two

Understanding energy and your home

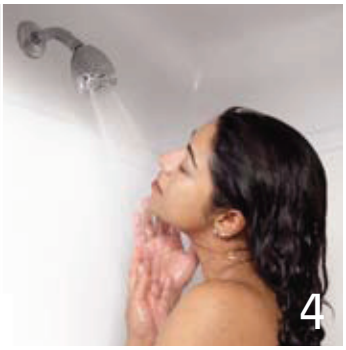
Here's how it works. With the first sign of cold weather, your home starts to cool down and someone in your home will likely turn on the furnace. As you and your home adjust to the temperature changes outside, you will adjust the thermostat accordingly – either by turning it up to make your home warmer, or turning it down to make it cooler. Adjusting the temperature is an action that balances the heat flows in your home.

As the weather warms up and spring arrives, you'll notice that you and your neighbours begin to open the windows in your homes. Everyone wants to enjoy the fresh, fragrant spring air! By opening the windows, you move the air around in your home – sending the stuffy air out and bringing the fresh spring air inside. By doing this, you are adjusting the air flows in your home.

Then in the summertime, when the humidity levels are high, you may either turn on the air-conditioner (if you have one) or a dehumidifier. By doing this, you're controlling the moisture flows in your home.

Sometimes these flows work together. For example, in the winter when you take a shower, you may turn the exhaust fan on. When the exhaust fan is running, the fan removes the moisture-laden air and replaces it with cool, dry, outdoor air, which is drawn in through the home's cracks and leaks. In this case, the moisture, heat, and air flows are being adjusted in your home.

So, as you can see, your home is in a constant balancing act. And this balancing act can have a significant impact on the energy efficiency of your home, and therefore on your home comfort and the amount you spend on your energy bills!



YOUR HOME WORKS AS A SYSTEM

It is important to understand how your house functions when planning major retrofit work. This will ensure the retrofit will meet your expectations and won't cause new problems while solving the old. Though this may sound complicated, it's a simple question of balance. To be comfortable, energy efficient, and safe – the air, moisture, and heat flows of your house must operate as a balanced system.

So before undertaking any major renovations, homeowners and contractors must ask- "What are the potential reactions to the work I am about to do?" "How can I avoid those problems from occurring in the first place?"

As you already know, no two homes are the same. However, whether your home is new or old, a bungalow or two storey, all homes have four common elements that include:

1 Building Envelope
2 Outside Environment
3 Mechanical Systems
4 Occupants

The first step when looking at your house as a system is understanding how the potential interaction of these four elements can affect your home's air, heat and moisture flows. Understanding these relationships is the secret to avoiding problems!

1 Building Envelope

The first element of your home's system is the building envelope. This is what separates the indoor living space from the outdoor environment. It is made up of all the materials and exterior surfaces in the building "shell" – the walls, ceiling, windows, doors, and floors.

The amount of insulation and air leakage in the building envelope will determine its relative resistance to air, heat and moisture flows. For example, in the winter, if there is too much air flow through the building envelope via air leaks, the warm, moist indoor air will be forced out – drawing in the cold, dry outdoor air. This creates a very dry, drafty, uncomfortable home that can be very expensive to heat.

Furthermore, as the warm, moist air exits, it can cause structural damage if it becomes trapped and condenses in the walls and the attic. Moisture must exit through controlled openings such as open windows and exhaust fans to avoid damage to building materials.

Likewise, if the building envelope in your home has little air leakage, and there is no provision for ventilation and combustion air to be introduced to the home through controlled means, you may have a problem with your fuel burning appliances venting properly. This situation could be hazardous to your health. In addition, without proper ventilation, moisture levels could rise encouraging the growth of mold.

By air sealing and insulating your home's building envelope, you reduce the amount of outside air entering your home through the cracks and leaks. This is a balancing act. You must still provide enough dry outside air to enter the home for the combustion appliances, its occupants, and to reduce moisture levels in the home – but yet reduce the amount of air flow into the home to provide a comfortable, cost effective home. You must find the "right" balance for you and your home.

2 Outside Environment

The second element in understanding how your home works as a system – is the outdoors! Although you expect your home to shelter and protect you from external environmental conditions such as precipitation, wind, sun, heat and cold, it sometimes fails to do so because of the intensity of the environmental conditions and/or the condition of the building envelope.

For example, prevailing winds can whistle right through your home, bringing in cold air and robbing your home of its heat and moisture. Climate conditions will affect the level of moisture present in the outside air as well as the level of ground water and ground frost.

A high water table around your home's foundation walls may increase the amount of moisture seeping into the basement through the concrete walls. The effect of the sun providing free heat in the winter and overheating in the summer depends on the orientation of your home, as well as the amount of window glazing and shading.

Many aspects of your home's external environment cannot be changed, but other elements of the house can be improved to minimize the impact. For example, air sealing will reduce the wind's effect; adding insulation will reduce heat flows through the walls and attic; opening and closing blinds and drapes at appropriate times will capture/reduce the sun's heat; and landscaping will improve drainage and provide wind and sun protection.

3 Mechanical Systems

The third element to consider when looking at your house as a system is your home's mechanical systems. This includes all equipment and appliances used for space heating (including fireplaces) and cooling; indoor humidification and de-humidification; air exhaust and supply; water heating; lighting; and laundry. These systems add or remove heat, moisture and air from your home's indoor space.

Understanding how these mechanical systems operate is very important since they depend on the air, heat, and moisture flows of your home to operate safely and efficiently.

For example, the mechanical systems which require combustion air can be affected if the building envelope is tightened by an extensive reduction of air flow through comprehensive air sealing, the installation of new windows, increased insulation levels, etc. A lack of combustion air creates the potential for poor venting of combustion by-products. This is a potential health hazard and one of the key reasons that you should understand how your home can work as a system, prior to undertaking any major retrofit work.

Your home may require direct combustion air. A knowledgeable mechanical contractor can assist with testing and providing combustion air needs.

Operation and maintenance of this equipment is also important in creating a healthy balance in your home's system. This equipment impacts the air, heat and moisture flows of your home. For example, venting an electric clothes dryer* into your home may provide additional heat, but it will also introduce moisture, odours and lint into your home. If your home can't handle the extra moisture, you may experience condensation problems. In addition, the lint and odours can be sources of health problems, and may actually aggravate asthma and allergy problems.

4 Occupants

You may not realize it, but you and your loved ones have an important effect on your home's system! The number of people and pets living in your home, as well as their lifestyles, is the fourth element of your home's system.

For example, the number of showers, the use or non-use of exhaust fans, the amount of cooking, and the operation of humidifiers can all have an effect on the amount of moisture being produced in your home. There is an increased need for ventilation when moisture levels rise too high. However, many people hesitate to open windows because they are concerned about losing heat and do not use exhaust fans because they are too noisy or are perceived to expel too much heated air.

It is often said that heat, air and moisture flows in a house depends on the number of children and pets, and how often they go in and out of doors! There is some truth to this – for example, in the winter, when the front door is opened, there is a rush of cold air into the house. The cold air is able to rush in because the air inside the home has a place to exit (i.e. into the attic, through cracks around windows, etc.). The air exiting the house takes heat and moisture with it and cool, dry outside air is drawn in thus cooling the house and lowering its moisture levels.

Understanding the relationship

Now that the four elements of your home's system have been identified – the building envelope, the outside environment, the mechanical systems and the occupants – it's a little easier to understand how they interact. It's also important to realize that maintaining a healthy balance in your home's system can have a profound effect on your home's comfort and your energy bills! In many cases, it's up to you to do a little homework to ensure that the balance is kept. Here are a couple of actual case studies that will help give you a better idea of how your home works as a system.

Case study: Installing new windows

In this first case study, you've decided to replace your old windows with new energy-efficient ones. Once installed, you're pleased with the way your new windows look and operate, and are glad that they're so easy to clean! You look forward to winter this year, knowing your home will be more energy efficient and comfortable.

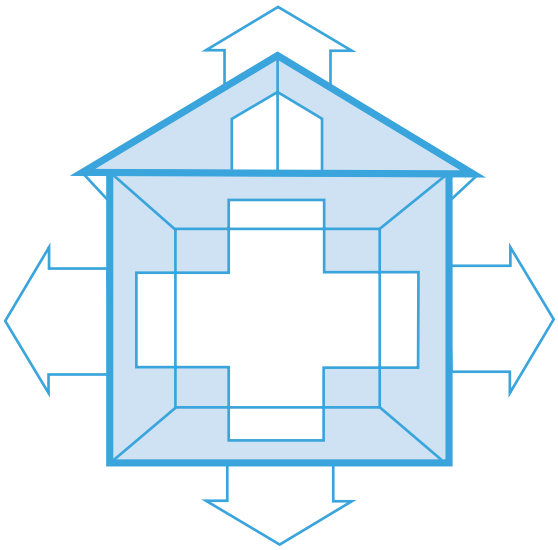
But – as the cold weather sets in, you find condensation dripping down several windows. You thought you'd left condensation problems behind with the old leaky windows!

* Natural gas dryers, for safety reasons, should NEVER be vented indoors.

You call the window contractor to complain that the windows are defective. But instead of admitting fault, he says that in fact, the windows have proven that they are airtight and properly installed. He explains further that the old windows were very cold and leaky, and easily allowed even the smallest amount of moisture in the air to condense on them. However, much of the moisture passed through to the outside. Since the moisture now has fewer exit points through the building shell with your new windows, your home's humidity level has increased. When your home's humidity levels increase to this point, condensation can occur easily on any surface that is slightly cooler than your home's air – like the surface of your new windows. So even though your new windows are more energy efficient and warmer than your old ones, if the humidity levels are higher, the window surface can still be cool enough to force moisture to condense.

The reduction in air exchange in your home due to the tighter windows is good, but now you have to take more control of your home's ventilation needs. Using your kitchen and bathroom exhaust fans more often, or by opening a window once in a while will help to eliminate odours and excess moisture; in turn, forcing fresh outdoor air to enter your home. How much do you control or reduce it? To the point that condensation no longer appears on the window surface and/or the air smells fresh inside your home. The goal of home renovations is to "build tight and ventilate right." The key is for you to be in control of the ventilation, not the wind whistling through the cracks and leaks in your building envelope! (for more information on controlling moisture refer to page nine Reducing Winter Condensation Problems and check out the government websites noted in the last chapter).

Was the contractor at fault? No. Were the windows faulty? No. The mistake the contractor made was not warning you about the potential for condensation. His explanation shows that he understands how your home works as a system, but he failed to share this with you before he installed your new windows. The secret to avoiding problems is in understanding the relationship between the elements of your home's system and the air, heat and moisture flows.



Heat moves out of the house in all directions.

Case study: A woodburning fireplace backdrafts!

The backdrafting of a woodburning fireplace is often a sign that your home's system is out of balance.

What is backdrafting and how can it be avoided? Combustion appliances, that use a chimney for exhaust, like woodburning fireplaces, natural gas or oil furnaces and water heaters, need a source of air to operate safely and efficiently. Backdrafting occurs when there is insufficient air for the combustion process and the by-products of combustion, such as carbon monoxide (CO), are drawn back into the house instead of venting safely up the chimney. Carbon monoxide is an odourless, colourless, tasteless gas that is harmful even in low doses. Every house with a combustion appliance should have a CO detector installed in the sleeping area. For additional resource information see chapter seven.

Can home renovations cause backdrafting? Yes. One or a combination of the following renovations can reduce enough of the natural air supply (leaking in through cracks around windows, etc.) to your woodburning fireplace, that it could cause combustion by-products to be drawn back down the chimney!

1. Adding rigid board insulation to the outside walls behind new siding or brick.
2. Extensive air sealing.
3. New energy-efficient windows.
4. Increasing basement, wall and attic insulation.

How can you tell if your woodburning fireplace is backdrafting? You'll be able to smell the smoke if the combustion by-products are entering the room instead of exiting up the chimney. You may also notice that the smoke has stained the brickwork above the fireplace, and/or it is difficult to light the fire.

In some homes, backdrafting is only experienced at certain times and may not be linked to renovations. Check to see if an exhaust fan or clothes dryer is operating while the woodburning fireplace is in use. Exhaust fans and clothes dryers expel air from the house, and may compete for air with your woodburning fireplace and other combustion appliances. Outside air enters the home through cracks to replace the air which has exited through the exhaust fans or dryer, rebalancing the air pressure in your home. If the outside air cannot be drawn in through baseboard, window and basement wall cracks, it will pull from the next easiest source – the chimney, causing backdrafting when the fireplace is operating.

Can you have an energy-efficient home and operate a woodburning fireplace? Yes, but you must consider your home's system when planning your renovations. If you are planning extensive energy management projects, you may have to provide a direct supply of fresh air to your woodburning fireplace.

Other options include avoiding the use of exhaust appliances (i.e. dryer) when your woodburning fireplace is in operation, and consider not using the woodburning fireplace at all. Standard woodburning fireplaces are not energy efficient, and actually remove more heated air up the chimney than they provide to you. If you want to have a fireplace, consider installing an alternative such as a direct vent natural gas fireplace.

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Some of the precautions you can take to prevent backdrafting include:

- Never tamper with fuel burning equipment, vents, or flues
- Never insulate or try to seal up a draft hood, wind cap, or exhaust vent on any natural gas appliance
- It is absolutely essential, for your safety, that panels and grills on the furnace are kept in place and that the fan compartment door is closed when the furnace is operating
- If you have a natural gas water heater, make sure that combustion air openings at the bottom of the tank and the opening below the draft diverter (on top of the tank at the flue duct) remain unblocked
- Do not store anything on top of your natural gas water heater
- For all fuel-burning equipment, make sure that vent hoods and pipes are securely in place

KEEPING YOUR SYSTEM BALANCED

Your home is an investment that should last a lifetime. To make your home last longer, to take pride not only in its appearance but also in its structural integrity, you need to get to know how your home's system works and how to maintain a good balancing act between the air, heat and moisture flows. Careful planning in the early stages of renovation work will prevent unpleasant surprises and ensure that the completed work meets your expectations. Remember "Build Tight - Ventilate Right!"

You'll see the results with a more comfortable home, greater energy efficiency, and savings on your monthly energy bills. And that's well worth the investment.

Heat recovery ventilator

If using exhaust fans and opening windows does not resolve your indoor air quality problems, you may require a ventilation control system such as a Heat Recovery Ventilator (HRV) to bring the airflow of your home in balance. This system acts like the lungs of your home, automatically moving air in and out of the house. As its name suggests, the unit recovers about 70 percent of the heat and preheats the fresh air before distributing it through the home's duct system. HRVs are presently being installed in many new and existing homes.

HRVs only provide fresh air for your home's occupants. According to code, provision must be made for venting combustion air from your appliances such as fireplaces, furnaces and water heaters.

An HRAI (Heating, Refrigeration and Air Conditioning Institute of Canada) trained heating/ventilation specialist will be able to help you determine whether an HRV and/or combustion air is required for your house. Check the HRAI website (**hrai.ca**), toll free 877 467-4724 or check your Yellow Pages under 'Heating Contractors' to find a qualified HRAI contractor.

REDUCING WINTER CONDENSATION PROBLEMS

Does condensation appear on your windows during cold weather, or perhaps while you are cooking or showering? Is there mold in an upper corner of a bedroom wall, in a closet, or on the bathroom ceiling? Perhaps it only occurs in the basement during the summer. These are all indications of moisture problems and no matter where and when it occurs, moisture can be damaging once it condenses.

If you can warm up surfaces (i.e. window glass), reduce moisture production, and/or directly vent moisture outside, most condensation problems can be resolved.

Often, achieving a comfortable level of humidity in your home during the winter can become a frustrating juggling act.

Sometimes the house air feels too humid; at other times scratchy and dry. It is generally easy to produce more moisture if needed (i.e. turning on a humidifier), so this section will deal with reducing moisture levels in your home.

Household Moisture Activity (for a family of four) Average litres per week* per occupant	
Cooking (three meals daily)	6
Dishwashing (three times daily)	3
Bathing	2
Clothes washing	2
Clothes drying indoors, or using an unvented dryer	10
Floor mopping per 9.3 m^2	1
Normal respiration and skin evaporation from occupants	38
Building Related Average litres per week*	
Seasonal building storage (i.e., framing, drywall, concrete)	56
Exposed, uncovered earth crawlspace	200–350
Drying and burning firewood (approx.)	35
New construction – drying, framing and concrete (over 18 months)	28–35

*Averaged over one year
Source: Natural Resources Canada

Inside storm windows must be air-tight, and outside storm windows must have breathing holes to allow moisture to drain and escape.

Drying up moisture problems

Step 1: Identify the source(s) of the moisture
Make a list of how your home and family produce moisture, noting the largest sources, such as a dirt floor in the basement or crawlspace (common in older homes), portable and furnace humidifiers, showers, cooking, laundry, wood stored indoors, etc. Excess moisture may also be entering the basement due to disconnected downspouts and lack of grading around the outside.

Step 2: Reduce the amount of moisture being produced
You can eliminate or reduce many sources of moisture with simple measures. For example, you can cover dirt floors with heavy plastic (overlapping and then sealing the edges of the plastic with acoustical caulking), turn humidifiers down or off, use bathroom and kitchen exhaust fans more often, vent dryers outside, avoid hanging clothes to dry inside, store wood outside, reconnect downspouts, and grade the landscaping to encourage water drainage away from the walls. For more information on how to choose an efficient and quiet exhaust fan see page 28 and refer to government websites noted on page 39.

Step 3: Warm up cold surfaces
Moisture is generally only a problem if it condenses on a surface. If surfaces are kept warm, condensation is less likely to occur. For example, you can keep windows warmer by ensuring that heat from baseboards, floor registers, or radiators isn't blocked by furniture or drapes. Another way you can warm the window surface is to add an extra window glazing, either inside or out, made of plastic sheeting, acrylic or glass.

Another example is condensation that occurs in particular spots on walls or ceilings. This indicates a lack of sufficient insulation. If possible, you need to add more insulation to that location and/or reduce the amount of moisture being produced in your home (see Step 2).

Step 4: Whole-house ventilation
Installing a Heat Recovery Ventilator (HRV), as discussed earlier in this section, is appropriate if you intend to retrofit your home to be energy efficient, comfortable and free of moisture problems. You may need to plan ahead to install an HRV (i.e. install some new duct work), so discuss your retrofit ideas with a heating/ventilation specialist before you begin renovating.
For additional resource information on HRVs and controlling moisture problems see chapter seven.