

*How well do you know  
the systems that make  
up your home?*

This book is for any homeowner  
who wants to spend less on energy  
and be more comfortable at home.  
Learn how your house works, then  
DO something about it!

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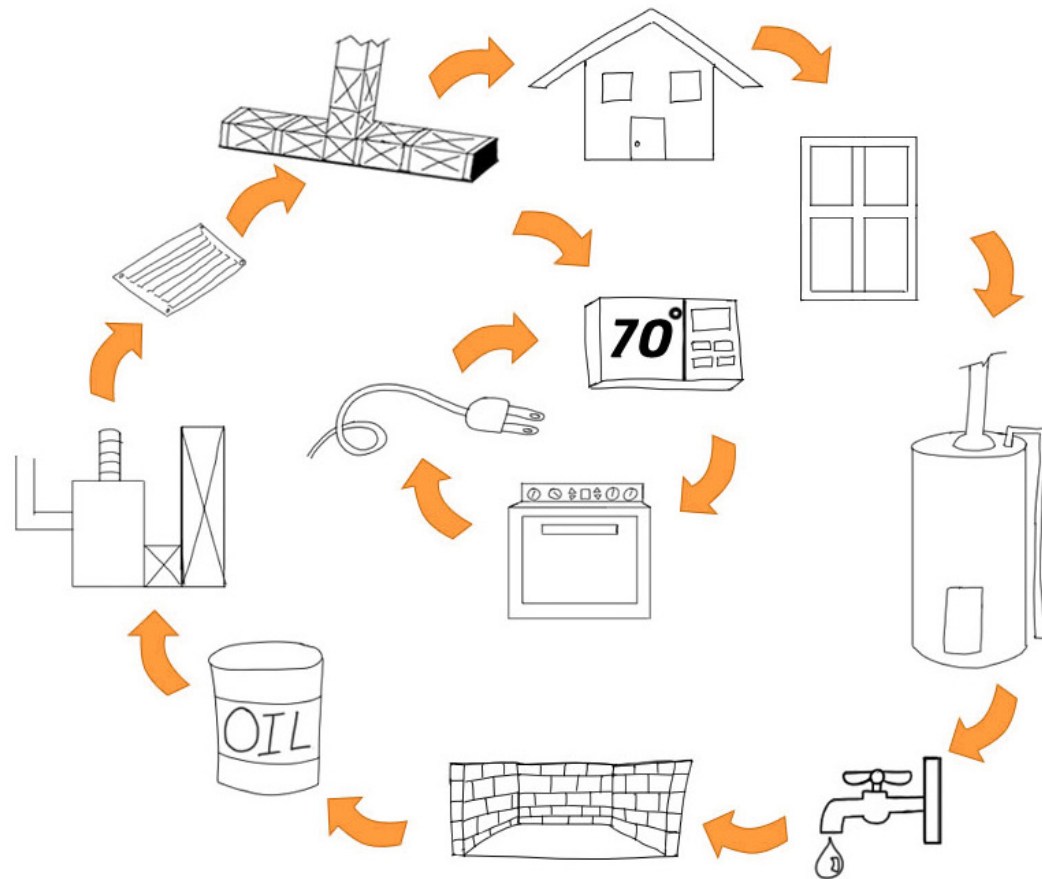
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## Home Systems 101 eBook



*Think Differently About Home Comfort.*

You've probably found your way to this eBook via MyHomeScience.com.

We wrote this eBook (and the blog) to help homeowners make their homes more comfortable AND more energy efficient.

*Are we challenging conventional thinking?*

Perhaps. But our collective years of experience have taught us how to best prioritize improvements to get the biggest bang for your home improvement buck.

The first step in doing this is understanding how the systems in your home interact with each other (not unlike the human body). Seeing how you're reading this eBook, you're well on your way!

*So what's the secret?* Check out the Action Plan at the end of this eBook and you'll find out!

~Tim, Joe, Larry & Susan  
Editors, MyHomeScience.com

# Heating & Cooling 101

Heating and Cooling as a home system is actually a combination of several sub-systems: HVAC equipment, Insulation and Air Sealing.

Nearly half of a home's total energy expenses go towards heating and cooling. Outdoor temperatures are either too cold or too hot most of the time to even think about keeping the windows open.

During frigid winter nights and on sweltering summer days, we depend on our heating and cooling system (also known as the HVAC system) to keep the home interior comfortable.

## High efficiency = low heating & cooling costs

According to the U.S. Dept. of Energy, an older furnace or boiler operates with an efficiency of 56% – 70%. A new, high-efficiency furnace can operate at 96% efficiency. Depending on the cost of fuel and electricity, an upgrade to a high-efficient HVAC system can pay for itself in just a few years.

## Is an older HVAC system causing problems in your home?

An older HVAC system has two main disadvantages. First of all, it's unreliable, forcing you to pay high maintenance and repair bills. Secondly, an older HVAC system is inefficient, which means that you end up paying too much to stay comfortable in your home.

Any HVAC system that's more than 15 years old is probably causing both of these problems. But even a well-functioning older system can be expensive to operate because of its inefficiency. For example, a 20-year-old furnace probably

operates at a maximum of 75% efficiency even when it's in perfect condition.

## High-efficiency HVAC to the rescue

Don't forget insulation and air sealing!

Even the most efficient HVAC system won't save you much money if your home has too many air leaks and too little insulation.

In the U.S. and around the world, HVAC technicians have made huge gains in heating and cooling technology. Today, [ultra-high-efficiency furnaces](#) and boilers are available that deliver up to 96% efficiency.

A high-efficiency HVAC system looks and works differently than old-style equipment. It's compact, quiet and reliable. Instead of requiring a chimney to vent flue gasses, a high-efficiency furnace and boiler relies on plastic pipe.

Upgrading to super-efficient HVAC equipment can cut heating and cooling costs by 30%-50%.

# Building Envelope 101

## What is it, and why is it so important?

Sometimes there's no avoiding scientific terminology. Not surprisingly, this terminology was named by building scientists.

Here's another way of looking at it:

**"building envelope" = the best all-weather jacket you ever owned.**

It sheds rain, keeps out chilly drafts, and has enough fluffy insulation to keep your body comfortable no matter what temperature Mother Nature dishes out.

*The building envelope's basic job is to separate interior from exterior space.*

It achieves this objective (with varying degrees of success, which we'll get to in a minute) with a variety of building materials such as studs, rafters, plywood sheathing, moisture barriers and insulation.

### **The bad news: Building envelope bungles are built into the construction process.**

Some building envelope problems are so obvious and urgent that we fix them right away. For example, you'd call a roofing contractor if worn-out roof shingles were allowing rain to leak into your house.

Other building envelope deficiencies are less obvious, but even more common. The minimum levels of attic insulation mandated by building codes don't even come close to protecting your home from extreme summer and winter temperatures.



Making matters worse, the construction process creates countless air leaks (gaps, cracks and openings) that allow conditioned (heated or cooled) interior air to escape and outside air to infiltrate. **Imagine wearing a t-shirt outside in a snowstorm.** The reason we tolerate these building envelope problems is that it's always possible to let the HVAC system work overtime.

But sooner or later, you notice that some rooms are too hot or too cold even though other parts of the house are comfortable. You also realize that your monthly utility expenses are consuming money you'd rather spend in other ways.

**The good news: You don't have to settle for a lousy jacket.** When a house has comfort problems or is expensive to heat and cool, a common response is to call an HVAC contractor and get an estimate to replace older HVAC equipment. Building scientists have three words of advice here: "Don't do this." Instead, have an **energy audit** done or have a certified home energy analyst test and inspect your home's building envelope.

You'll actually get a measurement of how leaky your house is during a blower door test. Plus the analyst will tell you exactly where your house is wasting energy because of inadequate insulation. Even if you do need new HVAC equipment, building envelope improvements will enable you to buy a smaller system that costs less to buy and operate.

It makes sense to replace a worn-out jacket that no longer keeps you comfortable. It also makes sense to invest in building envelope upgrades. Unlike clothing, building envelope upgrades like air-sealing and insulation never wear out. According to research underwritten by the Dept. of Energy, properly installed insulation and air-sealing upgrades can cut your heating and cooling costs nearly in half. That's around \$1000 of savings every year for a typical household —enough money for plenty of new jackets.

# Foundations 101

## Slabs, basements, crawl spaces and more...

Even though we often refer to the house foundation as a singular element, many houses have more than one foundation. For example, the living space may be built on a basement or crawl space foundation, while the garage has a concrete slab foundation. In parts of the country where basements are popular, many houses also have crawl space foundations that were built to support porches or additions.



The foundation's principle job is to elevate the home's main living space above ground level. It provides not just a solid building base but also a barrier to soil that contains moisture, insects, roots, radon gas and other things we don't want in our homes. Each type of foundation has specific advantages and limitations, which are summarized below.

## BASIC FOUNDATION TYPES

### Poured concrete slab

More common in regions where winters are mild, slab foundations rest directly on the ground. Plumbing lines (supply and waste) are often embedded in the concrete, a detail that can make remodeling difficult and expensive. A "radiant slab" contains tubing for hot water to provide whole-house heating.

The top surface of the slab can be colored and sealed to serve as the finished floor. But more often, the concrete surface is covered by other finished flooring. Slabs sometimes crack

because of unstable soil or inadequate reinforcement, necessitating structural repairs.

### Basement

Basement foundations can be built using poured concrete, concrete block, or (less frequently) pressure-treated wood. Historic houses sometimes have brick basement foundations. The quality of the basement space can vary greatly. Without effective waterproofing and dehumidification, a basement can be a wet, moldy space that detracts greatly from home value. Fortunately, this doesn't have to be the case.

Thanks to innovative waterproofing products and specialty contractors trained to install them (the "Basement Systems" contractor network is a good example), a basement can be just as attractive and functional as above-grade space.

### Crawl space

Resembling a basement but with shorter walls that don't allow someone to stand up inside the foundation, a crawl space can be built from concrete block or poured concrete. Some crawl spaces have dirt floors; others have poured concrete floors. Old-fashioned crawl spaces were built with vents that allowed outside air to circulate inside the foundation.



Today building scientists recommend that crawl spaces be "encapsulated" by sealing vents and covering crawl space floors and walls (from inside) with rugged moisture barriers. When performed by experienced specialists, the encapsulation process brings the crawl space within the home's building envelope. This treatment eliminates common vented crawl space problems like mold, wood rot, standing water, insect damage and poor energy performance.

# Plumbing 101

Save money, avoid leaks and conserve valuable resources with smart plumbing decisions

The miracles of modern plumbing came to light recently when I visited a restored, 250-year-old house.

The centuries-old structure had long ago gained running water and fully functional bathrooms. But the outhouse still stood in the backyard (repurposed as a garden shed) –a reminder of earlier days when washing machines and hot showers weren't even imagined.



Today we take running water for granted, forgetting that water heating can account for nearly 20% of a typical household energy budget. Plumbing definitely deserves to be a target for improving energy efficiency and cutting utility costs, especially if you use electricity to heat your water. Check out the Plumbing Priorities explained below to learn how you can save energy and money by using water wisely.

## PLUMBING PRIORITIES

- **Conserve water.** Using water wisely will save you money if you pay a municipal water bill. But water shortages in many parts of the country are prompting all of us to conserve this natural resource. Fortunately, it's easy and inexpensive to reduce domestic water consumption. Start by making sure to use eco-friendly (low-flow) showerheads and faucet aerators. When replacing a dishwasher or washing machine, select new

ENERGY STAR® models that feature efficient water use. Consider using xeriscaping strategies to cut down on lawn and garden watering.

- **Enhance convenience.** It's inconvenient and wasteful to wait for hot water. One easy, affordable way to reduce the wait is to insulate hot water pipes with slip-on rigid foam pipe insulation. For maximum effectiveness, pipe insulation should be used on any and all hot water supply lines that are accessible.
- **Avoid water damage.** Many homeowners don't think about a flooded basement until it's too late. If you haven't already done so, take steps to protect your home from a water disaster that can damage your property. Installing or upgrading a French drain and sump pump system with battery backup will help to prevent or minimize basement flooding in the event of a power outage. Make sure that your gutter and downspout system is functioning properly and carrying water away from the foundation. Replace aging washing machine supply hoses before they develop leaks. If necessary, install a basement dehumidifier to maintain 70% or lower humidity in basement and crawl space areas in order to discourage mold.
- **Cut water heating costs.** If your water heater is more than 10 years old, it's a good candidate for replacement with a more-efficient ENERGY STAR® heater. Talk to a home energy specialist (such as a Dr. Energy Saver dealer) to evaluate your water-heating options. Depending on your situation, you may want to consider a heat pump water heater, a tankless water heater, or an indirect system that uses your HVAC system to heat the water you use for washing. Solar water heating (aka solar thermal) may also be a possibility.

# Electrical 101

## We're using more and more electrical devices in our homes, so it's smart to focus on efficiency

Your home's electrical system is linked to quite a few other major home systems. It powers your lights and air conditioning system, pumps your water, spins the clothes dryer and operates an astonishing array of appliances, tools and other devices.

According to the [Energy Information Administration](#), the percentage of electricity used for home appliances and electronics has nearly *doubled* over the last 30 years. But thanks to Federal energy efficiency standards (administered primarily through the ENERGY STAR® program), overall household energy consumption has decreased by over 30%.

That's a remarkable achievement. And there are great incentives to continue saving: lower utility bills, fewer harmful emissions from power plants and greater resiliency for your home and family in the event of power outages.

**Want to keep lowering your electric bill? Consider LED lights, ENERGY STAR® appliances, phantom loads and (yes, you heard that right) insulation upgrades.**

You get the message: There are many different things you can do to lower your electric bill. Replacing inefficient incandescent light bulbs with ultra-efficient LED lights can cut the lighting portion of your electric bill by 80%. Buying ENERGY STAR®

appliances to replace older models also yields great savings. And if you haven't learned about the energy savings made possible by eliminating phantom loads (power consumed during "sleep" and "standby" modes of printers, TVs and other electronic devices), it's worth a look at the EPA's booklet on ["energy vampires."](#)

So what does insulation have to do with saving electricity?

*Plenty.*

Just think about difference between storing a cup of hot soup in a paper cup or a well-insulated thermos. That soup is going to get cold pretty quickly in a paper cup, but it can stay hot for hours in a good thermos. The electricity used to maintain comfortable indoor temperatures can go to waste when poor insulation allows heat to leak out in winter or leak inside in summer.

Since most houses have too many air leaks and too little insulation, it makes sense to upgrade these values. The good thing about "sealing your house tight and insulating right" is that these improvements never wear out or require maintenance. They just keep saving you money.

## Ready for Action?

Now that you've mastered the five primary systems that make up your home, are you ready to put that knowledge to work to make your home more comfortable? There's a smart, effective way to prioritize home performance upgrades. The "ABC Strategy" explained below is actually based on building science, the study of how different building systems interact.

The **ABC strategy** for improving home performance:

| <b>“A” is for Attic, 1st priority</b>   | <b>“B” is for Basement, the second target zone</b>   | <b>“C” is for Conditioned zone, your living space</b>   |
|---|--|---|
| <p>Too little insulation and too many air leaks are common problems in many attics. As a result, an astonishing amount of heat is lost through the attic during wintertime. In the summer, attic temperatures in the 140-degree range keep some rooms too hot even when the rest of the house is comfortably cool.</p> <p>Instead of blaming the HVAC system for comfort problems and high utility bills, it's smart to address the attic deficiencies that make your HVAC system work so hard. Fortunately, the attic is accessible and affordable to insulate and seal. Making the attic your first home performance priority can cut your heating and cooling expenses nearly in half –without the major expense of HVAC system replacement.</p> | <p>Just like the attic, a typical basement is often neglected during the construction process.</p> <p>Depending on the time of year, the substantial amount of air that leaks into the basement is either too cold or too moist. As a result, we endure cold floors, drafts, or excess moisture that brings mold and musty smells into our living space.</p> <p>Other issues that make the basement an important target for improvement include radon and waterproofing treatments that can prevent major water damage</p> | <p>It may seem counter-intuitive to put your main living area at the bottom of your priority list. But this isn't the case when you realize that "C" also stands for "complicated" and "costly."</p> <p>It's more difficult and less impactful to upgrade insulation levels in the enclosed walls that surround your living space. It's much more costly to install replacement windows than it is to upgrade attic or basement insulation.</p> <p>By dealing with attic and basement improvements first, you'll enjoy more noticeable benefits and a faster return on your investment.</p> |

*NOTE: If you would like to share this guide, please direct people to the link below, so they have a chance to join the newsletter as well. Thank you kindly!*

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