Energy Efficient Home Cooling

EnergyServices

Choosing an air conditioning system is an important decision. A poor choice may be costly and fail to provide the desired level of cooling. The best system depends on your climate, cooling needs and the design of your house.

Consider several options before installing a cooling system. In many parts of the West, evaporative coolers are the best choice. They work well in warm, dry climates. In more humid areas, air conditioners or heat pumps based on a compressor cycle system much like your refrigerator uses will be your only options. In either case, proper sizing, selection, installation, maintenance and use are keys to effective operation and lower overall costs.

Before you select an air conditioner, you may want to examine other methods of keeping your home cool.

In many areas, natural cooling strategies reduce or eliminate the need for an electric air conditioning system. Natural cooling strategies include:

- Light colored roof and walls;
- Upgraded insulation in walls and roof;
- Low-emissivity windows;
- Shading;
- Nighttime cooling using fans and natural ventilation.

Fans can reduce cooling costs

There are three types of fans to consider:

Air circulating fans move the air making the room comfortable even at higher temperatures and humidity levels. These fans allow you to use your air conditioner less.

Whole house fans pull air through open windows and exhaust it through ceiling and attic vents. These fans are a good alternative in windless areas and densely developed neighborhoods.

Attic vent fans can lower attic temperatures. However, they are not recommended in homes with good natural ventilation and proper insulation.

For more information about various types of fans see the Florida Solar Energy Center's publication: *Fans to reduce cooling costs in the Southeast* www.fsec.ucf.edu/pubs/energynotes/en-13.htm.

Energy efficient room air conditioners

If you only need to cool one to three rooms in your home, a room air conditioner may be your most economical choice. To optimize the performance of your room air conditioner, select an energy

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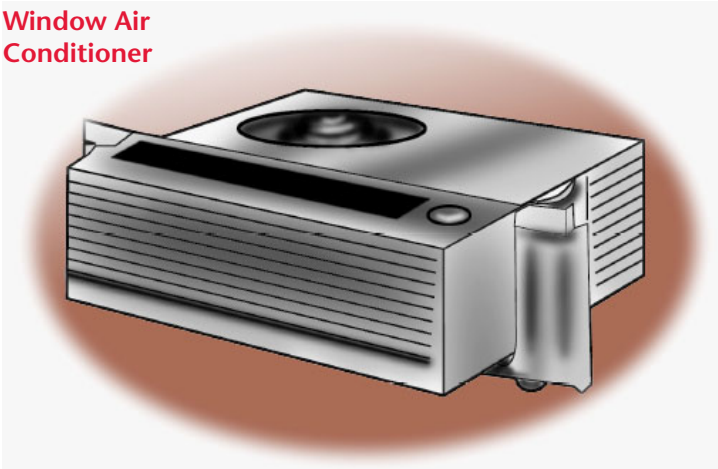
Central Air Conditioner

Window Air Conditioner



efficient model that is properly sized for the room you are cooling.

The Energy Efficiency Ratio (EER) is used to compare the efficiency of individual room air conditioners. It is the measure of the number of British Thermal Units (BTU) per hour of cooling provided for each watt of electricity used. Room air conditioners typically provide from 5,000 to 18,000 BTU/hr. The average EERs of units from the 1970s is about 5. Units made after Oct.1, 2000, are required to have an energy efficiency ratio greater than 9.78. The best room air conditioners on the market have energy efficiency ratios of 11 or more.

All room air conditioners sold in the United States must be labeled with an energy guide. The yellow EnergyGuide label includes an energy efficiency ratio for the appliance. Use this label to compare the efficiency of different models.

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The ENERGY STAR® www.energystar.gov website can help you select an energy efficient room air conditioner. Sponsored by the U.S. Environmental Protection Agency and the U.S. Department of Energy, ENERGY STAR is a program aimed at reducing pollution by promoting home appliances that use less energy. ENERGY STAR qualified central air conditioners are about 20 percent more efficient than models that only meet minimum federal requirements. ENERGY STAR qualified room air conditioners use at least 10 percent less energy than standard models.

The Seasonal Energy Efficiency Ratio (SEER) is used to compare the efficiency of central air conditioner systems. The SEER compares the total amount of cooling provided in a typical climate for an entire year to the energy consumed in the same period. Air conditioners made in the 1970s have a SEER ranging from 4.5 to 8. Models built after Jan.1, 1992, require a minimum SEER of 9.7 for single package and 10 for split-systems. Typically, residential central cooling systems provide from two to five tons of cooling. One ton of cooling is equivalent to 12,000 BTU/hr.

ENERGY STAR qualified split-systems are required to have a

The pros and cons of room air conditioners

Pros:

- Room air conditioners are less expensive than central systems. Smaller units start at just a few hundred dollars.
- They are less expensive to operate than central systems, if you are only cooling part of your home.
- Individual rooms can be kept at different temperatures.
- They are easy to install. Smaller units can be installed in most operable windows using existing electrical outlets. Larger models may require special adaptations and dedicated 240-volt circuits.
- They don't require a duct system in the house.

Cons:

- Room air conditioners are noisier than remotely installed central systems.
- They may create a security problem.
- Window units block views and incoming light and prevent the use of the window for natural ventilation.
- Room air conditioners have a lower average efficiency than central units.
- Some lack programmable controls.

minimum SEER of 13. Systems with SEERs over 16 are available. When shopping for a cooling system, look for the ENERGY STAR label.

Bigger is not better

An oversized air conditioner does not provide more comfort, in fact it may make the house feel clammy. Purchase an air conditioner with the correct cooling capacity for the room. Oversized appliances will *short cycle* – turn off and on quickly, with short *on* periods. As the air conditioner short cycles, the indoor coil never gets cold enough to condense and remove excess moisture from the room. Especially in humid climates, your home will feel cold and moist.

Room air conditioner sizing recommendations

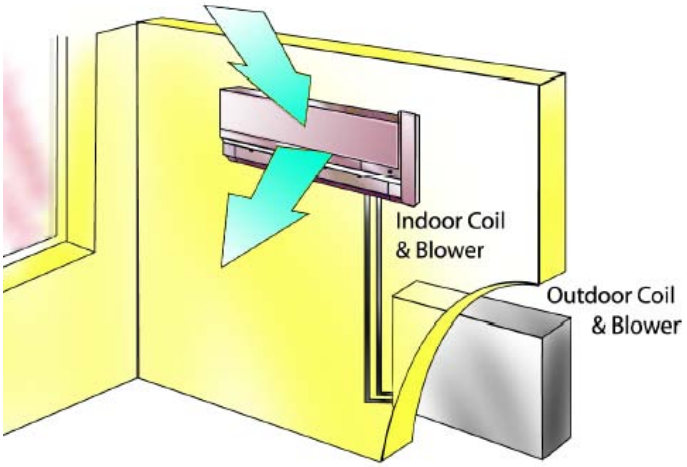
Area to be Cooled (Ft^2)	Capacity (Btu/Hr)
100 to 150	5,000
150 to 250	6,000
250 to 300	7,000
300 to 350	8,000
350 to 400	9,000
400 to 450	10,000
450 to 550	12,000
550 to 700	14,000
700 to 1,000	18,000

- If the room is well shaded, reduce capacity by 10 percent.
- If the room is very sunny, increase capacity by 10 percent.
- If more than two people regularly occupy the room, add 600 BTU/hr for each additional person.
- If the unit is for a kitchen, increase the capacity by 4,000 Btu/Hr.

Energy efficient cooling with central air conditioners and heat pumps

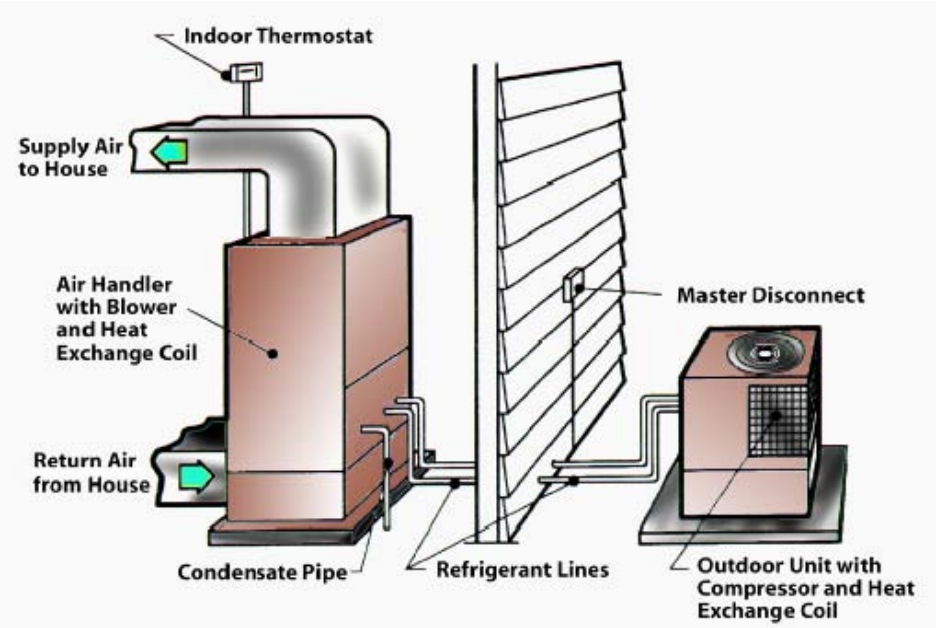
Split-system air conditioners connected to a duct system are the most common for cooling an entire home. These systems use a cool indoor coil installed in the furnace ductwork to collect heat from the house. The heat is transferred to an outdoor coil through refrigeration lines.

Heat pumps operating in cooling mode function like split-system air conditioners. If you have an electric resistance furnace, a heat pump may be the right choice for cooling your home. Heat pumps also can provide significant savings during the heating season. If you use gas or another type of fuel for heating, check with your utility to see if there is any advantage to using a heat pump.



Ductless Split System Air Conditioner

Ductless split-system central air conditioners have become available in recent years. These systems feature a heat exchanger coil in each room and don't require a duct system. They are more expensive than a conventional split-system air conditioner if the home already has a duct system; but for homes that don't have a duct system, they offer an excellent option.



Central Air Conditioner

Maximizing cooling efficiency of central systems

There are a number of variables that affect the efficiency of a central cooling system. Make sure the air conditioner you select is the right size for your home. If your system uses ductwork, make sure the ducts are large enough to provide good airflow across the cooling coil. Seal and insulate the ducts well.

Duct sizing is an important consideration when selecting a central air conditioner. If the ducts are not big enough to allow adequate airflow, the air conditioner will not operate efficiently. This can lead to a frozen indoor coil, premature failure of the compressor, plus excessive fan noise. The amount of ductwork in unconditioned attics, crawlspaces and garages can dramatically increase your cooling costs. Good duct design minimizes duct length and considers the type and location of supply and return registers. Make sure your contractor's bid includes any necessary duct modifications.

Some central cooling systems use Electronically Commutated Motor (ECM) blower motors. Instead of continually turning on and off like a traditional motor,

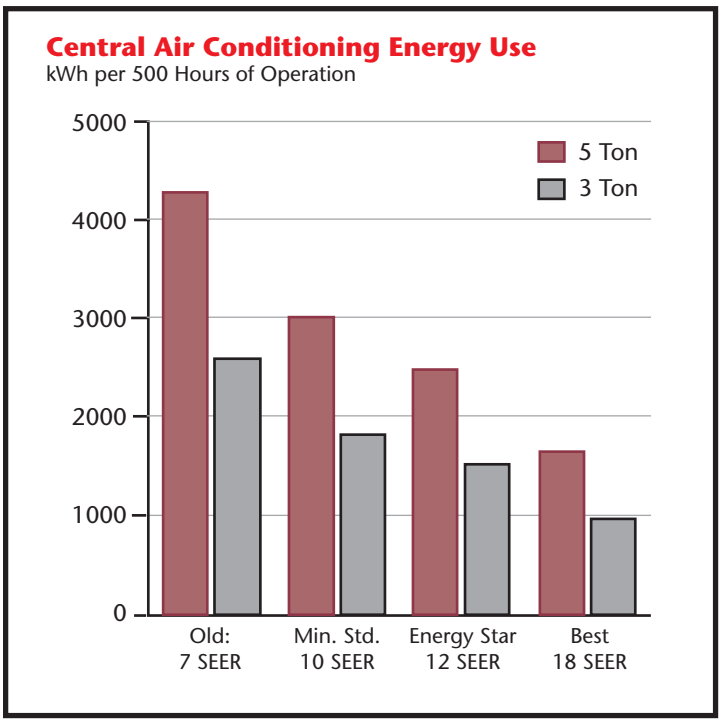
Central split-system air conditioners

Pros:

- Quiet indoors;
- Programmable controls are common;
- Easily adapted to central forced air heating systems;
- High average efficiencies.

Cons:

- Higher installation costs than room air conditioners;
- Most systems do not provide zonal control;
- Typically require a duct system for distribution;
- Efficiency losses as air moves through ducts and escapes via leaks;
- Noisy outdoor units;
- Require electricity for blower to distribute cool air through ductwork.



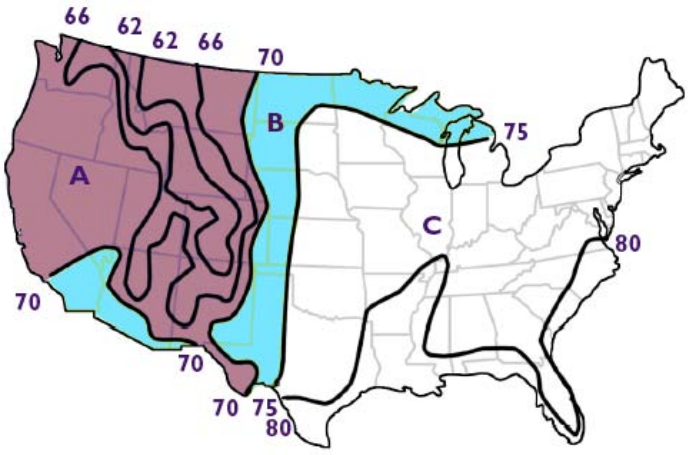
ECM motors run at reduced speed when the cooling load is lower. Because the motor speed is matched to the cooling load, ECM motors use significantly less energy than single speed motors. And since coolers with ECM blower motors stay on longer, they do a better job of dehumidifying the air, making the room more comfortable. ECM motors are especially useful when the blower operates for extended periods of time, such as during *fan only* cooling when additional air filtration or air mixing is desired.

Duct sealing and insulation is important if your ducts are in the attic or crawlspace. Leaky, un-insulated ducts can reduce the capacity and efficiency of your cooling system by up to 50 percent. Even if your ducts are in the conditioned space, it is important that they are sealed to ensure proper distribution of cooled air. Mastic, a paste-like substance, and improved mastic tapes help ensure a tighter duct system than many inexpensive standard cloth duct tapes. For more information about duct sealing see ENERGY STAR's publication titled *Seal your ducts* www.energystar.gov/index.cfm?c=ducts.pr_ducts. Make sure your contractor's bid includes any recommended duct sealing and insulation.

Evaporative coolers

Evaporative coolers, often called *swamp coolers*, have been popular for years because they offer an economical alternative to refrigeration-based air conditioning. They use a tenth to a quarter of the electrical energy and are much less expensive. And unlike central air conditioners, evaporative coolers operate without ozone depleting chlorofluorocarbons (CFCs).

Much as evaporating perspiration cools our bodies on a hot day, air blown through a wet pad is cooled as the water evaporates. An evaporative cooler uses a fan to draw outside air through a wet pad, humidifying and cooling the air. The cool air is blown into the house forcing warmer air out through open windows or special vents. Significant cooling requires dry outside air to enhance evaporation. The system adds moisture to air entering the house. As a result, evaporative coolers work best in the warm, dry climates typically found in the West.



An evaporative cooler should provide most of the cooling required for those who live in the *A* (red) area on the map. They may also work well for homes in the B (blue) area. Those who live in the C (white) area should consider refrigeration-based cooling.

Evaporative coolers

Pros:

- Economical to operate;
- Inexpensive equipment.

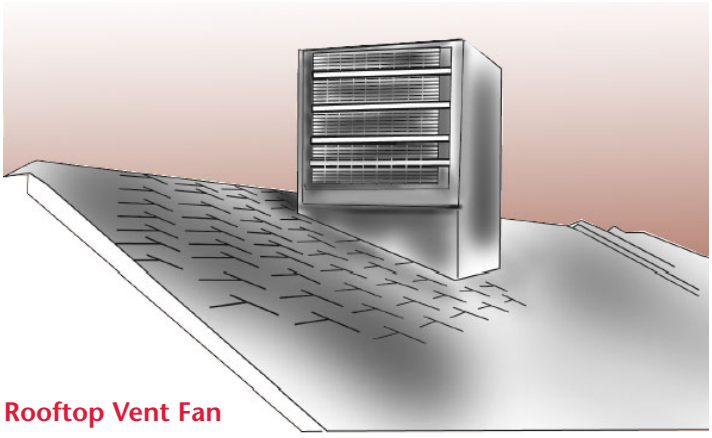
Cons:

- Limited to areas with low humidity;
- Require a good supply of clean water;
- Require large volumes of air;
- May require several units to cool an entire home.

Evaporative cooler types

There are *single-stage* and *two-stage* coolers. Single-stage, or *direct* evaporative coolers, are the most common and are categorized by pad type: *fiber pads* or *sheet pads*.

Fiber pads provide a wet surface through which air is circulated. The most common pads are shredded aspen wood fibers sometimes called *excelsior*. There are other synthetic fiber pads but high quality aspen pads set the performance standard. Pads vary in thickness, quality and cost. Thicker 2-inch pads are generally better. Fiber pads will normally need to be replaced annually as mineral deposits build up.



Rooftop Vent Fan

Rigid sheet pads are made of a stack of corrugated material and are usually 8- to 12-inches thick. These pads are more expensive than fiber pads but can last for many years if water quality is good. Rigid pads should be washed at the end of the cooling season before any residue dries and hardens.

Two-stage coolers produce air that is drier and cooler than that produced by a single-stage evaporative cooler. In the first stage, an evaporative cooler chills outside air, which then circulates through a heat exchanger, cooling the tubes. More outside air then passes through the cooled tubes where it is chilled by as much as 20 degrees without coming into contact with water. This cooled air then enters the second-stage, a direct evaporative cooler, where it is further cooled before entering the house. Because cooler air holds less moisture, the air entering the house from the two-stage cooler is drier than that produced by a single-stage cooler. Two-stage coolers work best on dry days when temperatures reach 100 degrees or more. They typically have rigid pads and are the most expensive type of evaporative cooler.

Types of installations

Rooftop installations using bottom discharge blowers are the most common and usually the least expensive. Ground mounted side- or up-discharge units, while often more expensive, are easier to maintain since you don't need a ladder to reach them. The building often can shade this type of appliance. Coolers can be installed as an add-on to existing refrigeration-based central air conditioning systems, as independent stand alone systems or even as window mounted units.

Air conditioner add-ons, such as evaporative coolers, can be used with your conventional air conditioner to reduce operating costs by half and improve indoor air quality by supplying more outside air. Add-ons also can extend compressor life of the refrigeration unit by minimizing short cycling during periods when less cooling is required. These systems are ideal for low elevation desert regions with high cooling loads.

Sizing evaporative coolers

Using a refrigeration-based air conditioner that is too large for the space to be cooled can create an uncomfortable indoor environment and cause equipment problems. Evaporative coolers are different. They require large amounts of air to cool a house. Manufacturers size the units by industry standard cubic feet per minute (CFM). Ratings generally range from 2,000 to 6,500 CFM. A large evaporative cooler with a big blower and a low horsepower motor will out perform a small cooler with a high horsepower motor.

For best results a system should be engineered and sized based on calculated room-by-room cooling load analysis. When this isn't feasible, use the following guidelines.

Type of System	***Sizing***
A/C Add-on	100 CFM per ton of refrigeration cooling
Independent Systems (including window mounted)	2-3 CFM per square foot of floor area (most climates)
	3-4 CFM per square foot of floor area (for hot desert)

Additional resources

Books

Consumer Guide to Home Energy Savings, 8th Edition; by Alex Wilson, Jennifer Thorne, and John Morrill; American Council for an Energy-Efficient Economy; Berkeley, Calif.; 2003.
Order a copy for $8.95 at www.aceee.org.

Websites

ENERGY STAR®
www.energystar.gov/

Energy Savers
www.eere.energy.gov/consumerinfo/energy_savers/

How to buy an energy-efficient home appliance, www.ftc.gov/bcp/conline/pubs/homes/applnces.htm, Federal Trade Commission and the U.S. Department of Energy

Home Cooling
www.rmi.org/images/other/Energy/E97-01_HEBCooling.pdf
Rocky Mountain Institute, Home Energy Briefs

Air Conditioning Cost Calculator
http://198.147.238.24/ac_calc/default.asp

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