

Energy Efficient Homes: *Programmable Thermostats*



Quick Facts

- Heating and cooling your home can use up to half of your home energy budget.¹
- If properly used, a programmable thermostat can save up to 10 percent in annual heating and cooling costs. The average American spends about \$2,200 annually on heating and cooling, so that's a savings of about \$220 per year.¹
- Programmable thermostats cost about \$100. The money that you save with a programmable thermostat covers the initial cost of the equipment in less than 1 year.²
- A programmable thermostat won't save you energy and money if you don't know how to use it. So, choose one that you find easy to use.

Common Household Thermostats

The diagram illustrates three types of household thermostats. On the left is a mechanical thermostat with a circular dial and a needle. In the middle is a non-programmable digital thermostat with a rectangular display showing '78°' and two buttons. On the right is a programmable thermostat with a large rectangular screen displaying '78', '7:15 p.m.', and 'Set to 78', along with 'System', 'Schedule', and 'Clock' buttons and a large double-headed arrow.

Mechanical: Not as common today as they were in the past. They are very simple to use but inefficient.

Non-programmable digital: These are easy to spot because they generally have only two buttons. These are more precise than mechanical thermostats.

Programmable: These have a larger screen and additional buttons that allow you to program a schedule that automatically changes the temperature at times you specify.

Programmable Thermostats

You've more than likely heard of a programmable thermostat. You may already have one installed at your house. Is your thermostat programmable? If so, do you know how to use it?

This publication will help you—

- recognize different types of thermostats.
- understand how your thermostat can work to save you money.
- learn how to pick the “right” programmable thermostat for your situation.
- learn how to program your thermostat.

Heating and cooling your home uses the largest portion of your home energy budget—43 to 54 percent. A **thermostat** is a temperature-controlled on/off switch that usually controls the home's heating, ventilation, and air-conditioning (HVAC) system. Why is an on/off switch a big deal? You've probably already guessed—because it can have a major impact on your yearly energy costs.

Types of Household Thermostats

Let's take a look at the variety of thermostats available at your home hardware store (or through your HVAC contractor).

Mechanical

Everyone is probably familiar with the mechanical household thermostat—a small square or round box attached to the wall. These thermostats are easy to use. Set the system switch to “heat” or “cool,” then set the temperature lever to your desired temperature. They're widely available from a variety of manufacturers.

Digital

Digital thermostats come in a variety of shapes, but all have a small liquid crystal display (LCD) or backlit display screen, and settings are changed using buttons or touchscreen controls. These controls are more precise, which makes it easier to adjust to an exact temperature, compared to a mechanical thermostat. Digital thermostats are available in both nonprogrammable and programmable models.

Nonprogrammable digital thermostats function in the same manner as mechanical thermostats—choose the system setting, and then set the temperature. In fact, a number of models are “digital” only in the sense that they have a screen. They use a switch to change the system setting and a dial or slider to set the temperature, just as mechanical thermostats do. Other models, however, are digital in the more usual sense of the word, in that buttons are pressed to change the onscreen display.

Mechanical and nonprogrammable digital thermostats are manual thermostats. Each time you want to change the temperature in the house, you have to manually reset the thermostat.

The screen of a **programmable digital thermostat** is larger, and the unit is equipped with memory so that you can **program** it. This means you can enter a temperature setting, and specify a time of day—or night—for that temperature. Furthermore, you can enter several temperature/time settings. The thermostat automatically changes the temperature at the time you choose.

Using Your Thermostat: Setback and Setforward

A simple and effective way to reduce your energy bill in winter is by lowering the temperature so the house is cooler than usual at night when everyone's asleep, or when you're away; there's no point in heating an empty house. Similarly, in summer you can raise the temperature so that the house is warmer than usual when you're away. After all, why pay for air conditioning if you're not home to enjoy it? Turning the temperature down is called thermostat **setback**; raising the temperature is called thermostat **setforward** (or **setup**).

With a manual thermostat, you have to remember to reset the temperature every time you leave home, every time you return, every night before bed, and every morning when you wake up. This is where a programmable thermostat comes in handy. You don't *need* a programmable thermostat to reap the energy savings that come with setback and setforward, provided you are diligent about resetting the thermostat yourself. But a programmable thermostat is certainly convenient—and it never forgets!

Debunking Some Myths

Setforward/setback strategy doesn't work.

A widespread myth is that the setback/setforward strategy doesn't work because it takes more energy to warm the house back up (or cool it back down) to a comfortable temperature than it would to simply keep the house at the same temperature overnight. Research has shown that this is not true.³ Although your HVAC system will indeed operate while returning the home to a comfortable setting, this uses less energy than keeping the house at a constant temperature around the clock. And the longer the setback period, the greater your energy savings.

"Valve" or "gas pedal" theory.

Another idea—the "valve" or "gas pedal" theory—suggests the higher the thermostat setting, the more heat a furnace puts out. A variant on this is the notion that the home will warm up (or cool down) more quickly if the thermostat is set higher (or lower) than the desired final temperature. Neither of these ideas is correct. A furnace puts out the same amount of heat at the same rate regardless of how high the thermostat is set—similarly for an air conditioner putting out cool air—and simply cycles on and off to keep the temperature at the thermostat's setting.

To repeat: these myths are indeed myths. Turning your thermostat down in winter, or up in summer, really *can* save you energy and money. Both the U.S. Department of Energy and Canada's Institute for Research in Construction estimate an annual savings of about 5 to 13 percent per year in heating and cooling costs.^{4,5} Note that this isn't a guarantee but rather a rule of thumb. Research has shown that your savings will be more modest if your home is well-insulated, which is not surprising, as insulation slows the rate of heat transfer. Similarly, if you have a modern, ultra-high-efficiency system with a multi-speed compressor, setback/setforward may not result in savings.

How a Programmable Thermostat Works in the Summer

6:45 a.m.: You get up to get ready for the day. The temperature of the house is 78°F. The air automatically turned on a bit earlier so it would get down to this temperature by 6:30.

7:45 a.m.: You leave the house and the thermostat is automatically set to 86°F. By setting the temperature forward 8 degrees for 8 hours, you are saving money on cooling costs.

4:30 p.m.: You start returning home. The air conditioner cycled on a bit earlier so the house would again be at 78°F.

10:30 p.m.: You go to bed and the thermostat is automatically set forward three degrees to 81°F.

Practice programming a virtual digital thermostat at https://www.energystar.gov/products/heating_cooling/programmable_thermostats.

A Note about Heat Pump Systems

Do you have a heat pump, rather than a separate air conditioning system? In its cooling mode, a heat pump operates like an air conditioner, so setting the thermostat higher when the home is unoccupied, or at night, will save energy and money. But in heating mode, a heat pump extracts heat from the outdoor environment and moves it into conditioned space, and its efficiency drops significantly during the coldest hours of the winter.

To make up for this inefficiency, it's also equipped with auxiliary electric strip heaters, which are much less efficient but can provide extra heat during really cold weather. With this in mind, it should be noted that significant increases in thermostat settings (greater than 2 degrees) typically cause the electric strip heat to come on. To limit this problem, make sure that any setbacks are 2 degrees or fewer during the winter months if you have a heat pump system.

There are programmable thermostats specifically designed to work with heat pumps, which will bring the temperature up from the setback point in winter without turning on the electric resistance heat system. Look for wording on the package that indicates the model is especially for heat pumps.

Buying: What to Look For

So what's a budget- and energy-conscious homeowner to do? Well, the first thing is to realize that you don't have to use a programmable thermostat in order to save energy and money on heating and cooling, provided you are consistent in setting back or setting forward your thermostat. But if you like the convenience of a programmable thermostat, and the idea of coming home to a home that's already at a comfortable temperature when you walk in the door (or when you wake up in the morning), read on.

Programming Options

Think about your family's lifestyle and day-to-day schedule. Programmable thermostats are available in models that allow varying degrees of programmability:

- **1-week** models allow you to set a single program for the entire week. These are the least flexible models but are the easiest to program.
- **5-2** models allow you to set a standard program during the workweek, and a second program for the weekend. These models are a good option for people with traditional workweek schedules.
- **5-1-1** models allow you to set a separate program for the workweek, Saturday, and Sunday. These models are a good option for people who have a traditional workweek schedule.
- **7-day** models allow you to program each day of the week individually. These allow for the most flexibility in scheduling but require a little more effort to program.

All models come with an override setting, which allows you to temporarily change the current settings without altering the programmed settings. This is a great convenience if, for example, that big Friday night party heats up the house. You can temporarily lower the temperature for the length of the party, then set it to return to your normally scheduled program once your guests leave.

Displays and Controls

Let's face it: if you are not comfortable with the display and the controls, you probably aren't going to use the programmable thermostat. The following are some of the common display and control options that you can choose from.

- **Touchscreen** display models have larger, backlit screens that are controlled by touching the screen. There are no traditional buttons to push. They can be easier to read, especially in low light.
- If you are not comfortable with a touchscreen, an alternative option is a more traditional **button-operated thermostat with a digital display**. These types are very common.
- Some models have an **onscreen calendar display** that can make programming the thermostat very intuitive.
- **Instructions incorporated into the thermostat itself**—as part of the onscreen display, for example, or on a swing-out faceplate—are useful features, because you don't have to keep the instruction manual on hand all the time.

The biggest factor is to make sure the thermostat you buy is easy for *you* to use. Shop around and look at a wide variety of models. If there are demonstration models available, try them out by programming them. See if the store clerks have suggestions on models that are simple to program. Look for displays and controls that you find easy to understand.

Extra Features

The following are just a few features that you may want to inquire about when shopping for a thermostat.

- **Battery backup** so that the thermostat doesn't lose its settings in a power failure.
- **System indicator lights** that warn when a new air filter should be installed or if a battery is low.
- **Keyboard lock** to prevent tampering with current settings.

Additional Thoughts

- Don't forget to check online, too. Almost all manufacturers have websites with downloadable user manuals for each of their models; read the manuals of the models that interest you to see if you find the instructions clear and easy to follow.
- And if you get the thermostat home and find it isn't as easy to use as you thought it was going to be, *return it*. Even a top-of-the-line model won't save you energy if you can't use it properly.
- Look at your home's HVAC system. Different thermostat models are available for each type of HVAC system; be sure your new thermostat (or thermostats, in the case of a zoned system) is compatible. Check with the manufacturer if you have questions regarding your model.

If this sounds a little overwhelming, don't panic. Many home improvement stores have websites with buying guides, installation guides, and even videos to assist you. Taking a quick online tour before you go to the store can better equip you to make a smart buying choice. If you're upgrading your air conditioning unit, or your entire HVAC system, your residential heating and cooling contractor will likely have recommendations about an appropriate thermostat. Either choice can help you to make your home more comfortable while also enabling you to save money—and energy—in the long run.

Installation

Putting in a new HVAC system is a project best left to a professional HVAC contractor. On the other hand, replacing an old mechanical thermostat with a programmable thermostat is within the reach of a do-it-yourselfer. Be sure, though, to check whether or not it will affect the warranty on your HVAC system.

You'll need to be familiar with the wiring of your home, as well as your HVAC system, in order to get a compatible model. New thermostats come with installation instructions; follow them carefully. Older homes may not have the proper wiring setup for a programmable thermostat. Depending on your particular situation, you may need a battery-operated unit, or a model that works with direct line voltage (used to power the thermostat in some older homes).

If your old thermostat is poorly situated, this is the perfect opportunity to fix the problem. A thermostat's location can affect its performance and efficiency. To prevent unnecessary system cycling, you need to choose a location that is unaffected by any source of heat or cold—away from direct sunlight, drafts, doorways, windows, skylights, fireplaces, and not under an air-supply duct from the system. The ideal location is on an inside wall where you can easily access the thermostat to program it. Placing it close to your return air grill is not a bad idea either, because the temperature of air entering the grill is a pretty good average of the air throughout your home.

Safely Disposing of Old Mercury-Switch Thermostats

If you're replacing an old mechanical thermostat, be aware that these devices frequently contain mercury switches (glass bulbs containing silver liquid). Mercury is a toxic material and must, by law, be disposed of safely. Fortunately for the homeowner, this is easy to do. Many HVAC wholesale distributors, HVAC contractors, and retailers who sell thermostats will accept old mercury-containing thermostats, and many counties have hazardous-waste collection centers that will accept them, as well.

In 1998, thermostat manufacturers set up the nonprofit Thermostat Recycling Corporation to facilitate and manage the collection and proper disposal of mercury-containing thermostats. This organization's website has a search function to enable you to locate collection points near you (see <http://www.thermostat-recycle.org/>).

Important: Do not disassemble the thermostat! Simply take the entire thermostat to the disposal location.

The Future Is Here—Already

Programmable thermostats are quickly becoming fancier. Already there are wireless-enabled thermostats that allow you to program them remotely from any phone or Internet connection. One manufacturer is offering a moderately priced thermostat with a full-color screen, changeable themes, and a USB port to enable you to load photos into its memory, so that they can be displayed as a constantly changing slide show! On a more practical note, it also can graph your home energy use so that you can see how your thermostat settings affect your energy consumption.

Other “smart” thermostat models allow you to get the latest weather forecast for your area, or estimate the cost of your monthly utility bill. One model being tested now actually monitors the weather based on a home’s zip code and adjusts energy use while still keeping the indoor temperature comfortable for occupants. There’s even a model for homes with solar panels installed on the roof that will track the energy output of those panels.

Be aware, however, that the new features may come at a cost. If you’re thinking about installing one of these advanced-control systems, find out how much energy they use. If the fancy screen and computer use 30 watts or more continuously, then you may be better served by a simple programmable thermostat.

Having more control over your home energy use will allow you to be comfortable *and* save money. This will be a good thing for both your budget and the environment!

Additional Resources

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This website includes an interactive demonstration showing how to program a generic thermostat.

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