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Today’s buildings—residential, commercial, and industrial—consume more energy than any other sector of the US economy, including transportation and industry, and are responsible for 40% of US carbon emissions at a cost of more than $400 billion. In achieving greater energy efficiency, what’s wrapped around a building through its envelope is just as significant to its operation as the inside mechanical and lighting systems.

What has been considered exceptional will soon become commonplace, says Eric Bloom, a research analyst for Pike Research, a market research and consulting firm that provides in-depth analysis of global clean technology markets. “Green building and sustainability in the early years was about companies doing something that was sort of ‘feel good, do the right thing,’ he says. “Now it’s really more of a question of ‘keeping up with the Joneses.’ So even companies that might not have been so fast to be an early adopter of sustainability are now getting pressure because they’re going to be perceived as a backward company that’s not hitting the sustainability wave.”

Joe Murray, a principle design architect with IDC Architects, a wholly owned subsidiary of CH2M Hill, says with that “deep realization now that buildings use an amazing amount of energy,” and while the 20th century approach was to run “fancy” air-conditioning systems, comes a greater awareness of significant opportunities to reduce energy consumption and carbon footprints. Murray points out that the building envelope works synergistically with mechanical approaches.

“When you have a better higher-performing building envelope, you take a credible amount of pressure off of your mechanical systems,” he says. “They can be downsized.”

Getting the LEED Out
Murray points to numerous examples in which IDC has designed buildings with an eye to improving the building envelope efficiency, thus creating an overall stronger energy performance on the inside as well. One such proj-
Project is the Leadership in Energy and Environmental Design (LEED) Gold Pittsburgh headquarters of Medrad, a division of Bayer AG, a provider of medical devices and services. Using an air barrier membrane system in combination with an underfloor air distribution system allowed building owners to significantly downsize the mechanical equipment.

“You spend a little bit more money on the building envelope, but you immediately get savings in the mechanical systems,” says Murray. “The operating costs have been excellent for them for the last five years.”

IDC Architects also is involved as a partner with Bayer MaterialScience AG’s EcoCommercial Building program. The program is an integrated planning and implementation concept to help implement environmentally sustainable and profitable construction projects.

Bayer MaterialScience is working with a network of members from various disciplines to support professionals such as architects, project managers, construction managers, developers, and managers of larger companies in the creation of public and commercial buildings. The services offered range from energy efficiency assessments during the planning phase and the use of environmentally friendly materials to the employment of renewable energies.

As part of that program, IDC works with Graham Architectural Products’ windows. That company developed a fiberglass-reinforced pultruded polyurethane window replacement system for the residential market, which IDC has adapted for a commercial curtain wall system.

“What we know through the studies is that the aluminum mullions that were used in a curtain wall system are the biggest weak point in the thermal transfer of energy from inside to outside,” says Murray. “By using this pultruded polyurethane, we’re able to greatly improve the performance and reduce the thermal loss through those systems.”

“When you look through a curtain wall, you think those are just skinny little sticks,” he continues. “When it adds up, it’s 15 to 20% of the wall system. It takes less energy to make this than to make virgin aluminum.”

Another CH2M Hill project in Scottsdale, AZ—the Henkel Consumer Products Headquarters—earned LEED certification for Sustainable Design Excellence. CH2M Hill worked in conjunction with Will Bruder+Partners of Phoenix as the design architect.

The 82-foot-high atrium of the 348,000-square-foot building was capped with an inflatable membrane skylight and is the first of its kind in the western U.S., allowing textured light to penetrate into the heart of the building. Seventy-five percent of the employee work areas are illuminated by natural light. A custom-designed fritting pattern etched into the building’s windows reduces sunlight intensity. A 1.5-acre desert roof garden provides respite for employees and insulates the floors below. Solar roof panels power washers and dryers.

Going forward, “one of the smartest things we can do for the environment is build buildings that last a long time,” notes Murray. “Research on the real value of using old buildings shows there’s probably a bigger, more significant positive environmental impact to reuse an old building than most people think.”

The idea of designing and constructing a high-performance building that gathers energy and lasts longer appeals to clients, especially in the institutional sector, Murray says. IDC recently conducted a study on an old research laboratory taken over by the state of West Virginia and targeted for a retrofit. “We said the first thing we should do is give the building a brand new envelope,” says Murray. “They said they couldn’t afford to do that. They told us to look at the mechanical systems. We did that and could not make the building efficient enough to reduce their operating costs to get them to a place where they could actually rent the building to researchers and make a few bucks.”

The discussion turned to the building envelope. “We showed them by doing a new high-performance building envelope, the mechanical systems could be reduced,” says Murray. “That lowered the front-end costs. They could start to make their performing numbers work. Now they are in a cycle to get this funded. It wouldn’t have worked out if
they hadn’t completely upgraded the building envelope.”

**Incorporating New Technologies**

John Bernardi, vice president of business development for Firestone Building Products, points out that with rising energy costs, “building owners need to be more vigilant than ever before about having energy-efficient buildings. Also, with energy becoming a topic that garners significant corporate and public awareness, building owners understand that having facilities with favorable energy efficiency makes them reflect a more environmentally responsible image and translates to having buildings that are easier to lease and that promote a positive attitude among employees.”

Firestone Building Products is developing and introducing a variety of new building envelope products to address building efficiency challenges, including daylighting systems to reduce the need for interior electricity use, vegetative roofing to promote effective building envelope passive stormwater management, numerous insulation products with the highest R value/inch of thickness, reflective roofing membranes to minimize heat gain in appropriate markets, and building integrated photovoltaic (PV) systems on roofs to help move buildings to a net-zero position.

Bernardi says the technologies have a favorable return on investment (ROI). “The payback on a daylight system can be a few short years based on the savings in electricity from not having to turn lights on during daylight hours,” he says. “PV systems can have a very favorable ROI as well, depending on the state and local government incentive programs.”

“One of the least expensive and most effective ways to increase the energy efficiency of a building is by adding insulation thickness to a rooftop which prompted President Obama to recently declare that ‘insulation is sexy,’” says Bernardi. “The addition of insulation is something that is easy to do in both new roofing applications as well as in reroofing projects.”

Going forward, designers need to incorporate these products into their plans, building regulations need to ratchet up in regards to building energy performance, and local municipalities need to adopt and enforce related building code upgrades, says Bernardi. “This process is already well underway with the introduction of the new International Energy Code, and, much like the fuel efficiency standards for cars continues to increase over time, drafts of future code edition language are already moving in the direction of increasing energy efficiency requirements.”

ACH Foam Technologies manufactures expanded polystyrene (EPS) for the packaging and construction industry. “Focusing on construction, we make rigid insulations from the frost line to the roof line,” says Frank Kiesecker, senior vice president of sales and marketing for architectural products for ACH.
An expert speaks about inspiring change and waiting for return on investment.

Eric Bloom, a research analyst for Pike Research, points out that because paybacks for building envelope energy-efficient measures, such as insulation and windows, are longer than most organizations are willing to accept, they tend to be low on the priority list, with mechanical and lighting retrofits taking greater precedence due to faster paybacks. He notes that the public sector is willing to accept long payback periods, whereas, in the private sector, the investment criteria is more stringent. Still, there are examples of building envelope programs drawing attention.

Case in point: the retrofit of the Empire State Building. All 6,514 windows in the Empire State Building have been retrofitted through a window refurbishment processing center built onsite to reduce transportation emissions. Some 95% of the glass was reused. The insulating value was increased from R2 to R7, and the refurbishment reduced overall cooling and heating expenses. Bloom notes that the windows were due for replacement and that because the building is so large, there were economies of scale involved in upgrading the windows from an in-house factory.

In general, however, “the premiums for efficient windows are unfortunately much higher than the conventional alternatives for other kind of efficiency measures,” he says. “I don’t see a huge near-term opportunity for windows, in terms of energy-efficient retrofits.”

He holds the same view for insulation. “Energy service companies tend to manufacture a lot of equipment, and that’s what they like to sell,” says Bloom. “There is not a lot of focus on insulation because that is not their core line of business. It’s hard to blow insulation through an entire building. Paybacks are fine for insulation, but if you can do something more mechanical in nature, that tends to be a little bit more appealing to all of the participants in a retrofit.”

In the case of new construction, however, insulation is a “huge” benefit, Bloom says, pointing out that new construction has been the most popular sector in the LEED Green Building system. “You’re building out the entire building and the envelope for the first time, so insulation is always going to be a huge part of making a building more efficient from the get-go,” he says. “As green building certification figures more prominently into the market, insulation will grow as a tool for making new green buildings efficient.”

Renewable Energy Solutions

As for renewables, “the whole market is propped up by incentives, and those are, in some cases, pretty reliable and may last for quite some time,” says Bloom. “The government extended the investment tax credit for renewable energy systems up to 2017, which is a huge boon, because it’s a 30% investment tax credit for solar systems and makes them appealing to a broader customer range.”

Additionally, there are a number of state and local incentives, he adds.

Bloom says that in California, there is a feed-in tariff where every kilowatt-hour of solar energy fed into the grid receives a flat rate of about 30 cents per kilowatt-hour, “which is very generous when you consider that electricity is only about 15 cents a kilowatt-hour in California,” he says. “You can actually make money by selling solar energy into the grid. If someone can find a way to finance the high upfront costs with a combination of incentives and other financing, they have this constant stream of revenue from feed-in tariffs.”

Solar opportunities exist on the state level, says Bloom, offering California and New Jersey as examples of states that offer generous incentive structures for solar. Such incentives can “come and go” from year to year depending on state budgets, he adds.

Public Support

Federal and municipal government entities, the early adopters of energy efficiency, have been more willing to accept longer paybacks on energy efficiency than the private sector, Bloom says. “The public sector only represents a quarter of the building stock in the United States,” he adds. “The real long-term opportunities are going to be in the private sector. But since private sector companies really aren’t looking to invest in anything with a payback of four years, then the drivers of efficiency—which are definitely considerable—are going to be a little bit different from the public sector.”

One factor promoting an energy-efficient economy in the US has been the ability to use energy to improve a company’s public image, notes Bloom. “It’s something you can photograph and drop into your annual report or corporate sustainability report. It’s a really great way for companies to show a commitment to sustainability.”

With the slowdown of the US real estate market, a lot of the focus has shifted from building new buildings to making existing ones more efficient, Bloom points out. “There’s a huge uptick for LEED in existing buildings in the last couple of years in response to the recession. Energy efficiency and green building has been a tool that building owners have used to try to attract tenants.”

“An awful lot of companies are saying they will only rent LEED Silver-certified space,” continues Bloom.

What the Future Holds

Bloom notes a few microtrends going forward. “In the near term, there are a couple of policy issues in the works that are going to change the game for energy efficiency,” he states.

One of them is PACE (Property Assessed Clean Energy) Financing. Municipal governments offer a specific bond to investors, who loan money to consumers and businesses to be applied towards an energy retrofit. Loans are repaid over an assigned term through an annual assessment on the property tax bill. The loan is attached to the property rather than an individual. “It addresses the barrier of private sector organizations only investing in efficiency that has a payback of a few years,” says Bloom. “Part of that is because private sector organizations are quick to flip buildings and move, so why would they invest in an efficiency project that has a payback of 10 years when they might not even be in that building in 10 years? They might let out all of this excess capital, but won’t really realize the benefits for themselves.”

“This is basically a loan from a municipality to pay for energy efficiency,” he adds. “You just need to be able to accept that you’ll pay a little bit more for your property taxes over the course of 10 years. If you sell a building that’s undergone an efficiency upgrade, then the additional assessment on your property taxes is given to the next owner. In a lot of cases, the energy savings from the retrofit will exceed the additional amount that you’re paying for those efficiency upgrades.”

In the commercial sector, the program has been available in Los Angeles, Cleveland, Washington DC, and a few other cities throughout the US, says Bloom. The program has been under development in the residential sector, but Fannie Mae and Freddie Mac decided not to back PACE financing programs, he says, adding that federal legislation has been introduced in an effort to re-examine that issue.

Another driver going forward will be commercial benchmarking laws, says Bloom. Conducted at the municipal level, the law requires commercial buildings of a specific square footage to provide potential tenants and buyers a year’s worth of back utility bills for hard data on how much it costs to operate the building on a per square-foot basis. “The idea is if you are a buyer comparing different buildings and one costs 30% less in terms of energy, it creates competitive pressure to improve efficiency as a way of attracting tenants and buyers,” he says.

The bottom line is that will take a federal energy bill or climate bill to get energy efficiency out of a “slow motion” mode, Bloom says. “Energy and electricity in the US is considerably lower than in most countries in Europe, for example, and just increasing the price of energy and putting a price on carbon is a huge driver for efficiency. That’s going to be a big game-changer, but not something we’re going to see in the next four or five years.”
Foam Technologies.

“We’re trying to create an insulation envelope to keep the heat inside in the winter and keep the cool in the summer. The biggest challenge owners of existing buildings have is to bring their buildings up to energy standards or for new construction, to build to a higher energy standard.”

The only way to do that is to create the R value of the envelope, whether it be below grade wall or roof insulation, says Kiesecker. “On a commercial building, the greenest surface area they have is the roof. There’s one area that, by achieving higher insulation and higher energy standards, it’s going to help them reduce energy consumption.”

While an ROI is site-specific, Kiesecker says it’s not uncommon for there to be a three- to five-year payback.

He also points out that while there are “great” technologies available with respect to HVAC and lighting, “if you don’t have an efficient envelope, all of that is for naught.”

What makes EPS unique is that it can be manufactured into a number of sizes and shapes to accommodate the design on a construction project and can also be made into varying R values based on the density of the material, which affects the strength of the material, says Kiesecker.

“In some cases, you may want to use a 60 psi on a roof deck because of pavers or there’s going to be roof access, or it could be a green roof where you may want to use only a 15 psi where it’s going to be used as a sheeting or a cavity wall on a building,” he adds.

Improving or increasing the efficiency of the insulation

By 2035, 80% of the country’s electricity will come from an array of clean energy sources.
allows a mechanical engineer to reduce the size of the mechanical unit to heat or cool a building, Kiesecker says. One such product to help do that is ACH Foam Technologies’ Nailbase Roof Insulation, a nailable panel of exposure I-rated oriented strand board and UL (Underwriters Laboratories) classified Foam-Control EPS roof insulation. It serves as a roof insulation and nailable roofing surface over structural roof decks.

**Reductions and Savings**

Fort Knox is a standout in Louisville, KY, for having reduced its energy use by 41% in the past 20 years while other businesses and military bases were increasing consumption. The reason: the deployment of geothermal heat pump systems, building automation technology, and other building and equipment upgrades installed by Harshaw Trane, an intelligent building technology and energy services provider with a focus on commercial and institutional buildings. The company is an Energy Star Product and Service Provider and a founding member of the Kentucky chapter of the US Green Building Council.

According to Pat Walsh, Fort Knox Public Works Director, the upgrades have reduced the carbon footprint at the 109,000-acre post while also helping to prevent mold common in buildings in the region. The upgrades are mostly internal and mechanical but also include the installation of energy-efficient windows in the building’s envelope. Other upgrades include a new boiler system at the hospital; low-flow toilets, faucet retrofits, and a golf course water collection pond for irrigation; geothermal heat pump systems with a common well field for cooling and heating 4 million square feet of building space; and energy-efficient lighting systems that harvest natural light when available and use occupancy sensors.

The total decrease in energy consumption has saved Fort Knox more than $10 million in energy costs annually and has reduced power plant emissions by 55,878 metric tons of carbon dioxide, 67 metric tons of nitrous oxide, and 76,731 metric tons of greenhouse gases. The upgrades are augmented by Trane’s Tracer Summit computer and control system, which monitors the air quality and temperature of more than 6 million square feet of space in approximately 250 buildings and sustainability services to keep systems running at peak performance.

Tom Abele, vice president of business development for Harshaw Trane, says even though there has been a federal EPAct policy requiring BTU density reduction in federal facilities, Fort Knox has been taking that stance long before that by having a designated energy manager, and have entered into an energy conservation order number 108, reflecting the number of their overall energy conservation orders.

Harshaw Trane’s energy services team’s focus has encompassed lighting and envelope projects. “At the centerpiece of the greatest BTU density reduction has been two strategies: geothermal technologies and building automation,” says Abele. “Coupled with building automation is what we call intelligent services, which is a carousel of retro-commissioning, or what we call continuous commissioning applications.

“One of the greatest opportunities in the future is for companies like ours and others to continue to perfect software applications that run continuous commissioning routines on buildings so that exceptions can be identified extremely quickly and dealt with,” says Abele.

Fort Knox, Harshaw Trane—through hundreds of thousands of data points on nearly 500 gas and electric meters—is able to run an energy density and demand profile and on a per building basis can set thresholds and annual goals through software, “and bring a high degree of transparency to how buildings are performing,” says Abele.

**HVAC, ROI, and the Smart Grid**

Abele points out that the interrelationship between the building envelope, lighting, and HVAC systems establishes the thermal load. “When we’re talking about commercial office space—assuming that the lighting is relatively modern
with T-8 technology, and assuming plug load is traditional in a traditional office space—HVAC will represent upwards of 70% of the consumption in the building. It absolutely dictates what happens with demand.

“The symbiotic relationship between HVAC and thermal loads is in direct proportion to the condition of the envelope,” he adds. “When we’re approaching a building, we start with the envelope to ensure it is as tight and thermally efficient as possible, which then allows you to size the HVAC systems most appropriately to the building load, assuming a building with a great deal of exposure.”

Abele echoes the stance of other experts in that the standalone payback on envelope projects such as windows and insulation—particularly wall insulation in getting the building sealed up, including vestibules, double doors, revolving doors, and using pressurization techniques—“is not going to fit the typical investors’ expectations when it comes to energy projects. In the education market, we see the longest paybacks accepted, particularly when the energy is used to fund infrastructure improvement.

“In the commercial sector, for-profit health care, commercial office space, or industrials, typically, when it comes to competition for capital funds or even the debt service, payback expectations are much, much tighter,” he continues, adding that it could be as little as three and a half years.

“Oftentimes we can augment the energy with some capital cost avoidance operational savings,” he adds. “We typically are able to at least see a ratio of 65% energy and 35% other savings.”

Even so, involving envelope solutions “almost always requires an extreme abuse on the HVAC side,” says Abele. “We confront envelope only when we find the most atrocious HVAC systems that need to be replaced and are operating so inefficiently that it pulls up and spins enough cash flow to fund the envelope, and particularly windows with today’s opportunity in daylighting.”

Harshaw Trane prefers using a small series of light shelves that sit inside the window, as well as ceiling replacement, lighting configuration, and lighting control. “That seems to give us the best return on investment while making the

Bruce Harley is technology director for Conservation Services Group, which promotes a whole house approach, designing programs for electric and gas utilities as well as state or other government agencies that want to cast a wide net to the public.

The programs vary and are client-specific, Harley says. Sometimes, trained auditors visit homes to advise homeowners on their options. In other markets, CSG trains third-party auditors, other energy professionals, or contractors.

Harley has trained builders, architects, and energy raters on how to recognize energy performance problems by looking at snow on a roof, especially snow melt pattern. “You can see when the conditions are right, where specific problems are, what parts of the upstairs or attic is semi-finished and insulated, and how well the insulation is working,” he says. “You can tell sometimes how the roof is framed by looking at the patterns and certainly where the big leaks are.”

Homeowners need to consider whole house performance when cutting energy consumption, Harley says.

“It’s not enough to roll out insulation in an attic, he adds. “You may have big air leaks that run between the house and the attic, and adding insulation didn’t do anything to stop those air leaks. Not only are you missing a big opportunity while doing the insulation work to do it right, but there’s an interesting problem that can happen.”

Once the attic is insulated, the roof temperature is colder, but by not sealing up air leaks, the warm and humid air gets up to the attic because warm air rises. “It’s going to condense water for much more of the winter because it is now colder than it was, and that can create rot, mold, mildew, and real problems that may not have existed in your attic before because you changed the dynamic and weren’t looking at the whole picture,” says Harley.

People mistakenly think insulation will block the air flow. “It doesn’t work that way,” says Harley. “You’re missing an opportunity that would be really inexpensive before you insulate: just lift up old insulation that’s there and block up the holes you can stick your arm through, or even crawl into.”

While an HVAC contractor will typically consider ways to fix malfunctioning equipment, “They’re not looking at the duct work to see if it’s leaking or whether the equipment is sized properly,” he says. “They’re not looking at whether there is some big flaw in the building enclosure that’s causing the comfort complaint, whereas very seldom does the comfort complaint result from equipment that’s too small.”

Rather, it could be improperly sized ducts, leaks in the ducts, or system imbalance, Harley says. “If they’re learning the whole house approach, they can take that all into account. Not only can they connect the homeowner with more kinds of incentives and tax credits that help pay for the whole job, but that contractor may actually be selling a bigger job, even though some of it is to subcontractors.”

A drawback in the typical approach is that a property owner thinks once they’ve had an energy audit, that’s all they need to do, Harley says. A study in Massachusetts revealed that even with an energy audit, there was no significant follow-through.

Part of the whole house approach is designing a program connecting customers with those doing the work, Harley points out.

As for ROIs, Harley says there are a few different ways of viewing a long-term payback—one is to consider cash flow instead of simple payback. Harley finds it ironic that people will invest in a kitchen remodel, for example, without thinking about a payback, but don’t transfer the same thought process to energy efficiency improvements.

“Obviously if you can reduce the initial cost, that helps,” he says. “We currently have a fairly unprecedented combination of state and federal tax credits and various utility incentives that help people cover part of the costs of work.”

If incentives are not covering a large portion of work, many people take out consumer loans to pay for it, Harley adds. “If you look at the debt payment compared to the savings, then the return, in terms of the time period it takes to recapture the investment, is almost irrelevant. If the energy savings are bigger than the debt payment, you get positive cash flow from the first year. You’re living in a more efficient, more comfortable, healthier house, and you’re getting paid to do that from day one. When the debt is paid off, then it’s even better.”

Harley favors the PACE program as a viable option to finance energy efficiency measures. “There was a problem with it because the secondary mortgage market was concerned that this would create a second lien that may in fact supersede the primary mortgage holder and cause problems for them if there was a default,” he says.

But he disagrees. “People are actually less likely to default if their energy costs are lower. The other point is it was never the intention that this funding mechanism would be the first in line lien
holder when there was a default.”

Harley says there has been some work—backed by real data on default cases—on rewriting the legislation or proposed rules in a state-by-state and municipality basis that would make it clear that the mortgage lenders are going to be the first in line to get paid when there’s a problem. “I think it’s an exciting idea because it makes it affordable for consumers right now and makes sure the cost is shared on a prorated basis by whoever lives in the house over a long period of time, which makes sense because they are the ones who benefit from the energy savings. And it doesn’t cost municipalities anything extra. It doesn’t change the tax base and the tax burden in communities, but it’s a way of instituting positive measures.”

Just as important as a whole house approach to energy efficiency measures is the financing to pay for them, Harley says. “Whether it’s PACE or any other kind of program people are looking at, if you can bundle together more measures and look at the total cash flow and payback rather than just measure by measure, sometimes you can get a package that meets the cost-effectiveness criteria and accomplishes more in energy savings even though some individual components of that package may not fare quite so well as some of the other ones.”

He adds that energy-efficient measures will become more cost effective against the volatility of energy prices and the potential for large increases. “There’s been more interest in low-energy homes and low-energy retrofits with the Thousand Home Challenge through Affordable Comfort Inc., and with net-zero energy new construction and renovation.”

Harley is a proponent of piggybacking energy efficiency on existing renovation projects.

Going forward, the development of better tools for tracking properties will enhance energy efficiency efforts, Harley says. “We’re seeing a maturing in the industry of the tools that people have to analyze houses. For example, the Building Performance Institute is now working on standard analyzing building data and bringing the savings estimate into line by using utility bill history.

“There’s an ASHRAE [American Society of Heating, Refrigerating, and Air-Conditioning Engineers] guideline for billing calibration. It’s meant for engineering analysis of commercial facilities. We’re trying to scale it down to a residential level and add reasonable performance metrics to it so we can try to rein in people’s savings predictions based on reality whenever that reality is available.”

most dramatic improvements for comfort,” says Abele.

Going forward, high level transparency in building performance will be critical, Abele says. “We’ve built an applet that measures daily Energy Star performance. The software has the same engine that the United States Department of Energy site has to establish Energy Star. The greatest issue that we have, as an energy services provider, is clients who buy energy solutions and then, on the back end, have no idea of whether they are receiving the savings or not.”

Abele says it’s important to have proof points for performance and to rally behavioral change for those “who don’t have to pay the bill.

“They’ve got to have some means of visibility,” he contends. “These software applications can be educational. They can be posted in a variety of areas. I can look at one of these applications, and, in nothing more than a few seconds, I can tell if a building has been performing well that day and if it’s performing well over the last week, the last month, and so forth.”

Another critical factor in addressing the national grid challenge going forward is demand control, he says. “Very few owners of buildings understand how demand is billed, how to manage it, when it’s happening, how to get their arms around it, and what the future is going to look like in terms of time-of-day rate pricing.”

Demand management comes through a series of strategies that include combined heat and power, thermal storage, load limiting, and proper scheduling, he says.

One of the issues facing Fort Knox is its score card for BTU density reduction success. “Their utility bill has crossed a threshold—more than 51% of their bill is based on demand,” says Abele. “It’s reached a point that if energy density is our driver, then we’ll continue to go down this path, but if financial performance takes precedence, we need to start considering sacrificing some consumption for the sake of demand reduction. It creates a real dilemma.”

Abele says many energy service providers “are purely focused on consumption. They still frequently work on a financial basis of a blended rate, and the reality, for many energy conserva-

Utilities

Utilities are offering incentives for building owners to incorporate energy-efficient upgrades. Southern California Edison (SCE) started offering up to $10,000 in free energy upgrades to small businesses in select southern California communities in January, continuing the program in other cities through 2011. The Direct Install survey, equipment, and installation are targeted to qualifying small businesses that draw less than 100 kW. SCE-approved professional contractors visit the businesses, conduct a brief energy-use survey, and make recommendations for free upgrades. The upgrades include window film, occupancy sensors, fluorescent lighting, programmable thermostats, and refrigeration measures such as door closers, suction-line insulation, and strip curtains.

Utility companies are ramping up efforts to participate in energy efficiency programs. Con Edison did so when it hosted its first energy efficiency summit in June, featuring experts across the board including those in building envelope performance.

“We talk to other utilities around the country that have much more mature programs about how they
The approach to the role of windows in a building envelope has changed over time. Joe Murray, a principle design architect with IDC Architects, a wholly owned subsidiary of CH2M Hill, points out that during the 1970s energy crisis, the area of windows in buildings was greatly reduced. “Then they put reflective films on it to avoid heat gain inside the office building,” he says. “Because we have much better-performing glazing systems today, windows now are commonly double-glazed, not triple-glazed. They usually have a coating on the inside that helps reduce the ultraviolet infrared heat gain through the wall but allows the visible light to come in through the glass.

“Today’s design for sustainable buildings pushes a lot more towards more windows to bring more daylight into the space, particularly in commercial office buildings,” he says.

Artificial lighting inside of commercial office buildings is one of the largest energy consumers, says Murray. In one project, IDC designed the entire building for what the architects called “a vessel for capturing light,” says Murray. The company’s previous building had been a warehouse without windows and the employees “hated it”, he adds.

“They went to this new site with beautiful trees, and they wanted a lot of windows,” he says. “We designed big windows with roller shading devices on the outside so it would reflect and keep the glaring light from coming into the building and soften the light.”

Light sensors tied to the artificial lighting dim the lights down when the outside light is bright enough to where occupants don’t need the artificial lighting as much, greatly reducing the lighting energy consumption. Like so many architectural firms, IDC is redesigning the “typical” office layout where executive spaces are on the perimeter, encompassing a cubic-like inner office area. That’s what IDC has done in a project for Bayer AG. “We’re removing all of the closed offices into the middle of the building, giving them glass fronts so they get daylight outside and put all of the open cubicule areas on the perimeter,” Murray says. “The idea is that everybody gets access to daylight and views.”

Building owners and operators seek to maintain a comfortable environment for their workers and patrons, so typically it means the ambient air temperature must be kept between 74°F to 78°F, says Mike Turner, vice president of marketing for YKK AP America. “This is one of the largest reasons that buildings are such a large part of the US energy consumption,” he says. “In climates that have extreme cold or heat conditions, the building envelope plays an important role of minimizing heat transfer.”

While there are a variety of ways to improve the insulating properties of the roof and wall, it is equally important to provide efficient windows within the wall, Turner says. “In office and school buildings, productivity and learning improves by providing natural light and a connection to the outdoors. In retail buildings, windows allow merchandise to be showcased to the public and invite the public into their store. In medical buildings, the natural light provides a calming environment for patients to assist in their recovery.

“Windows, whether in form of curtain walls, storefronts, operable windows, or skylights, have an important function for the building,” he continues. “At the same time, they also must provide a level of insulation so that the energy used to condition the space does not flow out the window.”

With the US Department of Energy pushing to create net-zero construction in 2020, energy codes and green standards have been forcing improvements in the thermal performance of fenestration systems, says Turner. In 2009, YKK AP America launched a new family of products called enerGacade, which includes a wide variety of products typically found on the building envelope, such as entrance doors, storefronts, curtain walls, windows, sun shades, and light shelves.

“What makes these products different than our other systems is that they incorporate design elements to greatly reduce the amount of heat transfer,” says Turner. “It is important that architects have a suite to choose from as most commercial buildings require a variety of products to integrate with the rest of the building envelope to bring their design concepts to reality.”

As part of the enerGacade product group, YKK AP America also developed framing products that incorporate multiple thermal barriers to improve their ability to minimize heat transfer by as much as 64% over standard thermally broken products. “These products include the industry’s first architectural (AW) grade window system to achieve a 0.35 U-factor with standard glass—YOW 350 XT,” says Turner. “We have also launched the next generation of storefront that incorporates two thermal barriers—YES 45 XT and our advanced curtain wall system that incorporates multiple widths of polyamide strips to achieve superior thermal performance.

“All of these products are considered advanced systems and will meet the next generation of energy codes with standard low-e glass,” adds Turner. “They establish a new baseline of performance and allow designers to achieve even greater performance by integrating advanced glass, such as gas infills, warm edge spacers, triple glazing, and suspended film.”

These new products have improved the return on investment (ROI), Turner says. “The improvement of the framing system provides significant performance improvements with standard glass types,” he says. “For example, YKK AP’s advanced storefront system, YES 45 XT, provides nearly a 20% improvement in thermal performance when used with standard low-e glass types. Greater efficiencies can be realized with advanced glass. Their paybacks would have to be analyzed with the heating and cooling loads of the building ROI and could vary between two to ten years.”

Turner says the first step going forward is to tighten up the building to reduce the energy loss through its envelope. “The next obvious step will be to expand the integration of energy-producing systems with fenestration and sun control devices. This development, along with the continued improvements of other building products, HVAC systems and controls, will allow our industry to achieve net-zero construction in mainstream construction.”

The latest of the product innovations that have come forth from 3M’s Renewable Energy Division is the Exterior Window Film Prestige Series. Suitable for new buildings and retrofits, the window film comes in three gradients and is applied to the window’s exterior to reduce the risk of thermal stress, particularly on windows with multiple glass panels.

The ultra thin layers are designed to block up to 99.9% of damaging UV rays and provide heat control and glare reduction while preserving exterior and interior window views. “That particular technology utilizes something we call multilayer optical film,” says Doug Huntley, laboratory manager for the 3M Renewable Energy Division.

“It’s inspired by nature,” he adds. “If you look at the Morpho butterfly, you’re able to get very unique optical effects. It gives out a very blue color, but it has no pigment or inks in it that gives it that blue.”

“It actually has a precise structure in the wings that interacts with light to give off that color. We were able to precisely layer all of our materials together to
be able to reflect infrared heat very efficiently and yet still let the light through.”

The technology can be applied not only to new construction, but as a retrofit as well. “There are a lot of inefficient windows out there today,” he says. “We can apply our film technology to an existing window, and, with very little disruption and very reasonable costs, we can upgrade the efficiency of the building envelope.”

A typical ROI is two to five years, depending on the number of windows in a building, its location, and the glass type, Huntley says. He states that there are a number of utility companies that give rebates for window film. Additionally, many of the films also incorporate a safety and security element. “Glass is a wonderful material that enables us to be connected to the outside world,” says Huntley. “It brings natural light into a building, and yet inherently, glass isn’t that energy efficient. It’s not a sturdy material in terms of impact resistance, so we apply our films also to give storm protection, smash and grab protection, human impact protection—we even have cases where it’s applied for bomb blast protection.”

There’s a human element interwoven in the use of windows for energy efficiency, Murray points out. “There is a lot of research going on right now that confirms that being exposed to daylight and views has a very positive health impact on people,” he says. “There are a lot of empirical studies that have compared hospital rooms with different patients—one that has a view to green grass, blue sky, and daylight, and another one maybe has a view to a brick wall. They have found that people with the nice view and good daylight tend to heal more quickly and require less pain medication.”

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reduce those emissions.”

Pospisil calls the building envelope “a tough nut to crack, because even though it’s very visible, it’s invisible to building occupants, building managers, and property owners.

“If you’re behind the walls, up in the attic, or in crawl spaces just putting in insulation, it may have significant positive impact on energy use, but it’s not very visible, so it’s difficult to get people to make that investment,” he adds.

The Empire State Building’s window retrofit was a visible example, Pospisil points out.

He adds that Con Ed has had success with window films for those who don’t want to make a full investment in a window replacement but still seek substantial reductions in reducing a building’s cooling loads.

In addition to programs that provide incentives and rebates for measures undertaken by customers, Con Ed also provides cofunding for studies that seek solutions to building problems, including the building envelope.

Con Ed has a rebate program for well-defined prescriptive measures as well as innovative measures based on the calculated savings going forward. Because Con Ed also is a gas and steam utility, its programs extend to those sectors as well.

“When we look at improving an existing building, we really think the building envelope is the first thing that needs to be addressed,” says Pospisil. “Once you can improve that building envelope and make its performance as high as you can within financial reason, then the next thing you can do is properly size the building systems. If you don’t improve the building envelope, you’re going to put in systems that are larger than they need to be than if you actually improve the envelope.

“Once you have a very efficient building envelope with very efficient systems within it, then you can actually think about renewable energy because then you know what the right size would be.”

Pospisil believes tenants in New York will start shopping for efficiency because of the city’s Greener, Greater Buildings Plan. Established in 2009, the plan created a comprehensive set of efficiency laws, including requiring annual energy efficiency benchmarking to be disclosed to the public and mandating a set of cost-effective energy efficiency upgrades and evaluations of 16,000 of the city’s largest public and private buildings.

“We’re already hearing about a competitive nature among big portfolio owners who are very concerned their portfolio is going to show up as deficient compared to others once this all becomes public,” says Pospisil. “We have a lot of opportunities in our programs, which folks are trying to use to make improvements as soon as they can.

“There’s an improving economy, so we’re seeing some capital being released that we didn’t see last year, and we have a nicely funded portfolio of programs we can bring to help companies and building owners improve their systems. We think now is the time to act.”

Carol Brzozowski writes frequently on onsite power and energy reliability for Distributed Energy.