

ENERGY EFFICIENT ROOFING

by
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The Florida Solar Energy Center performed a real world study of the heat gains in houses with different roofing materials. The experiment monitored indoor cooling energy usage for seven side-by-side, virtually identical houses, except for roofing material in Ft. Myers during the summer of 2000. The homes were operated identically unoccupied and occupied to ensure study accuracy. Thermostats were set at a constant 77° F.

The 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. The study showed that white S-tile produced the lowest attic heat gain, but 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-size 1,770 square foot home approximately \$128, or 23 percent annually in cooling costs." Tables 1 and 2 below show the results of the different roofing types tested.

Table 1. Cooling Performance during Unoccupied Period July, 2000

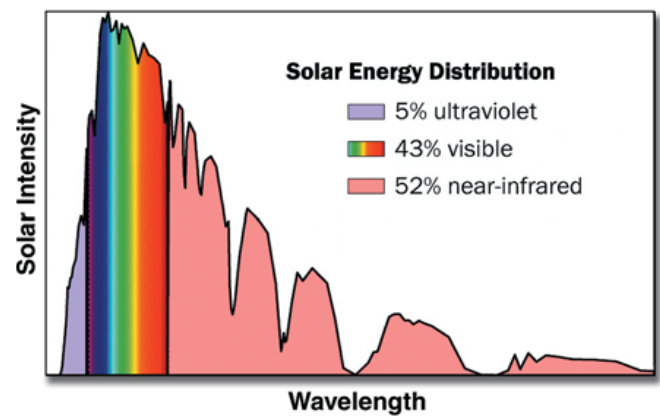
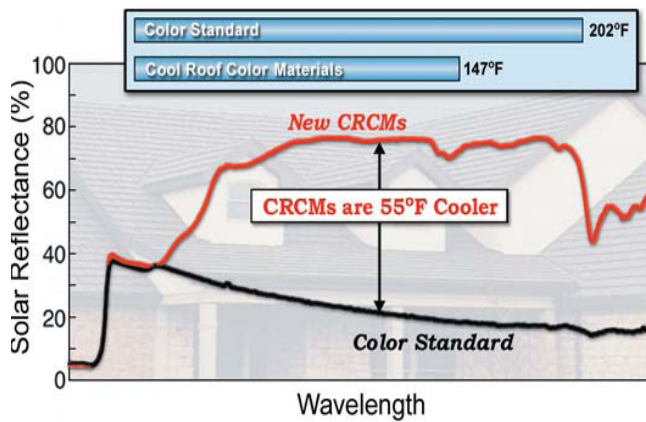
Site	Total kWh	Savings kWh	Save Percent	Demand kW	Savings kW	Saved Percent
Standard dark shingles (control)	17.03	0.00	0.0%	1.63	0.00	----
Above with sealed attic, R19 roof deck insulation	14.73	2.30	13.5%	1.63	0.01	0.30%
Terra cotta S-tile roof	16.02	1.01	5.9%	1.57	0.06	3.70%
White shingles	15.29	1.74	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 2. Normalized Savings & Demand Reductions Estimates

Case Description	Cooling Savings		Peak Demand Reduction	
	kWh	Percent	kW	Percent
Standard dark shingle (control)	0	0%	0	0%
Above with sealed attic, R19 roof deck insulation	620	9%	0.13	5%
Terra cotta S-tile roof	180	3%	0.36	13%
White shingles	300	4%	0.48	17%
White "Barrel" S-tile roof	1,380	20%	0.92	32%
White flat tile roof	1,200	17%	0.98	34%
White metal roof	1,610	23%	0.79	28%

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.

COOL ROOF COLOR PIGMENTS: 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. These CRCMs compare favorably to the "white metal" in the tables above.



The style of structure will dictate roof type sometimes. Other factors are the slope of the roof deck, the annual rainfall, the high/low seasonal temperatures, the cost, or the presence of trees nearby.

MATERIALS: Climate and techniques of installation are two factors, which will lead to success or failure of roofing choices. 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. The materials discussed below are suitable for Louisiana.

ROOF SLOPES: Manufacturers usually specifies a minimum slope for which they will warrant their product. For asphalt composition shingles, that minimum slope is usually 3:12. Some will only 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 chance of wind being able to blow water under shingles or flashing. For slopes 3:12 or less, 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. Membrane roofs, often referred to as a “low slope roof,” are available in a number of different materials (see below).

COMPOSITION SHINGLES (also called asphalt 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. At present, Energy Star certifies only two shingle roofs, both white, but other colors are becoming available with highly reflective exposed surfaces.

STRIP SHINGLES: 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. There are Energy Star certified shingles available.



Laminated Shingles

LAMINATED SHINGLES: These special shingles are made with two layers of tabs to create extra thickness. They are also referred to as 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.

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.

SLATE TILE SHINGLES: Traditionally, slate roofing tiles were hand cut and sized, but now manufacturers pre-cut the slate roofing tile to assure exact measurements. Nail holes are also pre-drilled and countersunk to speed construction. The countersunk holes allow the roof tile to lie flat for longest possible lifetime. Because of the weight of slate roofing material; the manufacturers require an architect's certification of adequate roof structural strength before installing them.



Concrete "S" Tile

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 structure and roof deck.



Concrete Flat "slate" Tile

METAL ROOFING: EPA's Energy Star certifies many metal roofing products.

- 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.
- A lightweight metal roof can be installed over an existing roof saving removal and landfill costs.
- Metal roofing readily adapts to photovoltaic installations.
- Several methods of insulating are available, to any R factor.
- Forms can vary from shingles, corrugated sheets, or a variety of standing seams.
- Materials are copper (expensive), aluminum: coated or uncoated, 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 fluopolymer coatings.



Copper Shingles



Standing Seam Metal



Metal Shakes

LOW SLOPE ROOFS: For this type of roof, a membrane system is applicable. 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 1/4" per foot of run to minimize ponding of water, which may cause deterioration. 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. Continuous insulation over the roof deck is far more effective than if the insulation were placed in the cavities between the roof joists below the roof deck.

Membrane roofs fall into the following categories: Built-up roofs (BUR) are multi-ply roofs, which may have a base sheet and a cap sheet. The membrane layers are asphalt hot mopped over organic or fiberglass felt. The edges overlap and multiple layers are installed. One of the best membrane roofs was the coal tar pitch built-up

roof. It was self-healing in hot weather. These roofs often lasted for 50 plus years without problems or failures. Installation was very labor intensive. The final 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. Each has different properties which make it appropriate for a particular application.

MODIFIED BITUMEN ROOFING: APP (Atactic Polypropylene): Coal tar pitch roofs became inflexible in very cold weather, and tended to crack. The modified bitumen roofs today are chemically formulated 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, a by-product from the manufacture of polypropylene, and high quality asphalt. Low Temperature Flexibility is maintained to 14°F (-10°C). A white acrylic coating can give a roof reflectance of 0.83 and an emissivity of 0.94 applied over modified bituminous and built-up roofs.

SBS (Styrene-Butadiene-Styrene) MODIFIED BITUMEN ROOFING: More resilient is another type of modified bitumen sheet incorporating the features of a strong fiberglass 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).

EPDM (Ethylene Propylene Diene Monomer) RUBBER: A flexible, black roofing membrane available in .045, .060, and .090-inch thickness. It has 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): Is a generic group of chemicals. White, and some colored, TPO roofing membrane meets Energy Star Roof Requirements.

PVC (polyvinylchloride): This material is often bright white and is highly reflective, making it very energy efficient roofing choice. It is most often adhered 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 3. Cool Roof Rating Council Top Rated Membrane Products Typical Properties

(CRRC)	REFLECTANCE		EMISSIVITY	
	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

Source: <http://www.coolroofs.org/products/search.php>, accessed 5 Nov. 2008

Green or Landscaped Roofs: These are beyond the scope of this article. EPA’s Heat Island Research group has resources for this topic. Go to <http://www.epa.gov/hiri/strategies/greenroofs.html>.