Roof Replacements and Upgrades

What are Roof Replacements and Upgrades?

Roof replacements and upgrades include any projects where an entire roof or a portion of the roof is replaced, repaired, or improved. Roof replacements and upgrades provide a great opportunity to improve energy efficiency because the roof plays a critical role in the energy performance and functioning of a building. Roof replacement and repair continue to account for approximately 75 percent of all roofing work, and industry sources suggested that about 30 billion square feet of roofs needed major repairs in 2009.¹ A roof replacement or upgrade also provides an opportunity to look at the building as a whole and evaluate issues such as thermal performance, systems integration, and indoor environmental quality as well as the impact of the roof’s materials on the environment. For example, a roof replacement may allow for the introduction of daylighting through the incorporation of skylights or roof monitors. Improving roof insulation can reduce heating and cooling needs within and the careful selection of materials can help mitigate urban heat island effect and/or conserve resources. There are many things to consider with a major roof replacement or renovation and a full discussion of these items can be found in the Philadelphia High-Performance Building Renovation Guidelines.

How to Implement Roof Replacements and Upgrades

There is a wide range of options to consider when undertaking a roof improvement project from adding insulation to considering a new type of roofing system such as a cool metal roof, vegetated or green roof or a photovoltaic system.

Fluid-applied roofing products can be applied over an existing roof to extend its life and increase reflectivity. A roof is often exposed to the sun all day and reflective roofing products can help reduce the building’s cooling loads. It is important to select products that have low-VOC emissions, recycled content, and reflective surfaces to reduce heat gain. Specify roofing products that carry the ENERGY STAR® roof label—for low-slope roofing products, these have an initial reflectivity of at least 65%. ENERGY STAR roof products are widely available with single-ply roofing, as well as various other roofing systems. It is important to consider the negative environmental effects of various roofing materials. Most extruded polystyrene and polyisocyanurate insulation is produced hydrochlorofluorocarbons (HCFCs) which deplete the ozone layer. However, some manufacturers are developing ozone-safe alternatives and are becoming commercially available.

Replacing the roof membrane and adding rigid-foam insulation will cost more upfront but can result in higher energy savings. In addition, the use of a protected membrane roofing systems allows for the reuse of the insulation in the future, reducing waste sent to landfills. Roofs and attics should receive priority for insulation retrofits because of the ease and relative low cost.

Cool metal roofing is a category of sustainable, energy efficient roofing products that includes unpainted metal, prepainted metal, and granular-coated metal. It is available in a wide variety of finishes, colors, textures, and profiles, for steep-slope and low-slope applications. Cool metal roofing products are part of an interdependent system of exterior roofing surfaces, substrates, underlayments, configurations, ventilation, and insulation. With proper design, cool metal roofing systems save energy by reducing a building's cooling and/or heating load. Many metal roof systems are reflective, easily vented, and help reduce heat gain into a building. Metal’s low thermal mass does not store heat and radiate it into a building in the evening hours. Many products are also formed in ways that stop heat transfer through conduction by allowing only minimal contact between the metal and the underlying structure. Other benefits of metal roofing systems include the use of additional insulation and the opportunity for the installation of solar panels that reduce reliance on electric energy (See On-Site Renewable Energy and Geothermal Systems strategy).

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Mill-finish metal roof systems have very high solar reflectance and provide further reductions in heat gain. Metal roofs with oven-cured, pre-painted organic coatings that incorporate new "cool pigment" technology offer high total solar reflectance and high infrared emittance even with darker colors. Emissivity as high as 90% can be achieved with these systems. Painted metal roofs retain 95% of their initial reflectance and emittance over time. Cool metal roofing systems typically have a minimum recycled content of 25% and are 100% recyclable at the end of a long, useful life. Most metal roofs are credibly proven to last over 30 years with minimal maintenance.6

Adding a vegetated or green roof onto a structure can also reduce energy costs, absorb air pollutants, provide a habitat for beneficial insects, butterflies and birds, serve as a sound barrier, mitigate the urban heat island effect and reduce stormwater runoff. The multiple layers of a vegetated roof provide excellent insulation. By increasing the building’s thermal mass, vegetated roofs can keep temperatures low in hot weather and warmer during the cool season. This means less energy spent on mechanically heating and cooling the building.7,8

It is critical to evaluate the structural integrity of a building when considering a green roof or any roof retrofit project and a qualified professional, such as a structural engineer, should be consulted. A thorough analysis of the existing capacity and the effects of the new loads on the roof structure including slabs, beams, and columns is necessary. If the existing structure cannot withstand the additional weight of a green roof, there are different methods available to strengthen existing buildings, including externally bonded fiber reinforced polymer (FRP) composites, span shortening, externally bonded steel, external or internal post-tensioning systems, and section enlargement. The strengthening techniques will vary by project in regard to the type of deficiency (flexure, shear, and/or torsion), magnitude of strength increase, constructability issues, aesthetics, and economics.9

For further information about roofing strategies, see the City of New York Department of Design and Construction Cool & Green Roofing Manual.

Examples

Solar Panel System added to Distribution Facility in Edison, NJ

This 4.26-megawatt system installed on an Avidan Management property in Edison, New Jersey, is projected to produce over five million kilowatt hours of power a year, about half of the power needs of the facility’s tenants.\(^\text{10}\)


Green Roof installation on the Allegheny County Office Building – Pittsburgh, PA

Green roofs can be costly to install but can also save a significant amount of energy costs monthly. The County office building in Pittsburgh, Pennsylvania had 8,400 square feet of its roof converted into a vegetated roof. According to the County, the roof has been saving the County over $7,000 in energy costs.\(^\text{11}\)

http://www.alleghenycounty.us/alleghenygreen/CORoof.aspx

Benefits

Roof improvement projects can:

- Save energy
- Improve occupant comfort
- Reduce emissions
- Conserve resources
- Reduce noise within the facility
- Reduce water pollution

Costs

The cost of a roof replacement or upgrade will vary greatly depending on the type of roof improvement and scope of the project. For a cost analysis about green and cool roofs upgrades, see Table 6 of the City of New York Department of Design and Construction


Cool & Green Roofing Manual.

While the initial installation cost of a vegetated roof is higher than that of a conventional roof, a vegetated roof typically lasts twice as long. Costs for a vegetated roof range from $10 to $15 per square foot and can be higher for intensive systems. Changing temperatures and UV rays decrease the quality and lifespan of a roof. Vegetated roofs protect rooftops and its structure, decreasing maintenance. Long-term savings from reduced heating and cooling costs and reduced maintenance can help offset the short-term capital costs. As seen in the example from Pittsburgh noted above, significant savings can also come from the added insulation provided to the building.

In most cases, initial material costs for cool roofs are comparable to traditional roofing material; however, not all materials are the same price. Some cool roof materials can cost less than traditional roofing materials, while more expensive options could cost up to 20% more. In order to fully measure the cost of a cool roof, it is essential to examine the energy savings that are to be accrued over time. Generally, cool roofs provide a 20% annual energy savings on air conditioning, which makes cool roofs a better investment in the long-term over traditional roofing materials.

According to a 2006 report for the Lawrence Berkeley National Laboratory, cool roof coatings cost between $0.75 and $1.50/SF for materials and labor, while single-ply membranes may cost between $1.50 and $3.00/SF. The cost premium ranges from $0.05 to $0.20/SF over conventional roofing products. These costs can be recovered in the relatively short term through decreased energy consumption.

Financial incentives may be available for builders and owners who install cool roofs. For up-to-date information on available incentives, please visit the New Jersey Clean Energy Program.

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Resources

Philadelphia High-Performance Building Renovation Guidelines

LEED for Existing Buildings (2009)
www.usgbc.org/leed/eb/

City of New York Department of Design and Construction Cool & Green Roofing Manual

Lawrence Berkeley National Laboratory – Cool Roof Program
http://eande.lbl.gov/HeatIsland/CoolRoofs/

The High R Roof: Guidelines for Energy Efficient Roofing and Re-Roofing
www.pima.org/BulletinFiles/TB115_v2.pdf

Cool Metal Roofing Coalition
http://www.coolmetalroofing.org/

Whole Building Design Guide – Cool Metal Roofing
http://www.wbdg.org/resources/coolmetalroofing.php

Metal Mag – Roof Retrofit

ENERGY STAR Roof Products Program
www.epa.gov/energystar

US EPA - Roof Calculator
http://roofcalc.cadmusdev.com/

US DOE - Cool Roof Calculator

Oak Ridge National Laboratory – US DOE Insulation Fact Sheet
http://www.ornl.gov/sci/roofs+walls/

The Cool Roof Rating Council (CRRC)
The Cool Roof Rating Council (CRRC) - Cool Roof Rating Programs and Guidelines
http://www.coolroofs.org/FAQs2.html


The Cool Roof Rating Council
www.coolroofs.org

US EPA - Heat Island Effect: Cool Roofs
http://www.epa.gov/heatisld/mitigation/coolroofs.htm

GSA LEED Cost Study