

Affordable Sustainable Design: Taking the First Step

By William Pancoast

This article will explore the ability of each of the following exterior building envelope systems to help reduce the carbon footprint of your facilities:

- Metal Roof and Wall Systems
- Reflective Roof Coatings
- Restoration Coatings and Other Maintenance-Related Materials
- Vegetative Roofing
- Long-Lasting Modified Bitumen Roof Systems
- Vapor Barriers
- Rainscreen Design and Related Insulation Systems
- Photovoltaic (Solar) Arrays

We will look at the contributing benefits of these components in relation to ten critical categories of sustainable design:

- Energy Savings
- Expected Service Life
- Recycled Content
- Biobased Content
- Methods of Manufacture
- End-of-Life Recyclability
- LEED^{®1} Point Potential
- Other Environmental Approvals, Verifications, and Incentives
- Proximity of Manufacture
- Aesthetics²



Environmental Approvals, Verifications, and Incentives

¹ LEED[®] is the abbreviation for Leadership in Energy and Environmental Design[®], both of which are registered trademarks of The U.S. Green Building Council.

² Although aesthetics is not a direct attribute of sustainable design, historically there has been a direct correlation between a building's aesthetic appeal and a community's desire to preserve it. For that reason, it is included in our analysis.

As a cautionary note, manufacturer hyperbole about the “greenness” of various products has resulted in the coinage of a new term: *greenwashing*. To avoid becoming the victim of exaggerated claims when searching for alternative sustainable solutions, be sure to assess:

- The ability of a specific system to contribute to certification by LEED, a voluntary consensus-based standard launched by the U.S. Green Building Council (USGBC) for developing high-performance, sustainable buildings.
- The existence of Environmental Approvals from organizations such as the Cool Roof Rating Council (CRRC³), which independently develops and validates environmental and sustainability standards for a wide range of building products, consumer products, and organizations, and ENERGY STAR⁴, a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy, which provides technical information and tools to help the design community and property owners choose energy efficient building solutions.
- The availability of third-party verifications such as UL Environment^{TM 5}, which provides product rating information using accurate and credible third-party methods for evaluating and labeling the solar reflectance and thermal emittance of building materials. Third-party verification agencies look at Environmental Product Declarations (EPDs), which represent an ISO 14025 standardized report of data collected in life cycle assessment, as specified by specific product category rules. EPDs are also taken into consideration in LEED v4, in the Materials and Resources category.
- The availability of federal or regional tax credits or other incentives for choosing a particular category of system (such incentives are most commonly related to the energy-saving potential of a particular solution).

When assessing the LEED point potential for various building exterior components for the purposes of this article, we will be evaluating those aspects of performance fostered by LEED, namely:

- Building service life
- The use and reuse of rapidly renewable content, recycled content, and regional materials
- Worker and occupant health and well-being through the elimination and/or reduction of hazardous materials

³ The CRRC[®] mark is a registered trademark of the Cool Roof Rating Council.

⁴ ENERGY STAR[®] is a registered trademark of the U.S. government.

⁵ UL EnvironmentTM Environmental is a trademark of Underwriters Laboratories.

Comparative Analysis of Sustainable Solution Benefits	Metal Roofs and Wall Systems	Reflective Coatings	Restoration Systems / Maintenance Solutions	Vegetative Solutions	Long-Lived Modified Systems	Vapor Barriers	Rainscreen Design / Insulated Wall Panels	Solar Solutions
Energy Savings	Good	Best	Good	Better	Good	Better	Better	Best
Expected Service Life	Best	Better	Better	Best	Best	Better	Best	Best
Recycled Content	Best	Good	Good	Better	Best	Good	Better	n/a
Biobased Content	n/a	Good	Better	Best	Best	Good	n/a	n/a
Manufacturing (Cradle)	Best	Good	Good	Better	Better	Good	Best	Good
Recyclability (Grave)	Best	n/a	n/a	Better	Good	n/a	Best	Good
LEED Point Potential	Better	Better	Good	Better	Better	Good	Better	Best
Eco-Related Approvals	Good	Best	Better	Better	Best	Good	Good	Better
Manufacturing Location(s)	Best (for on-site roll-forming)	Better	Better	Better	Better	Better	Better	Good (majority manufactured overseas)
Aesthetic Appeal	Best	Better	Better	Best	Better	Better	Best	Good

Metal Roof and Wall Systems

All metal roof and structural wall systems score extremely well in six out of the eight categories previously mentioned. They are 100 percent recyclable, which translates into zero adverse environmental impact at the end of their service lives. As one of the most easily recycled of all building materials, recycled steel is frequently incorporated into new steel using a process that requires only one quarter of the energy used to manufacture steel from raw materials. Recycled metals may include post-consumer and/or post-industrial content.



Even the least durable of the metals, when properly installed, will outlast most other roof and wall systems on the market today, with a minimum life span of 30 years and a maximum (in the case of copper and zinc) of well over half a century. Since the most commonly used metal is steel, and steel roofing and wall components can be roll-formed on site, many metal systems also provide the LEED-contributing benefit of regional manufacture. The other area in which metal building solutions score well is aesthetic appeal. Their design versatility makes metal roof and wall systems the preferred choice of architects.

Although metal systems are not innately energy conserving, they are frequently factory-coated with a reflective finish offering ENERGY STAR qualified performance to help reduce a facility's energy consumption. Finally, there are no health hazards related to the use of metal in the construction of building exteriors.

All things considered, incorporating metal into your exterior building envelope provides the highest sustainability value of all the building options under review.

Reflective Roof Coatings

The use of reflective coatings on roofs to reduce the energy required to keep building interiors cool has become an increasingly controversial topic in recent years. Many building owners, particularly in the public sector, have become wary of the one-regulation-fits-all approach being taken by some states and municipalities. The building industry, from architects and designers to manufacturers and consultants, have also expressed concerns that reflective coatings, when used in northern regions of the country, may inflate construction costs with no appreciable affect on energy cost reduction.

Nevertheless, when appropriately specified, reflective roof coatings provide the quickest return on your sustainability investment by realizing energy savings worth as much as twenty cents per square foot for commercial buildings⁶. This benefit is particularly apparent for buildings that draw rooftop air into their HVAC units, since it takes far more energy to reduce hot 185°F (85°C) air down to a comfortable 70°F (21.1°C), than it does to cool air that enters the HVAC at a cooler 110°F (43.3°C) temperature. Since the reducing the use of fossil fuels is a primary driver behind LEED certification, reflective roofing typically rates high for LEED point contribution as well.



Reflective coatings offer the additional benefit of extending a roof's service life by increasing UV resistance and reducing the thermal shock associated with extreme fluctuations in rooftop temperatures.

The final area in which reflective coatings are currently providing a real competitive advantage is in eco-related governmental approvals, tax credits, etc. Since the reduction of fossil fuels remains a primary governmental concern and reflectivity is the exterior design solution most frequently associated with energy savings, there may be powerful local incentives for choosing this sustainable design option.

Your roofing material manufacturer or design professional can help you determine the probable financial impact of a cool reflective coating, based on your regional climate and other factors such as shade-creating surroundings.

From an aesthetic perspective, white reflective coatings remain popular with the design community. Where aesthetics are not a driving concern, aluminized reflective coatings may provide a cost-effective sustainable alternative; there is also evidence that aluminized coatings offer better energy savings than white coatings when used in northern climates.

Some reflective coatings incorporate biobased and/or recycled content, for example, soy oils. Always check with your roofing manufacturer to determine whether such options are available. From a service life perspective, reflective coatings offer the advantage of extending the time between cradle and grave.

Restoration Coatings and Maintenance

⁶ U.S. Department of Energy, *Guide to Cool Roofs*, February, 2011 (http://energy.gov/sites/prod/files/guide_to_cool_roofs.pdf)

Although undoubtedly the least sexy of the many sustainable solutions on the market today, there have been great advances in the design of restoration and maintenance materials for both roofs and walls. This makes the restoration/maintenance category an ideal starting point for school districts and other capital-stressed organizations committed to reducing their carbon footprint.



For roofs beginning to show their age, restoration can extend service life by ten years or more. Restoring an aging roof has the immediate tax benefit of a maintenance, rather than capital expense, for private sector building owners. In addition, all facility owners will benefit from the postponement of reroofing and the landfill-destined waste associated with tear-off. If the restoration coating is reflective, additional benefits by way of energy cost reductions may be gained, depending on geography and other factors, as previously described.

Beyond these obvious benefits, the formulation of today's restoration coatings, as with the formulations of many next-generation maintenance materials, have changed radically over the last 20 years. There are green (or at least "greener") alternatives in almost every category of building exterior maintenance.

Vegetative Solutions

Vegetative solutions include both the sophisticated filtering and watering systems that allow plants to be grown across a roof's entire surface area, as well as roofs incorporating container-based plantings. When it comes to LEED point contribution and overall sustainability, vegetative roofs score highest of all building exterior solutions.



When combined with high-performance underlying roof systems, vegetative roofs can provide an exceptionally long service life. Further, the incorporation of living plants into workplace settings has been demonstrated to enhance the well-being of building occupants and of those occupying adjacent properties.

The trays, drainage layers, and other plastic components used in vegetative roofs are typically made from recycled content. Since many building owners source plants native to the area,

vegetative solutions are frequently eligible for LEED points related to origin (manufacturing location), and tend to provide a cradle-to-grave profile superior to most other sustainable solutions. Some municipalities also offer incentives for incorporating vegetation into a roofing project.

Long-Lasting Modified Bitumen Roofing

The longevity of a properly installed modified bitumen roof can rival the service life of metal roofing. Although modified bitumen roofs may not provide the design flexibility of metals, they do offer strong aesthetic appeal when combined with a highly reflective coating or bright white mineral surfacing.

Historically, the quality of modified membranes has varied greatly, based upon factors such as the tensile strength of their reinforcing materials, the amount and quality of rubber modifiers used, and the method used to mix the polymer into the asphalt. Today's membranes also vary in regards to their level of "green" fabrication. Specifically, depending on manufacturer and style, a modified roof may provide:

- Significant recycled content, from post-consumer materials such as rubber tires that might otherwise be sentenced to a landfill, to post-industrial materials, such as boiler slag
- Significant levels of biobased content, such as sea shells and soy oil
- Torch-free, kettle-free, VOC-free application methods, due to a new generation of environmentally friendly adhesives and floodcoats
- 100 percent VOC-free floodcoats
- 100 percent VOC-free membrane, flashing, and structural adhesives
- Low-VOC insulation adhesives



Vapor Barriers

The addition of vapor barriers to an exterior renovation or new construction can contribute to energy cost reductions by optimizing air flow and eliminating unwanted moisture. Although vapor barriers do not have the cachet of more obviously "green" building solutions, they are an excellent example of an engineered component that can allow a building owner or facility manager to modestly impact a building's carbon footprint while ensuring watertight performance.

Rainscreen Design/Insulated Wall Panels



Wall systems are another component too frequently overlooked when evaluating green building solutions. Highly engineered rainscreen wall systems combine exterior cladding, a drainage cavity for ventilation, insulation (which may be integrated into the wall panel or installed separately), and the structure of the building itself. Rainscreens expertly control and manage water infiltration, UV radiation, negative wind pressures, heat transfer into and out of a building, air infiltration, and vapor transmission.

The cladding frequently uses recycled metal content, and is itself, 100 percent recyclable. The insulation can incorporate as much as 75 percent recycled content and/or biobased materials such as natural stone. The resulting high-performance wall system provides extended service life while reducing energy consumption.

Solar Solutions

A roof system capable of sustaining the foot traffic associated with installing and maintaining a rooftop solar array should be a high-performance roof system that is built to last. Providing protection that is both watertight and ecologically responsible is the goal of every rooftop solar solution.

Since solar systems are essentially capturing and repurposing existing solar energy, they are in a category unto themselves. Although their return on investment may be proportional to a system's average exposure to sunlight over an extended period of time, given their current costs, a more rapid return on investment can only be achieved through government and/or utility incentives, regardless of climate.

Rooftop solar also scores well in LEED point contribution and eco-related approvals, with their associated rebates and tax credits. However, they do have some drawbacks, including a relatively high carbon footprint during their manufacturing phase; little to no recycling potential; an aesthetic that can be disruptive to a building's overall design; and the fact that most of today's solar solutions are manufactured overseas.

Conclusion

Taking that first step towards a sustainable future is the responsibility of each of us, whether we are actively engaged in the building trades or the stewards of public or commercial properties. Whether you are planning an ambitious new construction project or struggling to get the best possible return out of your aging properties, affordable green alternatives are available in many critical areas of exterior construction, renovation, and maintenance. Work with your architect, engineering professional, or building material supplier to determine a first step that's right for you.

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