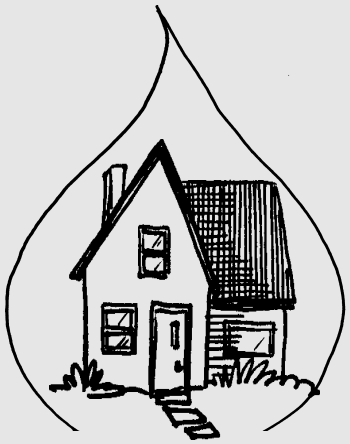

This worksheet helps you identify possible problems with your home heating system, duct system and the house envelope (the foundation, floors, walls, ceilings, and roof).

By keeping these systems in proper order, you can avoid unhealthy situations, reduce your energy bills, increase your comfort level and prevent structural damage to your home.

This assessment is divided into three parts:

1. **Combustion heating appliance ventilation safety**
2. **Rating your energy consumption**
3. **Improving energy efficiency**

Home*A*Syst

for New Jersey

Home Heating & Cooling Systems:

Saving Energy and Keeping Safe

What do we expect from our houses?

Your house should be a safe and healthy place that is comfortable, affordable, and durable. How a home is constructed, insulated, and heated and cooled directly affects how it performs. A house is only affordable to operate when energy costs for heating and cooling are reasonable. Energy bills are lowest if the home is tightly air-sealed, properly insulated and all mechanical systems are operating efficiently. (Before extensive air-sealing, however, it is critical to make sure that doing so will not cause health or moisture problems.) Above all else, your home must be a healthy and safe place to live.

Part 1 -- Safety Comes First with Combustion Heating Appliances

If your furnace, wood stove, boiler or water heater burns gas, oil, wood, or coal, it is important that the venting system, which carries combustion gases out of the house, is properly functioning. This section explains how venting systems work, and what will keep them safe. At the end of Part 1, fill out the assessment chart to identify potential risks with your system.

Are your combustion appliances safe?

Whenever a fuel is burned (gas, oil, coal, or wood), carbon dioxide and water vapor are given off. If the burner is not functioning perfectly, carbon monoxide and other harmful pollutants are also produced. Most combustion appliances are vented to ensure that combustion by-products are removed from the home. But over time, without proper maintenance, problems can occur such as blocked vents (where did that bird put its nest??), cracked flues, and rusted furnace heat exchanges. Unvented appliances should only be used in well

ventilated areas. Vents or flues should be checked annually to make sure they are in good working order.

There are three types of venting systems in gas-fired furnaces and boilers: natural-draft, power-vented, and sealed-combustion. The first, called "natural draft" or "atmospheric vent," relies on the natural tendency of warm gases to rise. Natural draft appliances always vent into a vertical flue (either masonry or metal) and have a draft hood, which draws in extra indoor air.

When exhaust equipment such as a clothes dryer, central vacuum, or kitchen and bathroom exhaust fans are operating, they draw air out of the house and can create a negative pressure within the house. This can cause combustion by-products to "spill" or be pulled into the house, instead of going out the vent. Natural draft appliances are most susceptible to this problem, known as backdrafting (see Figure 1 below).

Another type of furnace or water heater exhaust system is called "power vented"—a small blower is used to exhaust combustion by-products from the house. Flue gases from power vented appliances rarely spill back into the house.

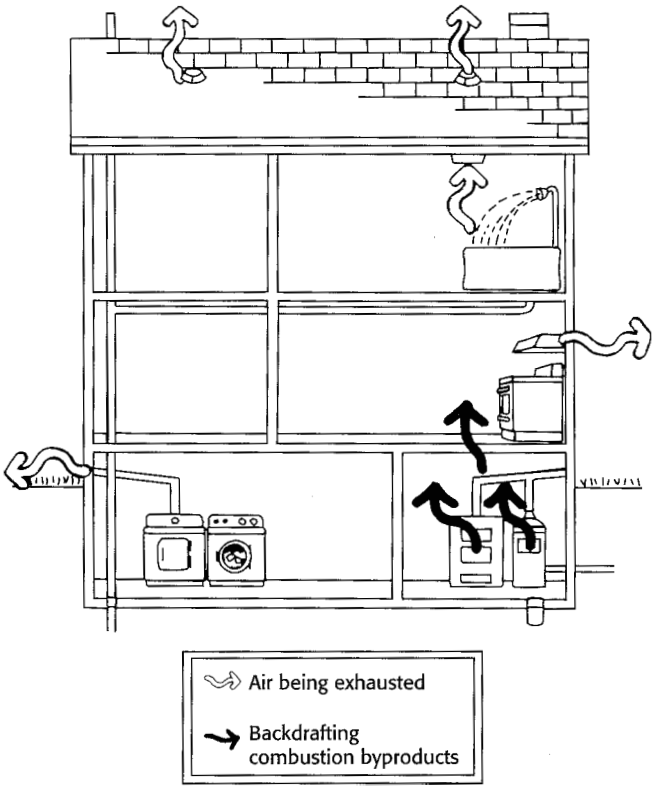

Figure 1. Backdrafting occurs when exhaust fans lower in-home air pressure.

The third type of venting system is called sealed combustion. The newest furnaces and water heaters bring the air needed for combustion in from outside through an intake pipe. Flue gases are vented outside through a second pipe and no chimney is needed. They are completely isolated from inside air, and as long as the intake and vent pipes are not blocked or damaged, these appliances are immune to backdrafting.

Most oil-fired boilers and furnaces use a strong blower to support combustion. Thus, they are less likely to backdraft. In this equipment, leakage due to a blocked chimney or rusted flue or heat exchanges will usually be accompanied by an oily, smoky odor.

Is there adequate air for your combustion appliances?

For safe operation, it is critical that combustion appliances have enough air to work properly. The National Fire Protection Association (NFPA) codes (or more stringent local codes) must be followed to ensure safe installation and operation of combustion equipment.

Sealed-combustion units draw air directly from outside the home. However, natural-draft and power-vented units draw air from the indoor space in which they are located. If you have combustion equipment located in a closet or other small space, air must be allowed to reach the appliance. This is often accomplished with louvered doors. Do not place anything inside or outside of the confined space that might block air flow.

While the use of unvented gas or kerosene space heaters cannot be recommended, if you do use these appliances it is important to follow manufacturers directions for safe use and operation. To minimize pollution, it is especially important that the combustion unit be cleaned and properly tuned (a properly adjusted wick in a kerosene heater, for example). Also, these heaters must not be operated in a room that is closed off from the rest of the house, and it is best to slightly open a nearby window to replace oxygen and dilute combustion gases.

Assessment 1 — Ventilation Safety for Combustion Heating Systems

Complete the assessment below only if you have a combustion appliance. For each question, put the risk-level number (1,2, or 3) in the column labeled "Your Risk." Although some choices may not correspond exactly to your situation, choose the response that best fits. Refer to the information above if you need more information to complete this chart.

Responding to Risks

Your goal is to lower your risks. Turn to the Action Checklist on page 102 and write down the high and medium risks you identified. Refer to the recommendations in Part 1 to help you make plans to reduce your risks.

ASSESSMENT 1 — Ventilation Safety for Combustion Heating Systems

	LOW RISK	MEDIUM RISK	HIGH RISK	YOUR RISK
Vent systems for combustion appliances	No combustion appliances (all electric) or sealed combustion.		Unvented space heaters or gas logs are used. -OR- Vent pipes are showing signs of damage. -OR- Rust or carbon present on top of appliance or below draft hood.	
Condition of chimney or flue	The chimney or flue inspected annually.	The chimney or flue inspected only once in past five years.	Chimney or flue has not been inspected or inspection record unknown.	
Air for combustion (does not apply to sealed combustion applicances)	All combustion equipment located in a well ventilated space (like an attic or garage).	Combustion equipment located in a well-sealed basement. This situation is worse if exhaust appliances (such as a clothes dryer) are also located in the space.	Combustion equipment located in a small space (like a closet) and openings are blocked.	

Part 2 -- Rating your energy consumption

The amount of energy your home consumes depends upon many factors, including how well it is insulated, the efficiency of appliances and equipment, local weather and climate, and your lifestyle. This section describes how to calculate your energy use, and determine if it is high or low. At the end of this section, fill out Table 1. If your energy consumption is low, that's good news. If it is high, or if there are ways you could save more energy (and money), continue to Part 3.

Does your house use too much energy?

Figure 2 shows how energy is used in the typical American home. The best and most accurate way to determine the energy efficiency of your home is to have a "home energy rating" performed by an energy service professional. Without an energy rating, it is not easy to know if your energy consumption represents "too much." The basic idea is to compare your current utility bills with the utility costs of an energy efficient home of the same size and having similar appliances. Contact your local utility company to see if they offer a free home inspection. During this inspection, your heating/cooling system and all thermal barriers - such as windows, doors, attics, basements, and ductwork - will be thoroughly evaluated for energy efficiency.

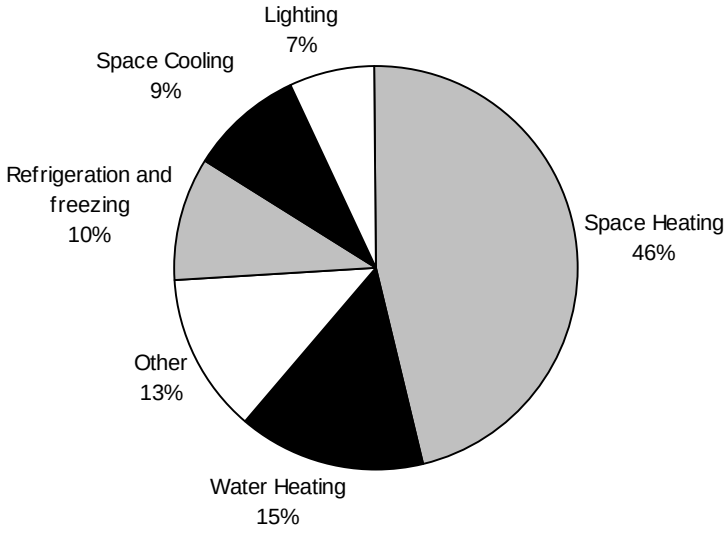

Figure 2. Typical distribution of residential energy use.
Data taken from US Congress, Office of Technology Assessment, Building Energy Efficiency, OTA-E-518, 1992.

If you'd like to do your own energy audit, contact your local utility to see if they provide data on average energy consumption for houses similar to yours. Alternately, you can ask them to quote you a monthly payment plan which will tell the average energy consumption for a house in your geographic location. When you call, be sure to describe your energy and fuel uses. For example, you may have an all-electric home, or you may heat with gas and cook with electricity. It is also important to specify whether or not you air condition your home.

Check your records or call your utility to determine how much you spent on energy bills over the last twelve month period (use Table 1). Divide your energy costs for one year by the number 12 to arrive at your average monthly energy bill. Compare this with the monthly bill of an "average home," or with the monthly payment plan amount. If your current bill is much greater, then there are probably many opportunities for improving the energy efficiency of your home. If your bills are lower than the average home, your home may already be energy efficient.

There are three key strategies to increase energy efficiency: air-sealing (leak proofing) your home, adding insulation, and using more efficient appliances and equipment. Each is covered in Part 3.

Part 3 -- Increasing Your Home's Energy Efficiency

The average home in the U.S. wastes 30-50% of the energy it uses. If every home installed energy efficient equipment and was well insulated, individual homeowners and the national economy would reap tremendous savings. The following two sections will help you identify where energy is being lost and how you can prevent future losses. Complete the assessment charts at the end of each section to see where improvements can be made.

3.1 Improving Heating & Cooling Systems

The single greatest energy consumer in your home is the heating/cooling system

Table 1 — Are Your Energy Costs High or Low?

Use the equations below to calculate and evaluate your energy consumption:

Total of heating/cooling bills for the past year (12 months)	$_____
Divide by twelve to get average monthly bill (A)	÷ 12
Average monthly bill	$_____ (A)
Average monthly bill for energy efficient houses similar to yours *(Note: Contact your local utility company for an estimate.)*	$_____ (B)

If A is larger than B, it may indicate that your home is using more energy — and costing more money — than it should. By increasing energy efficiency, you can cut your bills and save significant amounts of money over the long run.

(furnace, boiler, heat pump, wood stove, air conditioner). This system has three parts: 1) heating/cooling unit(s), such as furnaces and air conditioners, 2) ducts or other distribution mechanism, and 3) a thermostat to control output. You can save energy in all three areas.

How old are the parts of your heating/cooling system?

If your primary heating/cooling unit is over 15-25 years old, it may not be very energy efficient. Even if it still works, you may benefit by replacing it with a new, energy efficient model. A new device can pay for itself in fuel savings in only a few years. Or, if you find long term financing for the new equipment, the dollar value of the monthly energy savings may exceed the monthly payment for the equipment—resulting in a positive cash flow.

Is your system getting proper maintenance?

All machines work more efficiently — and more safely — if they are inspected and maintained. Your furnace, air conditioner, and other heating/cooling equipment should be checked and serviced at least every two years by a qualified professional. Monthly maintenance — such as inspecting and changing air filters — is recommended during the heating or cooling season. A forced-air system includes an air filter, which removes dust and debris before it reaches the air blower and the heat-exchange coils. Dirt on the coils reduces efficiency, so you should change (or clean) your air filter on a regular basis. Even a thin layer of soot in the furnace or boiler can reduce efficiency by 10% or more. A yearly cleaning of oil burners is recommended.

Are you using your thermostat to save energy?

One of the easiest ways to save energy is to set thermostats at a lower temperature in winter, and a higher temperature in summer so that the heating/cooling system runs less often. If a house is caulked and weatherstripped to prevent cold drafts, most people—when dressed appropriately—will be comfortable at 68°F during winter. To save more energy, temperatures can be turned down to 50 or 60 degrees while sleeping or when the house is empty. Digital or clock thermostats (also called automatic set-back thermostats) can adjust the temperature

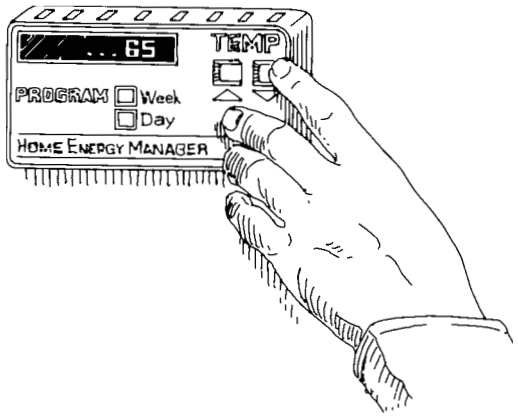

Figure 3. Digital or clock thermostats can be programmed to adjust the temperature automatically.

automatically. For example, they can turn the heat down every night at 11 p.m. and bring the temperature back up by 6 a.m.—before you get out of bed. The newest kind of residential thermostat—called a home energy manager—allows many temperature settings throughout the week. Depending on your lifestyle, these set-back thermostats can pay for themselves in energy savings in as little as one or two years. (Nighttime setbacks are not recommended for homes with seniors, who have diminished ability to cope with temperature extremes.)

Is your distribution system working well?

Unless there is a heating/cooling unit in each room, you probably have a system to distribute hot or cool air from a central heater or air conditioner. Over 90% of central heating systems and virtually 100% of residential cooling systems in America have forced-air distribution systems which use air ducts to move warm (or cold) air to the rooms of the house. If the duct system leaks, it can waste large amounts of energy.

Any ductwork located in an unheated space (such as an attic or crawl space) has a high potential for heat loss. Ducts in such spaces should be insulated. Also, all joints in the duct system should be properly sealed to make sure all the warm or cool air gets where you want it to go.

Besides providing supply registers in each room to deliver heated or cooled air, there must be a return duct to allow air to get back to the heating/cooling unit. Many newer homes do not have a return register in every room, but rely on the space under a closed door to allow supply air to return to a centrally located return. If you have a room that is uncomfortable (hard to heat or cool) when the door is shut but is fine when the door is open, you probably have an air distribution problem. You can increase the cut under the door or call a heating or cooling specialist to reverse the problem.

The second most common heat distribution system uses hot water, distributed through pipes to radiators or convectors. Pipes carrying hot water should be insulated everywhere - from boiler to radiator.

SAFETY NOTE

Your home receives outside air from all small holes and cracks in the structure, including any holes in the duct system that are located outside the conditioned space (such as an attic or crawl space).

Sealing a leaking duct system will reduce the amount of outside air that leaks into the home. While this will reduce energy consumption, you must also be aware of how it might affect combustion appliances and air quality within the home. Duct sealing is a job best left to a professional.

Assessment 3.1 — Improving Heating/ Cooling Systems

Use the table on the next page to identify areas where energy can be saved. Put your potential energy-loss level (1, 2, or 3) in the column labeled “Your Loss Potential” on the assessment table on the next page. Although some choices may not correspond exactly to your situation, choose the response that best fits. Refer to the information above if you need more information to complete this chart.

Responding to Your Potential Losses of Energy

Your goal is to reduce the amount of energy that is wasted. Turn to the Action Checklist on page 102 to record the high and medium loss potentials you identified in the chart above. Use the recommendations in Part 3.1 to help you identify ways to increase energy efficiency.

3.2 Preventing Loss of Heated (or Cooled) Air

Once you have reached a comfortable temperature indoors, your aim is to keep it that way. Preventing unwanted air leaks and blocking heat transfer are two important approaches to making your home even more energy efficient.

ASSESSMENT 3.1 — Improving Heating/Cooling Systems

	LOW ENERGY LOSS	MEDIUM ENERGY LOSS	HIGH ENERGY LOSS	YOUR LOSS POTENTIAL
Age of heating and cooling equipment	Less than 5 years old.	5 to 15 years old.	15 years old or older.	
Maintenance of heating and cooling equipment	Air filters are changed every month during use and equipment is serviced at least every 2 years.	Filters are changed occasionally and system is maintained on an irregular basis.	Filters are not changed or rarely changed and system is not maintained.	
Air temperature thermostat	A modern thermostat with variable temperature set-back is installed. It is routinely used to minimize energy consumption.	A newer thermostat installed, but it is not used to regulate temperature at night or when the house is empty.	An older thermostat is in use. It is set to maintain a constant temperature.	
Duct location	All duct work is located in heated/cooled space.	Some duct work is located in unheated space.	All duct work is located in unheated space.	
Return duct	There are air-return ducts in every room or bedroom doors are left open.	There is one "central" air-return. Bedroom doors shut at night but 2" or greater space under the doors.	There is one "central" air return. Bedroom doors shut at night with little space between bottom of door and floor.	
Air-sealing ducts and registers	Seams in the duct system caulked or sealed, especially where air registers enter the rooms.	There are no visible gaps in duct system.	Gaps visible in duct system or around room air registers.	
Air-intake or air handler	The intake/handler is located in heated space.	The intake/handler is located in unheated space (crawl space or attic).	The intake/handler is located in garage*.	

*** SAFETY NOTE:** If your air handler is in your garage, NEVER leave your car running in the garage. The air handler can pick up car exhaust fumes and distribute them to the house through the duct system.

Have you air-sealed your home?

Every house has openings through which outside air can enter. Some openings, such as windows and doors, are obvious pathways for air entry. Others, such as cracks around window frames, are unintended pathways for leaks. This uncontrolled leakage of air, known as infiltration, can account for a large portion of the total heat loss in a home—typically about 30% of the total heating bill. Cold (or warm) air entering a home must be heated (or cooled) if the home is to remain comfortable.

Sealing your home against air leakage is not difficult. For detailed information on how to reduce air leaks, contact the U.S. Department of Energy's Energy Efficiency and Renewable Energy Clearinghouse (EREC) or an experienced heating contractor or building inspector. See "For more information" on page 103.

Does your home need more insulation?

Even if you air-seal your house, you still need to prevent the transfer of heat or cold through walls, floor, or ceilings. Insulation acts like a blanket to retain the heating or cooling your system produces. Insulation materials are assigned an "R-value," which is a measure of how well they "Resist" the flow of heat energy into or out of your home. The larger the R-value, the more heat (or more cool air) is kept where you want it.

The recommended amount of insulation for a home varies with geographic location. If you have extreme temperatures, you will need more insulation. As a general rule for New Jersey, if your attic has 3 inches of insulation, add 6 inches more. If you have 6 inches of insulation in your attic, that should be sufficient (except in extreme northwestern New Jersey where more insulation is needed). Your local building supplier should be able to provide you with your good recommendations. The EREC publication "Insulation Materials and Strategies" describes various insulation products available and provides insulation recommendations for all areas of the United States by zip code. It also helps you to decide if you should attempt the job yourself or have it done professionally. Because of the expense, adding wall insulation to an existing home is generally a low priority; you should take other, less expensive measures to prevent the loss of heated or cooled air first.

Assessment 3.2 — Air-sealing and Insulation

As before, put your potential energy loss level (1,2, or 3) in the column labeled "Your

SAFETY NOTE

****Proceed with caution****. As stated before, your *home must be a healthy place to live*. Air-sealing may save energy, but it can also trap deadly pollutants.Air-sealing can cause a dangerous situation by reducing the air available for combustion appliances. Do not attempt to air-seal your home until you have taken care of these problem areas:

* Unvented gas or kerosene heaters or unvented gas fireplaces/logs must be removed or vented outdoors.

* If you have a gas cook stove that is not vented to the outside by a power-vented hood, do not extensively air-seal your home. Alternatively, open a kitchen window 1/4 inch while cooking and run an exhaust fan.

* If you have a high level of radon in your home, properly air-sealing can help reduce the problem. However, you should monitor radon levels carefully and contact a professional if the problem is not fixed. (See Home*A*Syst fact sheet on indoor air quality for more information).

* If you have natural-draft appliances, do not extensively air-seal your home without seeking the advice of an energy services professional.

ASSESSMENT 3.2 — Air-sealing and Insulation

	LOW ENERGY LOSS	MEDIUM ENERGY LOSS	HIGH ENERGY LOSS	YOUR ENERGY LOSS
Attic	All potential leak points are sealed or weather-stripped.	Only some potential leak points are sealed.	Most potential leak points are not sealed.	
Windows and doors	All sealed with caulk and weather-stripping and tested for leaks. Newer, well-sealed windows installed with tight storm windows.	Only some windows and doors caulked and weather-stripped. Older or leaky storm windows used. Some windows sealed in winter with plastic.	Older windows. Not sealed. Storm windows may be absent.	
Basement or crawl space	Sill plate, service entrances, windows, and wall cracks sealed with caulk or foam.	Leaks detected, but not fully sealed.	No sealing attempted.	
Attic insulation	Insulation equal to or greater than recommended for my region.		Insulation well below recommended levels, -OR- not insulated.	
Insulation in walls (above ground)	Wall cavity insulated with loose fill or 3 inch to 5 inch batt.		No insulation in wall cavity.	
Insulation in heated basements	Walls insulated with rigid foam or batt, according to regional recommendations.		Walls not insulated.	

Loss Potential" in the assessment chart on this page. Although some choices may not correspond exactly to your situation, choose the response that best fits. Refer to the information above if you need more information to complete this chart.

Responding to Your Potential Energy Losses

Your goal is to reduce the amount of energy you use. On the Action Checklist on page 102, record the high and medium loss potentials you identified above. Use the recommendations in Part 3.2 to help you find ways to increase energy efficiency.

ACTION CHECKLIST

Go back over the assessment charts and look for the high and medium risks and energy loss potentials you identified. Write them below. Next, list the improvements you plan to make. You can use recommendations from this worksheet —or from other sources — to help you pick actions you are likely to use. Write down a date to keep you on schedule. You don't have to do everything at once, but try to eliminate the most serious problems as soon as you can. Often it helps to tackle the inexpensive actions first.

Write all high and medium risks below.	What can you do to reduce the risk?	Set a target date for action.
Sample: Water heater not insulated.	Buy a ready made insulation blanket at the hardware store.	One week from today.

FOR MORE INFORMATION...

Who to contact for more information about Energy Conservation

Energy efficiency. The U.S. Department of Energy provides energy information through the Energy Efficiency and Renewable Energy Clearinghouse (EREC). EREC will send detailed information on the topics in this assessment, and much more. Call them toll-free at (800) DOE-EREC (800-363-3732), 9am - 7pm, Eastern time or visit their World Wide Web page at www.eren.doe.gov. Available titles include:

Cooling Your Home Naturally
Energy Efficient Lighting
Energy Efficient Water Heating
Energy Efficient Windows
A Guide to Making Energy Smart Purchases
Landscaping for Energy Efficiency
Loose-Fill Insulations
Selecting a New Water Heater
Solar Water Heating
Sunspace Basics

Energy-efficient appliances. Contact the American Council for an Energy Efficient Economy, 2140 Shattuck Ave. #2002, Berkeley, CA 94704.

Resources and Publications.

1. Contact your county office of Rutgers Cooperative Extension for the following publications:

EH 001 Kerosene Heaters - Safe Use and Operation and Supplement
EH 002 Portable Electric Heaters - Selection and Safe Use
FS 60 Controlling Energy Costs - Major Routes of Heat Loss
FS 61 Controlling Energy Costs - Major Users of Energy
FS 410 Need a New Heating System?
FS 836 Carbon Monoxide and Other Combustion Products
NE 251 Energy Conservation for Mobile Home Dwellers
PA 118 Energy Management Checklist for the Home ($1.00)

2. *Homemade Money: How to Save Energy and Dollars in Your Home*, by Richard Heede, 1995, Amherst, New Hampshire: Brick House Publishing, 280 pages, $14.95. To order, write Rocky Mountain Institute, 1739 Snowmass Creek Rd., Snowmass, CO 81654

3. *The Virginia Energy Savers Handbook: A Guide to Saving Energy, Money and the Environment* by Ned Nisson and Alex Wilson, 1993, Virginia Dept. of Mines, Minerals and Energy, 120 pages. To order, contact the Virginia Dept. of Mines, Minerals and Energy, Division of Energy, 2201 W. Broad St., Richmond, VA 23220, (804) 367-6974.

This Home*A*Syst assessment does not cover all potential risks and concerns related to energy conservation which could affect health or environmental quality. It is meant to serve as a starting point for identifying and addressing the most apparent risks. There are other Home*A*Syst worksheets — on a variety of topics — to help homeowners examine and address their most important environmental concerns.

This worksheet was written by Lori Marsh, Virginia Polytechnic Institute and State University. Figures 1, 3, and 4 adapted from The Virginia Energy Savers Handbook, 1993.

This worksheet was adapted for use in New Jersey and technical review provided by Joseph Ponessa, Ph.D., Extension Specialist in Housing and Energy, Rutgers Cooperative Extension; Susan Lance, Program Associate in Water Quality, Rutgers Cooperative Extension; Jan Larson, Program Associate in Resource Management, Rutgers Cooperative Extension.