

ENERGY STAR® LABEL FOR ROOFING PRODUCTS

RACHEL S. SCHMELTZ

U.S. Environmental Protection Agency
Washington, D.C., U.S.A.

A CONTRACTOR'S VIEW OF THE ENERGY STAR® LABEL FOR ROOFING PRODUCTS

TIMOTHY M. DAVEY

Davey Roofing Inc.
Irvine, California, U.S.A.

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Home and buildings owners can save up to 40 percent of cooling energy costs by installing reflective roof systems in hot and sunny climates. The increase in exterior albedo and subsequent decrease in heat flow across the building envelope reduces the energy requirements to maintain air-conditioned space. Indirectly, the increase in overall albedo of a community as these roof systems are installed lowers ambient air temperature and decreases the need for air conditioning. Another indirect effect is a decrease in smog formation due to lower ambient air temperatures and less air pollution from power plants because of minimized electrical demand.

The U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) developed the ENERGY STAR label for roof products to create a vibrant market for cost-effective, highly reflective roofing materials through the widespread availability of products, clear recognition of the benefits by consumers, and active promotion of products by manufacturers.

KEYWORDS

ENERGY STAR, Energy, Energy Efficiency, Albedo, Solar Reflectance, Air Conditioning, Air Pollution, Roof Coverings, Reflectivity.

INTRODUCTION TO ENERGY STAR

The EPA and DOE are working together on a series of ENERGY STAR labeled products. The ENERGY STAR label helps designers, contractors and consumers easily identify energy-efficient products in the marketplace. Manufacturers join the ENERGY STAR program by signing a Memorandum of Understanding (MOU), after which they may place the ENERGY STAR label on products for which they have determined meet a mutually agreed on performance-based, energy-efficiency specification.

The overall goal of this program is to stimulate the installation of energy-saving products by making product selection decisions easier. By buying and using products with the ENERGY STAR label, consumers can reduce their energy use and save money on utility bills. In addition, these products may reduce air pollution by requiring less electricity,

which reduces the amount of fossil fuels needed to produce electricity, which in turn reduces emissions that contribute to smog, acid rain and global climate change.

The ENERGY STAR label already appears on compliant products for office equipment, TVs and VCRs, audio equipment, residential light fixtures, insulation, exit signs, residential heating and cooling equipment, household appliances, windows and new homes. ENERGY STAR-labeled roofing products follow the same pattern as these other labeled products but highlight the solar reflectance characteristics of roof surfacings.

Albedo¹ is the ability to reflect energy absorbed from the sun, also referred to as solar reflectance. For a given solar flux, a surface with low solar reflectance (e.g., 10 percent) has a higher surface temperature and is therefore hotter than a surface with high solar reflectance (e.g, 90 percent). The goal of labeling roofing products with ENERGY STAR is to help create a vibrant market for cost-effective, high albedo roofing products through the widespread availability of products, clear recognition by designers, contractors and building owners of the benefits, and active promotion of products by manufacturers.

BENEFITS OF ENERGY STAR ROOF SYSTEMS

Reduced Air-Conditioning Bills. Reflective roof surfaces have direct and indirect effects on building cooling loads. The direct effect is the energy savings of an individual building, which is achieved by directly reflecting incoming solar radiation and thereby decreasing the heat transfer through the building envelope. Akbari, et al. (1997) and Parker, et al. (1995) measured direct cooling energy savings in the range of 10 percent to 50 percent (ranging from \$10 to \$100 per year per 1076 square foot [100 m²]) in several residential and small commercial buildings after albedo was increased in the range of 34 percent to 61 percent [1, 2]. In another study, computer simulations were used for 11 U.S. metropolitan areas to estimate an average annual savings of about 175 kWh/1000 ft² (175 kWh/93 m²) for residential buildings with an albedo increase of

¹ Albedo is defined as the total hemispherical reflectance of radiation from 0.3 to 2.5 micrometers, which encompasses most of the solar radiation hitting the earth's surface.

0.30, and 273 kWh/1000 ft² (273 kWh/93 m²) for commercial buildings with an albedo increase of 0.45 [3].

The savings, of course, depend on building characteristics and climatic conditions. Building characteristics that result in the largest savings include large roof-surface-to-building-volume ratios and lower levels of roof insulation. Reflective roof systems and roof insulation are good options for saving energy, either individually or in combination. However, because they both work toward reducing heat gain in the summer, the savings from installing both will not equal the sum of the individual effects. In homes, savings from reflective roof surfaces are greater if ducts are located in the attic because the reflective surface reduces attic temperature, increasing the efficiency of the duct system.

In general, buildings and homes in the Sun Belt of the United States will benefit the most from installation of reflective roof surfacings. Those homes located in the northern regions may experience an increase in heating costs when a reflective roof surface is applied because less sunlight is absorbed by the roof during the heating season. However, in many locations and for many buildings, the savings in cooling electricity dollars far exceed the penalty in heating dollars because solar gain is decreased by lower sun angles, shorter day lengths, cloudy weather and snow on the roof [4].

The potential for total energy savings is high because the market is large. The U.S. market for roofing materials includes about 60 billion square feet (5.5 billion/m²) of residential and 40 billion square feet (3.7 billion/m²) of commercial roofs [3]. It was estimated that installation of reflective roof surfaces on all residential and commercial buildings would decrease annual direct electricity use by about 10 billion kilowatt-hours (BkWh) or 3 percent of the national cooling electricity. This corresponds to an \$800 million decrease in national net energy bills. Peak electrical demand savings are predicted to be about 7 million kilowatts (MkW), or 2.5 percent [3].

The primary indirect effect of reflective roof surfaces is a lower ambient air temperature and consequent reduction in cooling demand resulting from increasing the overall albedo of a community. The ambient air temperature of a community decreases with the installation of reflective surfaces because these surfaces do not transfer as much heat to the air as do conventional nonreflective surfaces. The consequent electricity savings from the indirect effect is not included in the savings estimates previously mentioned, but is predicted to be about half as much as the direct effect [5].

Lower Ambient Air Temperature and Less Smog. Reflective roof surfaces also help reduce air pollution by decreasing the amount of electricity needed to maintain interior building comfort levels. Seventy percent of electricity in the United States is produced through the burning of fossil fuels [6]. Therefore, less electricity use can reduce the amount of fossil fuels needed to produce electricity, thereby decreasing the amount of air pollutants that contribute to smog, acid rain and respiratory disease.

Smog formation is decreased further because of lower ambient air temperature. Smog is created by photochemical reactions of pollutants in the air, and these reactions are intensified at higher temperatures. When the ambient

air temperature is decreased even by a few degrees, there may be a significant decrease in smog formation. For example, a simulation of Los Angeles' summer weather conditions demonstrated that when moderate amounts of reflective roof systems and shade trees were added (up to 15 percent of all changes thought possible), the average summer temperature dropped 7.2°F (4°C). The moderate change in albedo reduced ozone on average by 5 percent [7].

Downsized AC Equipment. In some buildings, a highly reflective roof system (albedo greater than 50 percent) can reduce peak cooling demand by 10 percent to 15 percent. As a result, the home or building owner may be able to purchase a smaller HVAC system. The system would operate more efficiently and save a considerable amount of money. However, when specifying smaller HVAC systems, the possibility of decreased roof surface albedo over time because of weathering and aging must be considered.

Increased Durability. Roof systems can undergo significant expansion and contraction as they heat and cool. This thermally induced movement causes wear and tear on roof systems. Heat absorbed by a roof system can also accelerate degradation caused by ultraviolet radiation and water. Although not yet quantified, keeping a roof system cool or protected with a high-quality reflective material may also improve roof system durability.

PROGRAM DESIGN

ENERGY STAR partnerships are available to all manufacturers of roofing products. Partners sign a voluntary MOU with EPA agreeing to label any product that meets EPA specifications. The ENERGY STAR roof products specification delineates low-slope roofs from steep-slope roofs in an attempt to differentiate product types. The specification consists of two tables: Table 1 is for low-slope roofs and Table 2 is for steep-slope roofs. Products that can be installed on both roof slopes (e.g., coatings, single-ply membranes and some metal panels) must meet the specification in Table 1. The result is a simplified and nonduplicated set of specifications (Tables 1 and 2).

The ENERGY STAR roof products specification also consists of two main characteristics and the corresponding performance specifications. The characteristics are solar reflectance and reliability. Because all ENERGY STAR programs are designed to be simple, performance-based and technology-neutral, the ENERGY STAR roof products specification highlights only a few characteristics.

Solar Reflectance. The most important component of all ENERGY STAR product specifications is the solar reflectance of a product.

Initial Solar Reflectance - Initial solar reflectance is the starting point for determining the amount of energy savings possible from a newly installed ENERGY STAR roof product. The higher the solar reflectance, the greater the potential energy savings, and vice versa. In addition, initial solar reflectance is a property that can be measured in a laboratory using the industry-approved standard procedure ASTM E 903. This allows for confidence that those products labeled as ENERGY STAR may provide benefits to consumers.

Maintenance of Solar Reflectance - Some individuals in the roofing industry feel that attention should be given to the ability of roof systems to maintain solar reflectance over time. In general, natural weathering and air pollution cause light-colored roof systems to become darker with age and dark-colored roof systems to get lighter. To address this issue, a value of 15 percent absolute (not 15 percent of the initial albedo) was given for the maximum decrease in solar reflectance allowed over three years for a product installed on low-slope roof systems and 10 percent absolute on steep-slope roof systems. This value was chosen based on the limited data available on maintenance of reflectance of white coatings [8].

Testing procedures for measuring solar reflectance in the field of low-slope roof systems were just recently approved (December 1997) and have been designated as E 1918 [9]. This new standard will be used to determine the effects of weathering on the solar reflectance of materials over a three-year period. An ASTM standard does not exist for field measuring the solar reflectance of steep-slope roof systems. However, the testing procedures for ENERGY STAR roof products highlights a procedure that is regularly employed by several testing institutions, including Oak Ridge National Laboratory, using the Devices and Services Solar Spectrum Reflectometer. As an alternative,

though not recommended, a manufacturer can take samples from a roof system and have them tested according to ASTM E 903. The manufacturer is then responsible for proper repair of a roof system from which samples were taken.

Reliability. Because highly reflective roof systems may be relatively new concept to home and building owners, the ENERGY STAR roofing product specification includes reliability criteria in the form of manufacturer warranties. In general, a manufacturer warranty for reflective roofing products must be equal to the product warranty offered by the same company for its comparable nonreflective products. By requiring certain warranty criteria, the program can ensure that manufacturers will stand behind their products at least as much, if not more, as they do for their comparable nonreflective products.

The ENERGY STAR program is designed to evolve with any industry changes. As test procedures are refined or new ones developed, new products become available, or new research is completed, the specification for ENERGY STAR roof products may change. All modifications to the specification will be made in conjunction with the program partners and with input from industry associations.

Label Use. ENERGY STAR roof product partners must use the ENERGY STAR label according to the same guidelines as

Specification	
Characteristic	Performance Specification
Energy Efficiency	
Initial Solar Reflectance	Greater than or equal to 0.65.
Maintenance of Solar Reflectance	Greater than or equal to 0.50 three years after initial installation under normal conditions.
Reliability	
Manufacturers warranty for defects in materials and manufacturing	Each company's warranty for reflective roofing products must be equal in all material respects to the product warranty offered by the same company for comparable nonreflective roofing products. A company that sells only reflective roofing products must offer a warranty that is equal in all material respects to the standard industry warranty for comparable nonreflective roof products.

Table 1. Low-slope roof systems.

Roof Specification	
Characteristic	Performance Specification
Energy-Efficiency	
Initial Solar Reflectance	Greater than or equal to 0.25.
Maintenance of Solar Reflectance	Greater than or equal to 0.15 three years after installation under normal conditions.
Reliability	
Manufacturer warranty for defects in materials and manufacturing	Each company's warranty for reflective roofing products must be equal in all material respects to the product warranty offered by the same company for comparable nonreflective roofing products. A company that sells only reflective roofing products must offer a warranty that is equal in all material respects to the standard industry warranty for comparable nonreflective roofing products.

Table 2. Steep-slope surfaces.

partners for other ENERGY STAR products. The ENERGY STAR label is a registered certification mark with the U.S. Patent and Trade Office and may only be used to identify products that meet the specifications contained in the MOU or to provide general education. Program partners may include the ENERGY STAR name in general educational or informational materials that discuss the ENERGY STAR program. This includes promotional materials, brochures, newsletters, annual reports, speeches, posters, advertisements, articles, product sales materials and packaging. However, in each of these cases, the mark must be used to make reference to a specific product. The only time it can be used without making this reference is to inform the public of certification purposes of the mark.

Under no circumstances can the ENERGY STAR name or label be used to imply EPA or DOE endorsement of the partner or its products or services. When the label is used by a partner in connection with a product or its advertising, it must be accompanied by the following statement: "As an ENERGY STAR® Partner, [product manufacturer company name] has determined that this product meets the ENERGY STAR guidelines for energy efficiency."

EDUCATION AND OUTREACH

Extensive education and outreach is currently underway for the general public and roofing industry. Elements of this program include press releases, and articles in trade publications, newspapers and magazines. For example, articles have recently appeared in the following publications: *Building Operating Management*, *Rural Builder*, *Professional Roofing*, *RCI Interface*, *Metal Construction News* and *Today's Facility Manager*.

One plan for ENERGY STAR roof products is the development of a sales and marketing tool for roofing contractors, designers and manufacturers. With input supplied by users such as geographic locations, insulation levels, roof surface area and duct locations, this marketing plan tool will help determine the potential energy savings that come from installing a reflective roofing product on a home or building. The tool will use simulations to determine at least a range of possible energy savings. Contractors may also be made aware of the ENERGY STAR label through their industry associations, manufacturer provided training programs and point-of-purchase displays in distribution centers.

Consumers will see the label with public service announcements and in articles and editorials in newspapers and magazines. Finally, through the ENERGY STAR Web site and the toll-free hotline, consumers and those involved in the roofing industry can acquire information about ENERGY STAR roof products, the label and available products.

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A Contractor's View of the ENERGY STAR® Label for Roofing Products

The U.S. Environmental Protection Agency (EPA) has developed a program for placing ENERGY STAR labels on roofing products that can potentially reduce energy consumption and contribute to a reduction of heat build-up, smog and air pollution in urban heat islands.

Information about this program will be disseminated to the general public and roofing industry through an extensive education and outreach program. Roofing contractors can potentially be both positively and negatively affected by the program, depending on their ability to communicate the benefits and limitations of the product labeling to their customers.

KEYWORDS

ENERGY STAR, Solar Reflectance, Cool Roofing Materials, Albedo, Energy Savings.

INTRODUCTION

The ENERGY STAR label for roofing products has been described in the first part of this paper by Rachel Schmeltz of the Environmental Protection Agency. This paper presents the pros and cons of the program from a roofing contractor's perspective.

The ENERGY STAR program can produce positive benefits for roofing contractors, such as increased opportunities to sell additional products and services that will supplement more routine revenue producing efforts. But if the benefits and potential limitations of the ENERGY STAR-labeled products are not communicated accurately to customers, roofing contractors may inadvertently raise consumers' expectations beyond what is realistic, resulting in a loss of credibility and damaged business reputations.

POTENTIAL BENEFITS OF THE PROGRAM TO ROOFING CONTRACTORS

In any discussion of ecological benefits, roofing contractors cannot be separated from the general population. Programs that could potentially reduce air pollution, smog and energy costs, while at the same time reducing ambient summer temperatures in urban areas, would benefit the principals and employees of roofing contractors to the same degree, if not a greater degree, than the general public. Roofing contractors and their employees breathe the same air and pay the same utility rates as everyone else. A reduction in ambient air temperature and smog would most benefit those who perform difficult, strenuous outside work (e.g., roofing workers). Reducing air pollution and peak ambient temperatures would improve working conditions and ultimately result in a much more comfortable and desirable work environment for roof mechanics, probably leading to productivity increases.

Without any question, roof mechanics prefer to work with products of the lightest color possible during the hot periods of the year. To illustrate the impact of working on a cooler roof, consider that the rooftop temperature differential created by using the most highly reflective products, as opposed to the least reflective products, is substantially

greater than the temperature differential of an air-conditioned office interior compared to an uncooled office interior. Our employees who work in the office would probably find this seasonal workplace temperature fluctuation extremely uncomfortable. These field work environment issues are particularly significant today as there is a clear consensus among roofing contractors in the United States that attracting young workers into the trade is our most critical problem. Improving the overall work environment for roof mechanics is a critical step in making progress on the worker shortage dilemma, and providing cooler surfaces to work on would be a relatively simple way to achieve a significant improvement.

In the low-slope roofing market, roofing contractors can benefit from this program in several ways. Assuming the education and outreach program is successful in motivating building owners to increase the solar reflectances of their roof systems, numerous opportunities could be available to roofing contractors to install reflective coatings on a periodic basis. In addition to increasing revenue, these opportunities could provide contractors with the ability to maintain and strengthen relationships with their existing customers. Quite often, the execution of a high quality roof installation results in taking a customer's building largely out of the market for additional roofing services for the next 15 or 20 years. Increasing the potential of periodically maintaining the solar reflectance of a customer's roof system is a significant opportunity for a contractor to produce additional revenue and maintain a relationship with an existing customer who otherwise might not purchase anything other than routine maintenance until his roof system requires replacement. Additionally, by continuing to work with the customer throughout a roof system's service life, a contractor greatly enhances his prospects of doing the subsequent roof system replacement at the time it becomes necessary. In summary, a customer who is motivated to maintain the solar reflectance of his roof system will become much more valuable to the roofing contractor, both short- and long-term.

Many contractors would consider the sale of white thermoplastic membranes an "upsell" and take advantage of the opportunity to sell them whenever possible. The potential correlation of high solar reflectance and energy savings could be a powerful tool in the sales process, enhancing a contractor's ability to convince a customer of the additional value of what is usually a more expensive system. Developing credible measurements for determining energy savings associated with the use of ENERGY STAR products is critical to a contractor's ability to capitalize on the upselling possibilities available.

In the steep-slope roofing market, post-installation opportunities will probably be less apparent. Largely due to aesthetic concerns, I think it is doubtful that homeowners will wish to have their asphalt shingles or any other type of steep-slope system coated with a highly reflective coating, even if coatings were available that could be used effectively on these roofing products. In the steep-slope market, the primary opportunities for roofing contractors will be in reroofing. Contractors who are familiar with the

ENERGY STAR program and can communicate the potential benefits to customers will have the opportunity to positively differentiate themselves from their competitors, as customers perceive them to be knowledgeable, professional and environmentally responsible.

POTENTIAL RISKS OF THE PROGRAM

I would anticipate that steep-slope contractors could easily create problems for themselves if they are not careful in communicating the benefits and limitations of ENERGY STAR labeled products.

Contractors should be careful to explain to potential customers that the ENERGY STAR label on any roof covering material or coating is no assurance of performance. The label is merely an indication of the product's solar reflectance, not a certification of its quality or ability to perform as a membrane or watershedding material. Roofing products that do not have an ENERGY STAR label might outperform those that do. This must be carefully and clearly communicated to consumers.

PROGRAM LIMITATIONS

There is currently a limited capability to quantify the building's energy savings and the reduction in a community's ambient temperature from the use of ENERGY STAR-labeled roofing products. We are all familiar with stories of roofing contractors promising more than they deliver. Until the energy savings are readily quantifiable, the potential to provide less than building owners expect, regardless of the basis for their expectations, is quite likely. Developing a precise and highly objective presentation on the advantages of ENERGY STAR-labeled products will greatly impact a contractor's ability to maintain his credibility and deliver the results his customers expect.

A distinct limitation of the ENERGY STAR program in the steep-slope (primarily residential) roofing market is the relatively narrow selection of products that meet the minimum initial albedo level of 0.25. According to the Lawrence Berkeley National Laboratory's Cool Roofing Materials Database, of the shingles tested to date, only white shingles achieve the minimum 0.25 minimum solar reflectance level, testing in a range from 0.25 to 0.36. White is not the color of choice in most U.S. markets, and it is unlikely that consumers would deviate from their aesthetic preferences to achieve what will be, most likely, a nominal reduction in energy costs.

Other steep-slope roofing products provide a broader range of colors that easily meet the 0.25 threshold, including metal panels and clay and concrete tile. These products currently enjoy only a small share of the residential (steep-slope) reroofing market. Until consumers exhibit a wider acceptance of these other products, I don't expect to see a lot of ENERGY STAR-labeled products being applied in the residential (steep-slope) roofing market.

OTHER CONSIDERATIONS

There are a number of enhancements to the ENERGY STAR program currently in development that could greatly improve the value of the program for contractors. EPA is developing a product reporting form that would identify all the products currently bearing the ENERGY STAR label, which would help contractors recommend the most appropriate products to their customers. More importantly, EPA is developing case studies to measure actual energy savings from installations using ENERGY STAR products, which would allow contractors to estimate a range of savings to their customers. Providing solid research to back up cost-saving claims would add a significant amount of credibility to contractors' presentations.

Experience indicates that contractors will need to be aware of the potential for manufacturers to use the ENERGY STAR label even though their products don't comply with the performance specifications. Ultimately, as we've seen with other products, the contractor will suffer, probably disproportionately, in the event of a manufacturer's lack of conformity. The program is intended to be self-policing, meaning there is an assumption that competing manufacturers will monitor compliance with the performance criteria. I am doubtful of the effectiveness of this approach. If there are any questions about the compliance of specific products, I think contractors would be well served to look carefully at an individual manufacturer's track record for producing quality products, adhering to standards and maintaining overall integrity.

Finally, I believe the program has more potential in some regions of the United States than others. In some northern regions, where solar load is actually a benefit, energy savings would be difficult to achieve. Markets that favor white shingles and tile will take advantage of the energy savings available to a much greater degree than those that prefer darker colored roof systems. Areas, such as certain parts of the Sun Belt, that feature a lot of uninsulated roof systems will actually benefit more than regions that typically feature more thermally efficient roof systems. In short, I believe the program's performance will be greatly affected by climate and other regional characteristics.

CONCLUSION

Reducing energy consumption and the negative impact of urban heat islands is good for the environment and can be good for business. Contractors need to make sure they clearly understand the benefits and limitations of EPA's ENERGY STAR program, and with proper promotion, they stand to prosper from its existence.