

U.S. Department of Energy – Energy Efficiency and Renewable Energy

A Consumer's Guide to Energy Efficiency and Renewable Energy

Sizing Heating and Cooling Systems

Older space conditioning systems (more than 10 years old) are often unreliable and much less efficient than a modern system. When it's time for a new replacement, choosing one of the correct size (heating and/or cooling output) is critical to getting the best efficiency, comfort, and lowest maintenance and operating costs over the life of the new system. Some national surveys have determined that well over half of all HVAC contractors do not size heating and cooling systems correctly.

The most common sizing mistake is in oversizing. This not only makes the new system more expensive to install, but also forces it to operate inefficiently, break down more often, and cost more to operate. Oversized heating equipment also often creates uncomfortable and large temperature swings in the house. Oversized air conditioners (and heat pumps) do not run long enough to dehumidify the air, which results in the "clammy" feeling and unhealthy mold growth in many air-conditioned houses (see [dehumidifying heat pipes](#) as one solution to this problem).

Incorrect Sizing Methods

It is the installer/contractor's job to perform the correct sizing calculation for the building. However, many installers only check the "nameplate" (the label on the unit that has the Btu per hour output among other things) of the existing system and sell you one just like it, or even worse, one that's larger. *This is a not a correct sizing method and not in your best interests!* Other methods include simple "rules of thumb" based on the size of your home or using a chart that accounts for a variety of factors. While these methods might provide a first estimate, they should not be used to size your system.

Why Most Older Systems are Oversized

Before the era of tightly constructed homes, it was not uncommon to install furnaces and air conditioners that had two to four times the necessary capacity. Since many people have added new windows, caulking, weather-stripping, and insulation to their homes, going by the nameplate is likely to result in an oversized system. Making improvements such as these to reduce heat loss in the winter and heat gain in the summer should allow you to install a smaller system while still being comfortable, as well as saving large amounts of energy.

Manual J and Manual D: The Correct Way to Size a System

Correct system sizing requires considering many factors other than simply reading the nameplate of the existing unit. Key factors for correctly sizing a heating and cooling system include the following:

- The local climate
- Size, shape, and orientation of the house
- Insulation levels

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- Window area, location, and type
- Air infiltration rates
- The number and ages of occupants
- Occupant comfort preferences
- The types and efficiencies of lights and major home appliances (which give off heat).

Homeowners should insist that contractors use a correct sizing calculation before signing a contract. This service is often offered at little or no cost to homeowners by gas and electric utilities, major heating equipment manufacturers, and conscientious heating and air conditioning contractors. Manual J, "*Residential Load Calculation*," published by the Air Conditioning Contractors of America (ACCA), is the recommended method for use in the United States. There are also many user-friendly computer software packages or worksheets that can simplify the calculation procedure. You should make sure that the procedure used by the contractor follows Manual J.

If ducts are part of the installation, they should be sized using the ACCA's Manual D, "*Residential Duct Design*." The ACCA also offers a comprehensive guide for choosing home heating and cooling systems, called Manual S, "*Residential Equipment Selection*."

A Special Case: Sizing Steam Heating Systems

One exception to the above is in steam heating systems. For these systems, the boiler should be sized to match the radiators. However, there is still room for energy savings. First of all, the original boiler may be oversized for the radiators, so the contractor shouldn't just order the same capacity boiler, but instead should match the boiler to the radiators. Second, if you've increased the energy efficiency of your home, it may have more radiators than it needs.

It may be possible to remove radiators in the core of the house and shift the others around, replacing larger radiators with smaller ones. Since radiators are modular, it is theoretically possible to downsize a radiator by removing sections; in practice, this is usually difficult to do without damaging them. In many parts of the country, used radiators are available cheaply, so you can potentially buy small radiators to replace large radiators; if you do so, be prepared to replace the shutoff valves as well, since they often won't match. Newly manufactured steam radiators are available as well.

In any case, you should work with a heating and cooling professional when downsizing your system. Your house's heating needs should be calculated using Manual J, and your radiators should be downsized appropriately. Match the new boiler to the remaining radiators. Note that balancing steam heating systems is more an art than a science; ideally, you will find a heating professional with experience in steam heating systems.

Steps a Good Contractor Should Take to Size Your System

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Many factors affect a home's heating or cooling requirement, or "load." A good estimator will measure walls, ceilings, floor space, and windows to determine the room volumes, and will assess the R-value of the home's insulation, windows, and building materials. A close estimate of the building's air leakage is also necessary. A blower door test is the best way to measure air leakage.

A good estimate will also include an inspection of the size, condition of seals on joints and insulation, and location of the distribution ducts in forced air systems. The placement of supply and return registers should be appropriate for the system type and size.

The orientation of the house also affects heat gain and heat loss through windows. Overhangs can reduce solar gain through windows. Make sure the contractor uses the correct design for the outdoor temperature and humidity in your area. Using a higher summer design temperature results in oversizing air conditioners.

When the contractors are finished, get a copy of their calculations, assumptions, and the computer printout or finished worksheet. This is your only proof that they did the job right. To summarize, when designing your new heating and air conditioning system, the contractor you choose should do the following:

- Use a computer program or written calculation procedure to size the system
- Provide a written contract listing the main points of your installation and includes the results of the heating and cooling load calculation
- Give you a written warranty on equipment and workmanship
- Allow you to hold the final payment until you are satisfied with the new system.