# Energy-Efficient Homes: Air Conditioning

## Quick Facts

- The average energy bill for a typical single-family home in the U.S. is $2,200. Roughly 46 percent of the bill, or $1,012, is spent on heating, ventilation, and air conditioning.
- For every degree setting below 78°F, you spend up to 8 percent more in cooling costs.
- The average residential price of electricity in Mississippi in 2011 was 10.17 cents per kilowatt-hour. The average U.S. residential price in 2011 was 11.72 cents per kilowatt-hour.
- A central air conditioning system lasts about 20 years. You may save 20 to 40 percent on your cooling energy costs by replacing an air conditioner that is only 10 years old with a newer, more efficient one.
- Approximately 140 billion square feet of residential building space in the United States is cooled. About 55 billion (or 40 percent) of the total square footage was built within the last 20 years.

## Terms to Help Get You Started

- **AHU (air handling unit)**: The indoor unit that moves the air through the heating and cooling system.
- **BTU (British thermal unit)**: A traditional unit of energy; the amount of energy needed to heat one pound of water by 1 degree Fahrenheit.
- **Building envelope**: Elements of a building, including the roof, exterior walls, and floor, that form a barrier separating the interior of the building from the outdoor environment.
- **Condenser**: The outdoor unit that compresses refrigerant from a gas to a liquid. Compressing refrigerant cools it so it can better cool the inside of your home.
- **Cooling load and load calculation**: Measurements that calculate what size system is appropriate for a particular structure given its square footage, ductwork analysis, insulation, windows, and so forth.
- **ENERGY STAR®**: An Environmental Protection Agency (EPA) designation for HVAC equipment that meets EPA guidelines for efficiency (which exceed standard government minimums).
- **Heat pump**: An air conditioner equipped with a valve that lets it switch between "cooling mode" and "heating mode."
- **HVAC**: Heating, ventilation, and air conditioning equipment.
- **Infiltration**: Uncontrolled outdoor air that makes its way into the house.
- **kWh (kilowatt hour)**: The billing unit for energy delivered by electric utilities; a 100-watt light bulb that is on for 1 hour consumes 0.10 kilowatt hours of energy (100 watts/1000 * 1 hr = 0.10 kWh).
- **SEER (seasonal energy efficiency ratio)**: A measure of efficiency for air conditioning units; the higher the SEER number, the more energy efficient the unit is in cooling the air.
- **SHR (sensible heat ratio)**: A measure of efficiency for the ability of air conditioning systems to remove moisture or humidity; the higher the SHR number, the less capable the system is in removing humidity.
- **Supply and return**: Supply registers and ducts bring conditioned air in; return registers and ducts draw air out to be reconditioned.
- **Thermal barrier**: The shell of the building that serves as a barrier to unwanted heat transfer between the interior of the building and the outside conditions. For example, the thermal barrier in an insulated attic is just above the ceiling. The rest of the space in the attic (above the insulation) is considered the building envelope, but not the thermal barrier.
- **Ton**: A size measurement used to determine cooling capacity (1 ton = 12,000 BTUs/hours).

### *Why should I care about the efficiency of my air conditioning?*

It gets hot in Mississippi! As a result, we are forced to rely heavily on our air conditioners. We do so at a cost, though, because the largest consumer of energy in a typical Mississippi home is the heating, ventilation, and air conditioning (HVAC) system. The HVAC system uses about 40 percent of the energy consumed by the average Mississippi residence. The amount of energy your HVAC system uses is affected by many factors, such as insulation levels, system efficiency, shading on the home, quality and sealing of the windows and doors, integrity of the duct system, and, of course, how it is used.

Because of the heat and humidity in the summer, most Mississippians rely on air conditioning systems not only to cool the air but also to reduce the humidity inside the house. The size, efficiency, and placement of an air conditioning system are all important. The air conditioning contractor you hire is just as important, though, because the system must be installed properly to achieve its performance rating.

A skilled air conditioning contractor will

- choose the proper size system for the specific cooling load of the home,
- select and properly install thermostats or controls,
- install and commission the system properly,
- design a duct system that can deliver the correct amount of conditioned air to each space within the building, and
- seal and insulate all ductwork.

### *Isn't bigger better?*

An air conditioner that fits the home provides better humidity control and typically results in energy savings compared to an oversized air conditioner with the same performance characteristics. An air conditioner that fits the building will run for longer periods at a time than an oversized unit. When the unit runs, the coil operates at its coldest temperature, which allows condensate to form and flow out of the system. When condensate can flow out of the system, the humidity stays lower. Reducing the number of on and off cycles can result in energy savings and longer equipment life.

Oversizing generally results in higher equipment costs but allows faster cool-downs. An oversized unit can also compensate for leaking ductwork, poor AC maintenance, poorly insulated ductwork, missing or improperly installed insulation, and excessive infiltration. In the long run, though, it is better to fix those problems than to compensate with an oversized unit. A properly sized system and efficient components will bring more benefits to you and your home.

To assure proper sizing, the load must be calculated—not just estimated based on square feet. Load calculations are based on the exact area, orientation, and type of construction for each component of the thermal envelope and allow for the heat given off by the lights, people, and equipment inside the building. The standard for residential air conditioning sizing is ACCA Manual J or a method based upon Manual J. ACCA stands for Air Conditioning Contractors of America (***http://www.acca.org***).

Make sure your potential contractor conducts comprehensive load calculations before you accept his or her bid. Central air conditioner and heat pump cooling capacity is generally referred to in terms of tons. A ton of air conditioning is equal to 12,000 BTU per hour.

### *What exactly is SEER?*

The cooling efficiency of a heat pump or an air conditioning system is rated by the seasonal energy efficiency ratio (SEER). The SEER is defined as a ratio of the average amount of cooling per unit of electricity used. Federal regulation mandates a minimum SEER of 13.0 for most residential air conditioners manufactured after January 23, 2006. Efficiencies of some systems can be as high as SEER 20.0 or more. To carry the ENERGY STAR® label, the system must have a SEER of at least 15.0. Many older units have SEERs lower than 10. Remember that even a unit with a very high SEER will be less effective if it is attached to an inefficient system, such as one with leaky ductwork. The air distribution system is not used to determine the SEER rating.

### *So a high SEER system will also take care of the humidity in my house, right?*

Not necessarily. You also need to consider the sensible heat ratio (SHR), which describes the moisture-removal capability of air conditioning systems. For example, if the HVAC equipment has an SHR of 0.7, 70 percent of the air conditioning unit's load is devoted to cooling and 30 percent to removing humidity. It is critical that the HVAC contractor accurately estimate the humidity load, also called latent load.

Outdoor air, coming in through poorly sealed windows and doors, open fireplace dampers, and bath and kitchen vents, causes most of the moisture load in your home. Even the simple act of opening and closing exterior doors adds humidity to your home. In addition, plants, bathing, cooking, cleaning, combustion, standing water in commodes and drains, and even breathing add to indoor humidity.

A proper Manual J load calculation yields both the latent load and the temperature-based or sensible load. Note that many high SEER units have poorer humidity removal capacity, so it is important that the contractor verify that the unit chosen can remove the calculated latent load from the structure. Keep in mind that air conditioners operate based on room temperature, and any humidity control is a byproduct of temperature control. Humidity is not controlled directly by the air conditioner.

### *How does it all add up?*

This is where it gets a bit complex. The SEER, the SHR, and the system tonnage must be in balance so difficulties don't occur with indoor air quality. Systems that have an inadequate SHR or inaccurate tonnage cool without removing moisture. An oversized air conditioner will cool your home too quickly to remove moisture effectively. This results in a home that is cool but clammy. When the house feels damp, most owners lower the thermostat. Every degree the thermostat is lowered increases cooling bills up to 8 percent, so systems that cool fairly efficiently but dehumidify inadequately can end up costing more money.

### *What are some short-term solutions to improve the efficiency of my existing system?*

The U.S. Department of Energy suggests the following:

- Set your thermostat at 78°F or higher. Every degree below 78 raises your cooling cost by 8 percent.
- Use bath and kitchen exhaust fans sparingly when the air conditioner is operating. By their nature, these fans remove air from the interior of your house and vent to the outside. Your air conditioner has to work harder if you have exhaust fans on while your unit is operating.
- Inspect and clean the coils of your air conditioner, both indoors and outdoors. The indoor coil in your air conditioner acts as a magnet for dust because it is constantly wet during the cooling season. Dirt buildup on the indoor coil is the single most common cause of poor efficiency. The outdoor coil must also be checked periodically for dirt buildup and cleaned if necessary.
- Check the refrigerant charge. The circulating fluid in your air conditioner is a special refrigerant gas that is put in when the system is installed. If the system is

overcharged or undercharged with refrigerant, it will not work properly. You will need a service contractor to check the fluid and adjust it appropriately.
- Reduce the cooling load by using cost-effective conservation measures. For example, shade east and west windows. When possible, delay heat-generating activities, such as dishwashing, until the evening on hot days.
- Over most of the cooling season, keep the house closed tight during the day. Don't let in unwanted heat and humidity.
- Try not to use a dehumidifier at the same time your air conditioner is operating. Dehumidifiers put off heat while operating, which can increase the cooling load and force the air conditioner to work harder.
- Consider installing ceiling fans to circulate the air. The improved circulation will make you feel cooler.
- Install a programmable thermostat. You can schedule the time blocks when your heating or air-conditioning system operates. As a result, you can set the equipment to more economical settings—such as lower temperatures in winter while you are asleep or when you are away from home. Choose one that can store and repeat multiple daily settings, so that you can have both a workday and a weekend heating/cooling timetable. A manual override feature is a great convenience, allowing you to override current settings without affecting the rest of the program. Before purchasing, make certain the thermostat is designed to operate with your system.

### *When I'm ready to invest in a new air conditioning system, what should I keep in mind?*

**AC component locations**

Central HVAC systems have a component called an air handling unit, or AHU. It's often referred to simply as the "air handler." If you have the option, place the air handler in a conditioned space. These are some of the advantages of placing the AHU in a conditioned space:
- It is in a more favorable environment.
- A central location can minimize duct lengths and optimize air flow.
- It offers easier access for maintenance.
- Any air leaks occur in conditioned space.

Another often-overlooked area of installation concerns the placement of the outside unit, or condenser. Manufacturers' recommendations for proper clearance distances should be followed to the letter to ensure there is no blockage of air flow from the unit. Also, do not vent a clothes dryer within 10 feet of the outdoor unit, as dryer lint will cling to the condensing coil, lowering the system's efficiency and shortening its service life.

Keep in mind that the major components of the system, such as the air handling unit and the condenser, are joined together for the first time when they are installed at your house. The efficiency and reliability of the system depend on high-quality planning and installation of the complete system, including the thermostat and duct system.

**Questions the HVAC contractor should ask**

The HVAC contractor should ask you the following questions to design a system that fits your home and lifestyle:
- Would you like to change anything about your current air conditioning or heating system?
- What do you like most about your present system?
- What benefits do you expect from your new system?
- Does your existing system heat and cool your home to your satisfaction?
- Are there rooms that are too hot or too cold?
- What temperature is your thermostat set on during the summer? Winter?
- Do you have a scheduled lifestyle that encourages adjusting the thermostat frequently, or for stretches of time when you know the home will not be occupied?
- Do you set the thermostat at different temperatures for the hours that you're awake and the hours you're asleep?
- What types of heating or cooling problems have you experienced?
- Have you had any problems with condensate drainage?
- What is your average summer electric bill?
- Who performs your regular energy-savings check-ups?
- How long do you plan on residing in this home?
- Do you plan to remodel or expand your floor plan in the future?
- Have you made any changes to your home since the existing air conditioning or heating system was originally installed?
- How many people reside in your home?
- Does anyone residing in your home have allergies?
- Do you understand ratings like SEER and SHR?
- Do you understand how HVAC systems work? More specifically, do you understand how the system I'm recommending for your home works?

You should also realize that many of the same questions listed above should be asked when determining what HVAC system should go in a new home as the building plans are being drawn.

**Other considerations**
- Be sure your contractor is licensed, well trained, and experienced. Ask to see a valid contractor's license. In Mississippi, you can check for licensure at ***www.msboc.us***. Click on "Check a License," then conduct your search, or call 1-800-880-6161. Ask to see proof of coverage for workers' compensation and a certificate of insurance coverage for liability and property damage. A checklist for prescreening contractors is available at ***http://www.msboc.us/wp-content/uploads/2012/10/Checklist-for-Prescreening-Contractors.pdf***. Ask for proof that your contractor is certified to handle refrigerant in cooling systems. Also ask about references and membership in contractor associations.
- Request a calculation of your savings. Heating and cooling equipment comes with three price tags: the cost to buy the equipment, the cost to repair and

maintain it, and the cost to operate it. Your contractor should be able to calculate your utility bill savings and total lifetime costs.

- Request a load calculation. Ask your contractor to calculate equipment size using computer software or professional guidelines. This will require taking measurements in your house and asking questions. Don't use a contractor who wants to size your system solely on the square footage of your house.
- Inspect ducts. Ask your contractor to inspect your ducts for leaks, incomplete connections, and compatibility with the rest of your system. Evaluate your system's performance. Ideally, your contractor should use diagnostic equipment and, if necessary, fix leaks using a UL-rated quality duct sealant. In some cases, proper duct repairs may include actual duct modifications to ensure proper supply and return airflow.
- Consider a house pressurization test. If you have any kind of fuel-burning equipment (gas, wood, kerosene, propane, oil) in your home, test your house and appliances for back-drafting. Back-drafting occurs when the fumes from the combustion process are pulled back into the home, threatening the health and safety of occupants.
- Replace both indoor and outdoor units. If you're replacing an air conditioner or heat pump, be sure to replace both indoor and outdoor units for maximum efficiency and reliability if the units do not match in age, refrigerant, or efficiency.
- Obtain a written contract. Always obtain a written contract or proposal before allowing your contractor to install a new system. Be sure to ask about warranties for labor and parts.
- Weigh the costs. Remember that the lowest price may not always be the best price. Carefully evaluate a contractor's proposal to ensure you get the equipment and service that best meets your needs. Paying slightly more now may get you better equipment and service and save you money in the long run.
- Install for easy maintenance. Make sure the inside coil can be reached for its annual cleaning. Air filters should be easy to remove for cleaning and changing. Check filters monthly during the peak season.

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