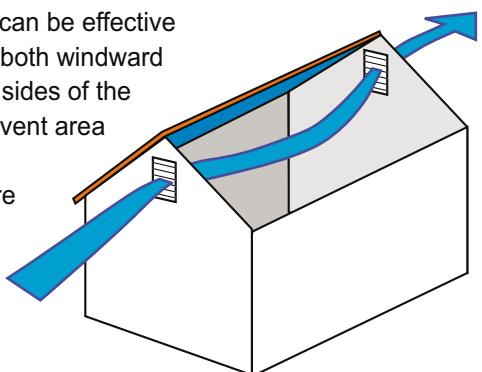
### Ridge and Eave or Soffit Vents

Combine a baffled ridge vent with eave or soffit vents for best airflow.



### Other Venting Options

Gable vents can be effective if located on both windward and leeward sides of the house. Total vent area should be at least 1 square inch per 1 square foot of attic.



## Cool Windows

### Keep cool with a view, too

Windows deserve attention because they are the easiest way for the sun's heat to enter into your house. The best cooling strategy is shading. Overhangs, awnings, and trees keep the sun from striking the window. Where exterior shading isn't feasible, invest in solar-control windows.

### Solar Control Windows

Window type	Typical values (see below for details)			
	SHGC*	VLT**	UV%***	Cost
Low-e <sup>2</sup> windows	.36	.70	43%	+\$4.00/s.f.
Double-paned				Make sure to get the "tropical," "sunbelt," or "low-e squared" type of low-e window with a SHGC of less than 0.40.
BEST				
Green/blue tinted	.69	.83	42%	+.50¢/s.f.
BETTER				
Gray or bronze tinted	.69	.61	35%	+.50¢/s.f.
GOOD				
Clear	.86	.90	71%	—
POOR				

 Look for the SHGC on the window's NFRC label.

\*SHGC = Solar Heat Gain Coefficient measures the fraction of solar heat admitted through a window; the lower the SHGC, the less heat transmitted.

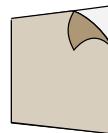
\*\*VLT = Visible Light Transmission indicates the fraction of visible light admitted through a window; the higher the VLT, the more light that passes through.

\*\*\*UV = Ultraviolet light. Lowering the UV light coming in through a window can help prevent sun damage to people, furnishings, carpeting, and drapes.

### Window Film

For existing windows, plastic window films can be applied to reduce heat. A wide variety are available. Applied to clear glass, they reduce SHGC from around 0.9 down to as low as 0.3.

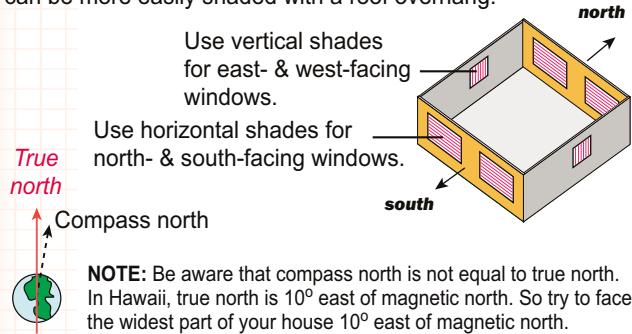
High performance films reduce heat while allowing in visible light. Look for a SHGC of 0.40 or less, together with a VLT of no less than 0.40.



## Cool Windows

### Orientation & Window Blinds

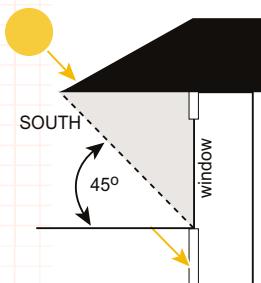
Try to orient your biggest windows facing north or south so they can be more easily shaded with a roof overhang.



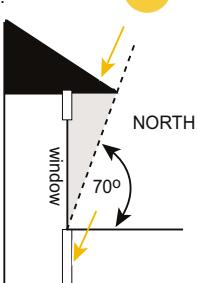
### Roof Overhangs

#### To determine how much of a roof overhang to build:

Use a 45° angle for overhangs over windows that face south (sun is lower in the sky in the south).



Use a 70° angle for overhangs over windows that face north (sun is higher in the sky in the north).



### Tips & Techniques

- Windows on the north or south side are preferred because they are easiest to shade.
- Avoid west-facing windows unless you really like the view, because it is difficult to block the afternoon sun.
- East-facing window area should be minimized as well, especially in hot parts of the islands.
- Vinyl or wood frames block heat gain somewhat better than aluminum frames.
- White frames are a little better because they reflect sunlight and stay cooler.

### Cost

- \$0.30 - \$4.00 per square foot (depending on strategies)

### Savings

- Up to about \$200 per year for a typical home with air conditioning.

## Cool Walls

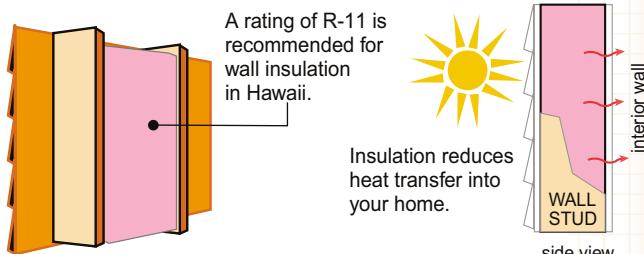
### Keep the sun out and stay cool

Unshaded walls can get very hot and make your home uncomfortable. The best "cool wall" strategy is shading with overhanging eaves, lanais, or landscaping. If complete shade isn't feasible, use insulation or radiant barriers in the exposed walls as illustrated below. In air conditioned homes, all walls should have insulation or radiant barriers to reduce electricity bills and air conditioner size requirements.

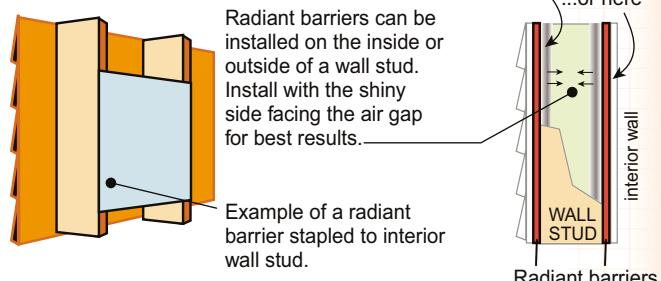
### Cool wall options:

Insulation and radiant barriers work well to keep the sun's heat from seeping through the walls into your home.

#### Wall Insulation



#### Radiant Barriers



### Tips & Techniques

- Use a white exterior finish to improve cool wall performance.
- Consider spray-on cellulose and foamed-in-place insulation as alternatives to fiberglass batts. They offer better sound reduction and air sealing.
- Blown-in insulation is a retrofit option for existing walls.

### Cost

- \$0.25 to \$1.00 per square foot for new walls.

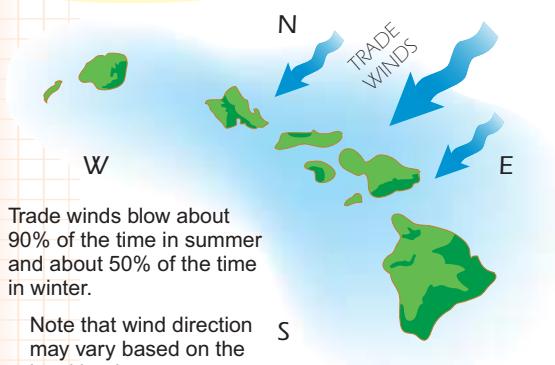
# Natural Ventilation

(Big Bang Technique #3)

## Cooling with nature

Gentle trade winds can make air conditioning unnecessary in most areas of Hawaii. Fortunately, summer is the windiest time of year in Hawaii, and you can capture cooling breezes to keep your home comfortable. Natural ventilation also helps reduce health hazards such as mold and mildew.

### Where does the wind come from?

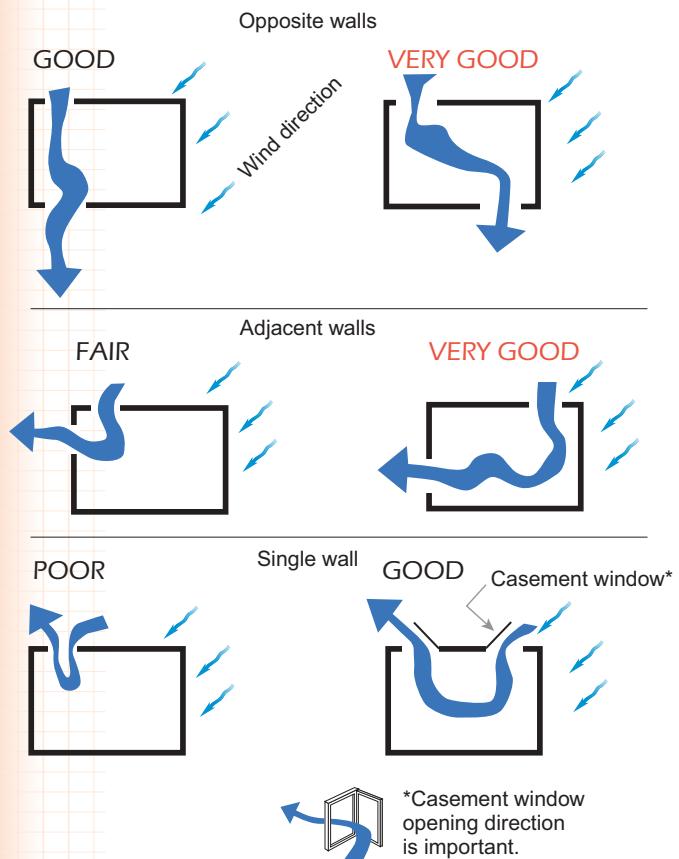


Trade winds blow about 90% of the time in summer and about 50% of the time in winter.

Note that wind direction may vary based on the local landscape.

### Where should I put the openings?

Orientation about 45° to wind direction is best.



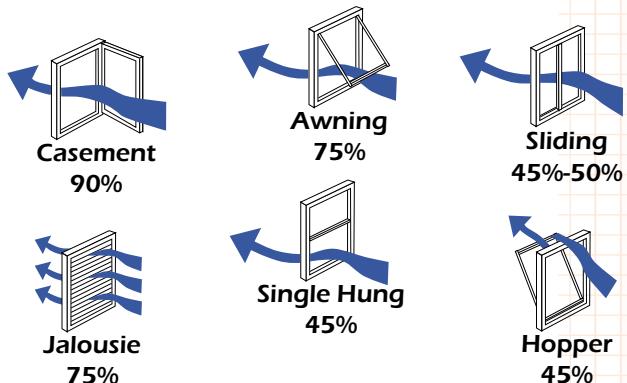
## Natural ventilation

(Big Bang Technique #3)

### How big should the openings be?

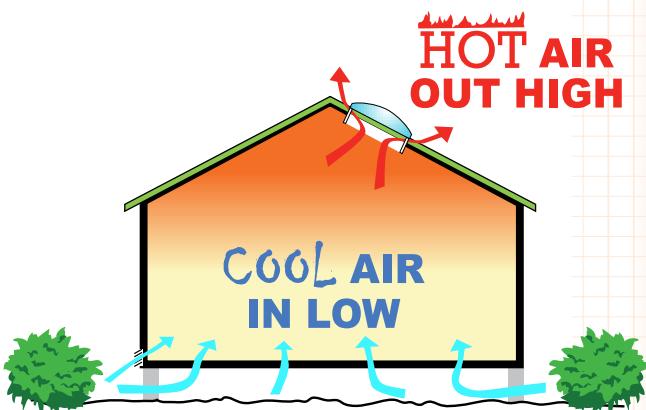
A reasonable rule of thumb is that the opening area should be about 12% of the floor area. Use more area for calm locations and less for very windy locations. Remember that the opening area is less than the total window area.

Opening Area as Percentage of Window Area:



### The "Chimney" Ventilation Alternative

Take advantage of the buoyancy of warm air to ventilate the house, even when no one is home.



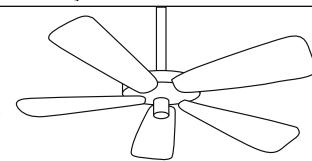
- Draw air from a cool shaded spot, as low as possible.
- Place outlet vents as high as possible, options include: vented skylight, ridge vents, vented cupola(s), gable vents and exhaust fans.
- Provide generous vent area:
  - at least 1 square inch per 1 square foot of floor area for combined inlet and outlet area, roughly 50/50 inlet/outlet.
- Consult an architect with stack ventilation experience for design details.

## **Natural Ventilation**

(Big Bang Technique #3)

### Ceiling Fans

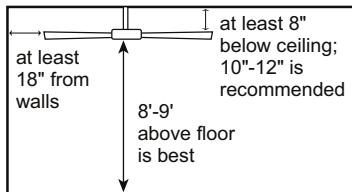
Ceiling fans create a gentle breeze that can take over comfort duties when the wind quits. They are also an excellent choice in noisy or dusty areas where it's unpleasant to keep the windows open.



Multi-speed fans can be adjusted to individual preferences.

Ceiling fans only need to run when someone's in the room. Otherwise they should be turned off to save energy.

Costs:  
\$75 - \$200



What size ceiling fan do I need to cool my room?

Room area (in square feet*)	Minimum fan diameter
100	36"
150	42"
225	48"
375	52"
400+	2 Fans Needed

\*To calculate the square footage of a room, multiply the width times the length. For example, a 10'x10' room would be 100 square feet.

### Tips & Techniques

- Provide shade on the windward side to keep incoming air cool. Shade the sunny side, also.
- Place appliances like refrigerators, ovens, and washer/dryers on the downwind side of the house.
- Try to place openings where they are secure from entry or rain so they can stay open at night and when no one is home.
- Provide catches to hold interior doors open to improve air flow or install louvered interior doors.
- To ensure comfort, also follow the recommendations for Cool Roofs, Walls and Windows.
- Casement windows are excellent for natural ventilation; jalousies should be avoided if the home will be air conditioned.
- Install ceiling fans to help out on calm days. Consider vented skylights in tall spaces (see Daylighting section).

### Cost

- Good orientation and sizing of openings can be free.

### Savings

- Avoiding air conditioning saves about \$18,000 in construction costs and \$400 per year in electricity bills.

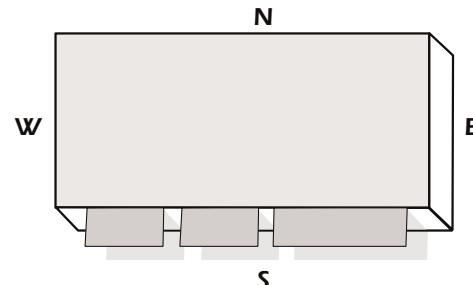
## **Site Planning/Landscaping**

### Plan to stay cool

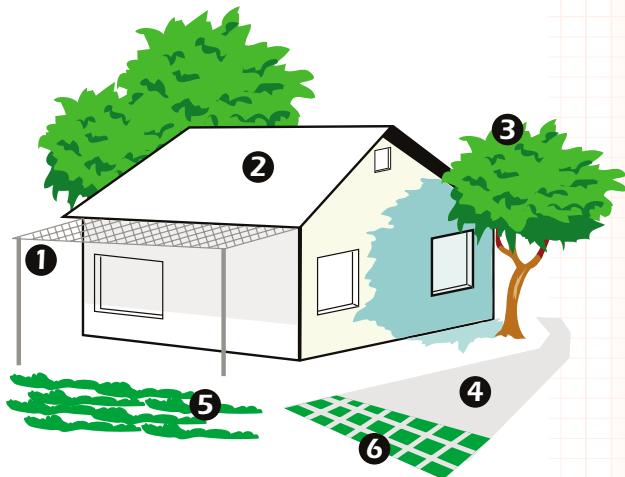
Through careful planning, you can stay cooler by keeping the air surrounding your house cooler, too.

### Site Planning & Landscaping for Comfort

Orientation is important. Try to minimize the area of east- and west-facing walls and windows because they are difficult to shade from the sun.



See the Cool Windows recommendations (pages 21 & 22) for shading south- and north-facing windows.



1. Build trellises to shade the house and paved areas.
2. Use light-colored roof to stay much cooler and help keep the surroundings cooler, too.
3. Use new or existing trees to shade walls and grounds.
4. Use light-colored exterior surfaces, such as cream-colored concrete, that stay cooler in the sun.
5. Limit area of unplanted and paved surfaces.
6. Use porous paving materials that can handle some auto and foot traffic but still allow grass to grow in gaps.

See the Natural Ventilation section (pages 24-26) for more site planning considerations.

# Resource-Efficient Homes

Resource-efficient homes make the best use of natural, human, and built resources. Worldwide, buildings are responsible for 12% of freshwater withdrawals, 25% of wood harvest, and 40% of material and energy flow.

In recent years innovation has made available a variety of resource-efficient products that minimize the overall environmental impact of a home by conserving the raw materials and natural resources used to build it. Conservation can occur at any point in the product's life: production, use, or disposal.

## Building Materials

### Reduce, reuse, recycle

Each product used to build a home represents an investment of energy, water, and raw materials, and has an impact on the environment. The environmental cost of building materials is not easily quantified, but there are several guidelines to help make good decisions.

Favor products that:

- Are produced locally.
- Foster the use of less material.
- Are durable and long-lasting.
- Include recycled content.
- Can be recycled.
- Are produced from a sustainable and renewable resource.
- Can be reused, reworked, or recycled.

### Tips & Techniques

- To minimize waste, design for standard dimensional lumber, sheathing, and panels.
- Avoid creating construction scrap.
- Specify installation with screws instead of glue to permit easy disassembly.
- Use salvaged materials.
- Avoid unnecessary coverings or coatings.

## Building Materials

### Concrete

Use concrete with fly ash (a by-product at Oahu's coal fired power plant) replacing up to 30% of the Portland cement. Use epoxy-coated steel reinforcement to extend the life of concrete. Use reusable form-work to reduce waste. Use recycled concrete for fill or to make new concrete.

### Insulation

Cellulose insulation is made in Hawaii from recycled newspapers or telephone books and is very resource efficient. It may be blown, poured into enclosed cavities in a dry form, or wet-sprayed. Cellulose provides fire retardancy and pest control when mixed with boric acid or sodium borate. When wet-sprayed in place, it provides an excellent barrier to air leakage. Some fiberglass batt insulation is manufactured using recycled glass. Products are available with at least 30% recycled content.

### Steel Framing

Steel is a durable, termite-proof, recyclable framing material. It has long-term performance and is easily recyclable. It does not contribute to poor indoor air quality. Protect studs and joists from corrosion and rust by using hot-dipped galvanizing and assembly with good quality connectors. Framing members are available with a minimum of 25% recycled content.

### Lumber

Use sustainably-harvested wood that is certified by the Forest Stewardship Council (FSC). Use engineered wood products made from smaller pieces of wood. Products include glulams, oriented strand board (OSB), laminated veneer lumber (LVLs), I-joists, and finger jointed lumber. Wood preservatives such as CCA and tribucide are toxic and present environmental hazards (both during treatment and at construction waste disposal sites). ACQ and Hi-Bor are less toxic.

### Roofing Materials

Roofing material should be durable, have high reflectance (see Cool Roof section), and be recyclable. Consider light-colored metal panels because they are durable and recyclable. Composite shingles, tiles, and panels made from fiber-reinforced cement products use recycled-content material and are durable (but not recyclable). If using asphalt shingles, use those with high recycled content.

### Floor Finishes

Consider salvaged, laminated, and veneered wood flooring. Laminated flooring makes efficient use of lumber and provides a durable surface. Bamboo flooring (plywood and tongue-and-groove) is available locally.

Natural linoleum is highly durable and made from renewable, biodegradable materials such as wood dust, linseed oil, and cork.

Traditional carpeting waste and scrap does not decompose readily and contributes significantly to the construction waste stream. If using carpets, consider using those made with Nylon 6 or Nylon 6,6 that offer a high level of recyclability, or those made with recycled content. Modular carpet tiles also reduce waste because they can be replaced selectively. Wool carpets (or other natural fibers) are biodegradable and renewable. Minimum amounts of low- or non-toxic adhesives should be used to lay the flooring.

### Gypsum Board

Drywall manufactured with recycled gypsum is equivalent in quality and price to conventional drywall.

# Water Conservation

Don't let it go down the drain

## Xeriscaping

Design water-efficient, low-maintenance landscaping (xeriscaping) by using drought-tolerant landscaping and native plants. Irrigation costs and water usage can be lowered 30%-60% through xeriscaping. Some drought-tolerant plants that grow well in this climate are:

**Trees:** wiliwili, kiawe, plumeria, autograph tree.

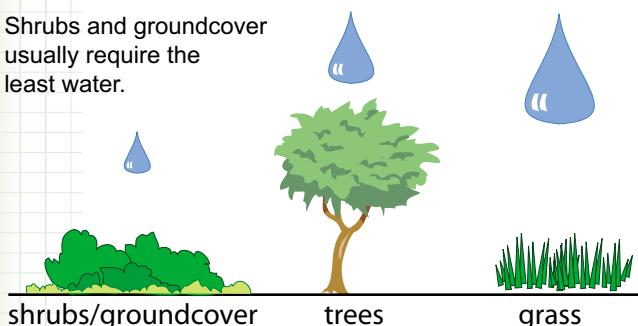
**Shrubs:** naupaka, plumbago, 'ulei, native plumbago, akia, ilima, kukui, natal plum, wax fiscus.

**Vines:** bougainvillea, cape honeysuckle.

**Groundcovers:** succulents, pohinahina, prostrate ilima, purple lantana, creeping rosemary.

Xeriscaping also includes improving the soil; reducing lawn areas by planting ground cover and local grasses; using mulch; and collecting surface runoff to water the plants.

Shrubs and groundcover usually require the least water.



## Rainwater Harvesting

Use rainwater-harvesting systems for garden applications. Also consider rainwater for showers, sinks, laundries, dishwashers, toilets, and, sparingly, even for drinking. Rainwater is collected from roof or ground level surfaces and stored in a cistern. The water is then filtered and delivered to terminals through pumps.

## Gray Water

Use gray water systems for nonpotable purposes like drought-resistant landscape irrigation and flushing toilets. Gray water is untreated "used" water that is not contaminated by toilet waste including water from showers, bathroom washbasins, and washing machines. It does not include wastewater from dishwashers, kitchen sinks, or laundry water from soiled diapers.

# Construction Waste Management

Waste not, want not

With a little planning, it's possible to reduce waste before it happens. In addition to helping preserve the Islands' environment, you can also save quite a bit in waste disposal fees.

## Tips & Techniques

- Have your contractor use the "Construction and Demolition Waste Management Guide" available from DBEDT's Clean Hawaii Center. Website: [www.hawaii.gov/dbedt/ert/chc](http://www.hawaii.gov/dbedt/ert/chc).
- Begin by buying recycled material.
- Reuse as much material as possible on your construction project.
- Separate recyclable and reuseable materials from non-recyclable materials and supply them to a business, charitable organization, or hauler.
- Set up specific areas for operations such as cutting and recycling, and clearly label these areas.
- Use suppliers who use recyclable or reusable packaging.
- Use reusable form-work for concrete.
- Provide weather protection for stored materials.
- Avoid the need to truck dirt on or off the site by balancing site cut and fill.
- Preserve existing vegetation and reuse as landscaping.
- Reuse material from deconstructed and demolished buildings.
- Avoid use of hazardous materials that require special waste handling.

# Recycling

Buying recycled products and separating recyclable materials from your garbage makes a big difference. Consider creating a space in your home to collect recyclable materials. Check with a local recycling center to see what they can take and what needs to be separated. Then set up bins to hold recyclables like newspaper, cardboard, mixed paper, glass, steel, plastics, and aluminum.



To find listings of products made from recycled materials, check out the Clean Hawaii Center at [www.hawaii.gov/dbedt/ert/chc](http://www.hawaii.gov/dbedt/ert/chc). You may also contact county recycling programs and drop-off centers. See back cover for their phone numbers.

# Composting

Composting can help lighten the load in your garbage can each week. If you cannot compost, contact the county for green waste pickup.

## What is it good for?

Compost can be used as a soil supplement in flower beds, vegetable gardens, lawns, and tree planting. It helps to conserve moisture, prevent erosion, and reduce weed growth. It also helps control diseases and pest infestation in plants, reduces the use of chemical fertilizers, and helps conserve natural resources.

## How to Compost

Composting is the controlled breakdown of biodegradable yard and kitchen wastes. There are several ways to get this to happen, and fortunately nature does most of the work. Success in composting depends upon sufficient moisture and oxygen.

### CAN IT BE USED FOR COMPOST?



Yard wastes like leaves, grass clippings, tree and shrub trimmings, wood chips, sawdust, and garden trimmings.

Kitchen wastes like coffee grounds, tea bags, raw vegetable scraps, fruit skins/cores/rinds, and corn husks.



Meat, bones, fats, grease, oils, dairy products, and raw manure. These materials easily attract animals and emit odors.

(Refer to county recycling and composting programs.)

# Healthy Homes

Most Americans spend about 60% of their time at home, so a healthy home environment is important. And good indoor air quality is probably the number one feature of a healthy home.

## Keep Dry and Clean (Prevent Mold)

Mold prevention is our top indoor air quality priority. Molds (also called mildew) are fungi. Some mold spores can produce an allergic reaction and a few are very toxic.

### Typical Symptoms Include:

- Wheezing, difficulty breathing, and shortness of breath.
- Nasal and sinus congestion.
- Eye irritation (burning, watery, or reddened eyes; nose or throat irritation; skin rashes or irritation).
- Dry, hacking cough.

It's tough to completely eliminate mold growth, but there are ways to help prevent it. The important thing to know is that mold needs both moisture and food, so the basic strategy is to keep things dry and clean.

### Mold Prevention Design Strategies:

- Use overhangs to protect walls from rain.
- Avoid air conditioning; however, if you must use AC, carefully insulate AC ducts and provide a well-sealed vapor barrier (typically plastic) around the insulation.
- Avoid the use of vinyl wall covering because it can seal moisture inside the wall.
- Minimize surfaces (drywall, carpet, grout, and rough unfinished wood) that collect dust or dirt. Whenever moisture is likely, use smooth surfaces (tile, finished hardwood, or sealed concrete) that are easy to clean.

### Maintenance Strategies:

- General cleanliness contributes to a mold-free environment.
- Immediately dry out materials that get wet from spills or plumbing leaks. Mold can start growing within 24 hours.
- Many materials cannot be properly cleaned once contaminated and may need to be thrown out. For guidance on cleanup see the U.S. Environmental Protection Agency web site: [www.epa.gov/iaq](http://www.epa.gov/iaq).

## ■ Indoor Air Quality

### Provide Fresh Air

A good common-sense method to help maintain good indoor air quality is to provide natural ventilation. Design tips for natural ventilation are covered on pages 24-26. Of course, this strategy is less useful in areas that are very dusty or have heavy outdoor contamination.

### Choose Healthier Materials

The materials we choose to build and furnish our homes have an impact on indoor air quality. Whenever possible choose materials with little or no off-gassing of volatile organic compounds (VOC), which can include irritants, toxic gases, or noxious odors.

### Wood Products

- Avoid products with particleboard, which typically contains formaldehyde.
- Use formaldehyde-free or exterior glue plywood instead of particleboard for countertop bases.
- Use exterior grade plywood, wood, or formaldehyde-free medium density fiberboard (MDF) for structural sheathing. Avoid wood treated with toxic compounds such as CCA and ACZA. ACQ and Hi-Bor are considered less toxic.

### Finishes

- Minimize use of carpet and upholstered materials because they can off-gas formaldehyde, permit accumulation of airborne contaminants, and foster growth of mold and dust mites.
- Maximize use of hardwood floors (factory-finished with low VOC finish or field finished with water-based finish) and concrete or tile.
- Use latex and water-dispersed acrylic paints and sealers with low or zero VOC content.
- Paints should be formaldehyde-free and ammonia-free (check ingredients). Do not be misled by "low-odor" advertising (low-odor products may still have troublesome ingredients).
- If adhesives are necessary, use low VOC, water-based products.
- Be aware that vinyl, used in flooring and wall covering, gives off toxic gases when burned.

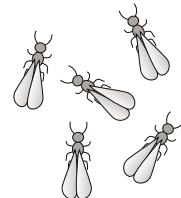
### Keep Clean During Construction

- Install insulation with care to ensure that occupants are not exposed to irritants such as fibers, retardants, stabilizers, and chemicals.
- Thoroughly clean the building before installation of carpet and baseboard trim.
- Perform final clean-up after construction with a high efficiency particulate air (HEPA) filter vacuum.

## ■ Termite Control

### Destructive Insects

Termites are a serious threat to the health of buildings in Hawaii, and conventional termite control strategies can present health risks to occupants and damage to ground water. Environmentally benign wood and ground treatment, combined with preventive design and maintenance for termite control, will enhance the health of the home and its occupants. Termites also create a health challenge for Hawaii homeowners because pest control methods may use toxic chemicals.



### Preventative Design and Maintenance

- Design with materials that are impervious or unattractive to termites such as concrete, steel, and plastic.
- Poured concrete walls are more termite-resistant than concrete blocks.
- Use alternative, environmentally friendly control methods such as stainless steel mesh and basaltic termite barriers.
- Provide easy access for termite inspection during occupancy.

### Ground Treatment

- Several effective and less-toxic chemicals are now available for soil treatment.
- For effective soil treatment provide at least 24-hours for the chemicals to dry and protect the treated soil layer with a slab, gravel, or surface soil layer.
- Termite bait systems are good insect growth regulators.
- Keep drainage flow routed away from the building by using appropriate grading and site drainage systems.
- Keep plantings at least 24" from the building perimeter.
- Keep the site and work area clean and clear of any organic debris, wood scraps, cardboard, and paper.
- When clearing vegetation, thoroughly remove all roots.

### Wood Treatment

- When treating wood, consider safer alternatives such as borate wood treatment (where it is unlikely that the wood will get wet), ACQ-treated wood, and naturally termite-resistant wood.
- When using oil-borne solvents, allow for adequate drying time before installation.

## **Energy Efficient Homes**

Refer to section pages for more details

### **Water Heating**

(Big Bang Technique #1)

page 5

- Install utility-approved solar water heating.
- Check for availability of state tax credits, utility rebates and Energy Star® Mortgages.
- Set your water heater's thermostat to 120°F or less.
- Install water conserving fixtures and appliances.
- Choose a horizontal-axis, front-loading washing machine.

### **Electric Lighting**

page 7

- Use "full-size" fluorescent lamp fixtures for best efficiency and color rendering.
- Choose electronic ballasts and T-8 fluorescent lamps.
- Replace standard incandescent light bulbs with compact fluorescent bulbs (CFLs).
- Replace halogen "torchiere" floor lamps with compact fluorescent floor lamps (halogen lamps get very hot and use much more energy).

### **Daylighting**

page 10

- Use light shelves and clerestory windows to help bring daylight into rooms.
- Install properly-sized skylights.

### **High Performance AC**

page 13

- Do not use AC except under extreme conditions. Check the recommendations for Cool Roofs, Walls and Windows (may not need AC).
- Buy the proper size air conditioner for your home (not too big!) - see page 13.

### **Efficient Appliances**

page 15

- Look for Energy Guide labels to compare energy costs for various appliances.
- Choose a refrigerator with top or bottom freezer instead of side-by-side.

## **Comfortable Homes**

Refer to section pages for more details

### **Cool Roofs (Big Bang Technique #2)**

page 18

- Install R-19 fiberglass insulation, 2" foam board insulation and/or a radiant barrier.
- Ventilate your attic with ridge and eave vents.
- Choose a light-colored roof surface.

### **Cool Windows**

page 21

- Shade windows using overhangs.
- Choose solar control windows.
- Avoid hot morning and afternoon sun by minimizing the size of east- and west-facing windows.
- Use window film for existing windows.

### **Cool Walls**

page 23

- Install R-11 insulation or a radiant barrier in walls exposed to sun.
- Choose light colors for wall exteriors.

### **Natural Ventilation**

page 24

(Big Bang Technique #3)

- Orient your windows 45° to wind direction.
- Choose casement windows to better capture air flow.
- Make opening area about 12% of the floor area of the room to be cooled.
- Install a multi-speed ceiling fan.

### **Site Planning/Landscaping**

page 27

- Shade south-facing windows and walls with roof overhangs.
- Build a trellis and use trees to help shade walls.
- Use light-colored concrete or porous paving materials for driveways and walkways.

## Resource Efficient Homes

Refer to section pages for more details

### Building Materials

page 28

- Use concrete with fly ash and recycled concrete.
- Use cellulose insulation or insulation products that use at least 30% recycled content.
- Use steel framing and sustainably harvested wood for home construction.
- Use composite shingles made from fiber-reinforced cement products for roof.
- Use laminated wood flooring or linoleum.
- If you must use carpeting, choose carpet made with recycled content.

### Water Conservation

page 30

- Use xeriscaping to save on water usage for landscaping.
- Harvest rainwater for garden use.
- Use a gray water system for landscape irrigation and for flushing toilets.

### Construction Waste Management

page 31

- Have your contractor use DBEDT's "Construction and Demolition Waste Management Guide" before, during, and after building your house.
- Recycle and reuse as much construction material as possible.
- Avoid using hazardous materials that require special waste handling.

### Recycling/Composting

page 32

- Recycle your household newspapers, glass, plastics, cardboard, and aluminum. Create an area for collection.
- Buy recycled products. Look for the "Buy Recycled Hawaii" label.
- Use composting to recycle yard wastes and appropriate kitchen wastes for soil supplements in your garden.

## Healthy Homes

Refer to section pages for more details

### Preventing Mold

page 33

- Keep your home clean and dry.
- Use overhangs to protect walls from rain.
- Avoid air conditioning. If you must use it, carefully insulate AC ducts.
- Avoid the use of vinyl wall covering.
- Immediately dry out materials that get wet from spills or plumbing leaks.
- Minimize surfaces such as carpet, grout, and rough unfinished wood that collect dust or dirt.
- Whenever moisture is likely, use smooth surfaces such as tile, finished hardwood, or sealed concrete that are easy to clean.

### Indoor Air Quality

page 34

- Provide fresh air to help naturally ventilate your home.
- Use latex and water-dispersed acrylic paints and sealers with low or zero volatile organic compound (VOC) content.
- Avoid products with particleboard.
- Use formaldehyde-free fiberboard; avoid wood treated with toxic compounds such as CCA.

### Termite Control

page 35

- Use naturally termite-resistant woods or materials such as concrete, steel, and plastic that are unattractive to termites.
- When using ground treatment, choose less-toxic chemicals.
- Use termite bait systems to help control termites.
- Keep drainage flow away from home.
- Keep plantings at least 24" from the building perimeter.

## **Additional Resources**

### **For more detailed information, see these DBEDT Publications:**

- Comfortable Homes in Hawaii Brochure
- Hawaii Energy Tax Credits
- Homeowner's Guide to Solar Water Heating
- Ceiling Insulation for Your Home

### **For information about potential utility programs:**

- HEKO (Oahu): 947-6937, [www.heco.com](http://www.heco.com)
- HELCO (Big Island): 969-0127
- Kauai Electric: 246-8280
- MECO (Maui, toll-free): 1-888-632-6786

### **For more energy efficiency information:**

- U.S. Department of Energy, Energy Efficiency and Renewable Energy Network: [www.eren.doe.gov](http://www.eren.doe.gov)
- U.S. Environmental Protection Agency, Energy Star program: [www.energystar.gov](http://www.energystar.gov)
- American Council for an Energy Efficient Economy [www.aceee.org](http://www.aceee.org)
- Alliance to Save Energy [www.ase.org](http://www.ase.org)

### **For recycling information:**

- City & County of Honolulu: 692-5410
- County of Hawaii: 961-8083
- County of Kauai: 241-6891
- County of Maui: 270-7880
- Clean Hawaii Center, [www.hawaii.gov/dbedt/ert/chc](http://www.hawaii.gov/dbedt/ert/chc)

The measures in this booklet will help develop a home that meets the levels in the **Hawaii BuiltGreen™ Home Program** rating system. Contact the Building Industry Association of Hawaii for more information (847-4666, ext. 210; [www.bia-hawaii.com](http://www.bia-hawaii.com)).

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