Photo courtesy of Alucobond/Connor Group/Daniel Lunghi Photography

Put the Pedal to the Metal

Metal roofing and wall systems' longevity, recyclability, and compatibility with retrofits and rooftop solar technology present an impressive sustainable scorecard

Sponsored by Metal Construction Association

None of the three little pigs built a house out of metal, but it would have been a good way to keep away the big, bad wolf.

Sturdy, strong, and sustainable metal walls and roof panels are known for their durable and green features. Metal is almost unbeatable among building materials for its recyclable properties, and metal walls and roofs contribute to reduced energy consumption, as their well-known cool roofing properties reflect heat energy and absorb less heat, keeping buildings cooler and reducing air-conditioning costs.

In fact, Andy Feth, project director at C.W. Driver Companies in San Diego, says he frequently specifies metal wall systems solely on account of their sustainable attributes. "Many metal products in the construction industry are manufactured with recycled materials," he explains. Notably, "it's an excellent reuse or repurposing of materials that might previously have ended up in a landfill."

One-hundred percent recyclable, metal walls and roofs can also be manufactured with 40 percent recycled steel. This figure is especially impressive in light of the estimated 11 million tons of asphalt shingles that end up in landfills. Consequently, it's easy to see why Florida's Department of Environmental Protection ranks metal roofing as one of the most eco-friendly roofing solutions in terms of waste reduction.[1]

CONTINUING EDUCATION

1 AIA LU/HSW

Learning Objectives

After reading this article, you should be able to:

1. Define the primary advantages that metal and metal roofs offer in delivering a long-lasting, energy-efficient building enclosure.
2. Identify the predominant aspects of metal roofing systems that make them highly compatible with rooftop solar technologies and life-cycle benefits.
3. List key integrated building systems and strategies for maximizing energy and performance savings with metal roofing retrofits.
4. Discuss case studies illustrating the sustainability of metal roofing and wall systems.

To receive AIA credit, you are required to read the entire article and pass the test.

AIA COURSE #MCA200

Photo courtesy of Drexel Metals

The Welcome Pavilion at Hershey Gardens in Hershey, Pennsylvania, features a new curved metal standing seam roof that mimics early 20th century design and seems to crown the conservatory.

Meanwhile, Gloria D. Lee, principal of Swift Lee Office Architects in Pasadena, California, is enthusiastic about what she considers the most noteworthy sustainability attributes of metal walls and roofing retrofits: long life, low maintenance, reduced probability of water intrusion, recycled steel content, high solar reflective index (SRI), light weight, and metal roofs' compatibility with clip-on photovoltaics (PV) or thin-film peel-and-stick PV.

As a highly durable, long-lasting material, metal roofs and panels deliver an excellent roofing return on investment.

Furthermore, "metal wall and roof systems offer numerous ways to contribute to a high-performing building envelope," adds Karl Hielscher, CEO, Metal Construction Association, a Chicago-based association.

Beyond these advantages, many architects and builders are turning to metal for its clean lines, ease of use, and versatility, finding inspiration—and innovation—in metal building products.

A LOOK AT THE MARKET

Industrywide, metal construction is on the rise—and for good reason. Recyclable, durable, and easy to install, metal has a loyal and growing following.

For example, out of the U.S. Department of Defense's new construction and reroofing for U.S. military bases, more than half of the facilities' 290 million square feet of roofing is now metal. Moreover, within the United States, about half of all one- and two-story business buildings are now built using metal building systems.

Photo courtesy of Liam Frederick/McElroy Metal Inc.

Metal's durability, sustainability, and optimal building enclosure attributes made it the clear facade choice for the University of Arkansas Champions Hall in Fayetteville. Regionally sourced with a high recycled content, the metal structure contributed toward LEED credits.

"As a result, it's safe to assume that a majority of low-rise government buildings being constructed today are made of metal," says Dan Walker, professional engineer and assistant general manager of the Cleveland-based Metal Building Manufacturers Association (MBMA).[2]

In low-rise, nonresidential construction, metal buildings have captured more than 50 percent of the market, according to the MBMA business review. Architects in Metal Architecture's 31st Annual Architect Survey report that metal wall panels, metal roofs, and metal building systems were specified more in 2016 than in the previous year—and 2017 looks to be even stronger, with more construction in general, and an increase in metal materials specifically.[3]

Metal's market share continues to grow, both in new construction—a 4.6 percent increase from 2015 to 2016—and with regard to renovation projects, where it spiked 12.2 percent over the same period. Furthermore, metal roofing is the second most-used residential roofing product on the market today.

LEAN AND GREEN

Metal building products can reduce the load on a building's foundations, resulting in significant savings in substructure design and construction, particularly with building extensions and brown-fill structures. In addition to roofing and cladding, metal-based technologies can be utilized as framing, composite floor slabs, non-load-bearing metal infill, and separating walls.

Continues at ce.architecturalrecord.com

A 2016 MCA Chairman's Award winner, the Tripartite House in Houston, capitalizes on metal's durable, maintenance-free, and sustainable qualities.
Manufacturer: Umicore Building Products USA Inc.
Metal Fabricator and Installer: Ideal Roofing

The environmental impact of metal buildings was found to be lower in case studies comparing structural and envelope materials to load-bearing concrete, masonry, tilt-up, and steel-framed construction within the same basic building footprint, as analyzed in a whole building life-cycle analysis study by the Houston-based Walter P. Moore Associates on behalf of MBMA. The study concluded that in buildings where metal is typically most economical, LCA performance is also better, with the least embodied building material impact.[4]

Furthermore, metal lends itself to modular construction and its accompanying expedited construction benefits. Nothing quite compares to witnessing a building take shape within a matter of weeks, along with concomitant lower costs and speed to occupancy.

Compared to other materials, metal roofing and walls are relatively lightweight, providing less of an impact on the load-bearing foundations. Installation is much quicker than with other heavier and bulkier wall materials, resulting in significant labor and scheduling savings. In addition, metal roofs and walls can be erected even in inclement weather conditions, allowing construction to proceed and enabling contractors to move forward with interior work.

LONGEVITY AND DURABILITY

Almost impervious to pests, able to withstand extreme weather, and non-combustible, metal roofs are unmatched in durability and longevity. Many manufacturers' warranty their metal roofs for decades, and the expected lifetime of a metal roof can be significantly longer.

In fact, an MCA study reports that certain metal roof systems can have a service life of at least 60 years. Most noteworthy, the study has been verified by the third-party Athena Sustainable Materials Institute (ASMI), a nonprofit research collaborative that assesses the life cycle of various products within the construction sector to deliver accurate, essential information about the footprint of projects or materials.[5]

"Metal walls and roof systems contribute to a high-performing building envelope in so many ways," affirms Lee. "When we're discussing wall-panel systems, there's the high insulation value, no need for thermal bridging of wall framing, low maintenance, long life, and resistance to moisture and mold. With regard to roof systems, there's the high SRI, low maintenance and long life, and the fact that it's PVC free and provides a clean surface for rain-water harvesting. For both walls and roof systems, the recycled steel content is a clear plus."

Metal can be bent and shaped to fit a structure, allowing these roofs to last typically two to three times longer than asphalt shingles.

As an added bonus, maintenance is practically nonexistent. Property managers and owners report that their metal roofs require little or no regular maintenance. Metal-roof owners spent a mere 3.5 percent in maintenance costs, as compared to 19 percent for single-ply roofs and 28.5 percent for asphalt, according to a BOMA International white paper, "Metal Roofs and Walls, Promoting the Future of 'Green' and Sustaining the Environment."[6]

Photo courtesy of Drexel Metals

At Emmaus Catholic Church in Lakeway, Texas, the scope of this project involved the design and construction of a new 600-seat sanctuary with church offices and fellowship areas. Metal roofing beautifully tops the structures.

COOL ROOFING

In addition to metal's long-lasting durability, metal roofs are a great candidate for cool roofing. As light-colored roof surfaces reflect heat away from the building, cooling loads can be shifted to non-peak hours, thereby evening out the energy load. In addition to noted energy savings, this helps prevent the grid from overloading during high-demand periods of time.

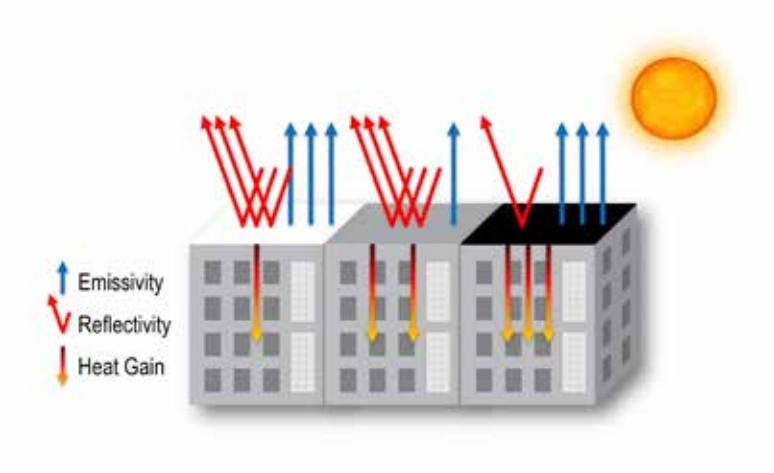

Image courtesy of MCA

Comparing the emissivity, reflectivity, and solar heat gain levels to white, gray, and black roof membranes, the absorbed heat in the light-colored membrane is much less than the darker rooftop.

Furthermore, the heat island effect is real and significant, especially in urban areas where air temperature can range from 6 to 12 degrees Fahrenheit higher than in outlying areas. In a city, the many dark areas and minimal greenery combine to provide less shade, less natural cooling, and a lot of heat being held in one place by all the buildings.

Cool roofing inherently replaces some of those black surfaces with a reflective alternative to lower the ambient air temperature, while the building it covers also requires less insulation. In sunny California, the Lawrence Berkeley National Library (LBNL) found that the surface temperature on a roof decreases by about 1 degree Fahrenheit for every 1 percent increase in roof reflection. Concurrently, it found that every 10 percent increase in roof reflectance resulted in decreased heating and cooling costs at approximately $0.02 annual savings per square foot. This varies with climates and utility rates but nevertheless demonstrates a direct link between cash savings and cool roofs.[7]

Also significant, the LBNL studied the effect of membrane roof colors on a retail store in Austin. It found that light-colored or white membranes can lower the temperature on the surface of a roof by more than 40 degrees Fahrenheit as compared to a membrane in a dark or black color. When the store switched from a black to a white membrane, the average surface temperature that summer dropped from 168 degrees Fahrenheit to 126 degrees Fahrenheit.

The Energy Efficiency & Renewable Energy Building Technology Program's guide Selecting Cool Roofs from the U.S. Department of Energy states that where roof failure is mainly caused by heat-related degradation, it seems clear that a cool roof would outlast a similar roof in a darker color.[8]

Another LBNL study determined that increasing a roof's albedo/whitening level could save millions in energy costs. "Clearly, FEMP should encourage use of cool roofs in new construction and during regularly scheduled reroofing to keep incremental costs down," the report states.[9] LBNL factors in additional recent data, estimating that were cool roofing to be utilized on 80 percent of commercial buildings in the United States, this would save 10,400 gigawatt-hours of cooling energy, approximately $735 million in annual overall energy savings, and a lifetime energy savings of $11 billion.

Contributing some additional compelling data, researchers at the Oak Ridge National Laboratory (ORNL) estimated the amount of insulation that would have to be added to a dark roof in order to achieve the energy savings provided by cool roofs. They concluded that an average R-9 value in insulation would be required to enable dark-colored membranes to deliver the same cooling cost savings as reflective roofs.[10]

In another study, ORNL's Buildings Technology Center used an emission meter and a solar-spectrum reflectometer in a three-year study of the service life and energy efficiency of metal roofing systems. Researchers concluded that the high solar reflectivity and emissivity levels of cool metal roofing can greatly mitigate urban heat island effects.[10] In addition, unpainted metal roofs demonstrate very high solar reflectance levels—depending on the color—from 10 to 75 percent, compared to 5 to 25 percent reflectivity for an asphalt roof.

METAL ROOFING AND SOLAR TECHNOLOGIES

As a most gracious host for rooftop solar systems, perhaps the most significant benefit that metal roofing systems have to offer is longevity. Whereas all other rooftop materials—including EPDM, BUR gravel, TPO, and modified bitumen—deliver an average service life of 20 years, metal roofs keep on ticking for 40 to 60 years. Naturally, this has significant ramifications on the economies of solar technologies.

For example, in a market survey of building owners conducted by the Troy, Michigan-based market research firm Ducker Worldwide, metal roofs were reported to last 41.6 years, as compared to 23 years for modified bitumen and BUR. Incidentally, the survey also reported metal roofing maintenance costs at 10 cents per square foot per year, with BUR and modified bitumen costing building owners 17 cents per square foot per year.

In another study, cited in an MCA white paper, "Benefits of Retrofit Roofing," research from the Colorado Springs-based Metal Roof Advisory Group reported that mounting a PV system on a sloped metal roof can provide savings of 24 percent to 43 percent, as compared to a conventional roof system.[11]

Significantly contributing to these savings is the fact that non-metal roofing systems require dismantling and reinstalling the PV system when the membrane itself requires replacement. Conversely, with metal roofing systems, the solar equipment will require replacement long before the metal roof needs to be retrofitted.

Photo courtesy of McElroy Metal

The metal roof of McElroy Metal's manufacturing facility in Peachtree City, Georgia, was ideal for mounting a full set of photovoltaic panels.

Another substantial benefit is that PV systems can be attached to a metal roof without penetrations, thereby boosting the thermal and watertight performance of the building enclosure.

"A standing seam metal roof allows the PV system to be clipped directly to the seams, eliminating the need to penetrate the roof plane and minimiz-

ing the opportunity for leaks," explains C.W. Driver's Feth. "It is also a more economical attachment system compared to supports attached to the building structure, which are much more labor intensive."

In fact, in a *Roofing* magazine article, "Rooftop Equipment Mounting and Penetrations for Low-Slope Standing-Seam Metal Roofs," Metal Roof Advisory Group President Rob Haddock explains that the first role of thumb in mounting rooftop equipment is to avoid penetrating the membrane whenever possible.[12]

When the membrane is penetrated, "it not only threatens weather integrity but can also violate the membrane's thermal-cycling behavior by inadvertently pinning the panel to the structure," he warns. "Such a point of attachment will fatigue and fail from forces of thermal expansion within a short time."

MOUNTING PV INSTALLATION

Alternatively, seam-clamping hardware can be utilized to grip the standing seam without puncturing the membrane. And because metal is a rigid, high-tensile material, unlike other roofing materials, the combination of the metal roof and clamping hardware provides a beam-like structure for convenient solar equipment anchorage.

"Seam clamps can provide holding strength of up to several thousand pounds on some profiles and gauges, last the life of the roof, and preserve thermal-cycling characteristics," says Haddock.

In general, designers should verify that the metal roof can accommodate direct attachment of the PV system. For example, "there may need to be a tighter spacing on the metal roof fasteners to the building substrate to account for the uplift wind force of the PV system," Haddock adds.

In comparing mounting options, not only do apparatuses systems requiring penetrations compromise building enclosure performance, but they also run a risk of leaking and often void the roofing system warranty.

With ballasted systems, the roofing system adds dead load and the PV equipment can only be mounted on new construction.

Adhesion is another option, but this is only applicable with a new roof or reroof, and this strategy only applies for thin-film solar panels.

Overall, Dustin Haddock, vice president of research and development, S-5!, Colorado Springs, Colorado, points out that a number of factors must be taken into consideration when installing PV systems on metal roofing. "External forces like wind and snow loads, seismic loads, thermal loads, and vibratory loads from building equipment, system integration, roof drainage, access for maintenance, and roof safety must be evaluated," he says. "It's important to consult with engineering professionals to ensure the PV system accounts for each and every area."

Whereas many commercial PV roofing projects will go with standard silicon solar panels, metal roofs, particularly standing seam, support thin-film solar panels as well. Although silicon offers higher efficiencies per square foot, thin-film efficiencies continue to improve. Most notably, they provide a smaller profile and are easy to install.

Made from solar cells with light absorbing layers approximately 350 times smaller than a standard silicon panel, thin film are ideal rooftop installations where available space is limited.

Weighing as little as 7 ounces per square foot, thin-film modules can be installed on low-load-capacity roofs incapable of supporting heavier conventional crystalline panels and rack systems.

This smaller, lower-weight, plug-and-play-type system also delivers a nicer rooftop aesthetic.

INCENTIVES AND CREDITS

According to MCA, a standing seam metal roof with a PV system currently qualifies for federal solar-energy tax credits. These include a rebate of 30 percent for the entire system cost, an accelerated depreciation schedule per the U.S. Internal Revenue Service, and a 50 percent first-year bonus depreciation with the balance depreciated over the next five years.

Projects may qualify for additional state and local tax and utility incentives for solar systems and metal roofing. Details on these programs can be viewed at www.dsireusa.org. DESIRE is operated by the North Carolina Clean Energy Technology Center at N.C. State University and funded by the U.S. Department of Energy.

Metal roofing also gets high marks in the green department for facilitating the use of solar panels. Bill Croucher, director of engineering for Fabral, Lancaster, Pennsylvania, says it is easier to attach solar panels to metal roofs. "A thin-film laminate can be adhered to a metal standing seam roof," he says. Or, a thin film can be adhered to a flat plate that can then fit on 16-inch or wider standing seam panels. Polycrystalline photovoltaic panels can also be mounted on the structural frame of a flat roof, but with the natural slope of metal roof, a framing system is not necessary.

METAL MANUFACTURER INSTALLS PV ON ITS PLANT FACILITY

A successful example of solar on metal, McElroy Metal recently installed a 500 kW PV array on its plant roof and carport canopy in Peachtree City, Georgia. As part of a solar initiative program in the state of Georgia, PV generated power is sold back to the regional utility provider, Georgia Power.

Photo courtesy of McElroy Metal

Attaching a 500 kW PV array on its plant roof and carport canopy with a stainless steel mounting disk enabled a penetration-free solar-to-roof attachment for McElroy Metal's manufacturing facility.

"In general, metal is the best substrate for solar considering that the lifespan of both products match up perfectly," states Peter Rienks, senior account executive, Inovateus Solar LLC, South Bend, Indiana, the general contractor on this project. "Solar on metal is not a new concept, but it is a growing trend. Solar installers are targeting metal roofs for the long lifespan and ease of installation."

Further capitalizing on the economies of scale, both the metal replacement roof and PV panels were installed at the same time. In particular, a 34-year-old metal roof was replaced with a galvanized R-panel symmetrical standing seam system, and 1,960 solar panels were installed on the new metal membrane.

As opposed to conventional standing seam systems, the installed panel system had matching left and right seams joined with a mechanically seamed cap. At 2 feet per panel, erection proceeded along at a faster clip as more square feet were covered per panel, according to David Dodge, president, Paramount Metal Systems, Little Rock, Arkansas, the project's rooftop installer. In fact, the crew was able to cover an average of 5,000 square feet per day. In the end, the 30,000 square-foot metal installation took approximately eight days.

Next, the solar panels were installed in 2½ weeks. To attach the solar panels, three different clamps were used—one for the metal panels, one for an existing through-fastened panel on the facility, and a third for another existing standing seam panel. As opposed to traditional rail or rack attachment methods, which penetrate the rooftop membrane, the PV array was attached with a new stainless steel mounting disk, enabling a penetration-free solar to roof attachment.

Furthermore, a 3½-inch retrofit clip elevated the height of the new roofing system to the top of the existing panels. Nestled between the ribs of the existing roof, the clip essentially eliminated the need for subframing, thereby reducing material and labor expenses.

Inside the space created by the clip, foam insulation was installed, thereby raising the roof's R-value and lending additional support to the roof panels. "Everybody in the field was pleased with the installation. I don't think it could have gone any better. The entire project took six weeks," reports Dodge.

CASHING IN ON METAL RETROFITS

As previously noted, Feth reiterates that metal delivers a much longer service life than shingles, built up roofing, or single-ply roofing. With replacement happening less frequently, this lessens the impact on old roof materials going to a landfill.

However, when it does come time to update an underperforming membrane of any kind, metal retrofits are a great opportunity to incorporate additional energy-efficient systems on the roof.

Strategies such as increased insulation, improved ventilation, and the incorporation of solar technologies are usually considered.

With an increasing focus on building envelope performance, coupled with current building code requirements, adding insulation to an existing roof, particularly in older buildings, is essentially a no brainer.

In fact, the U.S. Department of Energy estimates that 24 to 30 percent of a building's energy consumption is attributed to poor building envelope insulation and air infiltration. Considering the fact that insulation levels in older building typically range between R-6 and R-13, whereas many of today's building codes enforce ASHRAE 90.1 recommend insulation levels of between R-26 and R-38, it's easy to see how much energy can be saved with better insulation.

As delineated in MCA's "Retrofit Re-Roofing with Metal Roof Systems" continuing education unit, fiberglass batts are typically used for metal-over-sloped and metal-over-metal applications, while rigid polyisocyanurate is often the go-to solution in colder climates. Fiberglass, and a laminated vapor barrier, also help to control condensation under the new metal roof in cases where the cavity is not properly ventilated.[13]

Another ventilation strategy is above-sheathing ventilation (ASV). A notably effective technique, research conducted by the MCA and U.S. DOE's Oak Ridge Building Envelope Technologies Laboratories found that ASV decreases heat gain through the roof assembly by 30 percent in the summer and a similar heat loss reduction in the winter. With cool roofing membranes, these savings jump to 45 percent during the summer months.

When embarking upon a metal-over-sloped or metal-over-metal retrofit, the cavity is an ideal place to incorporate solar heat recovery. Similar to ASV, instead of venting the hot air out, the radiant heated air in between the existing roof and new roof can be used to heat the building. Eligible for federal solar energy tax credits, the collected air heats and rises through convection where it is then redistributed through an HVAC system with solar-powered fans.

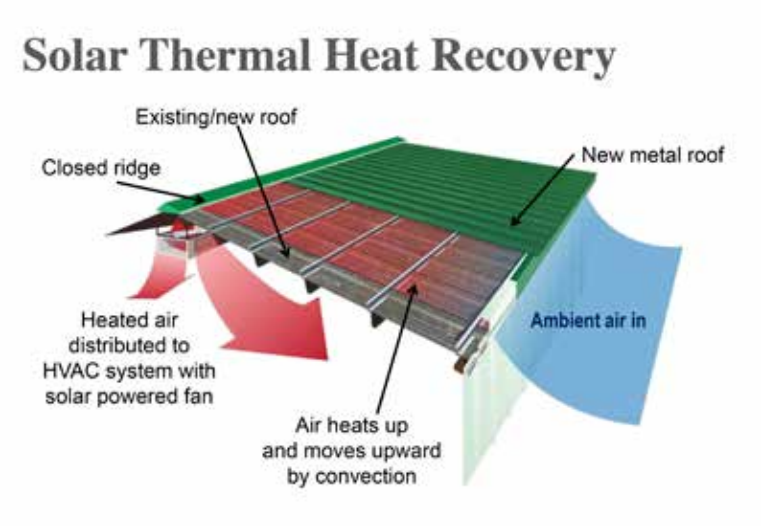

Image courtesy of MCA

The space between the existing roof and new roof provides an opportunity to incorporate solar thermal heat recovery in a metal roofing retrofit.

Another solar technology, solar thermal water, is a closed-loop application of glycol fluid in flexible tubing. Also installed under the new roof, the tubing heats up and is then distributed to hot water tanks and boilers in the building. Also eligible for federal solar energy tax credits, when combined with added insulation and ASV, MCA reports savings of $1+/- per square foot, equaling a three- to five-year return on investment.

CASE IN POINT

As part of the U.S. Department of Defense's (DOD) mandate to produce or procure 25 percent of all DOD building energy from renewable sources by 2025, reduce energy use by 30 percent by 2015, and another 37.5 percent by 2020, San Angelo, Texas' Goodfellow Air Force Base received a new metal roof integrated with energy-efficient technologies.

Photo courtesy of Paramount Metal Systems LLC

Utilizing data gathered from a U.S. Department of Energy Oak Ridge National Laboratory-installed data acquisition system to monitor San Angelo, Texas' Goodfellow Air Force Base's temperature and heat information, a highly sustainable 11,900-foot metal roof retrofit with photovoltaics, boosted insulation levels, a solar thermal system, and rainwater collection was installed.

After gathering key building energy performance data and utility billing information, the former collected from a DOE ORNL-installed data acquisition system to monitor the building's temperature and heat information, a baseline energy usage was established.

A highly sustainable 11,900-foot metal roof retrofit with photovoltaics, boosted insulation levels, a solar thermal system, and rainwater collection was then executed. While many reroofing projects have incorporated such technologies, the Goodfellow AFB was unique in that the energy-saving technologies were integrated into the new roof to form the building envelope.

Essentially, the roofing system components were integrated into one retrofit system to maximize electricity generation and minimize the building's cooling load. For example. the solar-thermal technology sits inside the roof cavity to optimize energy generated for domestic hot water and space heating. The system is anticipated to generate more than 750,000 KBTU of energy per year and save $11,750 in annual energy costs.

Furthermore, a 10,000-gallon cistern captures approximately 131,000 gallons of potable water for irrigation.

In the process of installing these integrated technologies, first, structural purlins were installed over the existing metal roof. Next, additional insulation in the form of rigid insulation board was placed over the existing roof, and a waterproof roof underlayment was applied over the insulation. After that, a radiant barrier was installed over the underlayment, and then the integrated solar-thermal system was installed over the radiant barrier to optimize heat transfer.

In addition, a thermal purlin is used to position the solar thermal system tubing and configured to support above-sheathing ventilation to take place from the eave to the ridge.

Finally, 24-gauge standing-seam metal roofing panels, prepainted with a polyvinylidene fluoride cool coating, were laminated with a thin-film PV system and installed directly over the solar-thermal system.

BEST PRACTICES

Sharing a few best practices for retrofitting metal-over-flat and metal-over-sloped roofs, Mark James, president of RetroSpec LLC in Dallas, emphasizes that first and foremost, the existing roof support system must be identified. This includes the type of system, spacing of secondary members, decking type, insulation thickness, and weathering membrane.

"Once this is completed, then the design of a new light-gauge structural framing system can be determined and estimated," he explains. "Design professionals and contractors must understand that the existing roof support system controls everything in the new framing's base member type and that the placement of the vertical members will support new roof purlins. The new roof purlin spacing is controlled by the new metal roof system's tested values for wind uplift and gravity load."

Proper anchorage is also key in order to prevent wind uplift from tearing the new roof off of the existing roof. Furthermore, wind uplift performance should be updated to comply with the current building code requirements.

For metal over flat, the added weight of a sloped build-up retrofit system is 2 to 5 pounds per square foot (PSF), and for metal over sloped, it's 1.5 to 2 PSF. The structure should be tested with a series of concentrated loads as opposed to uniform loads.

"A critical factor is ensuring a good sound substrate on which the new roof can be installed," adds Feth. "In addition, all penetrations, changes in plane, and transitions to other building elements must be detailed/sealed properly. Each manufacturer will have their own suggested details for various conditions."

CHOOSING METAL

Whether it's metal's exceptional longevity, durability, recyclability, compatibility with solar technologies, or the energy efficiencies delivered by metal roof retrofits, metal walls and rooms are an excellent sustainable choice for today's commercial buildings.

SUSTAINABLE METAL DESIGN BY THE BOOK

Awarded a 2017 Metal Architecture's Sustainable Design Award, the Swift Lee Office-designed Twin Rivers Charter School in Yuva City, California, features insulated metal panels with light-gauge metal framing and batt insulation, perforated aluminum sunscreen panels on Z-shaped frames for solar shading on three exposures, and perforated metal curtains to diffuse direct sunlight.

Photos courtesy of Swift Lee Office

At Twin Rivers Charter School in Yuva City, California, insulated metal panels with light-gauge metal framing and batt insulation, perforated aluminum sunscreen panels on Z-shaped frames for solar shading on three exposures, and perforated metal curtains to diffuse direct sunlight earned Swift Lee Office a 2017 Metal Architecture's Sustainable Design Award.

For the two-building complex—a 28,500-square-foot K-5 building with a media library, and a 21,500-square-foot building with grades six through eight classrooms and a gymnasium—the use of metal building systems offered multiple advantages.

For starters, by selecting preengineered systems and components that are designed to work together, this created flexible energy-efficient structures

capable of accommodating a wide range of use, explains Swift Lee Office Principal Gloria Lee, Pasadena, California.

Furthermore, future renovations will be less costly than working with conventional construction.

"With the metal building system, it's all very integral at the building component and structural levels," Lee explains. "Whether it's the tall gymnasium with the classrooms or lunch shelter with the admin and classrooms, we were able to create it with one building system."

Because the IMPs, for example, delivered a complete water- and air-resistant building enclosure with a high level of thermal performance, it was easier to add additional sustainable elements, such as skylights, clerestory windows, light scoops, and displacement ventilation.

"You're not building curbs, and you're not dealing with flashing issues and details," she explains. "The details are made to go together, so it's very quick and easy construction, and highly waterproofed."

In selecting metal building systems, it was the architect's intent to expose the metal architecture, thereby creating hands-on learning experiences about how the technology works.

In the grand scheme of things, Lee states that sustainability is much more than a checklist. "I think sustainability has to be thought about more broadly, not just about getting LEED points or using recycled material. But really about holistically seeing how sustainable it is to provide a learning environment for children who we want to grow up to be stewards of our planet."

AWARD-WINNING METAL PANEL SYSTEM DESIGN

When Sherwood Middle School in Shrewsbury, Massachusetts, needed a new building, the project coordinators embraced the metal panel exterior presented by architects Lamoureux Pagano & Associates.

Photos © Travis Blake

A well-designed composite metal panel system and a ribbed profile panel system earned Lamoureux Pagano & Associates an MCA Chairman's Award for Sherwood Middle School, Shrewsbury, Massachusetts, new facility.

The building's all-metal facade combines various substrate sand rainscreen panels, including a composite metal panel system and a ribbed profile panel system, winning the MCA Chairman's Award of 2013 for primary and secondary education facilities. The paneling is a steel and aluminum blend, presenting an aesthetic facade and a high R-value at a reasonable cost.

"One of the things that the community wanted was a very energy-efficient building," explains Kathryn Crocket, vice president, Lamoureux Pagano &

Associates, Worcester, Massachusetts. "[Metal] gave us some flexibility in terms of modulating the aesthetic of the exterior of the building and giving a futuristic look to the building, which was very appealing to all."

Crockett and her team designed a 130,000-square-foot building that insulates the interior well against the temperature swings that are typical of the Boston area. Another green feature is the southern exterior gym wall where a perforated metal panel system features a low-tech solar wall. The system gathers warm air, then a fan system pulls it inside, helping to heat the gym.

Thanks to superior insulation levels, temperatures inside the building take a long time to drop, even when it's well below freezing outside. "At the end of the day, the building holds its heat," says Robert Cox, superintendent of public buildings for the town of Shrewsbury. "These are sheathing panels. And it's all in one piece. That's it. You put it up, and it's sealed. It's tight. It's done."

That's an added advantage in public buildings, he explains, where operating money is hard to come by. "So when we do a capital project, we try not to skimp," he says. "We try to make it a building that's substantial, one that's going to last."

Now that the school's staff and 1,000 students have been occupying the building, the overall response to it has been very positive. "People are very excited about it," Crockett says. She notes that the school was designed and built to last for decades to come. "They were looking for a progressive school," she says. "They have extremely high standards for their curriculum, and they wanted a school that reflected that, and that would give them flexibility for 50 years."

END NOTES

[1]Kazlov, Paul. "Metal Roofing: An Unlikely Way to Reduce Waste and Save Energy." *Triple Pundit*. 6 August 2014. Web. 30 August 2017. <www.triplepundit.com/2014/08/metal-roofing-unlikely-way-reduce-waste-save-energy>.

[2]Government Product News Staff. "Expert: Metal buildings offer versatility to governments." American City & Country. 14 April 2015. Web. 30 August 2017. <www.mbma.com/media/American%20City%20and%20County%20Reprint.pdf>.

[3]Deffenbaugh, Paul. "31st Annual Architect's Survey." Metal Architecture. March 2017. Web. 30 August 2017. <www.metalarchitecture.com/articles/magazine-features/31st-annual-architect-survey.aspx>.

[4]Walter P. Moore and Associates. "Athena Impact Estimator Case Studies." August 2015. Web 30 August 2017. <www.mbma.com/media/WalterP-MooreAthenaImpactorCaseStudies-MBMA_Aug2015.pdf>.

[5]"ASMI accepts MCA report on increased service life of metal roofing." Construction Magazine Network. 26 August 2015. Web. 30 August 2017. <www.constructionmagnet.com/metal-roofing-magazine/asmi-accepts-mca-report-on-increased-service-life-of-metal-roofing>.

[6]"Metal Roofs and Walls: Promoting the Future of 'Green' and Sustaining the Environment." BOMA International. 2006. Web. 30 August 2017. <www.boma.org/research/Documents/Find%20a%20Resource/Metal.pdf>.

ONLINE PORTION

[7]Konopacki, S. and Akbari, H. "Measured Energy Savings and Demand Reduction from a Reflective Roof Membrane on a Large Retail Store in Austin." Lawrence Berkeley National Laboratory. January 2001. Web. 30 August 2017. <www.vinylroofs.org/wp-content/uploads/2011/06/LBNL_study-1.pdf>.

[8]"Guidelines for Selecting Cool Roofs." U.S. Department of Energy Building Technologies Program. July 2010. Web. 30 August 2017. <heatisland.lbl.gov/sites/all/files/coolroofguide_0.pdf>.

[9]Taha, Haider and Akbari, Hashem. "Cool Roofs as an Energy Conservation Measure for Federal Buildings." Lawrence Berkeley National Laboratory. April 2003. Web. 30 August 2017. <pubarchive.lbl.gov/islandora/object/ir%3A120601/datastream/PDF/download/citation.pdf>.

[10]Casey, Tina. "What Color is Your Parking Lot: New Research Combats Heat Island Effect." *Triple Pundit*. 17 September 2012. Web. 30 August 2017. <www.triplepundit.com/2012/09/heat-island-effect/>.

[11]"Retrofit Roofs Offer Design, Environmental, and Financial Benefits in New and Existing Construction." Metal Construction Association. August 2016. Web. 30 August 2017. <www.metalconstruction.org/download.php/education/tech_resources/retrofit/WhitePaper_BenefitsRetrofitRoofing>.

[12]Haddock, Rob. "Rooftop Equipment Mounting and Penetrations for Low-Slope Standing-Seam Metal Roofs." *Roofing*. 3 November 2013. Web. 30 August 2017. <www.roofingmagazine.com/author/rob-haddock/>.

[13]"Retrofit Re-Roofing with Metal Roof Systems." Metal Construction Association. Web. 30 August 2017. <www.metalconstruction.org/index.php/education/educationalresources>.