Phantom Screens White Paper

Managing the Energy Equation

Sustainable design options to create energy efficient living environments

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MANAGING ENERGY EQUATION

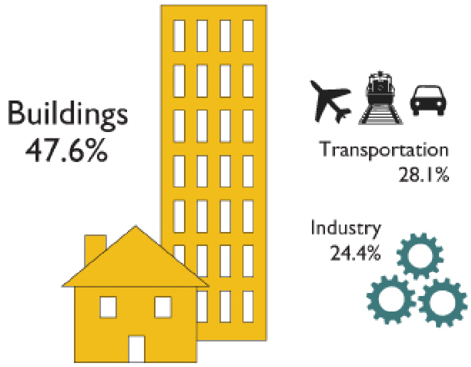
1. Introduction

Rising energy costs, fears about the depleting natural resources, and the growing awareness of more sustainable alternatives have many homeowners looking for efficient and less expensive ways to use and conserve energy. While consumers now have multiple energy choices, they also have more questions as to which options are best for them.

Incorporating sustainable and energy efficient design elements in new home design and construction, plus in renovation projects of the existing homes is an important step in improving the energy efficiency of buildings. This white paper explores some of those design options, and shares info on the steps one can take to create a more energy efficient home.

2. The Problem: supply and demand

Every year, nearly half (47.6%) of all energy produced in the U.S. is consumed by the Building Sector – about the same amount of energy used by both transportation (28.1%) and industry (24.4%) combined. Of the electricity we consume, three-quarters (74.9%) goes to operate the buildings we live and work in every day. By comparison, industry uses 24.9% and transportation, less than 1%.[1]



U.S. Energy Consumption by Sector

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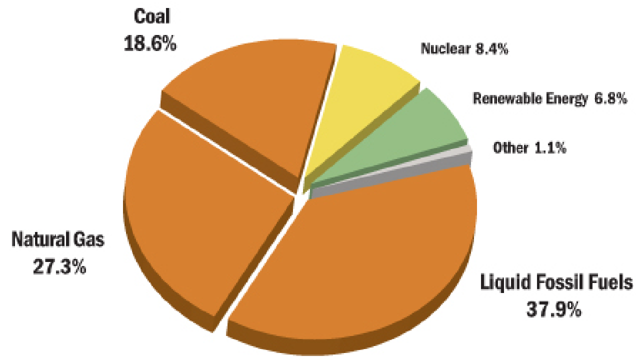
Data Source: U.S. Energy Information Administration (2012).



U.S. Energy Consumption by Fuel Type

Source: ©2013 2030, Inc. / Architecture 2030. All Rights Reserved.
Data Source: U.S. Energy Information Administration (2012).

The cost of energy derived from fossil fuels has gone up and down over the past 40 years. The average US household spends more than $2,200 a year on energy bills, with nearly half of this going to heating and cooling costs.

According to the U.S. Energy Information Administration, fossil fuels supply 75% of total Building Sector energy consumption. Additionally, the burning of fossil fuels was responsible for 79% of U.S. greenhouse gas emissions in 2010 as reported by the Environmental Protection Agency. These gases insulate the planet, and could lead to potentially catastrophic changes in the earth's climate.[3] Buildings are fitted with materials, products and systems from a network of raw materials that stretch around the globe. And the occupants of those spaces use energy and other resources in ways that are driven, at least in part, by the design of the space itself.

It is by now common knowledge that fossil fuels are finite resources, and that the extraction and use of these fuels has a negative effect on the environment. This has created the need to look for alternate options to sustain the energy use, practice more energy-efficient lifestyle, and look for alternative resources that can conserve and supply clean, renewable energy to replace fossil fuels, including water, biomass, wind, geothermal, and solar.

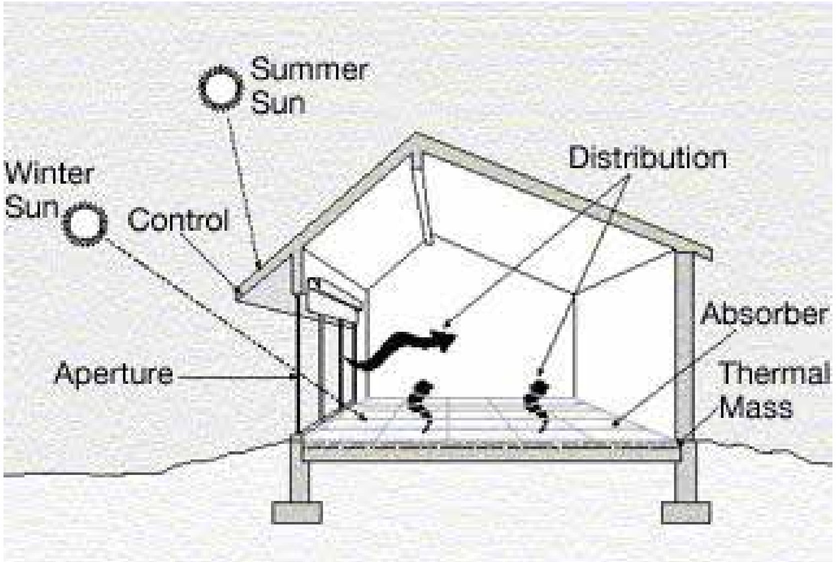
3. Solution

The design of the building and the method of specifying materials needed can respond to these trends in two ways: by conserving energy and by using natural forces whenever possible to provide light, heat, and cooling. Energy reduction targets can be achieved by 1) appropriate planning and passive design strategies, and 2) selection of more sustainable building materials, more efficient lighting, equipment, and appliances. Ideally, the resulting buildings contribute to sustainable environment and human health while minimizing harm from the construction and operation.

3.1. Energy efficient design

A growing number of building professionals construct and renovate houses and other buildings to be energy efficient, green, high performance, and even completely independent of fossil fuels (often referred to as zero net energy buildings or houses built to Passive House standards). The key elements of the Passive House-style homes are building location and orientation on the site; building layout; window design; insulation (including window insulation); thermal mass; shading; and ventilation. Each of these elements works with others to achieve comfortable temperatures and good indoor air quality.[4]

One of the main focuses to achieve these goals is to ensure the building receives the right amount of solar access – enough to provide warmth during cooler months but prevent overheating in summer without the need for a conventional heating system.[5]



Basic Passive Solar Design.

Source: www.greenspassivesolar.com

3.1.1. Control heat gain and loss

Lack of sun, poor solar orientation of living spaces, inadequate insulation, heat loss through air leakage, and lack of, or poorly placed thermal mass can each contribute or combine to make homes too cold in winter and too hot in summer.

All these factors can be properly managed by ensuring that correct materials and building techniques have been chosen that are appropriate for the specific area the home is located at. Using methods such as proper insulation, eliminating air leaks, and specifying energy efficient windows will all help to create a more comfortable living environment.

Many air leaks are easy to locate as it is simply easy to feel the cold draft entering the building from the old windows and doors. Leaks in attic, basements and crawlspaces are harder to find; sealing these leaks will deliver instant comfort, warmer temperatures, and reduced utility bills.

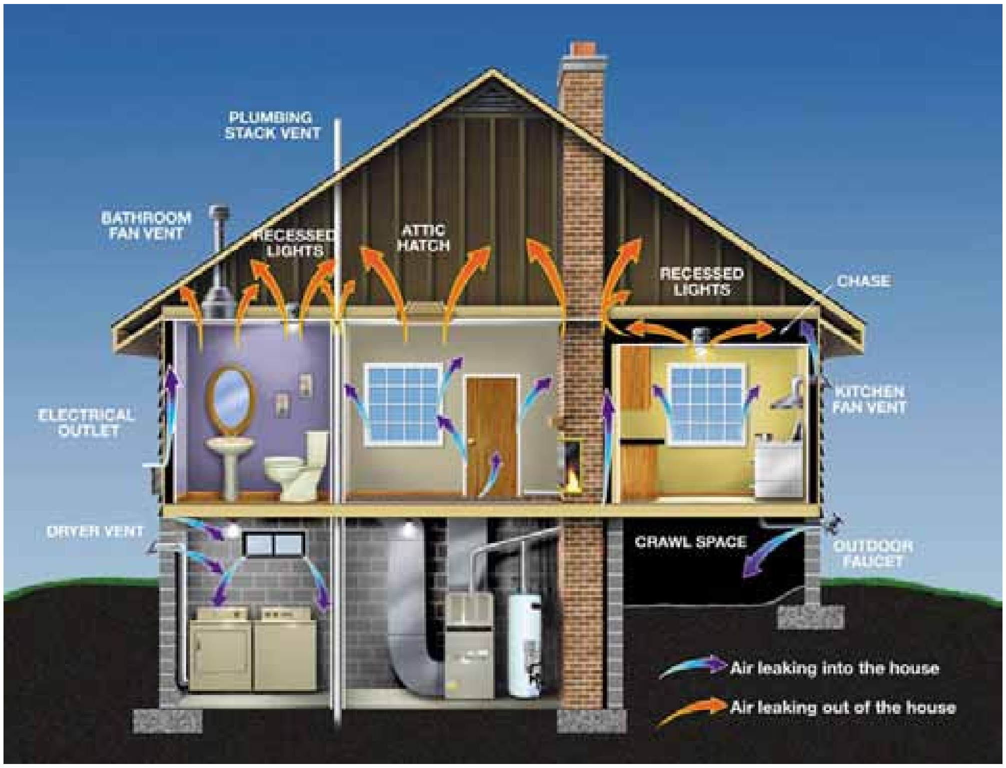


Image source: GEO Smart Homeowner Center[6]

3.1.1.1. Use of thermal mass barrier

Thermal mass is one of the vital and complimentary components of passive design. A material that has thermal mass is one that has the capacity to absorb, store and release the sun's heat energy. This is something many construction materials can do to a greater or lesser extent. Thermal mass is effective in improving building comfort in any place that experiences daily temperature fluctuations—both in winter as well as in summer. When used well and combined with passive solar design, thermal mass can play an important role in major reductions to energy use in active heating and cooling systems.

Materials with thermal mass are typically used in the floor or inside walls of a passive solar structure and located near the solar glazing (southern facing windows) to allow the sun's energy to shine directly on them. In this manner, they can store and release the sun's heat energy.[7] Buildings in climates with large day-night temperature swings, particularly high-elevation areas of Arizona, New Mexico and Colorado, benefit the most from the mass effect for heating and offer a great example of the delay effect of thermal mass. The buildings' walls absorb daytime heat, keeping the interior temperatures comfortable; during cold nights, the walls release the heat and keep the interior temperature warm.

3.1.1.2. Energy efficient windows

Windows account for more than a quarter of the annual space heating needs in a typical new home, so using the most energy efficient glazing is a key to conserving energy and realizing cost savings. In today's marketplace, builders, architects, and consumers have the option to choose between many different types of window products. A key determinant of a window's energy efficiency is its glazing. There are many factors to consider when choosing a glazing, including rising cooling loads, peak electric demands, and heat loss coefficients (U-value or u-factor). But one of the most important determinants of a window's energy efficiency is its Solar Heat Gain Coefficient (SHGC): the fraction of incident solar radiation that the window admits. The SHGC is a number between 0 and 1, with low solar gain products having an SHGC of less than 0.30 and high solar gain products an SHGC greater than 0.30.[8]

Traditionally, windows have been the weakest energy efficiency link in a building envelope, and early single-pane openings were the worst offenders. Single-glazed windows with clear glass allow "the highest transfer of energy (i.e., heat loss or heat gain depending on local climate conditions) while permitting the highest daylight transmission. Much better than single pane windows, insulated windows are better at preventing heat loss and heat gain, and keep the internal temperature of a house relatively stable. Depending on your region of the country, such a window—if it's Energy Star rated—features advanced technologies such as invisible glass coatings, vacuum-sealed spaces filled with inert gas between the panes, improved framing materials, better weather stripping, and warm edge spacers, all of which reduce undesirable heat gain and loss.

		
Example of a single glazed window Source: Rylock Australia	**Example of a triple-glazed window** Source: Intus Windows	**Example of a R-5 Series window** Source: Ply Gem Windows

In addition to the usual selection of energy efficient windows, homeowners can now select windows with dynamic glazing properties. These types of windows allow the occupant to control their environment by tinting (or darkening) a window with the flip of a switch or by raising and lowering a shade positioned between panes of glass. Some windows and doors can change their performance automatically in response to a control or environmental signal. These high-performance windows, sometimes referred to as "smart windows," provide a variety of benefits, including reduced energy costs due to controlled daylighting and unwanted heat gain or loss.

3.1.1.3. Exterior mounted shade systems / overhangs

Windows used for direct heat gain need protection against heat during times of the year when warmth is not needed: roof overhangs, blinds, shutters, awnings and/or exterior shading devices should be part of the design. It is important to avoid oversizing south-facing glass and make sure that south-facing glass is properly shaded to prevent overheating and increased cooling loads in the spring and fall.

Passive / sustainable design takes advantage of a building's site, climate, and materials to minimize energy use. A well-designed passive home first reduces heating and cooling loads through energy-efficiency strategies and then meets those reduced loads in whole or part with solar energy. According to the National Renewable Energy Laboratory, shading your home can decrease indoor temperatures by at least 20°F.[10] Shading may be accomplished naturally (shrubs, vines, and trees) or with built structures.

Retractable window screen, installed to deliver shade and control heat gain in the building.
Source: Phantom Screens

Some carefully selected window treatments can reduce heat loss in the winter and heat gain in the summer. Window treatments, however, aren't effective at reducing air leakage or infiltration. Inside controls such as blinds and drapes control light but don't keep out as much heat because it has already penetrated the glass. Awnings, external roller shades/retractable screens or roof overhangs mounted outside work better and have advantages that contribute to more sustainable buildings. The performance of the awnings, exterior roller shades/retractable screens are strongly related to the window conditions and orientation.

When looking at the impact of window screens, it needs to be pointed out that the results (heating and cooling energy use) depend on the type of window glazing and whether the screens are in place all twelve months or only during the cooling season. The energy savings and peak demand reductions provided by awnings, blinds and screens obviously depend on the building on which they're used, and how that building is operated.

For example, in Washington DC, window screens reduce cooling energy use by 21-29% as compared to the unshaded house. The higher savings are for the more dense shade screens over windows with clear glazings, while the lower savings are for less dense shade screens over window with Low-E glazings. Because permanent screens block useful solar gain in winter, heating energy use increases when the shade screens remain in place 12 months a year. Using retractable screens only during the cooling season produces the largest net energy savings.[11]

Exterior mounted retractable screens deliver the required shade, providing homeowners an option to either open the screened area to sunlight or pull them down when needed. By reflecting solar energy the screen fabrics can reduce solar heat gain, lower energy costs and improve comfort. The use of natural day lighting during the time the screens are not in use reduces the need for artificial lighting for additional energy savings.

Color, openness factor and exterior installation are the most important features to consider for energy savings and light management. Light color fabrics provide optimum heat reduction, reflecting light and illuminating the interior. Darker fabrics provide a superb view to the outside and absorb light to reduce glare, while also blocking heat.

Example: Impact of shade screens on a house in Washington DC with west-facing windows on a typical year.

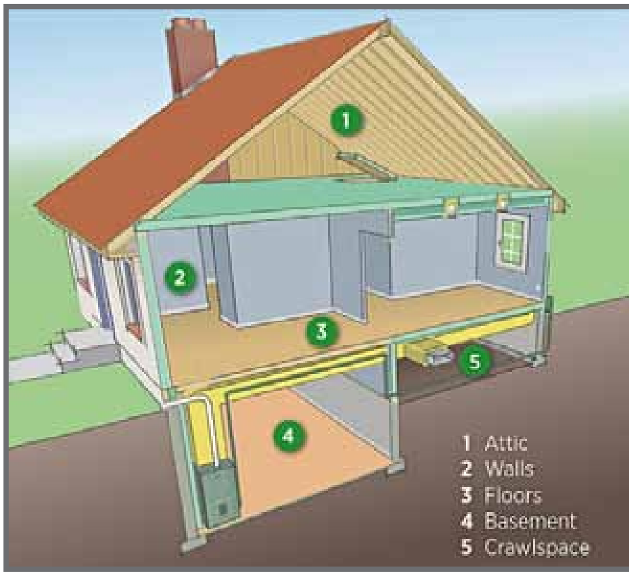
In this analysis, the building is an existing one-story house with a floor area of 1700 ft2, and 255 ft2 of windows, for a floor area to window ratio of 15%. *(Source: Phifer)*

Window Type	Shade Screen	Operation	Heating			Cooling			
			Energy (MBtu)	Savings (MBtu)	Energy ($)	Cool (kWh)	Savings (kWh)	Savings ($)	Savings %
Single Clear	Black, 5% openness factor, full basketweave	Summer	80.1	-0.2	-3	1766	604	81	25
Double HiSol LowE	Black, 5% openness factor, full basketweave	Summer	60.2	-0.1	-2	1497	462	62	24

3.1.1.3. Insulation

In addition to selecting proper shading options and energy efficient windows, homeowners need to also make a note of insulating their home to avoid high energy bills during the hottest and coldest times of the year. If the temperature in the house – especially in the upstairs rooms – remains stifling even when the shades are drawn and natural ventilation options are in place, it usually is an indication of insufficient insulation. The walls and the attic are exposed to external environmental conditions, and if they lack proper insulation, cool internal air will escape and hot external air will enter the building during summer and do the opposite during winter months.

Luckily, this is an issue that can easily be fixed. Just by adding insulation to the walls and attic, homeowners can lower the internal temperatures when the weather gets hot, and reduce the heating bills during the cold months of the year. In other words, insulation provides a protective barrier between the conditioned areas of the home and the outside environment. Insulation choices depend on the climate and how the home is constructed.[12]



The US Department of Energy insulation tips:

- Adding insulation in the areas shown here may be the best way to improve your home's energy efficiency.
- Consider factors such as climate, home design, and budget when selecting insulation.
- Insulation is made from a variety of materials, and it usually comes in four types: rolls and batts, loose-fill, rigid foam, and foam-in-place.
- Using higher R-value insulation, such as spray foam, on exterior walls and in cathedral ceilings to get more insulation with less thickness.

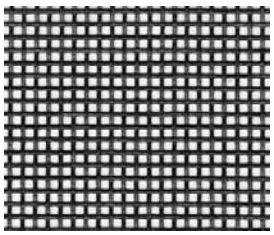
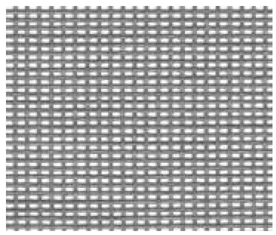
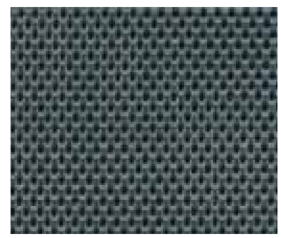
Image & tips source & more info:
www.energy.gov/energysaver/articles/tips-insulation

3.1.2. Control air flow

While insulation and thermal mass help to maintain even temperatures, ventilation provides passive cooling and improves indoor air quality. Passive cooling is the least expensive means of cooling a home in both financial and environmental terms.
Air movement is the most important element of passive cooling. It cools people by increasing evaporation and requires both breeze capture and fans for back-up in still conditions. In all climates, air movement is useful for cooling people, but it may be less effective during periods of high humidity.

The growing selection of building materials such as folding and lift & slide doors has created new options for homeowners to open their homes to the outdoors and make the most of the natural breeze and sunlight entering the building. It is important to consider the options for controlling the amount of air flow that is let into the building – depending on the season and the time of day, plus the location of the space, the homeowners need to have systems in place to manage these details properly in order to ensure the desired comfort levels.

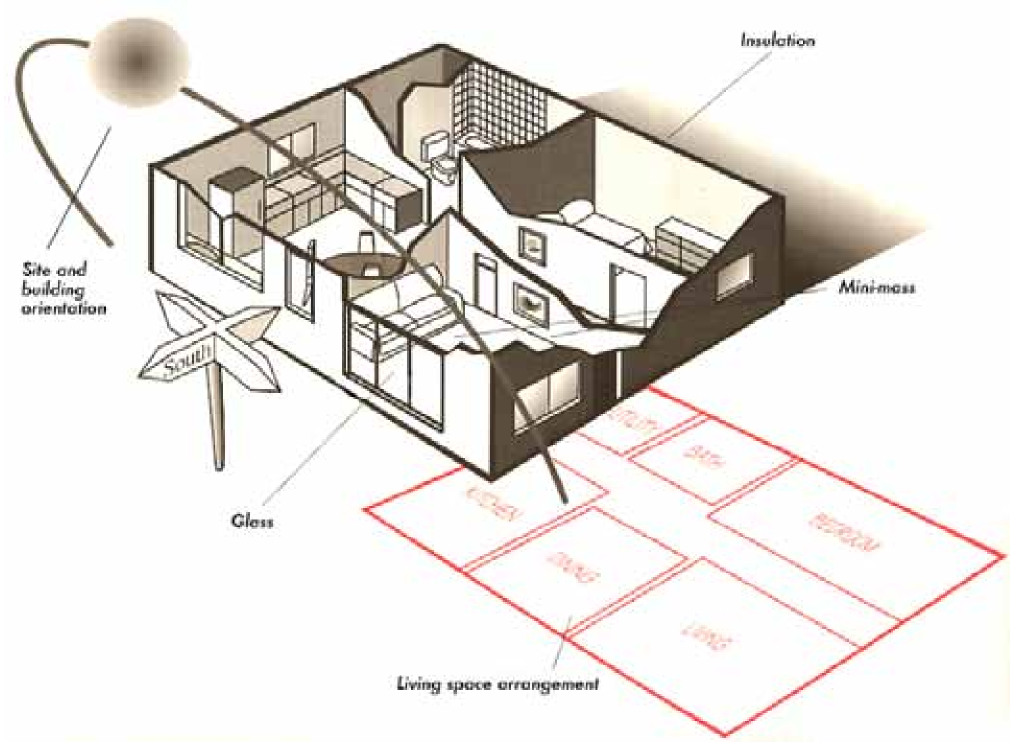
Additionally, retractable screens can be used to further control the air flow while blocking out the insects and a certain %age of UV rays and heat from the sun. The amount of protection/airflow provided depends on the openness factors of the chosen mesh:

		
Phifer 20/20 Insect Mesh - Charcoal Openness: 45% Sun/UV Protection: Up to 55% blockage	**Phifer 20/30 Solar Mesh -** Gray Openness: 32% Sun/UV Protection: Up to 65% blockage	**Phifer SheerWeave 2360 Privacy Mesh -** Charcoal/Gray Openness: 10% Sun/UV Protection: Up to 65% blockage

3.1.2.1. Site Orientation

Orientation, location and layout should be considered from the beginning of the design process – ideally, from the time the site is being selected. Site orientation of the building also plays a key role when creating natural air flow through the building in order to either heat it or cool it naturally. Where passive cooling is more of a priority than passive heating, the building should be oriented to take advantage of prevailing breezes. If optimal orientation can be achieved, it will reduce some of the heating requirement, energy costs and greenhouse gas emissions.[13]

It is therefore important to understand how the sun interacts with the building in high summer and the depths of winter. Housing in temperate regions can benefit from admitting the sun into the building interior. In those regions openings should be primarily orientated southwards. Kitchens are better facing east, living rooms to the south and west. Bedrooms are often better to the north to avoid light disturbance.[14]



Example of a site and building orientation of a sustainably designed home

Source: www.oikos.com

It may also be beneficial to add mass to the south facing walls of the passive solar homes in order to maintain even indoor temperatures. An easy option is to simply add two layers of drywall, or install clay tile on concrete board underlayment. Both techniques add thermal mass without changing the design of the home.[15]

3.1.2.2. Natural Ventilation

Natural ventilation as an alternative to mechanical ventilation has many benefits such as low running costs, no additional energy consumption, and low maintenance. Ventilation in buildings has three main purposes:

1. To maintain a minimum air quality
2. To remove heat
3. To provide perceptible air movement to enhance thermal comfort

Maximising the flow of cooling breezes through a home is an essential component of passive design. Unlike cool night air, these breezes tend to occur in the late afternoon or early evening when cooling requirements usually peak.

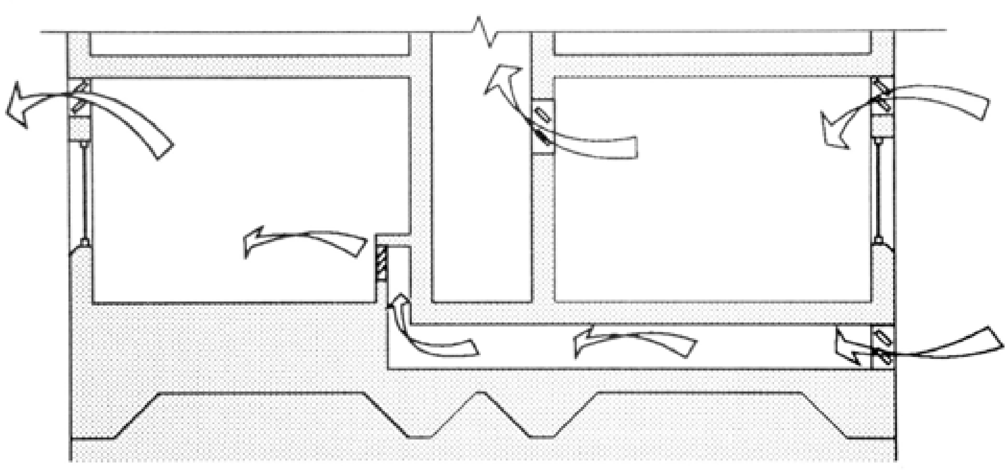
According to the Guide to Environmentally Sustainable Homes, published by Australian Government, cool breezes work best in narrow or open plan layouts and rely on air-pressure differentials caused by wind or breezes.

They are less effective in:

- buildings with deep floor plans or individual small rooms
- long periods of high external temperature (ambient or conducted heat gains above 35–40 watts per square meter (W/m^2)
- locations with high noise, security risk or poor external air quality, where windows may need to be closed.[15]

Wind-induced ventilation uses pressures generated on the building by the wind, to drive air through openings in the building. It is most commonly realised as cross-ventilation, where air enters on one side of the building, and leaves on the opposite side, but can also drive single sided ventilation, and vertical ventilation flows.[17]

The effectiveness of cross ventilation is usually determined by the design of the ventilated space. For example, cross-ventilation is usually not applicable to floor plans greater than 5 times the floor-ceiling height. Also, when ventilating a larger space such as double (or more) banked rooms, a bypass route is needed to deliver proper level cross-ventilation.[18]



Example of cross-ventilation with double (or more) banked rooms: duct supply delivers fresh air, pressurizing the corridor with fresh air, and allows independent control to the occupant of the leeward room.

Source: www.architecture.com

The use of conventional cross ventilation and night purge ventilation are just some of the ventilation options included in energy efficient design. Night purge ventilation keeps windows and other passive ventilation openings closed during the day, but open at night to flush warm air out of the building and cool thermal mass for the next day. 19 Homeowners planning to use that method of ventilation may also want to consider incorporating retractable screens on the windows in order to let in the breeze while keeping out the unwanted insects, thereby ensuring the optimum comfort levels.

4. Case Studies

Retractable motorized screens deliver energy efficient solution to reduce glare and heat build-up in residential and commercial buildings

4.1. The New American Home 2014

The New American Home (TNAH) is constructed annually as a centerpiece for the National Association of Home Builders (NAHB) International Builders' Show. As NAHB's official show home, The New American Home gives building industry professionals an opportunity to see design trends, construction techniques, and materials that can be used in any new or remodeled home.

Having met Emerald status under the National Green Building Standard, the 2014 New American Home is the greenest show home in the National Association of Home Builders' history. In order to achieve this designation, the architect Nate Berkus oriented the building to maximize natural light and solar energy while minimizing solar heat gain. Additionally, both Nate Berkus and the builder Josh Anderson of Element Building Company specified sustainable building materials and products to deliver a truly energy efficient and comfortable home. For example, the home's solar electric array helps to offset 83 % of the home's annual energy load. In addition, sprayed open- and closed-cell insulation plus high-efficiency windows keep the building envelope tight.[20]

An expansive outdoor living area with a large patio featuring an outdoor kitchen and a pool is one of the key areas of the home. It was necessary to find a way to merge the interior and exterior spaces in order to allow occupants to enjoy the outdoors without having to suffer from the sun's heat and glare. As Las Vegas is located in the middle of the desert, summertime average temperatures soar as high as 40.1°C/ 106° F, therefore it was important for the design team to select a product that would deliver protection from both the UV rays and the heat. They selected Phantom's retractable screens with a solar Mermet E-Screen 7510 mesh in charcoal finish which features a sun control factor of 90% and openness of 10%. The screens help significantly reduce the exposure to UV rays and block hot air from entering the home, plus control the temperature of the area where the screens are used. By recessing the components, the ten screens remain completely out of sight when not needed, uniting the indoor and outdoor spaces in a creative way. Powered by Somfy®, Phantom's motorized screens are fully integrated into the home's automation system, making it easy to program the screens to operate automatically whenever needed.

Phantom's motorized retractable screens make it possible for TNAH homeowners to expand their living space and make the most of their outdoor areas throughout the year.

Phantom's motorized screens create a seamless transition to outdoors while delivering shade and protection from the sun and the heat at the touch of the button.

4.2. Saanich Recreation Center

Gordon Head Recreation Center is located in Saanich, B.C., Canada. Featuring four pools, 3000 sq. ft. fitness centre, and 1400 sq. ft. dance/fitness studio, this recreation centre offers a wide variety of activities for all ages. The west-facing wall of windows allowed excess sun into the pool area of the building during sunny afternoons, resulting in an uncomfortable build-up of heat and glare in the interior.

Motorized retractable Executive screens by Phantom Screens were installed on the building's exterior to cover six of the eight windows on the west side of the building. The selected mesh – beige SheerWeave 2360 - delivers 90% sun & UV blockage, and offers 10% openness. The client decided to use a completely automated system with a sun and wind sensor that monitors the brightness level and deploys the screens prior to the sun hitting the west side walls. The sensor also retracts the screens in excessive winds. Installing motorized retractable screens on the exterior and using lighter colored fabric enhances the heat reflection away from the window surfaces. Additionally, the screens also lessen the amount of glare on the surface of the water. The result was better thermal comfort and improved safety for the occupants and the staff of the recreation center.

"There is a noticeable difference with the temperature on the deck. I just had the sun sensor / wind sensor installed and found this is making an even bigger difference. Something that we weren't expecting is in the evening when the sun is setting the life guards were having great difficulty seeing across the deck because of the glare off the water. The screens have made a huge difference. This has greatly increased the safety of the patrons."

John McKain
Building Service Worker II Supervisor, Gordon Head Rec. Center
District of Saanich, Victoria, BC

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