Chapter 10

Energy Efficient Roofing

Roofing is often ignored as an energy efficient component of a house, but it has a profound effect on the other systems, especially air conditioning. An efficient total roof system can lower the energy required for cooling a Louisiana home by 30 percent or more. Subdivision covenants may preclude making a good roofing choice and should be checked before planning a new home or buying an existing home if energy bills are important to you.

Dark asphalt shingles have been used for years due to mildew problems associated with our warm, moist climate. These are the worst choice from an energy efficiency perspective. There are new products on the market that are better and are less prone to this problem. There are some Energy Star roofing shingles currently available, with more to come. There are metal roofs that reflect much of the sun's energy, cool off quickly, and can save energy available today, many of which do not look like metal. No matter the style selected, it is important to consider energy costs when selecting a roof system.

The Roof Structure (A Good Foundation!)

To some, anything above the walls is the "roof". To clarify, there is a roof structure which includes rafters or trusses and above that, the roof deck which is a structural diaphragm resisting live loads and shear forces from wind loads on it and the walls. There are several types of roof decks which are of interest here. The common roof deck in residential construction is 7/16" Oriented Strand Board (OSB). This is a popular option because it is less expensive than plywood. The span between rafters of the roof deck and its load determines the required thickness. The typical truss or rafter spacing is 24" on center. A nominal ½" thickness of the roof deck may be fine for most light loads like composition shingles, but may deflect, or sag, between supports with a 24" span under heavier roof loads. For even larger spans, such as spaced beams (as opposed to rafters), a thicker tongue and groove deck should be considered. This could be 1 ¼" or thicker tongue and groove plywood, or tongue and groove deck boards with thickness dependant on the span. The Latin phrase "caveat emptor" (let the buyer beware) certainly applies to choosing roofing and roofing contractors.

There are numerous roofing products on the market. We will briefly examine several basic types and address the advantages and disadvantages of each. Many roof types will "choose themselves" based on the desire for increased energy efficiency, the character of the structure, style of architecture, the slope of the roof deck, the annual rainfall, the high/low seasonal temperatures, the cost, or the presence of deciduous trees nearby. These trees loose their leaves in winter so they are apt to clog up gutters and downspouts, but are helpful for preventing the low summer sun from penetrating windows, and good when bare in winter for letting light/heat into windows.

Non-Vented Attics Affect Shingle Life

Shingles over unvented attics are kept at a slightly higher temperature (2 or 3 degrees), which will shorten their life. The effect is equivalent to a 10 degree higher ambient temperature or the

installation of radiant barrier. More significant is that this effect is less than the color of the shingles or the roof orientation.[1]

SIPS

Another type of roof deck performs both as structure and insulation. It is about 6 or more inches thick, and can span long distances, or clear the span between eave and ridge. The material is referred to as the Structural Insulated Panel (SIP). It can easily provide R-20 to R-30 insulation with its foam core. This is an excellent deck when one chooses to use a non-vented attic. There are a number of energy efficiency and economic reasons one should examine this alternative. One benefit is being able to place ducts and HVAC equipment in semi-conditioned space. With this construction, the common insulated ceiling joist space is not necessary or desirable. Even without the use of SIPs, the non-vented attic concept can be accomplished by spraying insulating foam on the roof deck and rafters. See www.buildingscience.com for more information on non-vented attics in hot, humid climates.

The underlayment between the top of the roof deck and the roofing above is often asphalt saturated organic (or fiberglass) felt. There are also more expensive and possibly far better materials. These underlayments are a peel and stick type which is water proof. The actual roofing material, as discussed below, is the waterproof (water-resistant) exposed surface on the topmost layer of the sandwich of components.

Energy Efficient Roof Study

The Florida Solar Energy Center, with the sponsorship of Florida Power and Light and the Metal Roofing Alliance performed a study[2] of the heat gains in houses with different metal roofing materials. The experiment monitored indoor cooling energy use for seven side-by-side homes in Ft. Myers during the summer of 2000. Each home was virtually identical except for roofing material (one had a non vented attic and roof deck insulation). Seven identical, side-by-side, newly constructed Habitat for Humanity homes were built using various roofing materials: dark gray shingles, white shingles, white flat tile, white S-shaped tile, terra cotta S-shaped "Spanish" tile, and white metal. The seventh had an unvented attic with insulation under the deck and standard dark gray shingles. The homes were operated identically to ensure study accuracy. Temperature controls on the air conditioning thermostats of all the houses were set at a constant 77º F. Both occupied and unoccupied homes were studied.

The study showed that white S-tile produced the lowest attic heat gain. However, the home with the white metal roof posted the lowest overall cooling cost. Compared to a dark gray shingle roof, the study reported, "a white, galvanized metal roof should save a customer who lives in an average-sized 1,770 square foot home approximately $128 or 23 percent annually in cooling costs." Flat white tile offered a savings of 17 percent. Terra cotta roofing, the most popular roofing material in Florida, netted a modest $15 or 3 percent savings over dark shingle.

The study found that energy savings are most strongly influenced by the solar reflectance of roof materials. The study proves dark gray roofs reflect a mere eight percent of the heat associated with sunlight, while white shingle and terra cotta tile roofs reflect 25 and 34 percent, respectively. White metal and cement tile roofs provide the most dramatic results, reflecting 66 to 77 percent of the sun's energy. The following two tables concisely illustrate the results of this energy savings comparison:

[1] Joseph Lstiburek, pages 18-19; “Understanding Attic Ventilation”, Building Science Digest 102, October 2006

Table 10-1
Cooling Performance During Unoccupied Period July 8-31, 2000 [2]

Roof Description	Total kWh	Savings kWh	Saved Percent	Demand kW	Savings kW	Saved Percent
Standard dark shingles (control home)	17.03	0.00	0.0%	1.63	0.00	----
Above with sealed attic, R-19 roof deck insulation	14.73	2.30	13.5%	1.63	0.01	0.30%
Terra cotta S_tile roof	16.02	1.01	5.9%	1.57	0.06	3.70%
White shingles	15.29	1.74	10.2%	1.44	0.19	11.80%
White "Barrel" S_tile roof	13.32	3.71	21.8%	1.07	0.56	34.20%
White flat tile roof	13.20	3.83	22.5%	1.02	0.61	37.50%
White metal roof	12.03	5.00	29.4%	0.98	0.65	39.70%

Table 10-2 makes corrections for the variations in equipment performance and is scaled up to the average size Florida home of 1770 sq. ft. This is a better estimate of savings possible with a more reflective roof material.

Table 10-2
Normalized Annual Savings & Demand Reductions from Regression Estimates [1]

Roof Description	Cooling Savings		Peak Demand Reduction	
	kWh	Percent	kW	Percent
Standard dark shingle (control)	0	0%	0	0%
Sealed Attic	620	9%	0.13	5%
Terra Cotta S Tile	180	3%	0.36	13%
White Shingles	300	4%	0.48	17%
White "Barrel" S-Tile	1,380	20%	0.92	32%
White Flat Tile	1,200	17%	0.98	34%
White Metal	1,610	23%	0.79	28%

Cool Roof Color Pigments

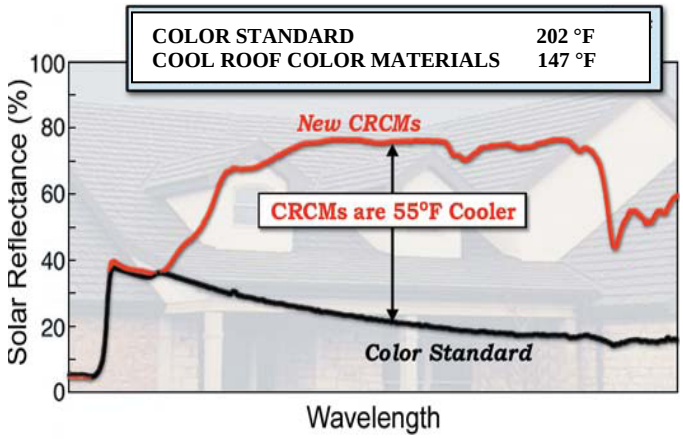
The California Energy Commission (CEC) has Oak Ridge National Laboratory (ORNL) and Lawrence Berkeley National Laboratory (LBNL) working collaboratively on a 3-year, $2 million project with the roofing industry to develop and produce the new reflective, colored roofing products. Cool Roof Color Materials (CRCMs), made of complex inorganic color pigments, reduce the energy needed to cool buildings, and reduce hot-weather strain on electrical grids by reducing summer peak loads.

[2] Source: Parker, D.S., J.K. Sonne, J.R. Sherwin, and N. Moyer, November 2000. "Comparative Evaluation of the Impact of Roofing Systems on Residential Cooling Energy Demand." Contract Report FSEC-CR-1220-00, Florida Solar Energy Center, Cocoa, FL.

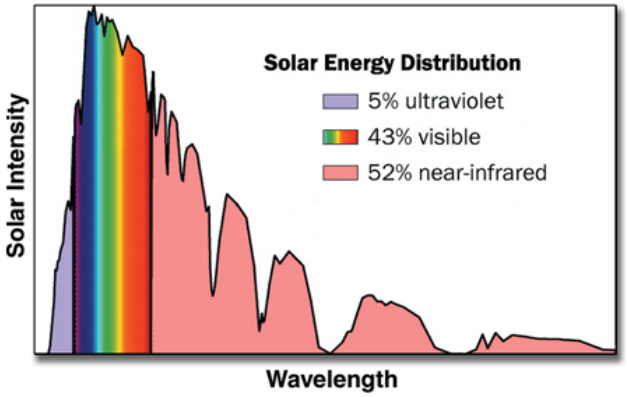
The key to the energy savings is the coating's ability to maintain a high reflectance and a high emissivity. The CRCMs compare favorably to the "white" metal roofing in the tables above. A roof covered with this special coated granular surface absorbs less solar energy and can reduce air conditioning costs by 20%. This in turn could lead to national energy savings of about 0.5 to 2 quads per year by 2010.

For tile, painted metal and wood shakes, the goal is products with over 45% reflectance. For residential shingles, the goal is a solar reflectance of at least 35% to 40%. The new CRCMs contain mixtures of chromic oxide and ferric oxide. The materials look dark in color yet reflect most of the sun's energy. How can dark roofs reflect as much energy as white roofs, or even more? The trick is in the eye of the beholder. Solar radiation consists of ultraviolet, visible, and infrared (IR) energy, but our eyes see only the visible portion. White roofs reflect most of the visible light spectrum, which mixes together to look white to our eyes, while dark roofs absorb most of the visible light, looking dark. Most solar energy, however, is in the IR region, which is not visible. CRCM roofs reflect more than 60% of the IR solar energy that strikes them.[3]

Figure 10-1
Color Standard Cool Roof Color Materials



Comparative heat buildup and solar reflectance in cool roof color materials and standard roofing materials.



Distribution of solar energy in the ultraviolet, visible, and near-infrared wavelengths.

What is Emissivity?

The emittance of a material refers to its ability to release absorbed heat. Scientists use a number between 0 and 1, or 0% and 100%, to express emittance. With the exception of a shiny metallic surface, most roofing materials can have emittance values above 0.85 (85%). One example is a chrome plated wrench left in the sun, which is hot to the touch because it has a low emissivity value.

Link Between Energy Savings and Emissivity[3]

Emissivity-Radiation is a continuous process not related to time of day. Items heat up because they are absorbing more heat than they are radiating. The hotter they get the more they radiate heat. High emissivity is important when the sun is shining on a roof. If a 'black body' has a reflectivity of '0' and an emissivity of '1' it will not heat above the ambient temperature.

[3] Cool Colors Project: Improved Materials for Cooler Roofs, Oak Ridge National Laboratory (ORNL) and Lawrence Berkeley National Laboratory (LBNL). Accessed Dec. 12, 2008 from http://eetdnews.lbl.gov/nl19/cool.htm

Solar reflectance is the most important characteristic of a roof product in terms of yielding the highest energy savings during warmer months. The higher the solar reflective value, the more efficient the product is in reflecting sunlight and heat away from the building and reducing roof temperature. This is particularly important in warm areas where peak load is a concern.

In warm and sunny climates, highly emissive roof products can help reduce the cooling load on the building by releasing the remaining heat absorbed from the sun. On the other hand, there is also evidence that low emissivity may benefit those buildings located in colder climates by retaining heat and reducing the heating load. Research on the benefits of emissivity is ongoing. Discuss reflectance and emissivity with the roofing supplier or contractor to determine what characteristics matter most given the unique local situation.

ENERGY STAR Requirements

ENERGY STAR qualified roof products must meet minimum initial and aged solar reflectance values. Emissivity is not currently a requirement for ENERGY STAR qualification. However, EPA began posting emissivity values for all products on the ENERGY STAR Qualified Products List on December 31, 2007 to assist consumers in their purchasing decision. Longer term, EPA plans to revisit the possibility of adding an emissivity component to the ENERGY STAR specification.

Materials

Climate and techniques of installation are two factors which will lead to success or failure of our roofing choices. Please be sure to consider them. Shingles which may often fail in our climate have been identified the hard way. For example, split-cedar wood “shakes” which look great and may work well in Oklahoma or New England fail prematurely in Louisiana.

Roof Slopes

The manufacturer of shingles usually specifies a minimum slope for which they will warrant their product. For composition shingles (asphalt composition) and fiberglass composition shingles, that minimum slope is usually 3:12. Some will warrant this low slope if two layers of asphalt saturated felt (so called “tar paper”) are used as underlayment. It is a good idea in Louisiana to get the water off the roof quickly. Increased slope of the roof minimizes the wind being able to blow water under shingles or particularly under flashing. For slopes 3:12 or less one should consider one of the types of metal roofs such as standing seam, or lock seam. When the slope is even less like 1/2:12 or 1/4:12, a membrane type roof is a better choice. The membrane roof, often referred to as a “low slope roof,” is available in PVC, EDPM, Modified Bitumen, or asphaltic built up roof (BUR) (see below).

Composition Shingles (also called asphalt shingles)

Composition shingles are either organic-based or fiberglass-based. Fiberglass shingles are more flexible and durable than organic. Fiberglass composition shingles are made of tiny glass fibers of varying lengths and then covered with a layer of asphalt and weather-resistant mineral granules. In 2009 Energy Star certifies several brands of shingle roofs in white and 4 colors.

- Strip Shingles – These are made to be three times as long as they are wide. These are distinguished by the number of tabs they have. The most common type of strip shingle is the "three-tab" shingle. Different textural and lighting/shadowing effects can be achieved with strip shingles depending on the number, shape and alignment of the cutouts.

- Laminated Shingles - These special shingles contain more than one layer of tabs to create extra thickness. They are also referred to as three-dimensional or architectural shingles because they create visual depth on a roof and impart a custom look. Laminated shingles are a favorite among builders, roofing contractors and homebuyers. They weigh about 350 pounds per square, or about 3.5 pounds per square foot.
- Interlocking Shingles - As the name suggests, interlocking asphalt shingles are individual shingles that mechanically fasten to each other, and are used to provide greater wind resistance. They come in various shapes and sizes providing a wide range of design possibilities. These shingles are not available everywhere, but they are specially shaped to "hook" on to the course below to provide uplift resistance.

Figure 10-2
Laminated Shingles

Clay Tiles

This ancient material is split from clay and formed into special interlocking thin sheets of ceramic. Then cut to length and width, and finally drilled for nail penetrations. They are an outstanding example of thermal mass which gathers heat from the sun and reradiates it at night into the space.

Slate Tile Shingles

Traditionally slate roofing tiles were cut and sized by hand, but now manufacturers pre-cut the slate roofing tile with a machine to assure exact measurements. Nail holes are also pre-drilled and countersunk to speed construction and repair. Countersunk holes allow the roof tile to lie flat for longest possible lifetime. A stronger roof structure is needed to withstand the weight of slate roofing material; therefore many manufacturers require an architect's recommendation on each property prior to installation of natural slate roofs. There are other alternatives to natural slate which are considered below.

Figure 10-3
Natural Slate Tiles

Concrete Tile Shingles

Concrete tiles are very wind-resistant, long-lasting, energy efficient and fire-resistant. They can be cast and dyed to look like slate or clay tile. Their weight does require a stronger roof deck and structure. The vented voids of the "S" tile cool the space above the roof deck through natural ventilation at the eave. The heat buildup is removed at the ridge before it can move into the attic.

Both Concrete tile types absorb condensation at night and cool by evaporation until dry during the morning.

Figure 10-4
Concrete Tiles

Concrete "S" Tile

Concrete Flat "slate" Tile

Rubber Shingles

These shingles are made from recycled automobile tires and can simulate the look of slate or wood shakes with relatively low weight. They are also hail resistant.

Figure 10-5
Rubber Shingles

Metal Roofing

EPA's Energy Star certifies many metal roofing products. According to Energy Star data, coated metal roofs generally have many advantages:

- Energy Star-rated, coated metal roofs have a high reflectance and a high emissivity. The former helps reflect infrared energy back to the sky before it can penetrate the structure, and the latter helps rapidly cool the metal by releasing absorbed energy to the night sky.
- Metal roofing is long lasting: 30 years or more with minimal maintenance.
- Metal roofing is environmentally friendly and is 100% recyclable.
- The recycled content is between 25% and 80%, depending on the steel or aluminum making process.
- A lightweight metal roof can be installed over an existing roof saving removal and landfill costs.
- Metal roofing readily adapts to photovoltaic installations.
- Metal roofing can reduce energy consumption and with cool roof coating properties it can reduce heat transfer through the roof.
- Several methods of insulating are available, to nearly any R factor.
- Forms can vary from shingles, "tiles," corrugated sheets, or a variety of standing seams.

- Materials are copper (expensive), coated or uncoated aluminum, galvanized (zinc-coated) steel, aluminized steel and galvalume (55% zinc, 45% aluminum alloy-coated steel).
- The better coatings have a twenty to fifty year warranty. Kynar 500 and Hylar 5000 are trade names for two of these fluropolymer coatings.

Table 10-3
Characteristics of Various Metal Roof Types Ranked by Reflectance [4]

Company	Brand	Model	Initial Solar Reflectance	Initial Emissivity	Low Slope?	Steep Slope?	Warranty (Years)
Metals USA Building Products	Allmet	Autumn Gold	0.93	0.94	N	Y	Ltd. Lifetime
Millennium Metals Inc.	CERAM-A-STAR	Polar White	0.85	0.88	Y	Y	40
Kirby Building Systems Inc.	Kirby-Cool	815W49	0.77	0.85	Y	Y	35
Petersen Aluminum, Corp.	PAC-CLAD	Bone White 431X471	0.73	0.85	Y	Y	20
Metal Sales Mfg. Corporation	PVDF	Linen White	0.73	0.86	Y	Y	45
Firestone Bldg.Products	Bone White SR (Steel)	UC-11,UR,VR,600,601,700,5VC,NB1,NB2	0.72	0.84	N	Y	20
Metal Sales Mfg. Corporation	PVDF	Sierra White	0.72	0.85	Y	Y	45
Central States Mfg., Inc.	CentralGuard	SPW 0295X	0.71	0.85	Y	Y	40
ATAS International, Inc.	ATAS Bone White, ATAS #26	PC Panel Standing Seam, and Castletop Shingle HCT	0.70	0.87	Y	Y	30
Drexel Metal Corporation	Regal White	DMC 100NS	0.70	0.87	N	Y	35
Merchant and Evans, Inc.	Zip Rib	Standing Seam Regal White SR	0.70	0.85	Y	Y	30
Interlock Roofing Ltd.	Alunar	Bone White #40	0.69	0.87	N	Y	40
Fabral	Architectural Profiles	Regal White V38	0.68	0.89	N	Y	20
McElroy Metal, Inc.	Regal White	Medallion-Lok, Medallion I & II, Maxima, ML-90, Mirage, Meridian	0.68	0.86	Y	Y	40
Alliance Steel, Inc.	ASI	Exposed Fastener Roof Profiles	0.68	0.84	Y	Y	20
Butler Mfg. Company	Butler	MR-24	0.68	0.86	Y	Y	20
Corrugated Ind. of FL, Inc.	Galvalume Plus	Galvalume Plus	0.68	0.86	Y	Y	25
Custom Metal Bldg. Products	Galvalume Plus	Galvalume Plus	0.68	0.87	Y	Y	25
Classic Metal Roofing System	Great American Shake	4001 White	0.68	0.85	N	Y	40
LifeTite Metal Products LLC	Lifetite Metal Products	Polar White	0.67	0.87	Y	Y	40
McElroy Metal, Inc.	Ivory	Max-Rib, Multi-Rib, R-Panel, Mega-Rib, Corrugated, U Panel	0.67	0.87	Y	Y	40

[4] Source: Extracted from www.energystar.gov – metal roof characteristics out of 1200+ products

Low Slope Roofs

For low slope roofs (so-called "flat roofs") the roofing manufacturer will not usually warrant the roof membrane unless the roof deck has a minimum slope of ¼" per foot of run. This is to minimize ponding of water which may cause deterioration of the membrane. For this type of roof, a membrane system is applicable. From an energy conservation standpoint, the membrane is almost always applied over insulation which may be flat on a sloped roof deck, or may be tapered to provide the required slope on a flat roof deck. By including the insulation over the roof deck energy conservation performance is far more effective than if the insulation were placed between the roof joists below the roof deck. The former insulation is continuous and the latter is cavity. Continuous insulation has a uniform R-factor everywhere, whereas cavity insulation R value is a mix of the area weighted average of the R-factor of the joist (low R-factor) and the R-factor of the insulation, which is interrupted at each joist.

Membrane roofs fall into the following categories: Built-up roofs (BUR); single- or multi-ply roofs, which often may have a base sheet and a cap sheet (so may be considered 2 or 3 ply roofs). The generic classes of membrane types are asphalt hot-mopped over organic or fiberglass felt, which is unrolled from rolls during the installation. They overlap at the edges and are installed in multiple layers. One of the best membrane roofs was the coal tar pitch built-up roof. Installation was very labor intensive and it was self-healing in hot weather. These roofs often lasted for 50 plus years without problems or failures. Unfortunately, today's economy doesn't tolerate labor intensive work because of the cost. A further blow to this type of roof was that the coal tar pitch was determined to be a carcinogen. Thus, these gravel topped roofs have largely been replaced by the "single" ply roofs. These roofs are made from PVC, or EDPM (rubber), or modified bitumen which is either hot mopped or torched applied. Each has different properties which make it appropriate for a particular application.

Modified Bitumen Roofing

APP (Atactic Polypropylene): Prior problems with coal tar pitch roofs were caused when they became inflexible in cold weather, causing them to crack and fissure. The modified bitumen roofs today are chemically designed to eliminate this to a large degree. There are several varieties of an APP-modified bitumen sheet, which incorporate the features of a tough, non-woven, polyester mat saturated and coated with a blend of APP polymer and high quality asphalt. Low temperature flexibility is maintained to 14°F (-10°C). The APP is a waste product from the manufacture of polypropylene and found a productive recycled use in this type of roof.

SBS (Styrene-Butadiene-Styrene): Even more resilient is another type of modified bitumen sheet incorporating the features of a strong fiber glass mat with a blend of SBS rubber, high-quality asphalt and fire-retardant additives. The elastomeric asphalt blend has full recovery properties after 100% elongation and provides elasticity and flexibility to the sheet. Low temperature flexibility is maintained to -10°F (-23°C).

Rubber Membrane

EPDM (Ethylene Propylene Diene Monomer) Rubber: EPDM is a flexible, black roofing membrane available in .045 inch, .060 inch, and .090 inch thicknesses. Due to its superior flexibility and strength, EPDM can easily contour to unusual roof shapes. A white-coated EPDM has been installed on RV's since 1983. Advantages are low maintenance, ease of repair, clean appearance, noise reduction, and thermal insulation. Now the energy efficiency of white on black EPDM is available

for all sorts of roofs. It is sold in sheets up to 50' wide and 100' long. It can be seamed for wider applications. It is typically held down by mechanical fasteners or ballasted with gravel.

Hypalon® (chlorosulfonated polyethylene): Made in Louisiana by DuPont, this material has demonstrated long life in harsh environments since 1957. It is thermoplastic enabling welding by hot air or solvents. Once installed the Hypalon® polymer slowly cures in place to reach its final mechanical properties.

TPO (Thermoplastic polyolefin): TPO is a generic group of chemicals. White and some colored TPO roofing membranes meet Energy Star Roof Requirements.

PVC (polyvinylchloride): This membrane material is often bright white and is highly reflective, making it a very energy efficient roofing choice. It is most often adhered as a single-ply membrane to the roof deck or insulation, or mechanically fastened. Joints are glued at the head and side lap. The material can be heat welded.

Table 10-4
Cool Roof Rating Council Top Rated Membrane Products Typical Properties [5]

(CRRC)	Reflectance		Emissivity	
Material	**Initial**	**Weathered**	**Initial**	**Weathered**
PVC	0.87	0.61	0.95	0.86
Hypalon	0.85	0.69	0.87	0.82
Modified Bitumen	0.79	0.68	0.87	0.75
TPO	0.79	0.70	0.90	0.86
EPDM	0.76	0.64	0.90	0.87

Attic Ventilation

What is the purpose of attic ventilation? Attic ventilation has been traditional in residential (wood frame) construction. If water enters the attic due to roof leaks, condensation, spills, or other means, it must have a way to dry out or the structure will suffer damage. The air introduced by soffit vents and expelled through ridge, gravity or turbine vents allow air to circulate through the attic. This assists in keeping the attic air circulating, able to remove moisture from the attic. Another primary reason for this ventilation in the South has been to help reduce the very high attic temperature which builds up in the summer. Actually, this benefit turns to a detriment in winter. With a cold attic gaining heat from the house, attic air circulation accelerates the heat lost from the living space. This is actually efficient in summer, and inefficient in winter.

One of the best arguments for insulating and sealing an attic space is the large reduction in attic temperature. Now that the roof rafters are insulated, the attic temperature buildup is slowed down. Due to less heat from the attic flowing into the conditioned house, the house and the sealed attic are both cooler than the house with the ventilated attic in summer. The sealed attic is also far warmer in winter as the heat flow reverses from house to attic. Why is this so beneficial? In today's typical house, the ducts, if not the entire HVAC (heating ventilating and air conditioning) system, are located in the attic. The homeowner first pays to cool air from the living space, and then send it

[5] Source: http://www.coolroofs.org/products/search.php accessed 5 Nov. 2008

through (nominally R-6) insulated attic ductwork across the attic where it may be as hot as 130°-150°F. The heat, which has been removed from the air, is regained through the duct material on the air's journey through the attic ducts. The fan propels the air through the coil, plenum and air ducts in the attic continuously, where the attic heats it prior to reaching the living space. This is far from efficient.

In a sealed attic, the insulation is placed between or above the sloped rafters, rather than between the horizontal ceiling joists (attic floor joists). This retards heat from the sun in penetrating the house envelope at the roof. The attic volume becomes semi-conditioned space. Semi-conditioned space is adjacent to conditioned space, but has no (or less than optimal) supply air registers present. Much like a closet within the envelope, the attic is not directly air conditioned, but loses or gains heat from adjacent conditioned spaces which moderate the temperature within. Compared to a ventilated attic which may be as hot as 140°F in summer, the sealed semi-conditioned attic space may be more like 75-85°F in summer. The supply air duct heat gain from the attic is reduced. Without insulation on the floor of the attic, heat flows from the semi-conditioned attic to the conditioned space where the slightly warmer air is mixed with cooled air. In winter, heat easily flows up into the semi-conditioned attic, keeping it warmer and thereby protecting any pipes that are located there. In winter, heat loss through the roof to the exterior is retarded by the roof deck insulation.

Another large energy saving from an insulated attic is related to air conditioning. A supply leak in the ductwork in a ventilated attic can waste large amounts of cooled air. Not only is this expensive, but when the cool air from the supply duct hits the very hot attic air, we introduce a water problem into the attic through condensation increasing the potential for mold and mildew growth from the water in a wood structure. This can be a big efficiency and maintenance problem.

If, on the other hand, there is a return air duct leak from the attic, hot air is sucked into the coil, and into supply air stream. If the attic were insulated, sealed, and at the far lower (semi-conditioned) temperature, a supply duct leak would only be another useful but unintended supply air register. The return leak may add a little extra heat into the air stream, but would not have the devastating effect on the energy use or monthly bill. Of course neither leak type would be conducive to the lowest possible utility bill. Therefore, in all spaces, it is extremely important to properly seal duct leaks with fiberglass tape, coated with duct-sealing mastic.

Attic Vents – common mistakes:

Vented attics are still the norm and required by some building officials. Proper use of ventilation products is important. Too many times, homeowners install products that short-circuit their ventilation system. When designing a ventilation system, avoid these common pitfalls:

- Using a combination of different types of exhaust vents, such as power vents with ridge vents where competing vents pull air from each other, instead of from the soffit vents.
- Underestimating your ventilation needs. Remember that 11 louvered type roof vents or five turbine vents would be needed to provide the same ventilation as a ridge vent installation on a gable roof.
- Installing exhaust vents without adequate intake. An effective balance of intake and exhaust must be achieved to properly ventilate your home. The flow of air in your attic is limited to the amount of intake or conditioned air will be pulled from the house.
- Installing a ridge vent that doesn't have an external baffle to increase air flow and protect from weather infiltration.

Green Roofs

NRCA (National Roofing Council of America) is beginning to use the term "landscaped roof systems" in lieu of "green roof systems" to prevent confusion in the building industry. Landscaped roof systems require a combination of roofing concepts and waterproofing concepts. A landscaped roof system is a wet environment and a waterproofing membrane is mandatory. Roof system details are modified to accommodate growth medium and green components. On a typical low slope roof, the insulation would be found under the water proof membrane. NRCA recommends a waterproofing membrane be adhered with insulation above it. Therefore, a landscaped roof system membrane is thermally stabilized and protected from damage and puncture by the insulation itself. However in the case of Green or "landscaped roofs, the turf or planting will be at the surface, with soil drainage created by crushed stone or gravel below the plants, but above the rigid insulation which sits on top of the waterproof membrane at the lowest level. Positive drainage is strongly recommended. Water must be free to drain from all of the planted area, to collect at common points, and to be directed away from the building. There may be other areas designed specifically to hold the water for use by the planting. The idea of these roofs is illustrated below:

Table 10-5
Advantages and Disadvantages of Green Roofs

Advantages of Green Roofs	**Disadvantages of Green Roofs**
Environmentally friendly.	Increased roof weight may require increased structural member sizes and cost.
Can create usable outdoor space.	Safety/liability may be an issue for public access.
Increase thermal efficiency of the building.	
Reduces HVAC equipment and operating cost.	
Reduces interior noise levels.	
Extends roof membrane service life.	If a roof membrane leak does occur, it may be difficult to locate.
Provides storm-water management, aesthetic benefits, rating system benefits (e.g., LEED™ and Green Globes).	Cost to repair roof and then to replace living flora and soil above may be very high by comparison.
Reduces rooftop temperatures.	
Mitigates urban heat islands.	
Improves, urban air quality, wildlife habitats, community green space.	

The 2007 edition of the NRCA Green Roof Systems Manual has much more detail. Also NRCA University's Roofing 101 program offers an interactive, cost-effective online training tool to learn roofing fundamentals. Go to www.nrca.net for a link to Roofing 101.

Figure 10-6
Landscaped "Green Roof"

This landscaped roof is over the east addition to the Louisiana State Capitol. The subterranean space below grade functions as the House of Representative's Committee Rooms. A similar addition on the west side is over the Senate Committee Rooms. The difficulty of aesthetically matching this 1937 high rise historical structure with flanking additions played a role in making the additions below grade. The energy savings and creation of public spaces were also a benefit.

To Top It OFF

The roof receives the most solar radiation of any building component under normal circumstances. A Louisiana home owner can save money while helping the environment by having a cool roof color (CRC) on Energy Star Approved metal panels, CRCM covered shingles or other high-reflectance, high-emissivity roof. A sealed attic can provide even more help. Wise use of shade trees can help inside and out. The goal is to keep the sun's heat from entering the conditioned space rather than admit it and then have to remove it through air conditioning. It is this kind of thinking about how heat flows and where it can be blocked or slowed down that will lead to advances in energy efficiency in the 21st Century.

Notes: