Windows

CO_2RE Home$avers

Take Action on Climate Change

EcoVision EDMONTON

CO_2RE
Carbon Dioxide Reduction Edmonton
Supporting EcoVision Edmonton®

THE CITY OF Edmonton

Supporting Sponsors

THE CITY OF Edmonton

Technical Support

CO_2RE Community Business Partners

About CO_2RE

Created *by* Edmontonians *for* Edmontonians…

Carbon Dioxide Reduction Edmonton (CO_2RE) is the City of Edmonton's community-based strategy to permanently reduce local greenhouse gas emissions.

The CO_2RE Strategy was developed by representatives from the residential, business, industrial, institutional sectors and not-for-profit organizations who worked with the City to develop a single, coordinated plan. The group, known as the CO_2RE Team, consulted extensively with many local groups and organizations to develop a consensus on the best approach and strategies. CO_2RE was launched to the public in 2004.

The CO_2RE mission is to work with Edmonton residents, businesses, institutions, non-profits, and industry to provide services, programs and initiatives to assist in reducing energy use, thereby reducing the levels of the GHG (greenhouse gas) emissions that are responsible for Climate Change.

The Original CO_2RE goals include:

- up to a 6% reduction in GHG emissions (from 1990 levels) by the year 2010 and
- a 20% reduction in GHG emissions (from 1990 levels) by the year 2020.

Current Status

Edmonton's GHG emissions increased from 13.9 million tonnes in 1990, to 18.2 million tonnes in 2008 (the most recent year of data), an increase of approximately 38%. Much of this increase is attributable to Edmonton's 24.3% population growth, as well as significant economic growth during this period.

On a per capita basis, GHG emissions appeared to have peaked in 2001 at 29 tonnes of CO_2 per person per year. Since then per capita emissions have continued to fall.

Do your part…

We can do many things to reduce our emissions – and that includes making our homes and lifestyles more energy efficient. The publications in this series are a first step, providing Edmonton with specific how-to guides on improving home energy efficiency, saving money and reducing GHG emissions.

For more ideas on how to become more energy efficient, log onto our website at **www.edmonton.ca/co2re!**

Free Membership

Why get a membership? Becoming a CO_2RE member is free and the more people who join us in taking action on climate change, the faster we will achieve our goals. CO_2RE is working with local companies to offer incentives on energy-efficient products and programs to further assist residents. You'll also receive a regular newsletter with new ideas and updates. Sign up today at **www.edmonton.ca/co2re.**

Organizations or individuals in the industrial, commercial, and institutional sectors can contact our commercial coordinator by calling 311.

Introduction

This booklet provides information and guidelines to help you understand and assess windows, improve their performance and, if replacing, to make good purchase decisions.

Windows are essential elements of every home, adding character, and providing fresh air, daylight and a view. They admit warm sunshine in winter and cool breezes in summer; and yet, windows are also a weak spot in the exterior building shell. They are often a source of cold drafts and can become covered with condensation and ice on cold days. Windows can also cause overheating and poor ventilation if they are the wrong size, wrong type or in the wrong place.

Poor window performance wastes energy and increases space-heating costs and corresponding greenhouse gas (GHG) emissions. Because window performance affects both indoor comfort and energy consumption, careful consideration must be given to window design, location and selection when planning a new home or renovating an existing home.

The table below shows a **Low**, **High** and **Average** yearly heating system gas usage due to window heat loss based on the analysis of 4,000 EnerGuide audit results for Edmonton homes.

Home Age	Low Usage	High Usage	Average Usage	Average Cost *
1900-1919	14.10 GJ	182.73 GJ	50.30 GJ	$503
1920-1929	13.22 GJ	101.83 GJ	45.84GJ	$458
1930-1939	20.95 GJ	84.80 GJ	42.26 GJ	$422
1940-1949	15.12 GJ	90.90 GJ	38.17 GJ	$381
1950-1959	10.80 GJ	156.23 GJ	38.73 GJ	$387
1960-1967	13.46 GJ	188.99 GJ	43.16 GJ	$431
1968-1979	13.93 GJ	176.75 GJ	44.44 GJ	$444
1980-1989	9.99 GJ	197.36 GJ	47.64 GJ	$476
1990-2003	17.88 GJ	200.52 GJ	50.38 GJ	$503

* Based on cost of $10 per GJ including fixed charges, variables, GST, etc.

There are two options for upgrading the performance of windows:

- upgrade your existing windows with caulking, new weatherstripping and interior or exterior storm windows, or
- replace the existing windows with new higher efficiency Low-E (emissivity) sealed units.

Understanding Window Terminology

Brief explanations of the window terms used in this booklet are provided (Figure 1).

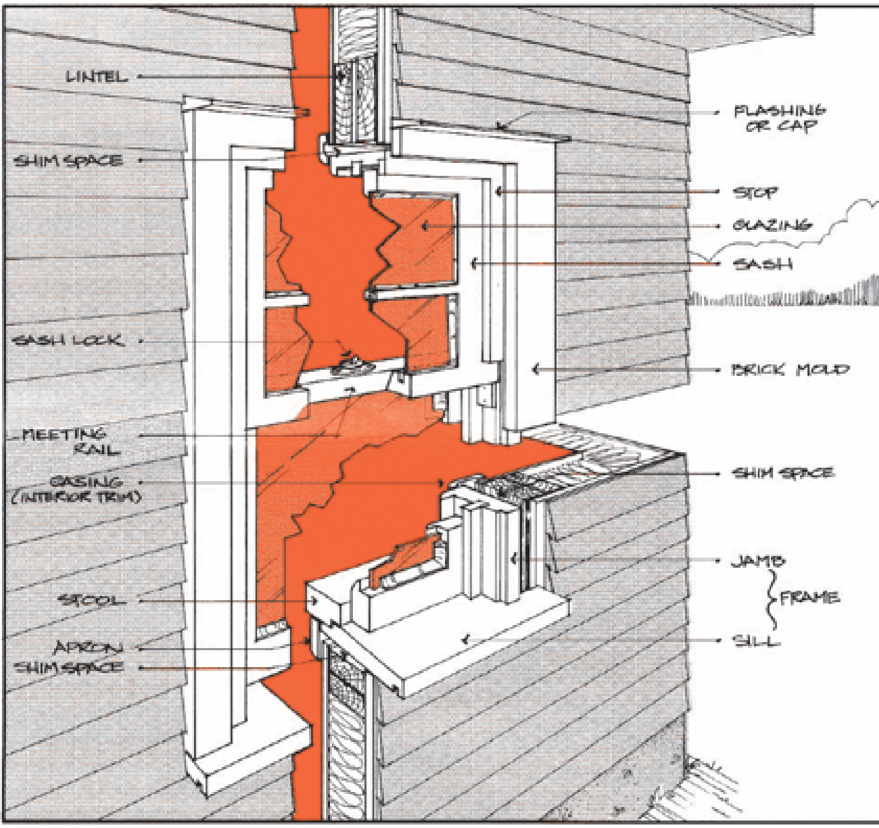


Figure 1

Frame – the casing or frame of the window. This holds the sash in place.

Glazing – clear part of the window. Glass is a glazing as are rigid plastics often used for interior windows.

Rough Opening – an opening in the wall into which a window is placed. The rough opening width is the horizontal distance between the house framing studs on either side. The rough opening height is the vertical distance between the framing support above (lintel) and the framing support below.

Storm Window – layer of glazing added to the interior or exterior of an existing window.

Sash – framework which holds a pane of glass.

Sealed Unit – factory-assembled window unit with two or more layers of glazing sealed around the edges making it airtight. Often referred to as **insulating glass or thermo pane units**.

Heat Movement Through Windows

Understanding how heat is transferred between indoor and outdoor environments can help you when choosing windows. **Heat transfer takes place whenever and wherever a temperature difference exists.** The transfer processes are conduction, convection, radiation and air leakage.

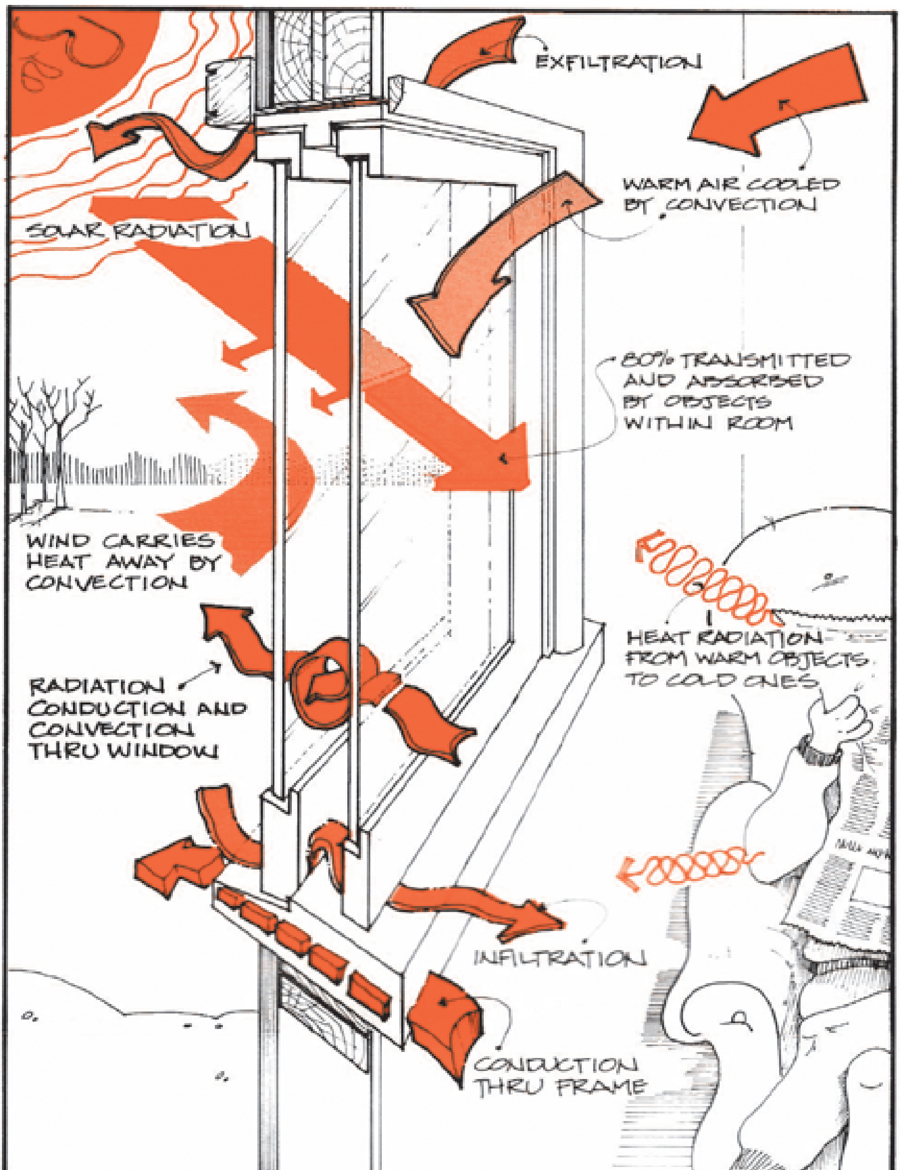


Figure 2

Conduction

Anyone who has gripped the handle of a hot metal frying pan has painfully experienced heat transfer by conduction. Although heat transfer can be rapid, **the ability of different materials to conduct heat varies greatly**. It is important, therefore, that windows are constructed of materials with low conduction rates.

The paths for heat conduction through a window are the sash, the frame and the glazing (Figure 2). Choosing frame and sash materials with low conduction rates will reduce heat loss through this part of the window. Heat loss through the glazing is primarily affected by the amount of air trapped between the panes. Air is a poor conductor of heat. Conduction is slowed by layers of still air (called air films) along the inner and outer surfaces of each glazing unit (pane of glass) and by the air trapped between each pane.

Materials that are **poor conductors** of heat are said to have a **high resistance** to heat flow. This thermal resistance is designated by the metric RSI-value (or imperial R-value). Materials with higher RSI (R) values are better insulators.

Convection

Convection is the movement of heat in liquids and gases due to temperature difference. Although air is a poor conductor it readily convects heat because warm air is light and tends to rise while cold air is heavy and sinks. As shown in Figure 2, convective heat loss from the window occurs in the following ways:

- Cold winter winds take heat away from the window surface by convection. Wind also reduces the window's overall thermal resistance (RSI or R-value) by removing a large portion of the outside air film.
- Convection results in the formation of air currents inside as warm air next to the glass is cooled and sinks to the floor.
- Convection also occurs in the air space between glazings as the warm inner space loses heat to the cold outer pane. Convection increases with spaces larger than 19 mm (¾ inch).

Radiation

When you are sitting in front of a campfire or fireplace, you are warmed by radiant energy transmitting from the fire. The sun radiates energy (solar gain) in the form of visible light, short wave infrared radiation and, in smaller amounts, ultraviolet radiation. The amount of radiant energy transmitted into and absorbed by the house interior depends on the number of layers of glass. For each additional layer, solar gain is reduced by approximately 10% (Figure 2).

Low-E (emissivity) windows have a thin, metallic coating applied to the glass or a plastic film that increases the RSI (R) value of a window unit. Each layer of Low-E film also reduces the amount of radiation transmitted by about 10%.

In a house, most transmitted solar energy is absorbed by room surfaces and re-radiated as long wave infrared radiation (heat). The part that is re-radiated back to the window surface is absorbed almost entirely by the glass. Most of it, however, will be trapped indoors. If a room has a lot of windows with west or south exposures, it can cause overheating even in the winter.

Air Leakage

Uncomfortable drafts in winter are not only caused by convection currents, but also by cold air leaking into the house (infiltration) as warm air leaks out (exfiltration) (Figure 2). This leakage is caused by a pressure difference between the inside of the house and the outdoors. Winds or household appliances that exhaust indoor air outside, such as furnaces or clothes dryers, cause this pressure difference.

Air leakage occurs through ill-fitting, poorly weatherstripped and improperly installed windows (Figure 3). It can be detected by using a “draft indicator” such as the smoke column from an incense stick.

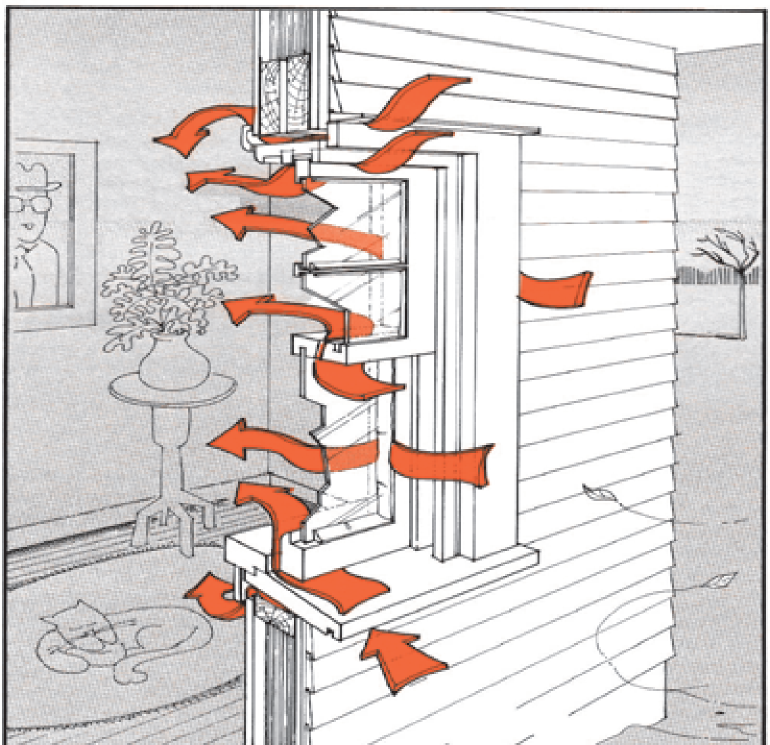
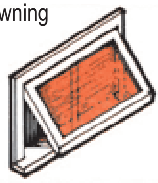
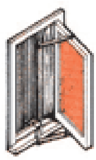
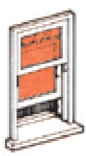
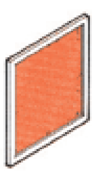
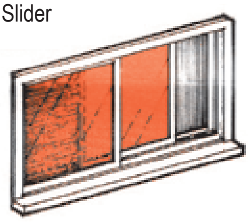


Figure 3

Various styles of windows are available. Table 1 compares five common window types: awning, casement, double hung, fixed and slider.

Table 1 – Comparison of Common Window Styles

Window Style	Comments
Awning 	Will not allow rain penetration when open. Easy to weatherstrip. Combines with fixed unit for more energy efficient window. Provides up to 100% ventilation through window area, but will not readily catch a breeze. Poor emergency exit when used in basement.
Casement 	Directs breezes into a room. Easy to weatherstrip. Provides up to 100% ventilation through window area. Size limited by strength of hardware. Generally most expensive. Can be damaged if open in high winds.
Double Hung 	Most common in older homes. Provides ventilation through 50% of window area. Generally high air leakage and frequent weatherstripping maintenance. No built-in screen. Can be difficult to clean especially with small panes. Meeting rail between sashes can obstruct view.
Fixed 	Least air leakage. Accommodates large glass areas. No hardware or mechanism to fail. Provides maximum light and view. Most secure against forced entry but no emergency exit. No ventilation. Outer panes must be cleaned from outside.
Slider 	Includes horizontal and vertical units. Horizontal units allow ventilation and rain protection simultaneously. Easy to clean from inside if sashes are removable. Normally least expensive of operable windows. Provides ventilation through 50% of window area. Requires frequent weatherstripping maintenance. Generally least secure against forced entry.

Some window manufacturers offer a number of new combination windows such as tilt and turn units. When you are assessing these new units, ensure that they have a good air seal and weatherstripping.

Other window styles that you may consider for special purposes are:

- **Bay or Bow** – This style is formed by a series of windows extending out from the wall. The bay window usually has three sections, the bow five. Set at various angles, the bay or bow window takes full advantage of light, ventilation and views. Bay and bow windows are difficult to install and must be properly air sealed and insulated, especially in the floor overhang.
- **Patio Doors** – The typical patio door is a friction fit type like a standard horizontal sliding window. The weatherstripping must be regularly inspected and maintained to ensure a proper air seal. Low-E double and triple glazed units with argon gas are available.
- **Skylights** – These are windows in the roof or ceiling, which provide additional light and ventilation while maintaining privacy and wall space. Skylights are available in fixed or operable styles and with double or triple glazing. They should be used sparingly due to potential high heat loss, cold drafts and condensation problems. Get professional installation advice to avoid problems.
- **Solar Light tubes** – feature reflective tubes that carry light from the roof of a building (through the attic) into living or working spaces. The basic components include a clear plastic dome that sits on the roof and lets in sunlight; a reflective tube that carries light into the interior; and a light diffuser, which looks like a ceiling light fixture and distributes light around the room. Light tubes are more energy efficient than skylights with fewer problems.

Assessing Your Windows

The first step in improving windows is to assess performance and identify any problems. Table 2 lists some common problems and suggests probable causes and solutions.

Table 2 – Window Problems, Causes and Solutions

Indication	Possible Causes	Suggested Solutions
Water pooling on sill	Sill does not slope away from window	Cut or build slope into existing sill
Water runoff towards house on underside of sill	Underside of sill is flat (not notched)	Cut drip groove along underside to ensure proper runoff.
Condensation between layers of glazing	Air leakage into space between glazings Broken seal	Install additional layer of glazing. Install new sealed thermal unit.

Indication	Possible Causes	Suggested Solutions
Blistering, cracking, flaking and peeling paint	Water penetration and moisture saturation High indoor humidity	Determine moisture source and eliminate if possible. Clean, dry and then repaint affected area.
Warping and rotting wood windows	Moisture penetration of window parts due to deterioration of paint or caulking	Repair damaged parts of window and repaint. Cover with aluminum or vinyl cladding. Replace with maintenance free windows.
Cracked, loose or missing glazing or glazing putty	Putty has dried and weathered with age	Reputty or reglaze (new glass) window as necessary.
Drafts	Infiltration through and around window Cold glass temperature	Provide good air seal around glass, weatherstrip and caulk (see *Home$avers – Caulking and Weatherstripping*). Seal rough opening shim space. Reglaze existing sash with thermal unit. Install additional layers of glazing.
Overheating	Inadequate shading Excessive glazing Inadequate ventilation	Install awnings, sun control films or tinted glazing. Eliminate or reduce window size. Replace window with unit that provides more ventilation. Install additional window or skylight.
Inadequate natural lighting	Insufficient or poorly positioned glazing	Enlarge window opening. Install additional windows, solar light tubes or skylight.
Glare	Too much glazing or unbalanced lighting	Reduce glazing area or balance lighting by installing a window on adjoining wall or skylight. Install aftermarket sun control films (Low-E) on problem window.
Condensation inside surface of inner pane	High indoor humidity combined with cold inner pane	Reduce indoor humidity level. Install additional layer of glazing. Reglaze existing sash with thermal unit.
Condensation on frames of aluminum or steel windows	Cold metal frame inside due to excessive heat loss	Reduce indoor humidity levels. Replace windows with units whose frames are made of less conductive materials.
Condensation on specific windows only	Refer to *Home$avers – Condensation Concerns* for detailed descriptions.	

Choosing a Plan of Action

Once your window problems are identified, decide on methods to solve them. Options ranked in order of increasing cost and efforts are:

- Repair deteriorated windows.
- Caulk and weatherstrip.
- Install additional glazing such as interior or exterior storm windows or reglaze with new sealed glazing units.
- Install sun control devices such as solar films, awnings or tinted glass.
- Replace and modify existing windows.

Repair Deteriorated Windows

Replacing windows is expensive and it is sometimes desirable, less expensive and more convenient to repair windows rather than replace them. Water damage causes most window deterioration. Before repairing windows, identify and eliminate any sources of moisture penetration. Examine the sill; it should slope away from the window to allow water to drain. If the under side of the sill is flat, a drip groove may have to be cut to ensure proper runoff (Figure 4).

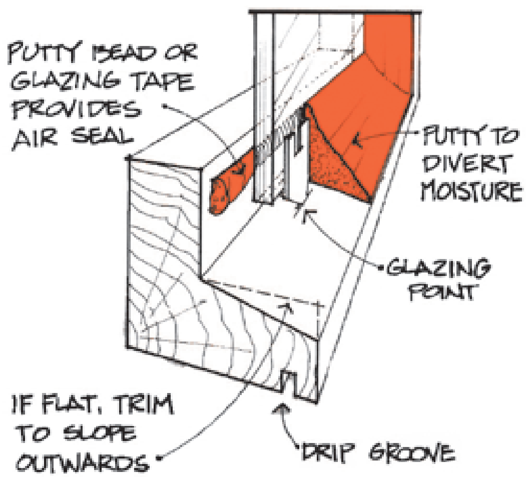


Figure 4

Examine for paint cracks and chips and check the wood for deterioration. If decay is not extensive, the area can be dried, treated with fungicide and repaired with putty. If deterioration is more serious, saving the window may be possible by using fungicide to stop decay and then cladding the surfaces with a material such as aluminum.

To repaint windows, start by removing the sash. Repair, caulk and weatherstrip the sash and the frame. Caulk the joint between the jamb and the sill to control water penetration. Remove excess layers of paint that make windows difficult to operate and repair or replace faulty hardware.

Before replacing broken glazing or installing new putty, remove existing putty, glazing points, glass and putty behind the glass. Reglaze the window as shown in Figure 4.

Lay a bead of putty to provide an air seal, press the pane of glass into place, insert glazing points to secure the glass and, finally, lay a bevelled layer of putty around the edge of the glass to seal against water penetration.

Repaint windows with good quality acrylic latex or alkyd (oil base) paint. Before painting new windows or new woodwork, apply a primer appropriate for the finish paint to be used. A good quality penetrating, transparent stain could be used instead of the primer.

Caulk and Weatherstrip

Air sealing the windows can be inexpensive and easily done. The uses of different sealing products are described in more detail in *Home$avers – Caulking and Weatherstripping*. A number of points it mentions are:

- For windows that have never been weatherstripped, a compressible weatherstripping such as tubular vinyl or closed cell foam provides a good durable seal.
- Where possible, apply weatherstripping along the edge of the sash **as well as** along the jamb. This double weatherstripping ensures an excellent seal on windows that open.
- Metal, wood and vinyl sliders usually have factory-installed pile weatherstripping. When it is worn out, new weatherstripping can usually be slid into the channel. Replacement pile weatherstripping with a vinyl strip is available and provides an improved seal.
- For wide gaps, ethafoam rope or weatherstripping tape can be applied in the fall and removed in the spring.
- Consider a permanent seal of caulking to windows that are not needed for ventilation. Apply strippable caulking compounds designed for one season's use. **Ensure that they are not potential emergency exits.**
- Be sure the caulking is compatible with other materials you are using. Acid-based silicone, for example, cannot be painted.
- Install sash locks to seal the sash tightly against the weatherstripping.

After windows are repaired and sealed to reduce air leakage, you may wish to increase indoor comfort and reduce heat loss by increasing their thermal resistance.

A common air leakage pathway is the shim space between the window frame and rough opening. Methods of sealing are shown in Figure 5.

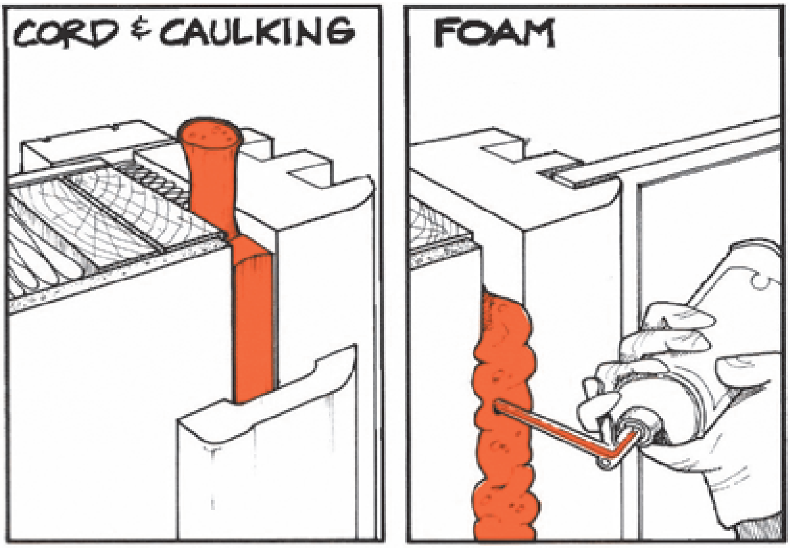


Figure 5

Polyurethane foams are most easily applied in cracks greater than 12 mm (½ inch) and provide a good seal with high thermal resistance. Some expand, however, and should be applied with caution or the window frame may warp (apply in two or more passes with small amounts each time). For smaller cracks, ethafoam cord and caulking is effective. The cord should be two times the diameter of the crack width to ensure a good fit.

Install Storm Windows

Increasing a window's RSI (R) value with a storm window can substantially reduce conductive heat loss through a window. It can be installed on the inside or outside of the window.

A storm window that provides an additional air space of at least 12 mm (½ inch) will decrease the heat loss from a single glazed window by approximately 50%. Remember, most of the increased thermal resistance comes from the air space created, and not from glazing. Benefits include reduced condensation and icing due to the increased temperature of the inner glazing.

Properly installed, storm windows also reduce air leakage. Although both permanent and storm windows should be well sealed, **it is important that the inner layer of glazing is sealed tighter than the outer**. This prevents warm moist air from leaking between glazings and condensing on the inner surface of the outer glazing.

Table 3 compares common glazing materials. Glass is the most widely used and its optical and thermal properties are the basis for comparison. If a glazing that is stronger, lighter or easier to cut than glass is required, new plastic and polycarbonate products may be more suitable.

The choice should be based on cost and function, as thermal performance does not vary significantly between different types of glazing.

Table 3 – Common Glazing Types

Glazing Type	Advantages	Disadvantages
Glass 3 mm ($^{1}/_{8}$ inch) (Rigid)	Readily available. Excellent transparency. Excellent durability. Non-combustible, chemically inert. Scratch resistant. Low IR transmittance.[a] Low thermal expansion/contraction.	Heavy. Low impact resistance. Breakage causes safety hazard. Careful installation required.
Polyethylene 0.15 mm (6 mil) (Flexible film)	Readily available. Lightweight. Easy to cut. Inexpensive.	Short service life. Easily damaged. Poor visual appearance. High IR transmittance. Flammable.
Vinyl 0.25 mm (10 mil) (Flexible film)	Lightweight. Easy to cut. High solar transmittance. Stronger than polyethylene.	Becomes brittle with age. Hard to eliminate wrinkles. Some visual distortion. High IR transmittance. Flammable.
Vinyl-UV treated[b] 0.25 mm (10 mil) (Flexible film)	Resistance to UV degradation. Does not become brittle.	Similar to untreated vinyl but does not get brittle.
Acrylic 3 mm ($^{1}/_{8}$ inch) (Rigid)	Readily available. Lightweight. Good durability. Moderate impact resistance. Fairly easy to cut. Low IR transmittance.[a]	Incompatible with butyl tapes and sealants. Susceptible to scratches. Softens under moderate heat. High thermal expansion/contraction. Flammable
Polycarbonate 3 mm ($^{1}/_{8}$ inch) (Rigid)	High impact resistance. Lightweight. Good durability, transparency. Low IR transmittance.[a] Available with scratch resistant surface.	High thermal expansion/contraction. Flammable. Expensive.

[a] *Does not readily transmit infrared radiation.*

[b] *Exposure to ultraviolet radiation can break down some plastics over time.*

There are different systems available for attaching glazing materials to the windows. The most common are shown in Figure 6.

- **Magnetic Seal and Rigid Acrylic –** Although more expensive, this method of installing rigid plastic interior storm windows ensures a good air seal.
- **Heat Shrink Film and Double-Sided Tape –** This is the least expensive and provides a good seal. When the film is in place, heating it with a hair dryer tightens it across the opening. It is generally not reusable. Removing the tape often removes paint.

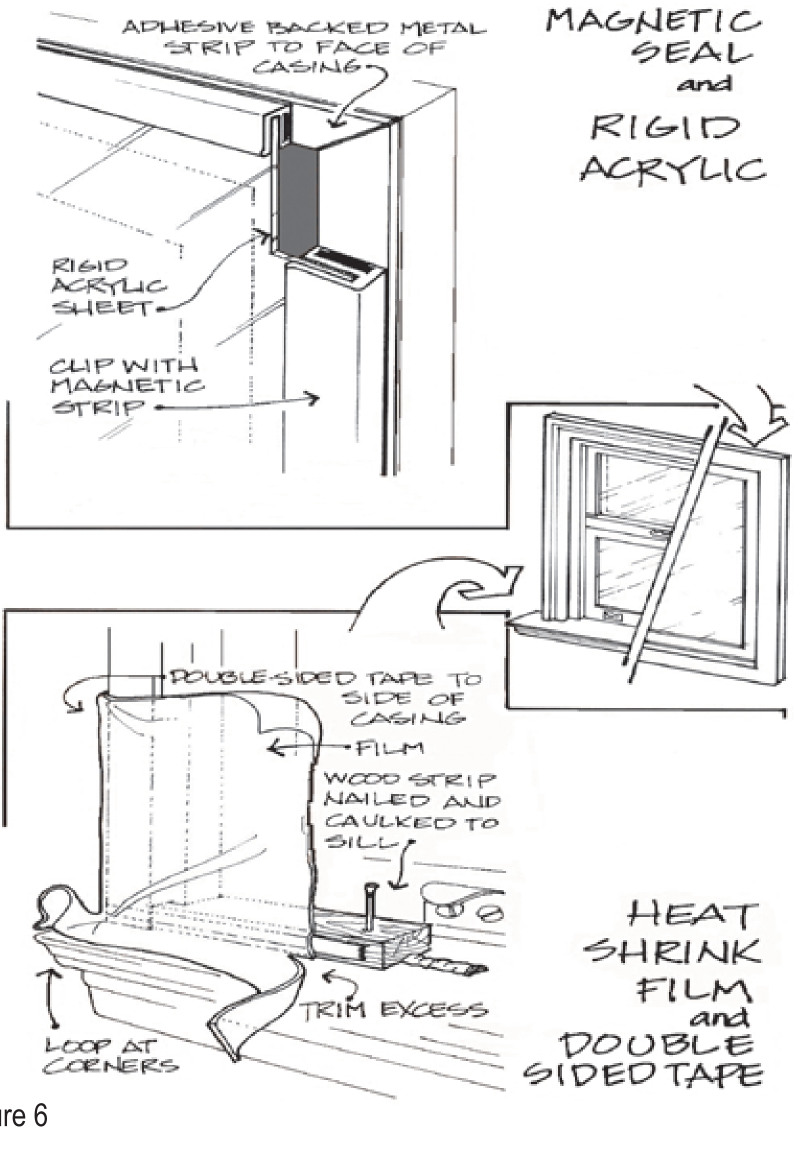


Figure 6

Interior application is preferable to reduce air leakage and increase durability. A tight seal to the inside will reduce condensation between glazing layers. If the window is a room's ventilation source or an emergency exit, ensure interior or exterior storm windows can easily be removed.

Exterior storm windows of wood or metal can also be installed but this is an expensive alteration and sometimes difficult to install and seal each year. A variety of units are available, including permanent or removable. Their main function should be to improve the thermal resistance of windows and not to stop air leakage. The principle air seal should still be provided by the inside window. **Consider ventilation requirements, the need for emergency exits, maintenance and appearance when choosing exterior storm windows.**

Upgrade Window Glazing

Another way to increase thermal resistance is to replace existing glazing with higher RSI (R) value multi-glazed sealed units. Whether or not this can be done depends on the design, material and condition of the existing sash and frame. If the window cannot accommodate a sealed unit with an air space of at least 12 mm (½ inch) between glazings, it may be more efficient and less expensive to install a storm window or simply purchase a new window unit.

Consider hiring a qualified contractor because improper installation will void the manufacturer's warranty. If you do the conversion yourself, get proper installation information from the supplier and make an allowance for expansion.

Sun Control

Rooms with large window areas facing east, south or west can get too much sun resulting in overheating, glare and fading of furniture.

Drapes and blinds block incoming sunshine, but obscure vision and reduce light. It is preferable to stop sunlight before it passes through the window. Shading with trees, overhangs, awnings or shutters can provide adequate sun control. Indoor "solar films" applied to the inside face of the glass are an alternate solution that still admits light but blocks UV and infrared light from penetrating.

Solar films are available in a variety of types, each with a different sun-screening capability. Most solar films are applied to the inside of the glass. These films block summer heat gain and ultraviolet light and help reflect radiant heat back into the home during the winter months. Once installed solar films are not easily removed and should be considered permanent. They do get scratched so care must be taken when cleaning the window. The appropriate film must be chosen if applied to larger windows, which could expand too much and crack. The application of solar films is best handled by an experienced, certified contractor.

Another alternative is to install tinted glass. This is a more expensive option but it is a permanent solution.

Replacing Windows

If none of the previous methods adequately solves your particular concerns, the alternative may be to replace the windows.

If yours is an older home, window sizes may no longer be standard. Don't despair! As long as the window frame is in good condition this is not a major renovation. Many manufacturers custom build windows to your specifications.

Replacement units can be made to fit existing window frames (Figure 7). If you do the work yourself, proper installation is extremely important to ensure good window performance.

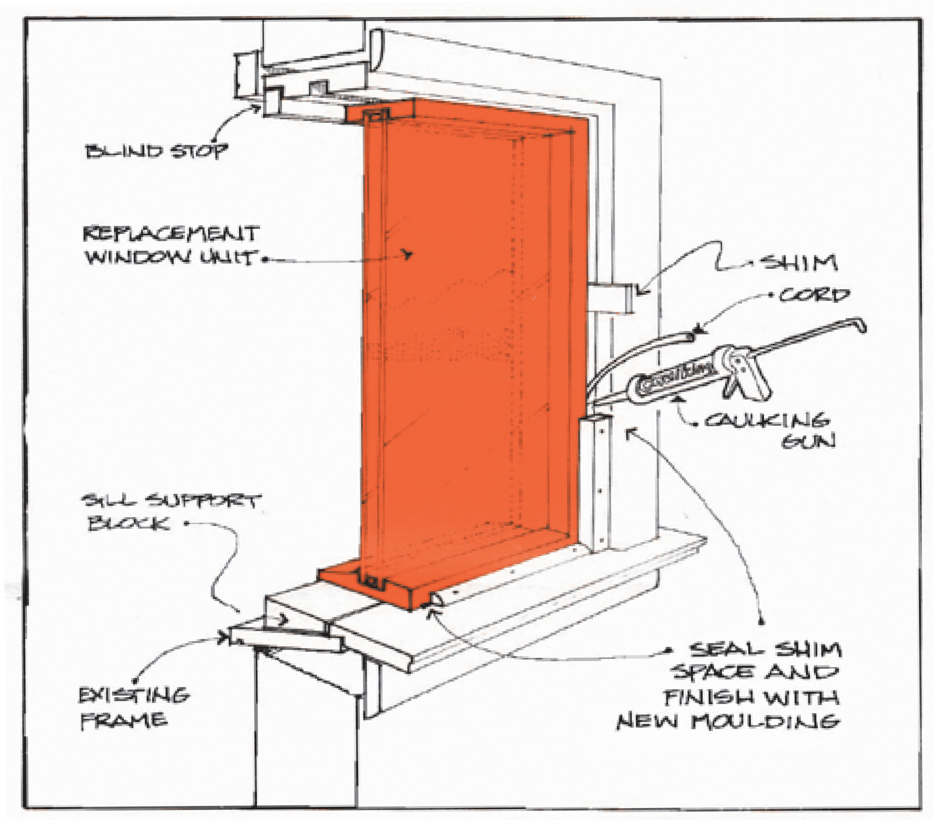


Figure 7

The shim space between the frame and rough opening must be insulated and sealed to reduce heat loss and air leakage.

The methods shown in Figure 5 will provide a good air seal.

To operate properly, the window must be installed plumb, level and square (Figure 8). Ensure flashings are installed and the frame is adequately supported.

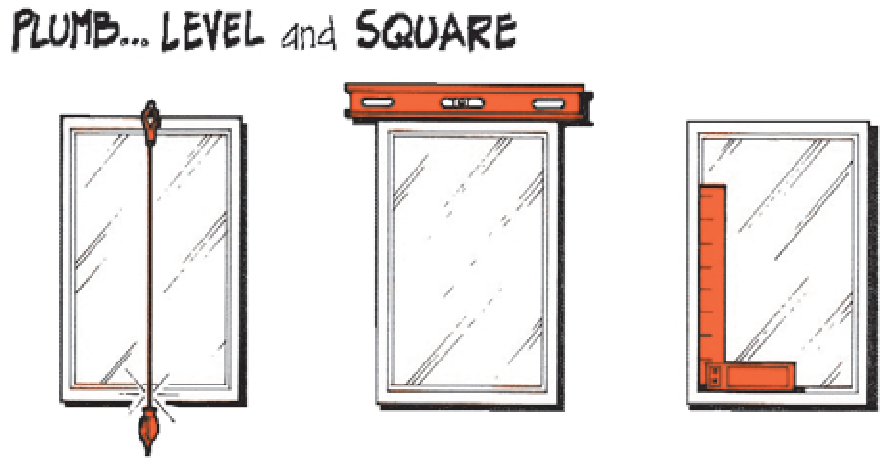


Figure 8

Selecting a New Window

In recent years window manufacturers have met the challenge to produce well-designed, long lasting, energy efficient windows that require little maintenance.

Various research agencies and companies have been working to improve the thermal resistance of windows to values as high as RSI 1.8 (R10). **Three developments are low-e units, gas filled sealed units and insulated spacers.**

Low-E or low emissivity coatings are a thin, metallic coating applied to glass or plastic film to increase the RSI (R) value of a window unit. The coating allows light to pass through but prevents the outflow of heat radiation. When applied on the outer surface of the inner pane of a double glazed window (with a ½ inch air space filled with argon gas), it raises the RSI value to RSI 0.72 (R4.1).

There is a reduction of 8% or more of the light admitted compared to triple glazing. Low-E is now being used as a coating on triple glazed units and with a ½” air space filled with argon glass an RSI 0.95 (R5.4) is achieved.

Also triple glazed units with 2 layers of low-E coating and two ½ inch air spaces filled with argon gas achieving an RSI 1.5 (R8.4). (According to manufacturers specifications.)

Argon gas is an inert, environmentally safe gas, which significantly slows conduction and convection heat losses through the window giving the units higher insulation values.

Traditionally, metal **spacers** have been used to separate the panes of glass in a sealed unit. Metal conducts heat and because of this, traditional sealed units lose a lot of heat around the edges. This results in condensation and icing during cold spells. New materials such as butyl-metal and silicone foam are being used as spacers to reduce this “edge effect” heat loss.

The following five example tables use data from 4,000 Edmonton EnerGuide home audits to show the average natural gas, costs and GHG savings possible upgrading to high-efficiency windows. Area homes are grouped by age, construction characteristics and building code requirements.

Figures provided are average savings for each group of homes achievable by upgrading existing window units to Low-E, double glazed (2 panes of glass), argon gas filled windows.

Note: Proper air sealing, possible during window installation, should increase cost savings by at least 30 to 50% compared to the figures shown.

Example 1 – Homes 1900 to 1939

A 29% reduction in window heat loss & $135 in yearly heating costs

EnerGuide Results	Gas (GJ)	Yearly Costs	Tonnes GHG
Average Gas Usage	46.13	$461.30	2.29
Potential Gas Savings	13.56		
Potential Cost Savings *		**$135.60**	
GHG Savings ** (CO_2)			**0.67**

+ personal GHG emission reductions of 670 kilograms a year.

Example 2 – Homes 1940 to 1967

EnerGuide Results	Gas (GJ)	Yearly Costs	Tonnes GHG
Average Gas Usage	40.02	$400.20	1.98
Potential Gas Savings	11.36		
Potential Cost Savings *		**$113.60**	
GHG Savings ** (CO_2)			**0.56**

A 28% reduction in window heat loss & $113 in yearly heating costs

+ personal GHG emission reductions of 560 kilograms a year.

Example 3 – Homes 1968 to 1979

EnerGuide Results	Gas (GJ)	Yearly Costs	Tonnes GHG
Average Gas Usage	44.44	$444.40	2.20
Potential Gas Savings	13.64		
Potential Cost Savings *		**$136.40**	
GHG Savings ** (CO_2)			**0.68**

A 30% reduction in window heat loss & $136 in yearly heating costs

+ personal GHG emission reductions of 680 kilograms a year.

Example 4 – Homes 1980 to 1989

EnerGuide Results	Gas (GJ)	Yearly Costs	Tonnes GHG
Average Gas Usage	47.64	$476.40	2.36
Potential Gas Savings	12.41		
Potential Cost Savings *		**$124.10**	
GHG Savings ** (CO_2)			**0.62**

A 26% reduction in window heat loss & $124 in yearly heating costs

+ personal GHG emission reductions of 620 kilograms a year.

Example 5 – Homes 1990 to 2003

EnerGuide Results	Gas (GJ)	Yearly Costs	Tonnes GHG
Average Gas Usage	50.38	$503.80	2.50
Potential Gas Savings	6.69		
Potential Cost Savings *		**$66.90**	
GHG Savings ** (CO_2)			**0.33**

A 13% reduction in window heat loss & $66 in yearly heating costs
+ personal GHG emission reductions of 330 kilograms a year.

* *Based on costs of $10/GJ*
** *Greenhouse gas emission (GHG) savings based on average gas usage savings.*

Although overall yearly heating cost savings are not large in comparison to the costs of upgrading your windows, the additional benefits provided are substantial including:

- Reduces the cold feeling sitting next to windows in winter (reflects radiant body heat back),
- Reduces cold winter drafts and air currents,
- Reduces window condensation and eliminates frost build-up except on the coldest days,
- Provides maximum light without overheating or glare,
- Reduces fading caused by ultraviolet light.

GHG emission reductions are also small but each and every kilogram reduced contributes to lessening the future impacts of global warming and climate change.

Before selecting new windows, review Table 1 to determine the style you want. Figure 9 illustrates window features to consider. Choose a window with as many of these features as possible. Determine colour, maintenance and ventilation (opening windows) requirements. Measure the rough opening of the windows to be replaced and write the measurements down as width times height (W x H).

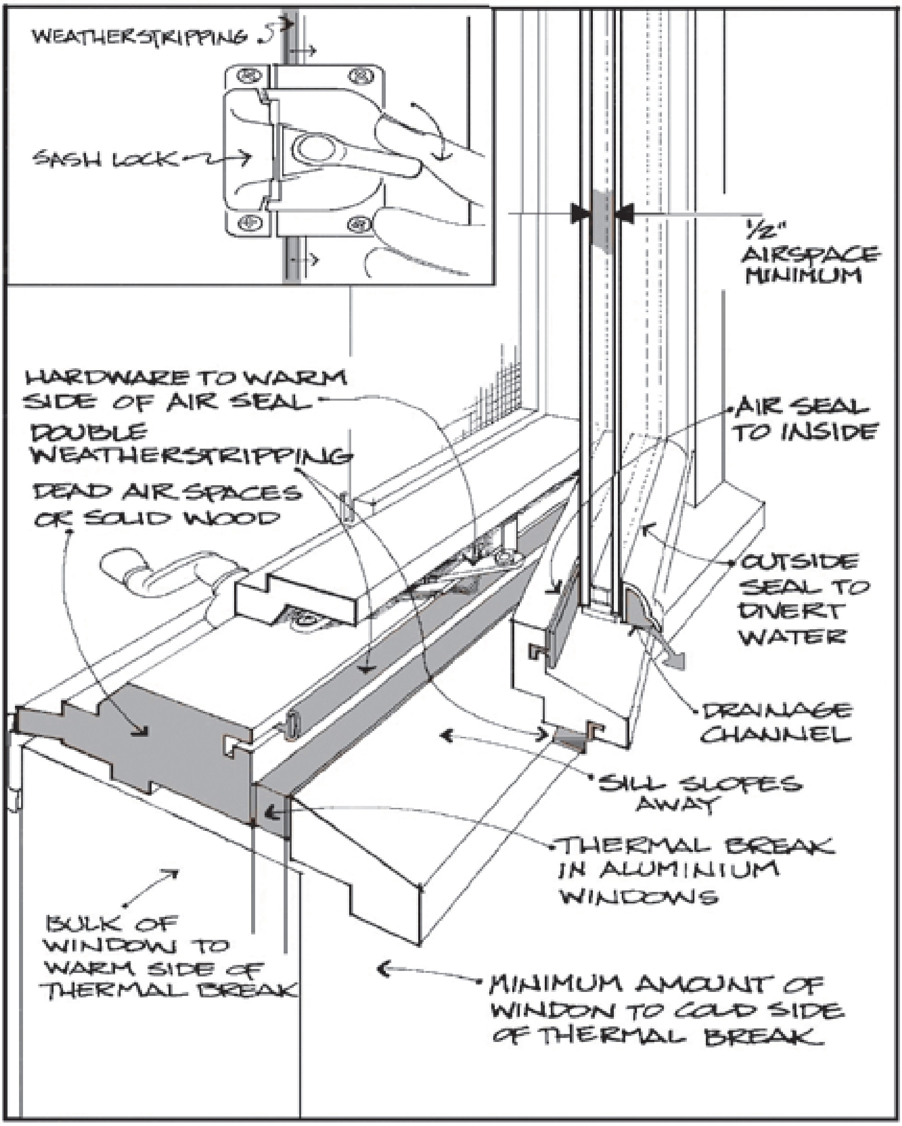


Figure 9

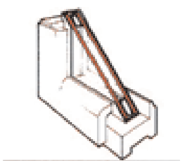
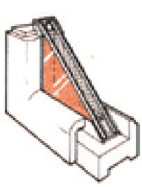
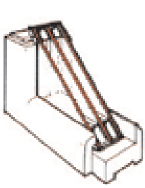
The features in Figure 9 can be found in windows made of wood, metal, fibreglass and a plastic called polyvinyl chloride (PVC). Wood is the best natural insulator, but it requires more maintenance and, unless it is clad with aluminum or vinyl will need to be painted every four or five years.

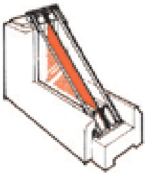
Window units may be clad completely or weather-protected on the outside only, retaining the natural wood look inside.

Metal windows are poor insulators and require a thermal break such as plastic or rubber (Figure 9) to slow down the movement of heat to the outside and help prevent condensation on the sash and frame. A large number of Edmonton homes have older aluminum sliding windows, which cause condensation problems and higher heat loss. Metal windows are usually coated with a baked-on enamel finish and require little maintenance.

Vinyl and fibreglass windows, like wood, are poor conductors of heat and do not require a thermal break. They are virtually maintenance-free and impact and scratch resistant. Different colours are available and some can be repainted. Table 4 provides a comparison of available products.

Table 4 – Window Selections

Glazing Type	Comments
Double Glazed 	RSI 0.36 (R2.0) with a 12 mm (½ inch) air space. Standard sealed window unit. About one half the heat loss of single glazed.
Double Glazed Low Emissivity (1 Low-E) 	RSI 0.56 (R3.2) with a 12 mm (½ inch) air space and 1 Low-E surface. Admits slightly less light than clear triple glazed, amount depends on type of coating. Same performance as basic triple glazed units without the bulk and weight.
Double Glazed (1 Low-E + Argon Gas) 	RSI 0.70 (R4.0) with a 12 mm (½ inch) air space filled with Argon gas plus 1 Low-E surface. Admits same light as double glazed Low-E. Better performance than a basic triple glazed unit.
Triple Glazed (all glass) 	RSI 0.56 (R3.2) with two 12 mm (½ inch) air spaces. Lets in about 10% less light than double glazed. Reduced outdoor noise. Bulkier than double glazed. Extra weight on hardware. Good resistance to condensation in cold temperatures.

<table>
<tr><th>Glazing Type</th><th>Comments</th></tr>
<tr><td>Triple Glazed – Low Emissivity
(2 Low-E + 2 Argon gas)
</td><td>RSI 1.48 (R8.4) with two 12 mm (½ inch) air spaces both filled with Argon gas plus 2 Low-E surfaces.
10% less light emitted than a standard triple glazed.
Same advantages and disadvantages as triple glazed.
The best window available for reducing heat loss or heat gain.</td></tr>
</table>

***Note: All RSI-values (R) represent the center of the glazing. These values will vary with the type of spacer and frame used. Check manufacturer's literature for RSI (R) values of specific window units.**

Additional Information Sources

Natural Resources Canada – Office of Energy Efficiency

www.oee.nrcan.gc.ca – The Office of Energy Efficiency offers a wide range of free publications, programs and services to help Canadians save energy and reduce the greenhouse gas emissions that contribute to climate change.

Recommended Reading: *Keeping the Heat In* is a comprehensive source of energy efficiency how-to information for homeowners. This free publication is available from Natural Resources Canada. Call toll free at **1-800-635-7943** or download it from **http://publications.gc.ca/pub?id=259273&sl=0**.

Canada Mortgage and Housing Corp.

www.cmhc.ca – CMHC is a valuable resource for information. The CMHC Order Desk is a one-stop shop for all free and priced publications, fact sheets, reports, videos and other CMHC resources. You can order online, or through their call centre at **1-800-668-2642**.

EPCOR

www.epcor.ca – The website contains information on energy and water efficiency with calculators, tools and downloadable publications to assist you in reducing your energy and water consumption.

Tools include a ***Home Energy Audit***, a do-it-yourself home audit with a library of resources; ***EPCOR House***, an animated tour of a typical home with efficiency information; and calculators for most major appliances, plus a ***simple electricity calculator*** and ***water audit tool***. Tools are located in the EPCOR-Customer Service drop down menus.

Environment Canada

www.ec.gc.ca – Environment Canada's website provides weather and environmental information to help connect Canadians, exchange information and share knowledge or environmental decision making.

Climate Change Central

www.climatechangecentral.com - Climate Change Central has information and resources to help Albertans save energy and reduce the greenhouse gas emissions that contribute to climate change.

Become A CO_2RE Member

We all contribute to the problem of Climate Change and each of us can contribute to the solutions. Become a CO_2RE Member. Membership is free and you can sign up on the CO_2RE website at www.edmonton.ca/co2re.

CO_2RE
Carbon Dioxide Reduction Edmonton

Publications Currently Available

- Attic Insulation
- Basement Insulation
- Caulking and Weatherstripping
- Condensation Concerns
- Conserving Electricity
- General CO_2RE Brochure
- Heating Systems
- Renewable Energy
- Ventilating Your Home
- Water Conservation
- Windows
- Eco-Landscaping Brochure

THE CITY OF Edmonton

Deputy City Manager's Office
Office of Environment
Suite 750, Tower I Scotia Place
10060 Jasper Avenue NW, Edmonton, Alberta T5J 3R8
Phone: 311 (in Edmonton) / 780-442-5311 (outside Edmonton)
Website: www.edmonton.ca/co2re

FSC Recycled
Supporting responsible use of forest resources
www.fsc.org Cert no. SW-COC-003345
© 1996 Forest Stewardship Council
100%