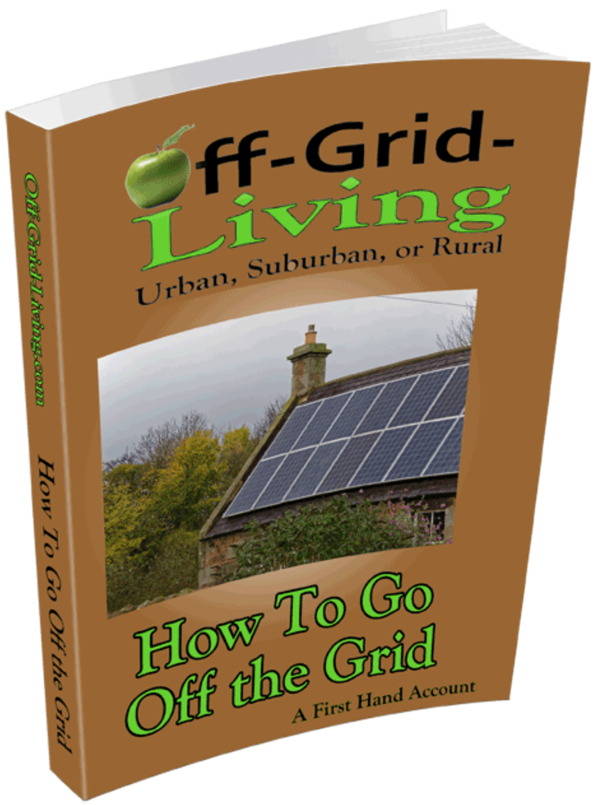
Off-Grid-Living
In An Urban and Suburban World



Lesson #12 …

Home Cooling

The most important thing to take away from this lesson is...

You can cut your cooling cost in half easily, even eliminate them. Cooling your house can be accomplished easily with proper planning.

Although your first thought for cooling may be air conditioning, there are many alternatives that provide cooling with less energy use. A combination of proper insulation, energy-efficient windows and doors, daylighting, shading, and ventilation will usually keep homes cool with a low amount of energy use in all but the hottest climates. Although ventilation should be avoided in hot, humid climates, the other approaches can significantly reduce the need to use air conditioning.

Types of Cooling

Ventilation Systems

Ventilation is the least expensive and most energy-efficient way to cool buildings. Ventilation works best when combined with methods to avoid heat buildup in your home. In some cases, natural ventilation will suffice for cooling, although it usually needs to be supplemented with spot ventilation, ceiling fans and window fans. For large homes, homeowners might want to investigate whole house fans.

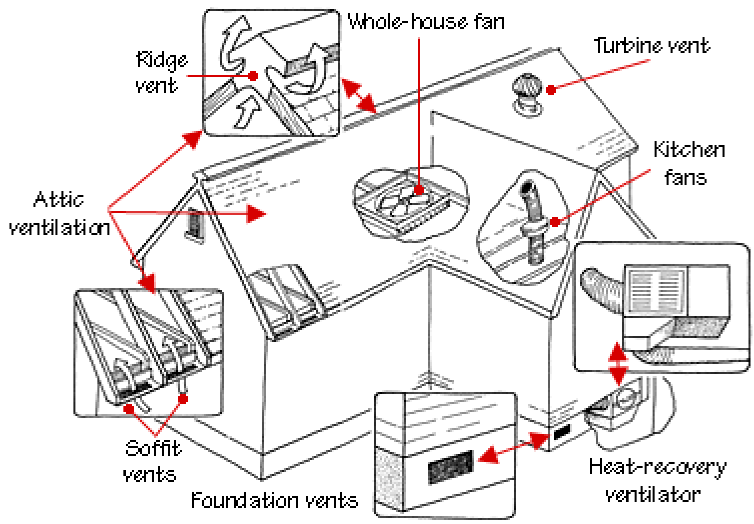
Ventilation is ineffective in hot, humid climates where temperature swings between day and night are small. In these climates, attic ventilation can help to reduce your use of air conditioning. Ventilating your attic greatly reduces the amount of accumulated heat, which eventually works its way into the main part of your house. Ventilated attics are about 30°F (16°C) cooler than unventilated attics. Properly sized and placed louvers and roof vents help prevent moisture buildup and overheating in your attic.

Natural Ventilation

Natural ventilation relies on the wind and the "chimney effect" to keep a home cool. Natural ventilation works best in climates with cool nights and regular breezes.

The wind will naturally ventilate your home by entering or leaving windows, depending on their orientation to the wind. When wind blows against your home, air is forced into your windows on the side facing into the wind, while a natural vacuum effect tends to draw air out of windows on the leeward (downwind) side. In coastal climates, many seaside buildings are designed with large ocean-facing windows to take advantage of cooling sea breezes. For drier climates, natural ventilation involves avoiding heat buildup during the day and ventilating at night.

The chimney effect relies on convection and occurs when cool air enters a home on the first floor or basement, absorbs heat in the room, rises, and exits through upstairs windows. This creates a partial vacuum, which pulls more air in through lower-level windows. The effect works best in open-air designs with cathedral ceilings and windows located near the top of the house, in clerestories, or in operable skylights.



Passive solar homes are often designed to take advantage of convection to distribute heat evenly through the home. These homes are often amenable to natural ventilation by ventilating them near the top.

Natural ventilation can be enhanced or diminished through landscaping. Depending on the house design and wind direction, a windbreak—like a fence, hedge, or row of trees that blocks the wind—can force air either into or away from nearby windows.

Ceiling Fans and Other Circulating Fans

Circulating fans include ceiling fans, table fans, floor fans, and fans mounted to poles or walls. These fans create a wind chill effect that will make you more comfortable in your home, even if it's also cooled by natural ventilation or air conditioning. Ceiling fans are considered the most effective of these types of fans, since they effectively circulate the air in a room to create a draft throughout the room.

If you use air conditioning, a ceiling fan will allow you to raise the thermostat setting about 4°F with no reduction in comfort. In temperate climates, or during moderately hot weather, ceiling fans may allow you to avoid using your air conditioner altogether. Install a fan in each room that needs to be cooled during hot weather.

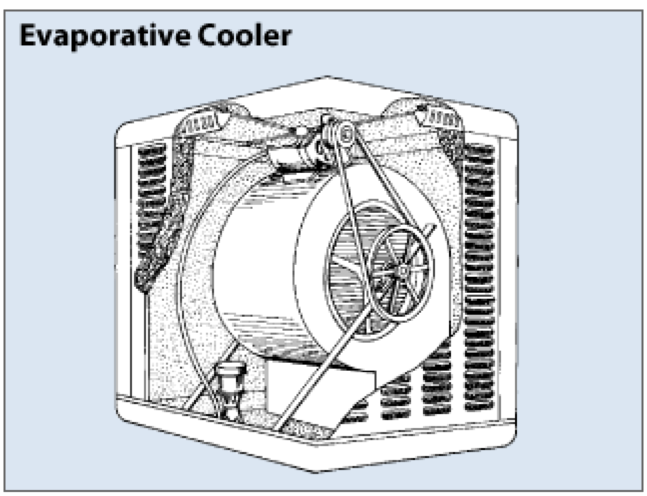
Ceiling fans are only appropriate in rooms with ceilings at least eight feet high. Fans work best when the blades are 7–9 feet above the floor and 10–12 inches below the ceiling. Fans should be installed so their blades are no closer than 8 inches from the ceiling and 18 inches from the walls.

Larger ceiling fans can move more air than smaller fans. A 36- or 44-inch diameter fan will cool rooms up to 225 square feet, while fans that are 52 inches or more should be used in larger rooms. Multiple fans work best in rooms longer than 18 feet. Small- and medium-sized fans will provide efficient cooling in a 4- to 6-foot diameter area, while larger fans are effective up to 10 feet.

A larger blade will also provide comparable cooling at a lower velocity than a smaller blade. This may be important in areas where loose papers or other objects will be disturbed by a strong breeze. The fan should also be fitted to the aesthetics of the room—a large fan may appear overpowering in a small room.

A more expensive fan that operates quietly and smoothly will probably offer more trouble-free service than cheaper units. Check the noise ratings, and, if possible, listen to your fan in operation before you buy it.

When buying window fans, look for the ENERGY STAR® label. Fans that earn the label move air 20% more efficiently, on average, than standard models.



Evaporative Coolers In this example of an evaporative cooler, a small motor (top) drives a large fan (center) which blows air out the bottom and into your home. The fan sucks air in through the louvers around the box, which are covered with water-saturated absorbent material.

In low-humidity areas, evaporating water into the air provides a natural and energy-efficient means of cooling. Evaporative coolers, also called swamp coolers, rely on this principal, cooling outdoor air by passing it over water-saturated pads, causing the water to evaporate into it. The 15°–40°F-cooler air is then directed into the home, and pushes warmer air out through windows.

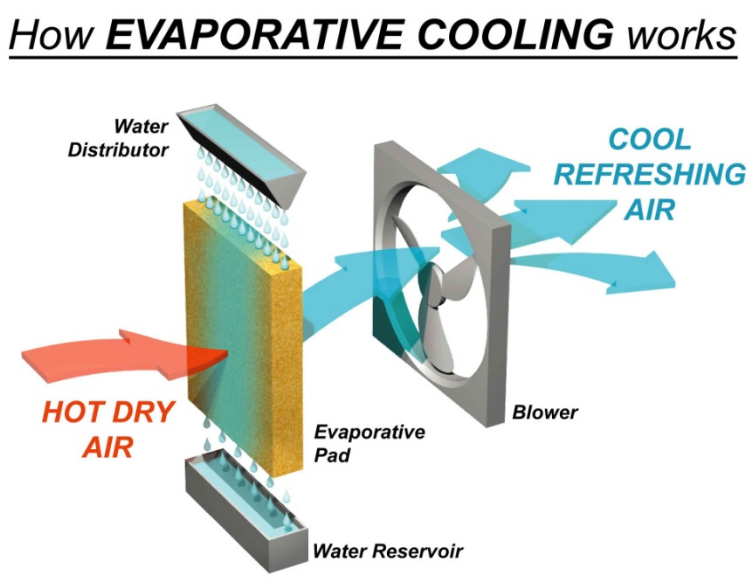
When operating an evaporative cooler, windows are opened part way to allow warm indoor air to escape as it is replaced by cooled air. Unlike central air conditioning systems that recirculate the same air, evaporative coolers provide a steady stream of fresh air into the house.

Evaporative coolers cost about one-half as much to install as central air conditioners and use about one-quarter as much energy. However, they require more frequent maintenance than refrigerated air conditioners and they're suitable only for areas with low humidity.

In general, evaporative cooling can be used where:

1. temperatures are high;
2. humidity is low;
3. water can be spared for this use; and
4. air movement is available (from wind or electric fans).

Operation



An evaporative cooler should have at least two speeds and a vent-only option. During vent-only operation, the water pump does not operate and the outdoor air is not humidified. This lets you use the evaporative cooler as a whole-house fan during mild weather.

Control the cooler's air movement through the house by adjusting window openings. Open the windows or vents on the leeward side of the house to provide 1–2 square feet of opening for each 1,000 cfm of cooling capacity. Experiment to find the right windows to open and the correct amount to open them. If the windows are open too far, hot air will enter. If the windows are not open far enough, humidity will build up in the home.

You can regulate both temperature and humidity by opening windows in the areas you want to cool, and closing windows in unoccupied areas. Where open windows create a security issue, install up-ducts in the ceiling. Up-ducts open to exhaust warm air into the attic as cooler air comes in from the evaporative cooler. Evaporative coolers installed with up-ducts will need additional attic ventilation.

Optional filters remove most of the dust from incoming air—an attractive option for homeowners concerned about allergies. Filters can also reduce the tendency of some coolers to pull water droplets from the pads into the blades of the fan. Most evaporative coolers do not have air filters as original equipment, but they can be fitted to the cooler during or after installation.

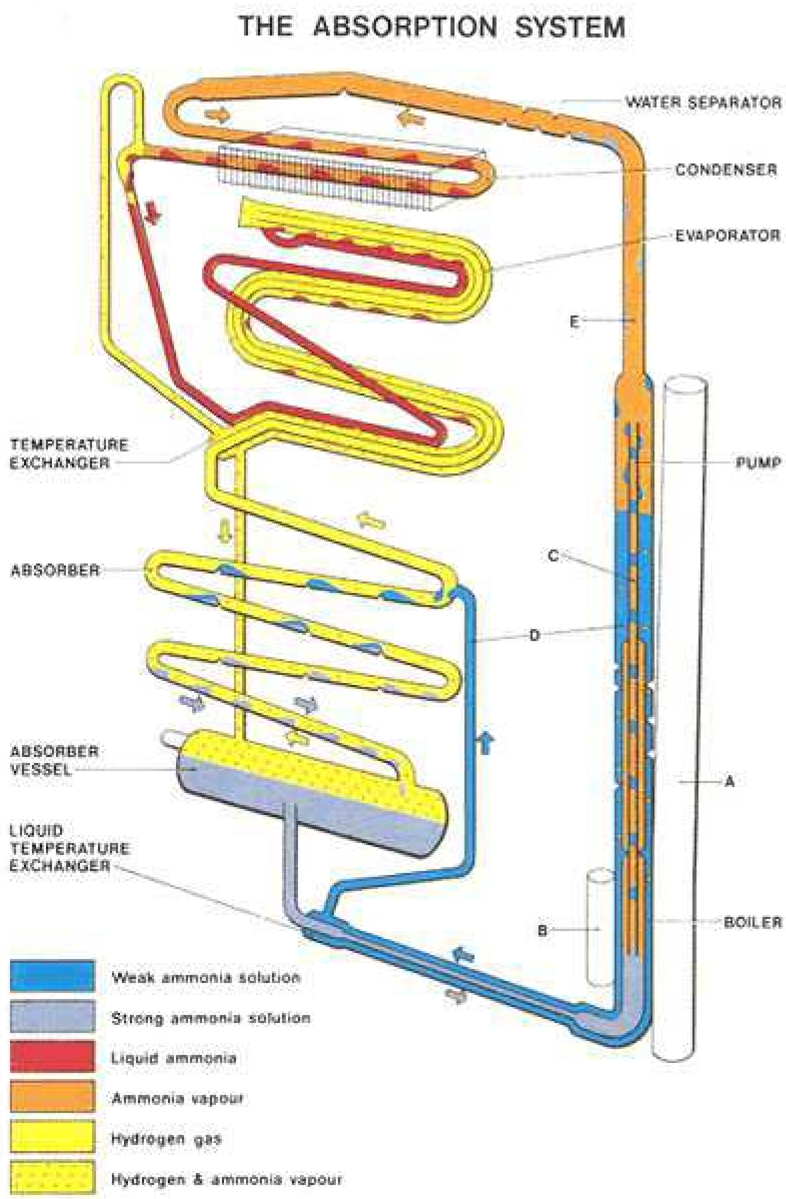
Two-Stage Evaporative Coolers

Two-stage evaporative coolers are newer and even more efficient. They use a pre-cooler, more effective pads, and more efficient motors, and don't add as much humidity to the home as single-stage evaporative coolers. Because of their added expense, they are most often used in areas where daytime temperatures frequently exceed 100°F.

Drawbacks of Evaporative Coolers

Evaporative coolers should not be used in humid climates because they add humidity. Also, they cool your house down to a higher temperature than an air conditioner would. They require maintenance (albeit easy) about once a month. If the cooler is installed on the roof, there is some roof deterioration caused by routine maintenance trips. A sunlit rooftop cooler will be about 1°F less effective than a shaded cooler. Rooftop maintenance also requires using a ladder, which may be an inconvenience.

By their nature, evaporative coolers also continually use water. In areas with limited water supplies, homeowners may be concerned about the water-use impact of adding an evaporative cooler.



Absorption Cooling

In the more tropical portions of the Southern U.S., where air temperatures peak above 90 degrees Fahrenheit in the day, humidity is high, and overall low night time temperatures remain above 80 degrees, **a solar-powered "absorption chiller"** can be used to reduce air temperature and humidity in the interior living quarters down as low as any human could possibly desire.

The absorption chiller concept is unfamiliar to most homebuyers, architects and builders today. They are skeptical about everything that they do not understand.

In the 1920's, this reliable, low-cost, noiseless, phase-change, absorption cooling technology was used extensively in "gas refrigerators", especially in urban-and-rural homes that had no electricity. Many modern designers are not familiar with the characteristics or economics of absorption cooling. It revived for use in Recreation vehicles.

A water-based absorption chiller can inexpensively drop the temperature down to 40 degrees. Other non-water versions can go well below freezing for making ice, etc. When powered by concentrated solar energy (instead of 1920's natural gas), absorption chillers cost almost nothing to operate, and have essentially nothing in them to wear out (as do today's noisy, expensive, electromechanical freon-compressor-based air conditioners and refrigerators, which have to be replaced at high cost every few years). The heat source causes circulation, fluid/gas phase change, and cooling.

Absorption cooling is essentially an air conditioner driven not by electricity, but by a heat source such as natural gas, propane, solar-heated water, or geothermal-heated water. Because natural gas is the most common heat source for absorption cooling, it is also referred to as gas-fired cooling. Although mainly used in industrial or commercial settings, absorption coolers are now commercially available for large residential homes.

Absorption cooling usually only makes sense in homes without an electricity source, but may also be employed to make use of renewable energy. Absorption cooling is essentially a heat pump technology; absorption coolers are absorption heat pumps that are not set up to allow their use as a heating device.

Earth Cooling Tubes

In the 1970s and early 1980s, earth cooling tubes received a great deal of attention from architects, builders, and homeowners as an alternative or aid to conventional air conditioning. While the concept of routing air through underground tubes or chambers to achieve a cooling effect seems like a good idea, in practice it is not very effective, both technically and economically. Perhaps a few hundred systems were constructed, but information on the practical application of the concept is limited. There are few functioning installations, and limited quantitative performance data exists. The following information is a summary of the key points from the citations in the bibliography below.

How They are Supposed to Work

Cooling tubes are long, underground metal or plastic pipes through which air is drawn. The idea is that as the air travels through the pipes, it gives up some of its heat to the surrounding soil, entering the house as cooler air. This will occur only if the earth is at least several degrees cooler than the incoming air.

A cooling tube system uses either an open- or closed-loop configuration. In an open-loop system, outdoor air is drawn into the tubes and delivered directly to the inside of the home. This system provides ventilation while hopefully cooling the home's interior. In a closed-loop system interior air circulates through the earth cooling tubes. An alternative is to direct the cooled air from either type of system into a mechanical air conditioning system to reduce the air conditioner's cooling load.

A closed loop does not exchange air with the outside; instead the system recirculates the home's air through the earth cooling tubes. This makes the closed loop system more efficient than an open loop design, since it does not require as high a degree of dehumidification as an open loop system.

Design Considerations

Tube Material

The main considerations in selecting tube material are cost, strength, corrosion resistance, and durability. Tubes made of aluminum, plastic, and other materials have been used. The choice of material has little influence on thermal performance. PVC or polypropylene tubes perform almost as well as metal tubes; they are easier to install, and are more corrosion resistant.

Tube Diameter

Optimum tube diameter varies widely with tube length, tube costs, flow velocity, and flow volumes. Diameters between 6 and 18 inches (15.2 and 45.7 centimeters) appear to be most appropriate.

Tube Location

Earth temperatures and, consequently, cooling tube performance vary significantly from sunny to shady locations. Where possible, the inlets in open loop systems and the cooling tubes themselves should be placed in shady areas.

Tube Depth

Tubes should be buried at least 6 feet (1.8 meters) below grade. Only rarely is burying them more than 12 feet (3.7 meters) justifiable. When digging trenches at these depths, cave-ins are an extreme hazard, and appropriate precautions should be taken.

Earth Temperature

The temperature of the earth at depths of 20–100 feet (6.1–30.5 meters) remains about two to three degrees higher than the mean annual air temperature. At depths less than 10–12 feet (3.1–3.7 meters), earth temperatures may be strongly influenced by air temperatures and may vary during the year, depending on the locale. Near the surface, earth temperatures closely correspond to air temperatures.

Tube Length

There is no simple formula for determining the proper tube length in relation to the amount of cooling desired. Local soil conditions, soil moisture, tube depth, and other site-specific factors should be considered to determine the proper length.

Soil Properties

The amount of heat conducted and how widely it is diffused varies from one soil type to another. The moisture content of the soil is a major influence on conductivity and diffusivity, and accounts for large variations on how heat moves through the earth.

Potential Problems

Earth cooling tubes are likely to perform poorly in hot, humid areas, because the ground does not remain sufficiently cool at a reasonable depth during the summer months. Moreover, dehumidification, another equally important aspect of cooling, is difficult to achieve with earth cooling. Mechanical dehumidifiers will most likely be necessary.

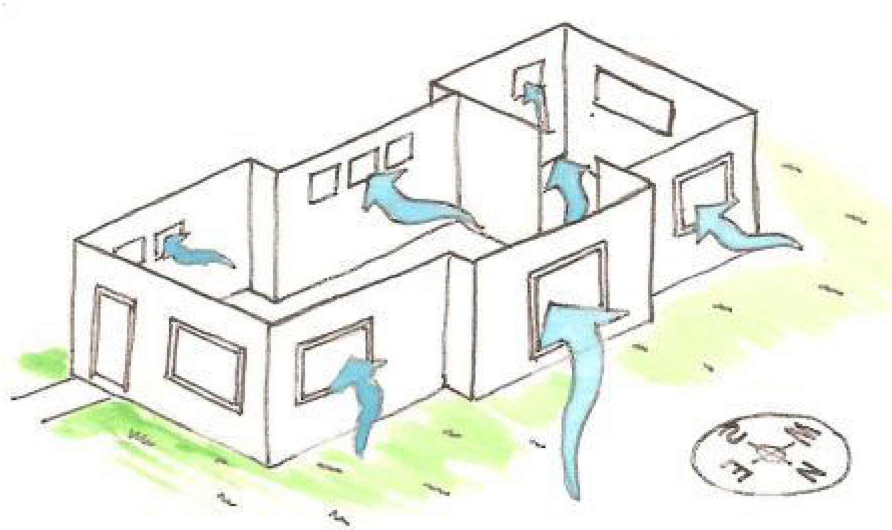
The dark and humid atmosphere of the cooling tubes may be a breeding ground for odor-producing molds and fungi. Furthermore, condensation or ground water seepage may accumulate in the tubes and encourage the growth of bacteria. Good construction and drainage could eliminate some of these problems.

Insects and rodents may enter the tubes of an open-loop system. You should install a sturdy grille and insect screen at the tube inlet to deter potential intruders.

What You Can Do Starting Today

Almost anyone can determine the way the wind predominately blows during the summertime. Using this simple natural system, you can easily figure out which windows to open. Add window fans to these windows, pulling cooler air into the room, and blowing it out will almost always result in a cooler, more comfortable, room.

Now try this; locate the hottest rooms, and open those windows too, only this time, face the fans in the opposite direction. That is, reverse the fans so they are blowing OUT. This will create a natural convection.



You can take this concept one step further by adding small "vent" windows at the top of the ceiling. This is not hard, or expensive to do. An easy week-end job. What you'll do in effect is put small 6" x 18" vents in the top of the room.

You could also put the same at the bottom of wall on the "cool" side of the house. This can be easily accomplished by adding them to the top and bottoms of existing windows.

What this will do is create a natural "Breeze" though-out your house. Try it! You'll be surprised. In some climates, this is all that is necessary to adequately cool your house, even in the depths of summer. You won't need air conditioning. In most places in the US, this can be sufficient.

That, of course, is only the beginning. Look at ways, depending on your climate, of permanently reducing and/or eliminating the need for air conditioning. I've presented solutions here for all climates.

Take it a step at a time. Determine your climate, your needs, and your comfort zone. Don't assume because you live in a humid, coastal area, or the desert there aren't solutions available…there are. People lived for 1000's of years without these comforts. They made the best of their environments and you can too.

With a little planning, forethought, and research you can design a low cost alternative. Maybe you'll find convection is all that is needed. Maybe you'll need to add a attic fan, or ceiling fans to get even better cooling.

Maybe you'll decide an evaporative cooler will work for you. All of these ideas are more cost effective than the solution (air conditioners, central air) you are using now.

As always assess the situation, plan a replacement, take action.

PS...Don't forget you can get personalized coaching at Off-Grid-Living.com/ For some this is the ideal way to get hands on experience as well as personal attention needed to make this work for you.

Coming Up Next ...

Lesson #13: "Hot Water Heaters"

In the next lesson we'll be talking about what you can do immediately to cut down on the high cost of hot water.