Green and Energy Efficient Roofs Articles and Research

Green Roof Provides Stormwater and Energy Benefits

-Research is looking up for sustainable development solutions-

ORLANDO – The Florida Department of Environmental Protection (DEP) today announced the monitoring results from the first two years of operation of the 1,600-square foot “green roof” at the University of Central Florida. Green roofs have been used for approximately 50 years in Europe, where benefits such as stormwater management, energy conservation, improved air quality and even improved health have been recognized.

“Investing in new ‘green’ technologies to reduce stormwater pollution, conserve energy and protect our rivers, lakes and springs will further water quality protection and provide clean water to meet future water supply needs,” said DEP Secretary Michael W. Sole. “This project is a great and leading example of how to adopt environmentally-sustainable practices that not only protect natural resources but help reduce the potential for some of the harmful effects of climate change.”

In January 2004, DEP contracted with the University of Central Florida (UCF) Stormwater Management Academy to construct and monitor the green roof as part of a multi-year research project to study low-impact best management practices. The 1,600 square feet green roof was built on a new addition to the University’s student union building. Researchers monitored the new green roof extension and a section of the existing traditional roof to compare stormwater and energy characteristics and determine how the roof affects energy consumption and stormwater runoff.

Monitoring results show that the green roof can retain 80 percent of the average annual stormwater volume from the roof, thereby reducing flooding and water pollution. Additionally, using the stormwater to irrigate the green roof reduces the need for potable water for irrigation, one of the biggest uses of potable water in the State. Energy monitoring identified that the green roof is much more energy efficient than even an ENERGY STAR® conventional roof. The results show as the green roof matures and the other roof ages, the potential energy saving in the summer months jumps from 18.8 percent to 43.3 percent. When the outside temperature is less than 550F, the green roof savings is about 50 percent.

The UCF green roof project was funded by a $350,000 grant through the DEP water quality restoration grants program as part of its mission to develop new best management practices to reduce stormwater pollution. An additional $37,000 from DEP’s Florida Energy Office helped assess the energy savings associated with green roofs as part of a larger project focused on energy efficiency at the UCF campus.

Green roofs are an innovative stormwater management solution that can simultaneously improve the energy performance of buildings, air quality and the urban ecology without taking up additional land. In addition, life cycle costs are reduced because the roof last longer than the standard 10-20 years – some lasting as long as 50 years or more.

Green roofs use waterproofing, drainage systems that allow a layer of vegetation to grow on flat or sloping roofs, and a cistern to store stormwater. The stormwater filtrate is then used to irrigate the green roof. The environmentally-friendly design reduces energy transfer through a roof, decreases stormwater pollutants, and lessens stormwater volume by naturally evaporating the runoff through the plants.
For more information about the UCF Green Roof Project, please visit www.stormwater.ucf.edu, or for general information on green roofs visit www.greenroofs.org.

Energy Star roofing information:
http://www.energystar.gov/index.cfm?c=roof_prods.pr_roof_products

Articles regarding energy efficient roofs:
http://www.energystar.gov/index.cfm?c=manuf_res.roof_articles

Cool roofing materials database:
http://eetd.lbl.gov/coolroof/

Energy efficient roofs: Center for Environmental Innovation in Roofing:
http://roofknowledge.org/main/energyefficientroofs/selectinganenergyefficientroof/buildingrating systems
Energy Efficient Roofing: The Number One Green Building Improvement

We’re going green. No longer political rhetoric, we are becoming acutely aware that we must be environmentally-responsible to our communities, our country, and our planet. A 2009 US Green Building Council news release* asserted, “The future clearly centers on energy efficiency, water reduction, cleaner indoor air, (and) sustainable environments” while recent LEED** studies indicate that up to 72% of the nation’s electricity consumption comes from...buildings.

Going “green” should reduce operating costs and conserve material resources. The American Recovery and Reinvestment Act makes “going green” big news at the personal level. This stimulus bill expands the existing Federal tax credits for energy-efficient capital improvements from 10% to a generous 30%, offered as a Federal Tax Rebate. Oklahoma has received $107 million as their part of the stimulus package, with over $46 million earmarked for state energy programs. That means there is up to $6,500 available per home for energy efficiency upgrades for a qualified family of four, earning under $44,000 annually.

How do I choose which green improvements to make in my home? Do the cheapest, easiest things first. Fix drafts around your doors, windows, and foundation. Usually, a caulk gun or expandable foam is all that you need. But for the sake of our discussion, let’s focus on two areas of significant impact that may qualify for a 30% rebate from the Federal Government – your attic insulation and your roof.

Insulation is one of those things that everyone seems to know they need, but understand very little about. In the summer, we want to keep our air-conditioned, cool air inside and the sun’s heat out. In the winter, we want our warm living rooms shielded from the wintery temperatures outdoors. Our understanding of this process has to do with thermal insulation, like the rolls of pink stuff in our attics. These Fiberglass or Roc Wool types of insulation are classified as “thermal” for they function much like a blanket. Just like adding more blankets, thicker insulation offers a greater thickness of captured air to act as a thermal insulator, but this solves only part of the problem.

Thermal insulation, since it deals with “capacity” (R-value) can reach a point where it becomes “full”. Picture a sponge held under running water. At some point, water runs right through because the sponge can hold no more. The more R-value you have, the bigger your sponge, but at some point it still saturates. With late-summer heat-waves like we experience in Oklahoma, it won’t take long for even the best thermal insulation to saturate. What then? Once your insulation is “full”, heat begins to pass through to your conditioned space. In fact, the insulation can work against you, as it releases pent-up heat into your home in the evening, even after the outdoor temperatures have dropped!

So, what can be done about these thermal deficiencies? NASA scientists discovered the solution is to reflect away radiant heat, rather than absorb it. They found radiant barrier technology efficiently holds in body warmth in a space suit, and insulates against the extreme radiation of the sun in space. The beauty of radiant barrier technology is it has no capacity limits! It can reflect away heat day-in and day-out without any performance change. Today, the same radiant barrier technology can be found in car shades, lunch bags, and now in our homes.

Radiant barrier film is a lightweight, aluminum-faced material that works with your existing thermal insulation to dramatically increase your home’s energy efficiency. With a single layer over your attic insulation, perforated radiant barrier film can reflect away up to 98% of the radiant energy that was being absorbed by your thermal insulation. Radiant barrier can be installed quickly, with most jobs requiring only a few hours in your attic. This combined thermal/radiant barrier system helps your house act like an insulated vacuum bottle, efficiently holding your heated or cooled air right where you want it — within the walls of your living space. The insulating properties of the combination of
thermal and radiant products can be amazing, with homeowners reporting a 8 – 25% reduction in energy costs. This government-tested product performs so significantly, that it qualifies for the 2009 30% tax rebate program. It may be the best value of any energy improvement you may choose to make!

Another area that significantly impacts your energy bill is your roof. Not everyone is ready to replace their roof right now, but what you know about roofing products will help you make a “green” decision in the future. Many traditional roof materials were developed for their protection and durability, but never were evaluated for their thermal properties or environmental impact. Heat buildup, toxic emissions, flammable properties, lifespan and landfill impact are all huge issues with our “green” mandates.

One of the most eco-friendly solutions is metal roofing. Here’s why: Metal roofing is a 100% recyclable product. New roof panels today very likely contain up to 40% recycled steel, and the same roof panels after a long life-cycle in use, can be 100% recycled into the next useful product. It’s unlikely that metal panels will ever become waste in a landfill. Secondly, today’s panels are treated with a galvanic undercoating, and then painted with advanced finishes like SMP (Siliconized Modified Polyesters) to withstand sunlight and weather for up to 40 years. Even then, metal roofs can be recoated to extend their life-cycle. Metal panels can outlast conventional roofs by as much as four times. A metal panel roof is lightweight, not subject to tear-off, and strong. Even most Oklahoma hailstorms can’t dent or scratch these panels. But the most significant quality of a metal roof with an EnergyStar finish is that it is the most radiant-reflective roofing material available, bar none. An EnergyStar metal roof reflects radiant energy of the sun, rather than absorb it like other roofing materials. The result is a cooler roof and attic space, which means less work for your insulation and your air conditioner. Because of this, EnergyStar-certified metal roofing qualifies for the same 30% tax rebate as other energy-saving improvements! Wide-ranging new colors and textures ensure your new metal roof will comfortably fit in with most neighborhood homes.

Although we’ve explored only insulation and roofing material in this article, there are many more “green” rebate-qualified improvements you can make to your home, and I invite you to explore all you can. The tax benefit program is designed to run through 2010, so now is the time to save. Find a reputable contractor, who can properly advise you and install your energy-efficient products. Even with tax benefits aside, you’ll be glad you did, once you see your dramatically-lower utility bills.


1.1.1: What is Energy Efficiency?
The term energy efficiency should not be confused with energy conservation. Although we can (and should) conserve energy by adjusting thermostats and turning off lights, energy efficiency saves energy by enabling a system to do the same amount of work with less energy. As a consequence, energy efficiency is usually achieved through more efficient technologies or processes rather than by changes in individual behavior.

Energy Efficiency and Roofing
Few other major building components can offer as many ways to save energy as roofs. Examples of successful energy efficiency measures that can be applied to roofing include:

Installing a High R Roof by increasing insulation levels above current roof insulation standards to use less heating and cooling energy, and by adopting insulation best practices such as placement of multiple insulation layers with staggered joints to reduce unnecessary
energy loss and the use of a protective cover board to prevent damage to the thermal insulation. The use of High R Roofs is especially important for large, low-rise buildings that have a high ratio of roof-to-wall surface area.

Installing a Cool Roof in warm, sunny climates to reduce surface heat gain and lower cooling energy and peak energy usage. The use of Cool Roofs is especially important for large, low-rise buildings that have a high ratio of roof-to-wall surface area.

In addition to reducing the amount of energy required to perform the same function, effective energy efficiency measures should also ideally provide a positive return on investment. However, it is important to consider future energy costs and energy policies as well as current energy costs in any investment decision. The economics of energy-efficient roofing are covered in more detail in a separate section of the Knowledge Center. Additional information regarding the economics of roof insulation is available from the SpecRight program of the National Roofing Contractors Association, which features the NRCA Energywise Roof Calculator.

Energy Efficiency and Renewable Energy

Energy efficiency and renewable energy are said to be the twin pillars of a sustainable energy policy. Both strategies must be developed concurrently in order to address climate change, energy security, and fossil fuel depletion. Efficient energy use is essential to slowing energy demand growth so that new clean energy sources can make deep cuts in fossil fuel use. If energy demand grows too rapidly, renewable energy development may not be able to catch up with the growth in demand. Likewise, unless clean energy supplies come online rapidly, a short-term slowing of demand growth by itself may be inadequate to reduce dependence on fossil fuels. Accordingly, a truly sustainable energy economy will require major commitments to a combination of energy efficiency and renewable energy as well as energy conservation.

In addition to the many ways that roofs can increase energy efficiency, the rooftops of the United States can serve as an important platform to generate renewable energy. Section II of the Sustainable Roofing Reference Tool will address roof-integrated renewable energy systems, including solar energy systems such as photo-voltaic and wind-energy systems.

(1) American Council for an Energy-Efficient Economy, The Twin Pillars of Sustainable Energy…
Science News

New Energy-Efficient Roof System Designed

*ScienceDaily (Aug. 30, 2007) —* Homeowners could see their summer utility bills fall by 8 percent or more with a new roof and attic system being developed at the Department of Energy's Oak Ridge National Laboratory.

From an energy efficiency perspective, roof technology has not progressed substantially in hundreds of years, but that is changing with the use of active thermal mass components, reflective pigments and coatings, subventing, radiant barriers and other novel techniques being tested by a team led by Bill Miller and Jan Kosny of ORNL's Building Envelopes group. Their prototype roof and attic system works by reducing attic temperatures by about 22 degrees Fahrenheit during a typical summer afternoon and decreasing the amount of heat that gets transferred through the attic floor to the living space.

At the heart of new roof system is a proprietary inorganic phase change material sandwiched between two reflective surfaces made of aluminum foil. This material is installed as a dynamic thermal barrier between the roof and attic area, creating separate air channels between roof rafters. The configuration is compatible with traditional wood and steel framing technologies. Moreover, the new phase change material overcomes problems that have plagued phase change materials for the past 40 years.

"In the 1970s and 1980s the housing industry made several moderately successful attempts to use phase change materials," Kosny said. "While these materials enhanced building energy performance, they were in many cases chemically unstable, were subject to corrosion or other durability problems and suffered from loss of phase change capability."

Another shortcoming of some previous phase change materials was their susceptibility to fire. Fire is not a problem with the ORNL material, according to Kosny, who noted that ORNL researchers are working with leading manufacturers of phase change material on the development of non-flammable organic material.

In tests at ORNL, phase change materials perform like conventional materials by absorbing heat as the temperature increases. However, as the material melts it continues to absorb large amounts of heat without a significant increase in temperature. Then, as night falls and the ambient temperature around the liquid phase change material decreases, it solidifies again and releases the stored heat to the night sky, Miller said.

With an outside temperature of 92 degrees Fahrenheit, tests at ORNL's Buildings Technology Center show temperatures of conventional attics at 127 degrees Fahrenheit vs. attic temperatures of 105 degrees with the Dynamic Attic Heat Exhaust System. Kosny and Miller filed a patent last year for this technology.

"The next generation roof will consist of infrared reflective materials that are dark in color yet reflect light as if they were white," Miller said. "In addition, radiant barriers and phase change materials will be integrated into a dynamic attic system that reduces utility bills for homeowners. The conservation strategies contribute on a much grander scale by lowering peak demand on utilities, reducing carbon emissions and, ultimately, they could lead to cleaner air."

If just half of the homeowners in the U.S. made sure they had R30 attic floor insulation and used this roof and attic system, the nation could reduce its Btu (British Thermal Unit) demand by about 100 trillion Btu.

This research is funded by the DOE Office of Energy Efficiency and Renewable Energy's Building Technologies program. UT-Battelle manages Oak Ridge National Laboratory for the Department of Energy.
Green Roofs In Winter: Hot Design For A Cold Climate

ScienceDaily (Nov. 27, 2005) — A University of Toronto researcher has delivered the first-ever analysis of green roofs’ ability to keep buildings warm in winter.

“Everyone studies how green roofs operate in warm conditions,” says Brad Bass of the U of T Centre for Environment. “No one else has looked at winter design.” Bass analyzed a test roof built in Ottawa by Karen Liu of the National Research Council’s Institute for Research in Construction, to offer the first conclusive data that winter green roofs can help reduce heat loss and energy consumption during cold months. The results are currently on display in the Design For the Cold exhibition at the Chalmers Design Centre, Design Exchange.

The winter green roof uses evergreens – juniper shrubs – and a thicker soil base than typical leafy green roofs, which generally provide passive benefits to the environment by reducing the need for air conditioning on hot days. The winter roof was installed on both a standard test house and an energy-efficient winterized house. Bass used environmental systems performance software to chart the indoor temperature fluctuations in both buildings.

“The results for the winterized house were good, and the results for the regular house were dramatic,” says Bass. “The assessment opens up designers to considering winter roofs as part of a year-round energy efficiency strategy.” A poster illustrating the research will be on display until Nov. 27 at the Design Exchange, 234 Bay St. The University of Toronto Health Care, Technology and Place Program is also one of the partners presenting the exhibition, which called for planners, designers, artists and health researchers to design new ways for Canadians to thrive in cold winters. The winter green roof project was funded by Environment Canada, the National Research Council, the University of Toronto, the Office of Energy Research and Development (Natural Resources Canada) and the Climate Change Action Fund.

Green Roofs Differ In Building Cooling, Water Handling Capabilities

ScienceDaily (Aug. 13, 2008) — The first study to compare the performance of different types of green roofs has been completed by the Lady Bird Johnson Wildflower Center at The University of Texas at Austin and suggests that buyers shouldn't assume these roofs are created equal.

Interest in vegetated roofs has increased as water and energy conservation becomes more important to property owners. Yet the study of six different manufacturers' products found the green roofs varied greatly in capabilities such as how much they cooled down a building's interior and how much rainwater they captured during downpours.

"Just having a green roof may not mean anything in terms of preventing water from reaching the street level, for instance," said Dr. Mark Simmons, a center ecologist and the lead investigator on the study. "Green roofs have to be done right, and our hope is to help manufacturers understand how to improve their designs."

Simmons and collaborators recently published their findings online on the Web site of the journal Urban Ecosystems. The researchers will continue to collect real-time temperature and other data from the study.

Wildflower Center staff designed the first commercial green roof in Austin at the Escarpment Village Starbucks. Simmons, center colleagues and Brian Gardiner from Austech Roof Consultants
Inc. simulated green roof conditions by studying the manufacturers’ roofs atop metal insulated boxes. The study of 24 experimental roof tops during fall 2006 and spring 2007 at the center suggested a green roof could reduce a building’s air conditioning bills about 21 percent compared to traditional, tar-based black-top roofs.

During one 91-degree day of the study, for example, a black topped box without air conditioning reached 129 degrees inside. Meanwhile, the green roof replicas produced indoor temperatures of 97 to 100 degrees Fahrenheit.

"That’s a huge difference to have a 20-or-so degree temperature drop," Simmons said, noting that green roofs’ temperature-lowering capabilities are also believed to double the lifespan of roofing material.

An even greater temperature difference was found on roof surfaces, where black-top roofs reached 154 degrees Fahrenheit on that 91-degree day. By comparison, the soil temperature of the green roofs was between 88 and 100 degrees Fahrenheit.

Part of the rooftop differences, Simmons noted, resulted from the native plants used on the green roofs. Each had 16 different types of plants native to Texas in a similar arrangement as part of this first-ever study of their use on green roofs. The study didn’t directly measure their cooling impact. However, plants cool surfaces by providing shade, and by shedding water to cool down, like humans do by sweating.

States such as Texas that experience flash flooding may benefit even more from the ability of green roofs to capture water, lessening runoff onto streets and storm drains. Yet this feature varied the most among the six manufacturers. The better green roofs retained all of the water during a ½-inch rainfall, and just under half the water when 2 inches of rain fell. Some roofs, however, only retained about a quarter of the water in a light, ½-inch rain and as little as 8 percent during deluges.

The presence of native plants likely helped all the green roofs capture water better. In comparison to sedums, a type of succulents traditionally used on most green roofs, native plants can take in more water and release more of it to the atmosphere. The center will study these factors in future green roof research.

Regardless of those findings, Simmons doesn't expect to be giving blanket recommendations about green roof manufacturers because of the variability in their products. That variability is the reason that some of the green roofs in the study that captured water well didn’t have the best plant growth, for example.

"After you choose a manufacturer, tell them what kind of plants and what other features you want," Simmons said. "It's up to them to then tailor the green roof to your needs."

'Green' Roofs Could Help Put Lid On Global Warming

*ScienceDaily (Sep. 26, 2009)* — "Green" roofs, those increasingly popular urban rooftops covered with plants, could help fight global warming, scientists in Michigan are reporting. The scientists found that replacing traditional roofing materials in an urban area the size of Detroit, with a population of about one-million, with green would be equivalent to eliminating a year's worth of carbon dioxide emitted by 10,000 mid-sized SUVs and trucks.

Their study, the first of its kind to examine the ability of green roofs to sequester carbon which may impact climate change, is scheduled for the Oct. 1 issue of ACS' Environmental Science & Technology, a semi-monthly journal.
Kristin Getter and colleagues point out in the new study that green roofs are multi-functional. They reduce heating and air conditioning costs, for instance, and retain and detain stormwater. Researchers knew that green roofs also absorb carbon dioxide, a major greenhouse gas that contributes to global warming, but nobody had measured the impact until now. The scientists measured carbon levels in plant and soil samples collected from 13 green roofs in Michigan and Maryland over a two-year period. They found that green roofing an urban area of about one million people would capture more than 55,000 tons of carbon, the scientists say. That's an amount "similar to removing more than 10,000 mid-sized SUV or trucks off the road a year," the article notes.

Green Roof Example