Green Light

Window Fashions for Planet Home

HunterDouglas

CONTENTS

Fellow Citizens,

When I first came up with the idea for honeycomb shades, the country was reeling from the 1979 energy crisis. By 1985, when Hunter Douglas purchased the small company I had joined, energy efficiency was less of a concern. As a result, honeycomb shades were purchased more for their beautiful fashion than for their impressive energy-saving attributes.

The current global energy/environmental crisis will not be so short-lived. A child born today will live through our transition to a society without oil-based fuels. At Hunter Douglas, we are helping to ease this transition by educating people about the energy-saving function of window coverings. Our products can dynamically act as valves controlling energy flow in and out of windows. By doing this with maximum effectiveness, window coverings could cut home heating and cooling energy usage in half.

Please take the time to read and understand the contents of this booklet. For some, the science and math portions may be difficult going. Please persevere. It's important for the future of our children and our children's children that we all share an understanding of the principles presented herein.

Sincerely,

Wendell B Colson

Wendell Colson
Senior Vice President, Research & Development
Hunter Douglas Inc.

WE ARE Hunter Green™

THE LIGHT IS CHANGING

This has happened to all of us. We're stopped at a traffic light with a long line of cars behind us. Our thoughts drift: we're no longer driving a car, but lying on a beach or cooking tonight's meal or having a heated discussion at work. Suddenly a loud honk jolts us back to the moment. We look up and see that the light has changed, and we sheepishly accelerate — quickly, as though making up for our delayed reaction.

The world's population is about to honk.

People in dramatically increasing numbers are seeing that the light is changing and they are wondering when the line of traffic will start moving. They are deeply concerned about issues that once were controversial — climate change, environmental degradation, depletion of natural resources, and the quality of life awaiting future generations. As a society, we've been slow to respond to these problems. Now, clearly, the light is turning green and it's time for us to get moving.

At Hunter Douglas, we are already accelerating. We have a powerful vehicle: a corporate culture of innovation, visionary management, a history of energy-saving products, tremendous resources. This allows us to develop and market such state-of-the-art "green" window fashions as Duette® Architella® honeycomb shades. Their unique honeycomb-within-a-honeycomb construction creates three air pockets for superior insulation and control of solar heat gain.

Our invention and innovation are continual. We understand today's energy challenges and we are fully committed to meeting them — both with our window fashions and in our manufacturing operations.

Understanding Is Key

This booklet explains the essential value of window coverings in saving energy. Reading the following pages, you'll gain a fresh perspective on why energy needs grew to unsustainable levels. You'll learn definitive meanings of energy terminology and, better yet, how the movement of energy measured in that terminology really works. You'll appreciate anew the power of the sun, and learn how the energy it transmits can be controlled differently at the window in winter and summer. You'll see how automated window coverings can work together in a systematic approach to maximize energy savings.

Important key points will be highlighted throughout the booklet. These are the essential facts which form the foundation for a comprehensive understanding of energy issues. The key points will look like this:

> Windows are energy holes. In fact, 5% of *all* energy consumed in the U.S. relates to energy flow through residential windows. Properly installed and applied Hunter Douglas products in every window of every home could cut this energy consumption *in half*.

Grasping the importance of this key point is a good first step in learning the content that follows. Clearly, Hunter Douglas has tremendous potential to reduce the carbon footprint of our society and ease the transition to alternative energy solutions. At the same time, our products can save energy costs, as well as add great beauty and comfort to homes everywhere.

MOVEMENT OF ENERGY

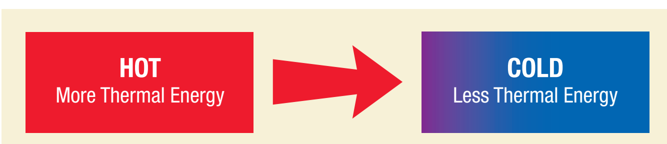
Movement of energy is generally good. The universe began 13.7 billion years ago with the Big Bang, an unimaginably powerful movement of energy. Movement of energy from stars makes life possible. Movement of energy from our bodies maintains the moderate body temperature necessary to continue life. The movement of energy within our cells *is* life.

The movement of energy into and out of our homes is a fact of life. To keep ourselves comfortable, we just need to control that movement in logical, sustainable ways.

Energy moves through windows in three forms: *heat* (transferred due to temperature differences between inside and outside); *solar energy* (which becomes heat after it enters the home); and *light*.

Why Energy Moves

Nature strives for stability and balance by equalizing energy. This is why thermal energy flows from areas of higher temperature to areas of lower temperature.



This flow works to make the interior of buildings the same temperature as the outdoors. To maintain the desired inside temperature, we mechanically heat or cool the home, which requires the burning of fuel.

Compared to well-insulated walls, windows allow seven to ten times more energy flow per square foot. Such massive energy flow can easily account for more than half the home's heating and cooling costs. "Money out the window" is an apt phrase.

Historical Architectural Solutions

Prior to our reliance on technology, architectural solutions were the only way to meet most comfort needs. It's useful for us to learn what role windows played in the implementation of these solutions.

In hot and dry climates, windows were small because daytime ventilation was undesirable. Plus, because of the intense sunlight, small windows were all that was needed to provide adequate interior light. Exterior and interior surfaces were light-colored to slow heat absorption on the outside and diffuse light on the inside. Homes were built with massive walls for their moderating time-lag effect: slowly heating by day, keeping the interior cooler than the outside; and slowly cooling at night, keeping the interior warmer than the outside.

In hot and humid climates, temperatures were lower but the humidity created greater discomfort. Relief depended on air movement across the skin to increase the rate of evaporative cooling. The typical antebellum house had large windows to maximize ventilation. High ceilings allowed for these large windows, plus permitted significant air stratification — people inhabited the lower, cooler layers. Vertical ventilation through high windows and sheltered roof openings increased air movement and exhausted the hottest layers of air first. Large overhangs and shutters blocked infrared solar energy and created shaded outdoor living spaces.

In cold climates, emphasis was on heat retention. In spite of the natural desire for views and daylight, windows were few — sacrificed for the more important need to conserve heat. Buildings were very compact to minimize the surface-area-to-volume ratio. Because hot air rises, ceilings were kept very low. Wood rather than stone was

Before modern technology, architectural solutions were the only way to maximize the comfort of people whose homes were in hot, arid climates (left); hot, humid climates (center); and cold climates (right).

OUT OF THE BOX

In parts of Europe during the Middle Ages — and in Sub-Saharan Africa even today — inhabitants burned so much wood for fuel that they deforested the land around them. To survive, they had to leave their homes and migrate to another region where wood was still available.

In modern societies, the fuel we burn comes mainly from beneath the ground: oil, coal, natural gas. In essence, over-consumption of these resources "deforests" our planet from the inside-out; but when we run out of this "wood," there is no place for us to migrate. We have no choice but to find alternative energy solutions which are both renewable and environmentally friendly.

used for walls to increase thermal resistance. South facing orientations were used whenever possible.

Fire provided added heat and light to supplement these primary architectural solutions when needed.

Masking the Problems

With increased technological sophistication, the perceived need for these architectural solutions gradually faded. By the mid-twentieth century, buildings were being constructed with less regard for energy flow. Fire — now indirect and unseen — had displaced architecture as the primary provider of thermal and light comfort. This fire masked the natural movement of energy. The fire of central heating masked heat loss. Air conditioning powered by the fire of electrical plants masked infrared solar heat gain. And the fire of incandescent light masked the need for effective daylighting.

All these fires, of course, require fuel. This is the unfortunate characteristic of fire: it consumes . . . in homes, office buildings, manufacturing and processing facilities, internal combustion engines.

Few people thought unfettered energy consumption was a problem in the 1950s. Resources were abundant and cheap. Global warming was imperceptible. Isolated pockets of air pollution were thought to be a small price to pay for progress.

Today, however, we realize that our energy resources are not unlimited. Crude oil production is projected to peak soon and effectively cease just a few generations from now — around the turn of the next century. Nor are our oil-based energy resources cheap. Supply and demand, along with geopolitics and inflation, have raised crude oil prices from $2.50 per barrel in 1950 to as much as $135 per barrel in May 2008, and further increases are forecast. Finally, global warming and environmental degradation are no longer considered small prices to pay.

Sustainability means meeting the needs of the current generation without compromising the ability of future generations to meet their own needs. Our current level of energy consumption, with its resulting environmental impact, is simply not sustainable.

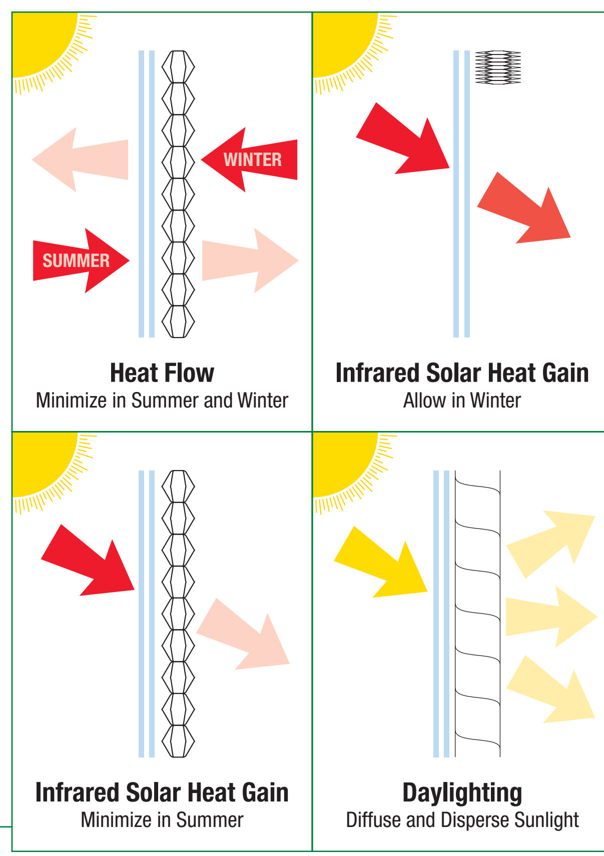
What Window Coverings Can Do

Installing window coverings over "energy holes" can play a valuable role in reducing energy consumption and helping to meet sustainability goals. Hunter Douglas products reduce heating and cooling fuel needs in three significant ways:

- Minimize heat flow resulting from temperature differences between inside and outside.
- Control infrared solar heat gain by allowing it in winter but minimizing its impact in summer.
- Maximize daylighting efficiency by diffusing and dispersing sunlight deep into a room.

As we discuss these functions in detail on the following pages, it's important to always keep in mind that we're talking about three distinctly different forms of energy — heat, infrared solar energy, and light.

Heat, *solar energy*, and *light* are different in how they enter a home, how they are measured, how they are controlled, and which window coverings are best for their control.



Heat Flow
Minimize in Summer and Winter

Infrared Solar Heat Gain
Allow in Winter

Infrared Solar Heat Gain
Minimize in Summer

Daylighting
Diffuse and Disperse Sunlight

Heat, or thermal energy, moves *out* through windows when it is colder outside, and *in* through windows when it is colder inside. The heat moves three ways: conduction, convection, and radiation. Learning about heat movement is essential to an understanding of how Hunter Douglas products insulate to increase energy efficiency.

Window coverings insulate by slowing the movement of heat that is caused by temperature differences between the interior and exterior of a home. The better a product works against conduction, convection, and radiation, the better it insulates.

Conduction

Conduction occurs when rapidly moving or vibrating atoms and molecules interact with slower moving atoms and molecules, transferring some of their energy (heat). When you put your hand against a cold pane of glass, the glass molecules on that surface are excited by the heat of your hand and their vibrational energy is quickly conducted through the glass to the other side of the pane. Glass is a good conductor of heat. Note that your hand feels cold because it has lost energy to the glass.

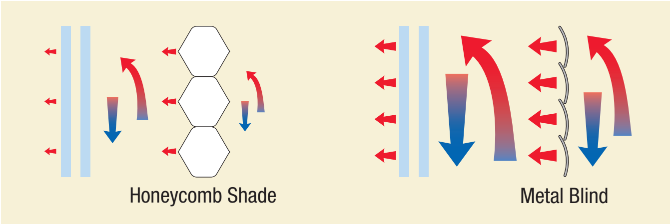
Heat inside a home is lost in a similar fashion. The kinetic energy of warmer air molecules contacting the glass is partially transferred to the colder glass molecules, and once again the energy is conducted to the other side of the pane. Fortunately, air is a poor conductor of heat because its molecules are relatively far apart; so the loss of heat is much slower than from your hand to the glass.

Air's poor conduction is a big reason why honeycomb shades are such good insulators. Their cellular air pockets slow the conductive flow of heat through the shade — and also slow another way heat moves: convection.

Convection

Convection speeds conduction by moving cooled air molecules away from the glass and warmer air molecules against it. Cool air is denser than the warm air, so it tends to sink. The warm air rises or "floats" on the cool air. When the warmer air contacts the glass, it cools and sinks. This process creates convective air currents to constantly move warmer air against the cooler glass.

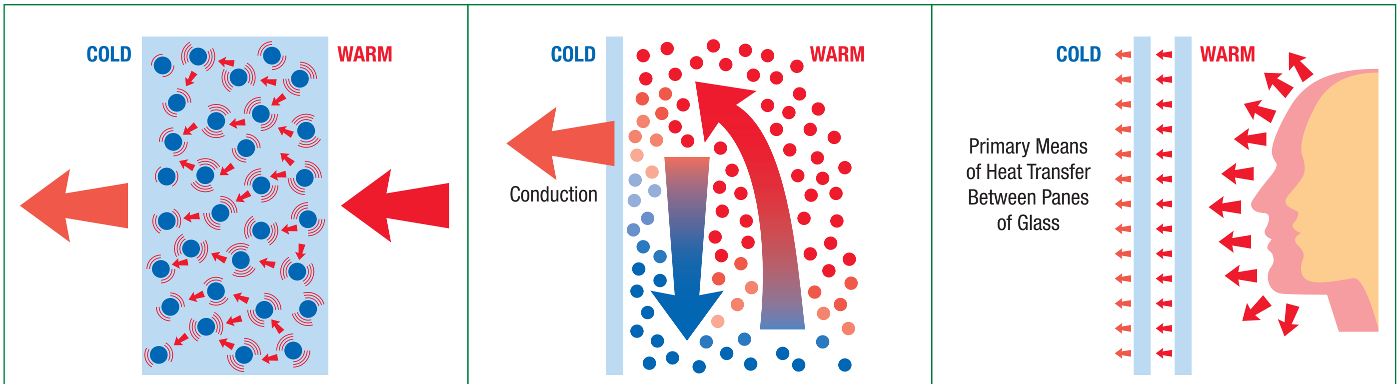
Honeycomb shades slow this cycle significantly. Their insulating air pockets reduce heat transfer to the window side, resulting in weaker convective air currents between the shade and window. Plus, the room-side surface of the honeycomb shade remains warmer, weakening convection on that side as well. The net result is slower heat transfer.



Products like blinds, single-layer fabric shades, and sheers are less effective at slowing convection. They allow room heat to move through them fairly quickly to the window side, where the conduction/convection cycle works to transfer heat. The cooled window covering can promote convection on the room side, as well.

Radiation

Radiation is the emission of waves. In this context, it is the emission of infrared waves. All objects give off and receive heat in this form. Hot objects emit more infrared waves than cold objects, and it is this imbalance which results in radiant heat transfer.



Conduction
Transfer of Vibrational Energy

Convection
Hot Air Rises, Cool Air Sinks

Radiation
Transfer of Radiated Heat

For example, if you're in a warm room on a cold winter day and a nearby window is uncovered, you will have a net loss of radiant heat on the side of your body facing the window. This loss will be most noticeable on exposed skin. The uncomfortable coolness is often attributed to a draft, but it is actually radiant heat loss. Covering the window noticeably reduces the loss.

Conversely, if the other side of your body is facing a hot wood stove, the stove at 350° is radiating more heat than your 98.6° body. Consequently, you feel the warmth of radiant heat gain. Simply holding a piece of paper between your face and the stove acts as a radiant barrier, just like the shade on the window.

Radiation is the primary component of heat transfer between the two panes of double-glazed windows, which will be discussed in more detail later.

Radiation is also the main factor in why opaque honeycomb shades are the best insulators. Their metallized interior surfaces have very low emittance, which means the surfaces do not radiate much heat. Once again, the net result is slower heat transfer.

R-Value

R-value is the measure of a material's resistance to conductive, convective, and radiant heat flow. The higher the R-value, the slower the heat transfer through the material. Walls of a house typically have an R-value of about 20, roofs about 30, and windows from 1.0 to 3.5. A double-glazed window with an R-value of 2.0 allows ten times more heat to flow through it than an R-20 wall. The wall is ten times more energy efficient.

The R-values of Hunter Douglas products are always measured in combination with a window. R-values are additive. If we know the R-values of both the window alone and the window covering/window combination, we can calculate how much R-value is added by the product.

Inside mounting an opaque Duette® Architella™ shade over an R-2.0 window increases the R-value of the covered window to about 6.0 (depending on the specific fabric type). The shade adds R-4.0. The energy efficiency of the window is tripled and heat loss through it is cut by two-thirds. The "Calculations" section at right *(optional reading)* shows the mathematics behind these statements.

Note that the percentage benefits of a particular window covering varies with the R-value of the window. If, in our previous example, the shade is installed over an R-3.5 window, the energy efficiency of the window is now slightly more than doubled and heat loss is cut by 53%.

R-value is a measure of *resistance* to heat flow. U-factor is a measure of the heat flow itself. The higher the R-value, the lower the U-factor, and the less heat flow through a material.

U-Factor

The R-value of a material is not measured directly. Rather, its U-factor is measured and then the R-value is calculated as the inverse of the U-factor (R = 1 ÷ U).

U-factor is a measurement of heat flow. Specifically, it is the measure of how much heat flows through one square foot of a material when there is a 1° temperature difference between the two sides. The result is a coefficient that enables the calculation of heat flow through a specific square footage for a specific temperature difference. Sample calculations are shown below *(optional reading)*.

CALCULATIONS

R-Value Percentage Benefits

To calculate the increase in energy efficiency provided by an R-4.0 shade over an R-2.0 window:

Total R-value ÷ Window R-value = Energy Efficiency Increase
(4.0 + 2.0) ÷ 2.0 = 6.0 ÷ 2.0 = 3
Energy efficiency is tripled (300%).

Same shade over an R-3.5 window:

(4.0 + 3.5) ÷ 3.5 = 7.5 ÷ 3.5 = 2.14
Energy efficiency is slightly more than doubled (214%).

To calculate the reduction in heat loss provided by an R-4.0 shade over an R-2.0 window:

Shade R-value ÷ Total R-value = Heat Loss Reduction
4.0 ÷ (4.0 + 2.0) = 4.0 ÷ 6.0 = 0.667
Heat loss is cut by two-thirds (67%).

Same shade over an R-3.5 window:

4.0 ÷ (4.0 + 3.5) = 4.0 ÷ 7.5 = 0.533
Heat loss is cut by slightly more than half (53%).

Heat Flow in BTU/Hour

BTU stands for British Thermal Unit. One BTU is about equal to the energy released by a burning kitchen match. A gallon of gasoline or heating oil contains approximately 130,000 BTU.

The U-factor of an R-2.0 window is 0.5 (R = 1/U; U = 1/R). To calculate the heat flow through this window if its size is 48" x 60" (20 sq. ft.) and the temperature is 70° inside and 0° outside:

Heat Flow = U-factor x Area (sq. ft.) x Temperature Difference
Heat Flow = U x A_{sf} x ΔT = 0.5 x 20 x 70 = 700 BTU/hour
Over a 24-hour period, heat loss would total 16,800 BTU.

To calculate heat loss with an R-4.0 shade over the R-2.0 window:

R-value = 4.0 + 2.0 = 6.0; U-factor = 1 ÷ 6.0 = 0.167
Heat Flow = U x A_{sf} x ΔT = 0.167 x 20 x 70 = 234 BTU/hour
Over a 24-hour period, heat loss would total 5,616 BTU.
The R-4.0 shade cuts heat loss by two-thirds (67%).

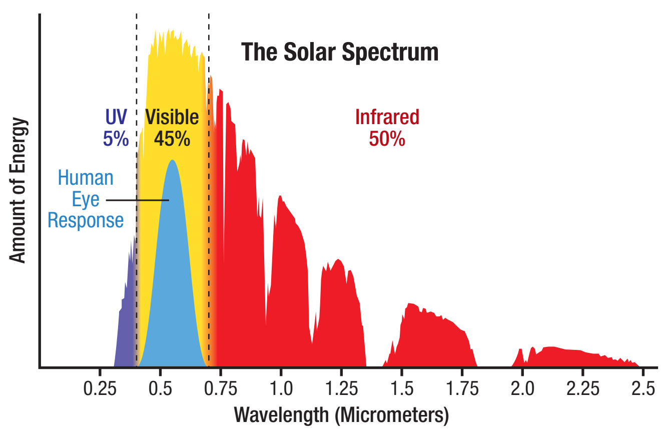
Exercise: Calculate the heat loss for a 48" x 60" window with an R-value of 3.5 and a 70° interior/exterior temperature difference. Add an R-4.0 shade to the window and repeat the calculation.

Solar energy is the second form of energy flow through windows we'll discuss. The amount of solar energy entering the home on a sunny day is comparable to burning two gallons of home heating oil or running five 5,000 BTU electric room heaters for ten hours. We want that solar energy to help heat the home in winter, but not in summer. Solar energy must be controlled, and window coverings can do so with great effectiveness.

Solar energy entering the home is good in winter, but bad in summer. Window coverings provide simple, flexible control of solar energy flow — opening to allow it, closing to minimize it.

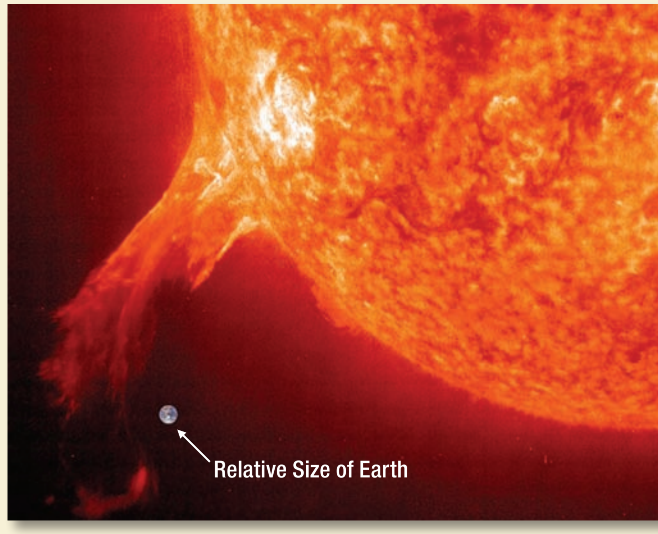
Solar Heat Gain

Solar heat gain is the amount of solar energy (either direct or reflected) that enters the home to become heat. To understand this phenomenon, it's helpful to become acquainted with the solar spectrum.



This graph shows the breakdown of solar energy at sea level into ultraviolet, visible light, and infrared waves. Because this spectrum originates at the 11,000° surface of the sun, the waves are very high frequency with very short wavelengths. Note the blue area labeled "Human Eye Response." This is what we call sunlight. As you can see, it's a relatively small part of overall solar energy.

While all wavelengths in the spectrum can add heat, the biggest contributor is infrared. Its short wavelengths easily pass through standard windows to enter the home where it warms walls, floors, furnishings, and window coverings. These objects, in turn, emit lower frequency, longer wavelength infrared because they originate at lower temperatures. These longer wavelengths cannot escape through glass, so the heat is retained in the room.



The sun is the star of our solar system. At 862,400 miles in diameter, it is only a medium-sized star — yet it is 109 times bigger than the earth (7,900 miles in diameter), roughly the size relationship of a grain of sand to a softball. Average distance from the earth to the sun is 93,000,000 miles, or 8 minutes 20 seconds at the speed of light. The next nearest star is over four light years away! If we were able annually to harvest just 0.023% of earth's incident solar energy, the sun could satisfy all our energy needs.

Solar Heat Gain Coefficient

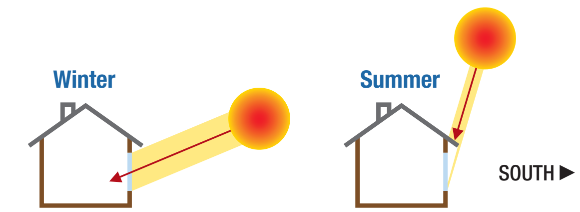
The measurement of solar heat gain is basically a calculation of how much solar energy incident on a window actually passes through it. A coefficient is needed to make this calculation — just as U-factor is a necessary coefficient to calculate heat transfer.

The solar heat gain coefficient (SHGC) is expressed as a number from 0 (none) to 1 (all). The lower the number, the less solar energy is transmitted. Standard double glazing has an SHGC of 0.76, meaning 76% of the incident solar energy passes through it. Adding an opaque shade drops the SHGC to as low as 0.15.

Why isn't the SHGC zero with an opaque window covering? Because solar heat gain has two components: directly transmitted solar energy (which is blocked by the shade) plus the solar energy absorbed by the window and shade that ultimately gets transferred into the room by conduction, convection, and radiation. The heated shade adds heat to the room, and this counts as solar heat gain. Such gain would not occur, of course, if a shade was on the *exterior* of the home.

Solar Angles

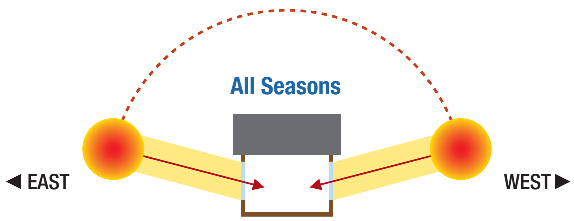
The amount of solar energy entering an uncovered window depends on the angle of the sun. In winter, when the sun is low in the sky, a great deal of solar energy enters south windows. In summer, when the sun is higher in the sky, its rays are either shaded by overhangs or mostly reflected because of the steep angle. This is the perfect situation in both seasons for energy efficiency.



Solar energy enters south windows almost "straight on."

Solar energy is blocked or mostly reflected.

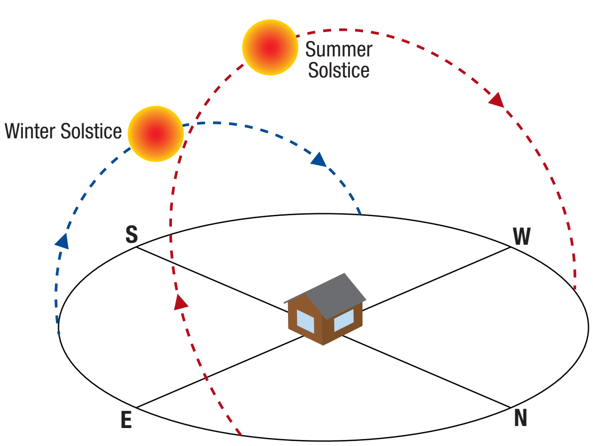
The situation is less ideal for east and west windows. Whatever the season, solar energy enters these windows for about half the day — and since days are longer in summer than winter, more solar energy enters during the season when it is least wanted.



Solar energy pours into east and west windows for hours each day, more in summer than winter.

South-facing windows allow significant solar energy into the home to help heat it in winter, but less in summer when the sun is higher in the sky. East and west windows are where most unwanted solar energy pours into the home in summer.

Shown below are solar paths for the winter and summer solstices at 40° latitude (Denver, Colorado). The paths for all other days of the year fall between these two extremes. Use the diagram to help you better visualize solar angles for different window orientations.



Solar Heat Gain Charts

Determining how much solar energy enters the home for various window orientations requires complex trigonometric calculations. Fortunately, that work has already been done for us. Solar heat gain charts, such as those in *The Passive Solar House* by James Kachadorian, organizes this information by latitude, month, time of day, and window orientation. Heat gain is shown in BTU/hour per square foot for each hour of the solar day.

Sample solar heat gain calculations using the charts are shown below for windows in both winter and summer *(optional reading)*.

CALCULATIONS

General Solar Heat Gain Calculation

To calculate solar heat gain, multiply the solar heat gain coefficient of the window by its area by the incident BTU per square foot:

Solar Heat Gain = SHGC x Area (sq. ft.) x Incident BTU (sq. ft.)
Solar Heat Gain = SHGC x A_{sf} x $BTU_{incident/sf}$

Solar Heat Gain in Winter

A south-facing window at a latitude of 40° N is 48" x 60" and has an SHGC of 0.76. Consulting solar heat gain charts, we learn that 1,550 BTU per square foot is incident on a day in December.

Solar Heat Gain = SHGC x A_{sf} x $BTU_{incident/sf}$
Solar Heat Gain = 0.76 x 20 x 1,550 = 23,560 BTU/day
This is the equivalent of running a 5,000 BTU electric room heater for almost five hours.

During the morning hours on an east-facing window of the same size, 374 BTU are incident per square foot.

Solar Heat Gain = 0.76 x 20 x 374 = 5,685 BTU/morning
This is the equivalent of running a 5,000 BTU electric room heater for just a little more than one hour.

In both examples, there is a *net gain* of heat during sunny hours. We know this because, in the calculations on page 5, we learned that 700 BTU/hour were lost through a 48" x 60" window with a 70° ΔT.

Solar Heat Gain in Summer

Same windows on a day in June. The south-facing window has a total of 630 BTU incident per square foot over the course of the day, while the east window has 1,038 BTU incident per square foot just during the morning hours.

Solar Heat Gain (S) = 0.76 x 20 x 630 = 9,576 BTU/day
Solar Heat Gain (E) = 0.76 x 20 x 1,038 = 15,778 BTU/morning
The morning heat gain from just one east-facing window is the equivalent of running a 5,000 BTU heater for three hours.

Note that the solar heat gain of the south window in summer is only 40% of the winter solar heat gain through the same window, even though the days are much longer in summer. The east window heat gain in summer, however, is *300%* of its winter heat gain!

LIGHT

Light is the third form of energy flow through windows. Natural light entering the home is important to people for both visual comfort and mood.

Using natural light to illuminate home interiors is called "daylighting." With good window and home design, plus the right Hunter Douglas window fashions, daylighting could provide most, if not all, needed daytime light — thereby saving significant energy.

The goals of daylighting are to diffuse incoming light for a more even intensity and to bring light deep into the room. Good daylighting not only reduces the need for electric light, it maximizes our visual comfort.

Properly applied window covering systems can dramatically improve the distribution and quality of natural light in a home.

Daylighting and Direct Sunlight

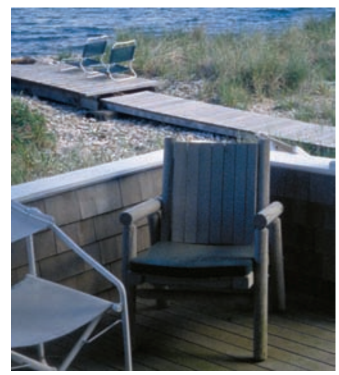
The biggest problem facing good daylighting is direct sunlight. It simply creates too much contrast in a room. Dark areas seem darker and sunlit bright areas are harsh and glaring.

To vividly understand just how much contrast direct sunlight creates in a room, we need to quantify it. Lux is the unit of measure for illuminance. A full moon on a clear night provides 0.25 lux; a candle at a distance of one foot, 10 lux; and a brightly lit office, 400 lux. The amount of light required for close detail work is 1,000 lux. Direct sunlight is measured at 100,000 lux, which is 100 times greater than the maximum amount ever needed.

For overall visual comfort in a room, the maximum ratio of illuminance from brightest to darkest is 20:1. When performing a close-up activity, the ratio of the task to the immediate surroundings (for example, a book to a desk) should be no more than 3:1. Clearly, it is very important to diffuse direct sunlight.

Diffusion

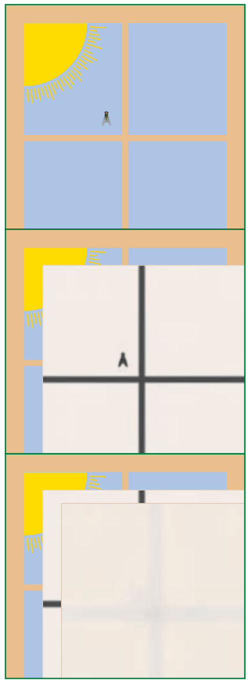
Diffusion is a bending of the sunlight coming into the home, causing it to scatter and go in multiple directions. The benefits of diffusion are well illustrated by clouds. When clouds diffuse sunlight, we can see the real details and structure of objects — because the details aren't lost in harsh shadows. Compare the chair in the two photos below. The details lost in the shadows of the left photo are revealed when the sunlight is diffused by passing clouds.



The goal of diffusion in window treatments is to mimic the soft, shadow-free effect of sunlight through clouds. Successful achievement of this goal is seen in the "after" photo below. The two sheer facings of Silhouette® window shadings beautifully soften the incoming light by scattering it in multiple directions.

In these "before and after" pictures, you can see the striking difference made by the two sheer facings of Silhouette window shadings. The harsh, high-contrast glare in the left image is gone. Instead, the light has been softened and diffused, and brought deeper into the room. The visual comfort of the room's occupants has been vastly improved.

Two Fabric Layers



The illustrations at the right show the benefit of two layers of fabric on a window covering. In the top drawing, we see a fly basking in the warm sun. In the second image, a single layer of fabric hides the fly, but we see its dark shadow, as well as the shadow of the mullions. In the bottom drawing, after adding a second layer of fabric an inch in front of the first, the fly's shadow has vanished and we see only a faint shadow of the mullions.

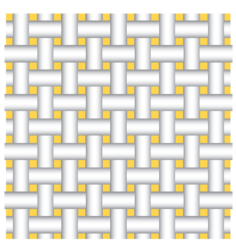
Why did the fly disappear? Sunlight through the window shines on the first layer of fabric and shadows it, but then also diffuses outward to land on the second layer much more uniformly. This creates an even glow on the fabric, minimizing any shadows and bringing a warm, diffused light into the room.

This is the principle behind all Hunter Douglas multi-layered fabric window fashions. It is also the principle behind something as ordinary as a table lamp — the frosting on the incandescent light bulb is the first layer of diffusion and the lampshade is the second.

Two layers of sheer or translucent fabric do an excellent job of diffusing light and bringing it deeper into a room.

Single Fabric Layers

Single-layer fabric products can also improve daylighting. At right is an illustration of roller shade screen fabric. Screen fabrics can allow from 3% to 25% visible light transmission, depending on color and openness factor.



10% Openness Factor

Openness factor is the percentage of open area in the fabric, typically ranging from 3% to 10%. The openness factor in the illustration is 10%. If this was black fabric, little more than 10% of the sunlight would shine through — most of the light striking the black threads would be absorbed. If this was white fabric, some of the sunlight would be reflected off the edges of the threads and as much as 25% of the light could pass through.

Redirection and Reflection

Another way to achieve the goals of daylighting is to redirect and reflect the sunlight. This is what light-colored blinds and shutters do so well. By tilting the slats, vanes, or louvers at the correct angles, light can be reflected to walls and ceilings, and redirected deeper into the room. With each redirection and reflection, the light is diffused and softened. The downside of these "hard" window coverings is the dramatic light/dark banding when direct sunlight shines between the slats.

Luminette® Privacy Sheers combine the benefits of single fabric layers with redirection and reflection. This product both diffuses light with its sheer fabric facing and redirects and reflects light with its vanes.

Pirouette® window shadings are also single-layer sheers that redirect and reflect. Although the contoured Pirouette vanes do not offer directional control, the open vanes of light-colored fabrics do reflect upward to the ceiling, bringing softened light deeper into the room.

The white louvers on these shutters redirect and reflect light to the white alcove and ceiling to help bring light deeper into the room.

OUT OF THE BOX

Now that we've reviewed the flow through windows of heat, solar energy, and light, can you choose one product that maximizes energy efficiency in all three areas?

The Duette® Duolite™ system is an excellent choice. With Architella™ opaque fabric on the bottom (to control heat loss in winter and solar heat gain in summer) and single-honeycomb sheer fabric on the top (to diffuse light for daylighting), it performs well in each area. Until it is motorized, however, its functions cannot be automated.

White shutters are also multi-functional, providing superior control over solar heat gain, excellent insulation, and very good daylighting.

But to truly maximize control of heat, solar energy, and light, the best choice today is a combination — an inside-mounted opaque Duette Architella shade with an outside-mounted Silhouette shading or Luminette sheer. Each product can be automated to respond to changing conditions, and together the combination offers superior energy efficiency in all three areas . . . plus superior beauty!

Understanding how Hunter Douglas products can affect energy flow through windows demands a basic understanding of the glass (glazing) that separates the interior of the home from the outdoors.

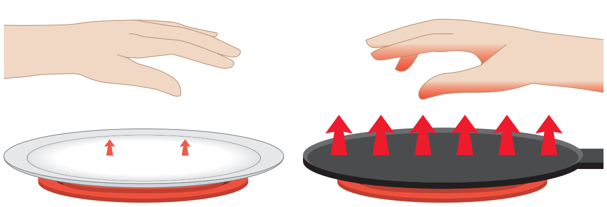
Modern windows are a recent development. In fact, "float" glass was not developed until the 1950s. In this manufacturing process, molten glass is floated over molten tin to create extremely flat surfaces with uniform thickness and few, if any, visual distortions.

Single-glazed windows with storm windows and screens were the standard before 1965. Then insulated glazing units (IGU) evolved, where typically two panes of ⅛" thick glass were sealed together with ½" air space between them. Argon and krypton gases are now more commonly used than air because of their better insulating properties. Better frame materials have also been developed to reduce conductive heat loss.

Low-E

But the most important improvement was the development of low-e coatings. Low-e is short for low emittance. A low-e surface does not emit much infrared radiation — it does not readily radiate heat.

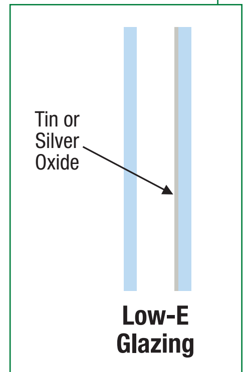
A good way to understand low-e is to compare a shiny aluminum plate to a black cast iron griddle, both heated to a very high temperature. If you hold one hand a few inches above the aluminum plate and the other above the griddle, you feel a big difference. The hand above the aluminum plate is comfortable because the plate has very low emissivity — like a low-e coating, it emits little infrared radiation. But the hand above the griddle is painfully hot — black cast iron has very high emissivity. (If you touch each object, however, the "ouch" is identical.)



Shiny Aluminum Plate   Cast Iron Griddle

If the plate and griddle were raised a couple inches above the electric burners and then heated, infrared radiation, rather than conduction, becomes the large part of the heat transfer. The shiny aluminum plate reflects much of that radiation, and consequently takes longer to heat. Once heated, it also takes longer to cool — because it is low-e.

With windows, a low-e coating is a very thin layer of metal oxide — tin or silver — which is applied to what will become one of the interior surfaces of an IGU. The low-e coating has significant impact on two forms of energy flow through windows: heat and solar energy.

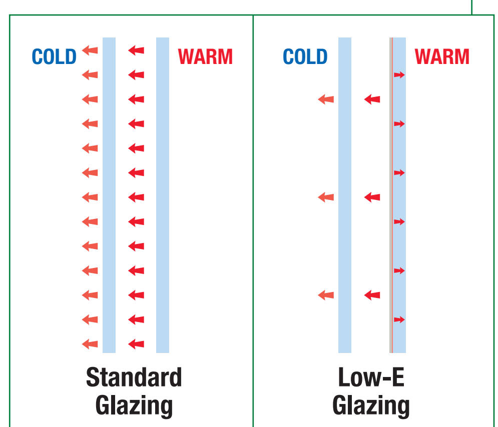


Low-e glass is an important refinement in window technology when used properly. The low-e coating helps reduce heat loss in winter and solar heat gain in summer.

Low-E and Heat

In seasonally cold climates, the biggest benefit of low-e windows is their increase in R-value. Standard double-glazing has an R-value of about 2.0. Compare that to an R-value of 3.5 or even higher for low-e double glazing. The low-e double glazing cuts heat loss through the window nearly in half.

How does low-e improve energy efficiency so significantly? In our earlier discussion of heat transfer, we noted that radiation was the primary way heat is lost between panes of glass. But since the low-e coating emits so little radiation, the heat that is conducted to it through the interior pane is not readily lost to the exterior pane. Heat transfer between panes is mostly limited to conduction and convection, both of which are slowed by the argon or krypton gas sealed within the IGU.

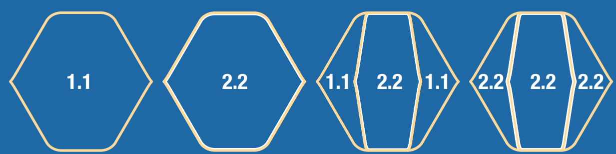


Along with the low emittance of low-e glazing comes high reflectance. The low-e coating reflects much of the infrared heat radiated to it by the warm room, further slowing heat loss.

OUT OF THE BOX

Opaque honeycomb shades are actually low-e window coverings. That shiny metallized film inside the cells does more than block light; it also slows radiant heat transfer from one side to the other, just like a low-e coating.

Metallized cells have a theoretical R-value of 2.2, compared to 1.1 for fabric cells. Opaque Duette® Architella™ fabric has one center metallized cell and two outer fabric cells for a theoretical R-value of 4.4 (not including the R-value of the air films on the outside of the fabric). Only one side of an air pocket needs to be metallized to achieve the 2.2 R-value; so if the center cell was metallized on its outer surface as well as the inner, the theoretical R-value of opaque Architella fabric would be 6.6!

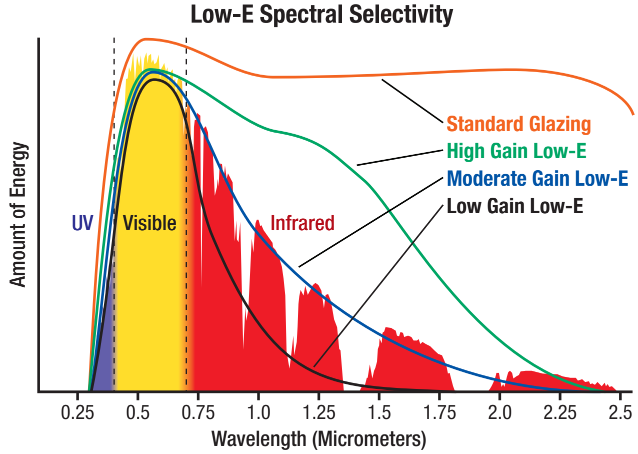


Low-E and Solar Energy

In hot climates, an added benefit of low-e glazing is spectral selectivity. Low-e coatings can be designed to transmit visible wavelengths of the solar spectrum, but to reflect ranges of infrared wavelengths and thereby limit solar heat gain.

Low-e windows are classified as low gain, moderate gain, and high gain. The spectral selectivity of these three types of windows, along with standard double glazing, is illustrated below. Notice that low gain low-e windows limit solar transmission throughout the entire infrared spectrum. High gain low-e windows limit very little of the spectrum. Notice also that none of the coating types significantly affect UV and visible wavelengths.

Low-E Spectral Selectivity



While R-values of low-e windows do not vary much with spectral selectivity, the solar heat gain coefficient certainly does. The SHGC is in the 0.30 range for low gain windows, 0.50 for moderate gain, and 0.70 for high gain — which is almost as much as the 0.76 SHGC for standard double glazing.

The Right Low-E Choices

Because of their ability to slow heat flow, low-e windows are the right choice for any home. But are low, moderate, or high gain low-e windows the best option?

The standard in the marketplace is low gain low-e. Unfortunately, this is often the worst choice. If used in regions with significant heating seasons, low gain low-e glazing blocks up to 70% of the free heat from the sun. High gain windows block only 30% or so, depending on the specific SHGC of the glazing.

The following chart shows the recommended low-e ratings by region. Note that low gain low-e windows are only recommended for the south region, where cooling needs dominate. In the north and central regions, high gain windows should always be used on south windows, and often on east and west windows, as well.

Recommended Low-E Glazing by Region

Region	North Mostly Heating	Central Heating & Cooling	South Mostly Cooling
South Windows	●●●	●●●	●
East & West Windows	●●●	●●	●
North Windows	●●	●●	●

●●● = High Gain (SHGC: 0.55 - 0.70)
●● = Moderate Gain (SHGC: 0.45 - 0.55)
● = Low Gain (SHGC: 0.30-0.45)

In the summer, of course, the solar heat gain must be reduced, particularly through east and west windows. Window coverings can do this very effectively, offering *flexible* control of solar heat gain rather than the *fixed* control of low gain low-e windows. With this dynamic, flexible control of solar energy flow, we can enjoy the full benefit of passive solar heating in winter, and still stay cool in summer.

Low solar heat gain windows are often the worst choice. High or moderate gain windows should be used where appropriate for climate and window orientation. Window coverings can then provide dynamic, flexible control of solar energy flow.

AUTOMATION

Think of window coverings as valves that open and close to control energy flow. Who operates these valves, and when? If we leave this task to the home's occupants, control of energy flow will be imprecise, and energy efficiency will suffer. To maximize energy efficiency, the valves must systematically open and close precisely as needed to control the flow of heat, solar energy, and light. The window coverings must be automated.

To maximize the energy efficiency of a home, its window coverings must be operated systematically — preferably automated to respond to dynamic input from sensors.

Simple Automation

The simplest form of window covering automation is a timer. Typically using RF (radio frequency) signals, the timer operates individual shades or groups of shades at preset times of day. In winter, for example, the timer could be set to raise shades in east windows at 8:30 AM and then close them at 11:30 AM. This allows solar heat gain when (on a sunny day) the gain is more than the heat loss through uncovered windows.

While this is not dynamic control (the timer doesn't know if it's a cloudy day), nonetheless it is more energy efficient than relying on a person being home and actually remembering to raise and lower the shades at the proper times.

Timers allow fixed automation of window coverings.

Direct Input Automation

Dynamic control of individual shades can be provided using direct input automation, which will soon be available for Hunter Douglas Platinum™ Technology products. A solar energy or BTU sensor is connected to the switch circuit of a motorized shade, and that sensor tells the shade when to open or close based on the amount of solar energy passing through the window.

The sensor typically has two settings: heating and cooling. If set to "heating," the shade opens when the incoming solar energy exceeds an adjustable threshold. The shade closes when solar energy drops below that level. On a sunny winter day, for example, a shade in a south window might open at 8:00 AM and close at 4:00 PM. The shade would also close during periods when the sky clouds over and solar energy falls below the threshold.

If set to "cooling," opposite actions occur — the shade *closes* when solar energy exceeds the threshold and *opens* when it drops below.

PowerRise® with Platinum Technology shades are ideal for direct input automation, which can be supplemented by remote control operation and timer automation.

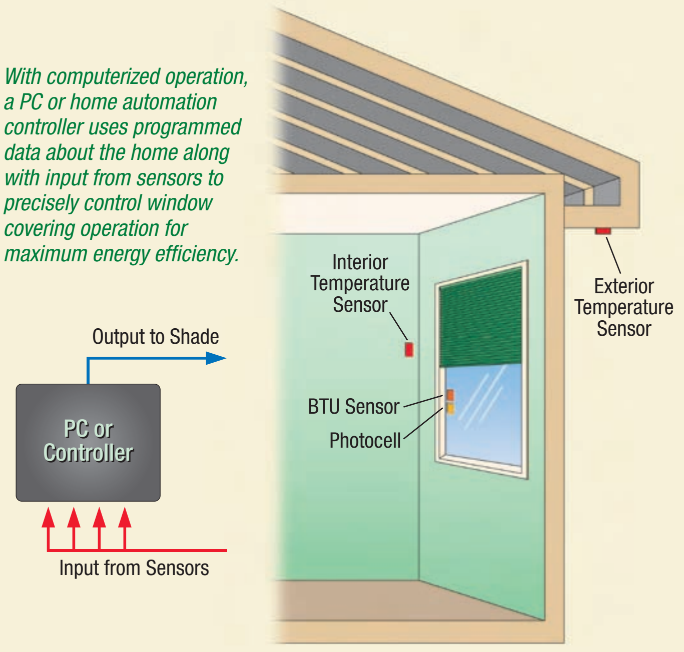
Direct input automation has limitations. With input from just one sensor, it cannot take into account multiple variables. Nor can it be programmed with data about the home to calculate window covering operation for maximum energy efficiency.

Computerized Automation

With computerized automation, energy efficiency can be optimized by using dynamic input from multiple sensors in conjunction with programmed data about the home. Such a system could be controlled using either a PC or a home automation controller.

Depending on system complexity, programmed data about the home could include such factors as its latitude and longitude, window size and orientation, and window R-values with shades raised and lowered. Even information about room usage and preferred lighting conditions could be entered into the system.

The PC or home automation controller would use this programmed data along with dynamic input from sensors to calculate when to raise or lower each window covering, or open and close its vanes. Basic input could be provided by window BTU sensors and photocells, with precise calculations also requiring interior and exterior temperature input. Manual overrides are possible with any system, and those would add input, as well.

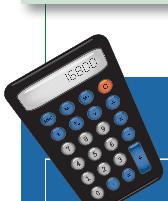


With computerized operation, a PC or home automation controller uses programmed data about the home along with input from sensors to precisely control window covering operation for maximum energy efficiency.

In winter, the basic objective of automation is to allow solar energy into the home when the heat gain that results is greater than the increase in heat loss when the shade is raised. In summer, the primary objective is to minimize heat gain by blocking or reflecting solar energy. Daylighting needs are factored into each situation, as well.

The "Calculations" section below *(optional reading)* includes winter and summer examples to demonstrate how programmed and dynamic data could be used to operate window coverings for optimal control of heat, solar energy, and light. Exterior screen shades are included in the examples to control solar heat gain *before* it enters the home, while still allowing visible light into the room.

Automated window coverings act like smart valves — opening and closing to precisely control the flow of heat, solar energy, and light.



CALCULATIONS

Data

- House located at 40° latitude N; sides of house oriented N, S, E, W
- 110 sq. ft. of R-3.5 windows on each side; SHGC = 0.70, U = 0.29
- 1500 sq. ft. of R-20 wall area; 1500 sq. ft. of R-30 roof area
- Opaque 1¼" Duette® Architella™ Panache™ shades inside mounted in all windows; with the glazing, R = 7.86, SHGC = 0.20, U = 0.13
- Silhouette® Quartette™ Originale™ shadings outside mounted over all windows; with the glazing, SHGC = 0.36 (closed vanes), 0.54 (open vanes), and 0.45 (half-open vanes)
- White exterior screen shades with 6% openness factor mounted over all except N windows; with the glazing, SHGC = 0.22
- Assume no natural or architectural shading of windows

Winter Example – December 21

Objective: Keep interior temperature at 68° using as little heating energy as possible, while bringing as much light deep into the home as possible; outside temperature is 0° with no wind.

Heat loss with Duette shades raised and lowered:
- Raised: U x A_{sf} x ΔT = 0.29 x 1 x 68 = 20 BTU/hour/sq. ft.
- Total per side raised: 0.29 x 110 x 68 = 2,200 BTU/hour
- Lowered: U x A_{sf} x ΔT = 0.13 x 1 x 68 = 9 BTU/hour/sq. ft.
- Total per side lowered: 0.13 x 110 x 68 = 990 BTU/hour

Duette shades should be raised when solar heat gain is greater than 11 BTU/hour/sq. ft. (the heat loss difference between raised and lowered shades). Using solar heat gain charts and 0.70 SHGC:
- N windows: Raised from 11:00 AM to 1:00 PM (2 hours)
- S windows: Raised from 7:30 AM to 4:30 PM (9 hours)
- E windows: Raised from 7:30 AM to 11:30 AM (4 hours)
- W windows: Raised from 12:30 PM to 4:30 PM (4 hours)
- Total solar heat gain 7:30 AM to 4:30 PM = 179,179 BTU

Total heat loss through walls, roof, and windows:
- Walls: U x A_{sf} x ΔT = 0.05 x 1500 x 68 = 5,100 BTU/hour
- Roof: U x A_{sf} x ΔT = 0.033 x 1500 x 68 = 3.366 BTU/hour
- Total walls and roof: 9 hours x 8,466 BTU/hour = 76.194 BTU
- Raised shades: 19 hours x 2,200 BTU/hour = 41,800 BTU
- Lowered shades: 17 hours x 990 BTU/hour = 16,830 BTU
- (Shade hours are per side of house; 4 x 9 hours = 36 hours)
- Total heat loss 7:30 AM to 4:30 PM = 134,824 BTU

Total heat gain exceeds total heat loss by 44,000 BTU. During the more intense solar hours, the PC or controller would perform the most energy efficient combination of these actions to both reduce the solar heat gain and improve daylighting:
- Lower Silhouette shadings and adjust vane tilt
- Raise shades in windows receiving less than 11 BTU/hour

Summer Example – June 21

Objective: Keep interior temperature at 70° using as little cooling energy as possible, while bringing as much light deep into the home as possible; outside temperature is 90° with no wind.

Heat flow into home due to inside/outside temperature difference:
- Heat Flow = U x A_{sf} x ΔT = 0.29 x 440 x 20 = 2,552 BTU/hour
- Over the 15-hour solar day: 15 x 2,552 BTU = 38,280 BTU
- If Duette shades are lowered: 17,160 BTU
- Total 15-hour heat flow through walls and roof: 37,350 BTU
- Maximum heat flow (raised Duette shades): 75,630 BTU
- Minimum heat flow (lowered Duette shades): 54,510 BTU

Solar heat gain through windows for 15-hour solar day:
- Solar Heat Gain = SHGC x A_{sf} x $BTU_{incident/sf}$
- Uncovered windows: 276,276 BTU
- Silhouette shadings lowered, vanes open: 213,127 BTU
- Silhouette shadings lowered, vanes closed: 142,085 BTU
- Exterior shade lowered: 86,830 BTU
- Duette shades lowered: 78,936 BTU
- All window coverings lowered: 20,000 BTU (est.)

Maximum and minimum total heat gain (solar and heat transfer):
- Maximum = 351, 906 BTU; minimum = 74,510 BTU

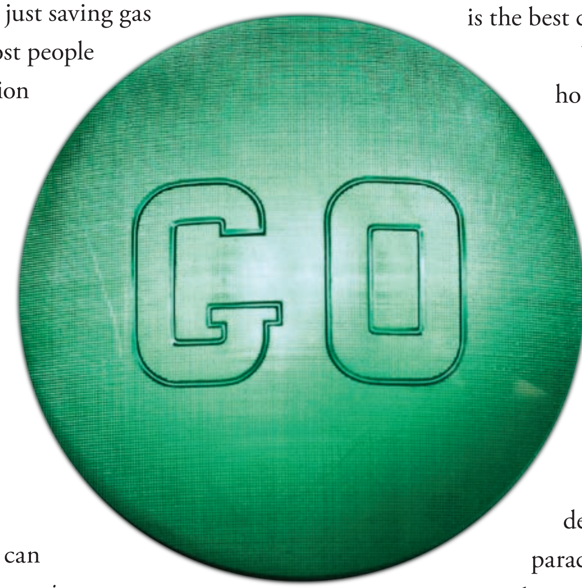
The difference between the minimum and maximum is the energy equivalent to two gallons of gasoline, a significant carbon footprint. On the other hand, the minimum allows no view or natural light into the home. Entering the following data into the automation system would result in a reasonable compromise:
- How many additional BTU you are willing to accept for better daylighting and life quality
- What rooms will be occupied at different times of day

If room usage is planned well, effective daylighting and good solar heat gain control can be achieved using the Silhouette shadings in combination with the exterior screen shades.

The line of traffic is moving. Many individuals and businesses have fully committed to proactive measures that reduce energy consumption and its waste products. Learning from the past, architecture is again leading the way. More and more commercial and government buildings incorporate design elements for passive heating and cooling, controlling solar heat gain, and daylighting. Residential construction, too, is growing greener — thanks to stricter building codes and more widespread builder and consumer understanding of heat loss, solar heat gain, and daylighting.

Also encouraging is the popularity of hybrid vehicles. They are in demand for more than just saving gas money — in the larger picture, most people are eager to contribute to the solution rather than the problem.

Like hybrid cars, our window coverings are socially responsible purchases — and they will only become more so. By learning that Hunter Douglas window fashions are easy ways to "contribute to the solution," people have an avenue to satisfy more than a need for fashion or function — when selecting one of our energy-efficient products, they can experience the satisfaction of taking *action*.



Redefining Beauty

An important part of "going green" is a redefinition of beauty. This is a process that is already happening in many areas. For example, people are beginning to see radically energy-efficient architecture as no longer odd looking, but beautiful in the purpose it serves. Likewise, bulky pod-shaped hybrid vehicles are beautiful for saving energy resources and reducing emissions.

Hunter Douglas window fashions become even more appealing when viewed in this light. Lowering a Duette® Architella® shade on a cold winter night or hot summer day can (and should) be seen as not only enhancing a home's décor, but also as increasing its beauty by reducing energy consumption and carbon dioxide emissions. How beautiful window coverings can be when they truly are window fashions for planet home!

Living Smart

Of course, there's more to facing up to today's energy challenges than choosing the right window fashions. Going green is about making small changes that can have a big impact: Choosing to replace incandescent light bulbs with compact fluorescent models, which use up to 75% less electricity and last up to 10 times longer. Choosing to drive less aggressively, which alone can reduce fuel consumption by 15%. Choosing to turn off the lights when leaving a room, to turn down thermostats, to recycle and reuse. Energy costs dollars — so the more energy we save, the fewer dollars we spend. Living smart is the best choice for everyone.

We are battling time, and the hourglass that marks the passing seconds is not filled with sand but with crude oil. More than half our time is already gone. Before the final drop slowly falls, we must have begun utilizing alternative energy and fuel sources, and found new raw materials for all the products our society makes from oil — everything from asphalt and plastics to ink, deodorant, volleyballs, bubble gum, parachutes, tape, tires, movie film, wax, medicines, and crayons.

To develop alternative resources, a massive amount of research and implementation remains. Our role in this evolution to a non-oil based society is no small one: to buy time . . . or, rather, to *conserve* time. By choosing energy-logical window covering products — and taking other common-sense energy-saving steps — we can help provide scientists, engineers, and business leaders with added years to find the solutions needed to make the coming transition less wrenching and more civilized for our children, grandchildren, and their children.

It's time for us to **GO**.

Today, window fashions are so much more than fashionable. They are tools to save energy resources, valves to control energy flow, and important ways we all can contribute to the achievement of sustainability by reducing the size of our carbon footprints.

Glossary of Terms

Angle of incidence: The angle of solar energy relative to a line normal (perpendicular) to a surface; the deviation from "straight on."

BTU: British Thermal Unit; the amount of thermal energy needed to raise a pint of water 1° F.

Carbon footprint: A measure of the impact a person has on the environment in terms of greenhouse gases emitted by his or her daily activities; measured in units of carbon dioxide.

Conduction: The transfer of thermal energy from a region of higher temperature to a region of lower temperature via the vibration or movement of adjacent atoms or molecules, or the movement of electrons.

Convection: The facilitation of conduction by moving higher energy atoms or molecules to regions of lower energy atoms or molecules.

Daylighting: The illumination of interior spaces with natural light — sunlight and sky light.

Diffusion: The bending of light, causing it to scatter and go in multiple directions, which "softens" it.

Equilibrium: The condition of a system in which competing influences are balanced; e.g., equal temperatures on both sides of a window.

Glazing: The glass portion of a window.

Heat Transfer: The movement of thermal energy from areas of higher temperature to areas of lower temperature in an attempt to reach a state of equilibrium.

IGU: Insulated glazing unit; two or three panes of glass sealed together with argon or other gas in the space between panes.

Infrared radiation: Radiation with wavelengths longer than visible light ("below red"); primary way heat is transferred from the sun to earth.

Insulation: Materials designed to resist heat transfer by slowing conduction, convection, and radiation.

Low-e: Low emittance; primarily used to describe microscopic layers of metal oxides on an interior pane of insulated glazing units designed to reduce radiant heat transfer and, to differing degrees, solar heat gain.

Lux: The unit of measure of illuminance.

Radiation: The transfer of thermal energy via the emission of infrared waves.

R-value: Inverse of U-factor; a relative measure of a medium's ability to resist heat transfer.

SHGC: Solar heat gain coefficient; indicates the percentage of incident solar energy that passes through a medium.

Solar heat gain: The increase in thermal energy resulting from solar radiation.

Sustainability: The utilization of resources which enables a society to satisfy its needs without compromising the ability of future societies to satisfy their needs.

U-factor: Coefficient of heat transfer; the measure in BTU per hour of how much heat flows through one square foot of a medium in an attempt to reach equilibrium when there is a 1° F temperature difference between the two sides.

VOCs: Volatile organic compounds; potentially toxic gases that are emitted ("off-gassed") from solids or liquids which may have short- and long-term adverse health effects.

Formulas

Energy Flow Through Windows (Excluding Infiltration):

Energy Flow = Heat Transfer + Solar Heat Gain + Light

Heat Transfer:

$BTU/hour = U \times A_{sf} \times \Delta T$

(U = U-factor; A_{sf} = surface area of window in square feet; ΔT = temperature difference between interior and exterior)

Solar Heat Gain:

$\text{Solar Heat Gain} = SHGC \times A_{sf} \times BTU_{incident}$

(SHGC = solar heat gain coefficient; A_{sf} = surface area of window in square feet; $BTU_{incident}$ = incident solar energy)

Further Reading

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Written, illustrated and designed by Hunter Douglas Product Brand Services

Key Points

Windows are energy holes. In fact, 5% of all energy consumed in the U.S. relates to energy flow through residential windows. Properly installed and applied Hunter Douglas products in every window of every home could cut this energy consumption in half.

MOVEMENT OF ENERGY	Energy moves through windows in three forms: *heat* (transferred due to temperature differences between inside and outside); *solar energy* (which becomes heat after it enters the home); and *light*.	*Heat*, *solar energy*, and *light* are different in how they enter a home, how they are measured, how they are controlled, and which window coverings are best for their control.
HEAT	Window coverings insulate by slowing the movement of heat that is caused by temperature differences between the interior and exterior of a home. The better a product works against conduction, convection, and radiation, the better it insulates.	R-value is a measure of *resistance* to heat flow. U-factor is a measure of the heat flow itself. The higher the R-value, the lower the U-factor, and the less heat flow through a material.
SOLAR ENERGY	Solar energy entering the home is good in winter, but bad in summer. Window coverings provide simple, flexible control of solar energy flow — opening to allow it, closing to minimize it.	South-facing windows allow signficant solar energy into the home to help heat it in winter, but less in summer when the sun is higher in the sky. East and west windows are where most unwanted solar energy pours into the home in summer.
LIGHT	Properly applied window covering systems can dramatically improve the distribution and quality of natural light in a home.	Two layers of sheer or translucent fabric do an excellent job of diffusing light and bringing it deeper into a room.
WINDOWS	Low-e glass is an important refinement in window technology when used properly. The low-e coating helps reduce heat loss in winter and solar heat gain in summer.	Low solar heat gain windows are often the worst choice. High or moderate gain windows should be used where appropriate for climate and window orientation. Window coverings can then provide dynamic, flexible control of solar energy.
AUTOMATION	To maximize the energy efficiency of a home, its window coverings must be operated systematically — preferably automated to respond to dynamic input from sensors.	Automated window coverings act like smart valves — opening and closing to precisely control the flow of heat, solar energy, and light.

Today, window fashions are so much more than fashionable. They are tools to save energy resources, valves to control energy flow, and important ways we all can contribute to the achievement of sustainability by reducing the size of our carbon footprints.

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