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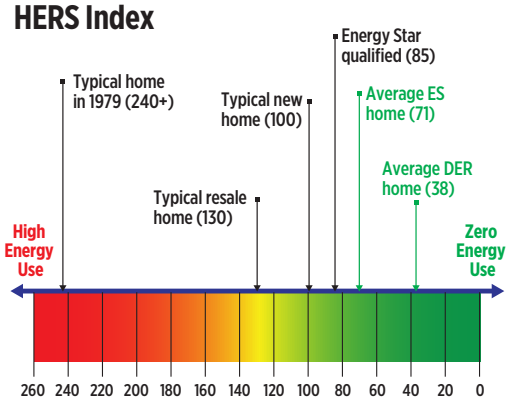

Features

ON THE COVER: Ben Canavan, a PV technician with Cotuit Solar in Cotuit, Mass., positions a module within a 9-kw residential array. See the story on page 29. Photo by Dave Holbrook.

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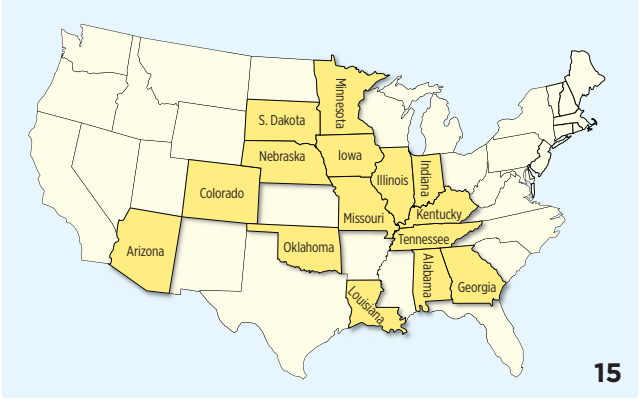

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Letters

The following excerpts were taken from comments posted on JLC*'s website. To see the articles referenced, visit jlconline.com.*

"Breaking Through the Language Barrier," by Mike Shannahan, *JLC* (10/12)

So a company is looking for people to make parts for them and several people are hired. After awhile, the management realizes the new hires are [not] making the parts ... the way the company has been doing it for 50 years with great success. The management team ... has to decide [whether to] change the whole process for the sake of the added employees or advise them to do the work the way it has been successfully done for many years. The management team makes a simple decision. Why make more changes to what already is proven to accommodate a few? Why are we encouraging this way of thinking and rewarding people who refuse to learn the skills it takes to do the job? Find the glove to fit the hand, don't modify the hand to fit the glove. — *Mike Lacko*

I agree with Mike. My parents immigrated to this country back in the mid-60s. They learned the language and culture and they have done rather well. Why should we change our lifestyle to accommodate others ... I refuse to learn another language so that I can communicate to others in their native tongue so I can work. Let them learn like my parents and others like them. — *Mike Soto*

I take a little different perspective in that my objective is to communicate with a large segment of our population, and not to pontificate on some notion that English is the only language spoken in the USA just because English-speaking soldiers wiped out everyone else to a large extent. When I travel to Asia or Europe (France excepted), people speak English as well as their native tongue. Only in France do the people share our arrogance and ignorance. — *elkhornsun*

[Learning a second language] makes you a more educated person and gives you skills that can benefit your company. Many Hispanic clients will use people they can converse with in their native tongue. I learned French in high school and have never been sorry. I now live in Texas, so I wish I had invested that time in Spanish. I don't think that educating yourself is ever a waste or bending to the will of others. Not only that, but I like the fact that you know what is being said in your presence in another language. — *Right Way*

I am a GC in California and I can say from experience that anyone who can communicate in both Spanish and English makes an average of $2 more an hour. That may not seem like much until you start to look at an entire year (2,080 hours). Four thousand plus a year is quite a return on investment, not to mention the relationships you can build among the workforce. — *Old Guy*

"Chaos on Long Island," by Ted Cushman, *Coastal Contractor* (11/1/12)

What helped a great deal after the 1989 Loma Prieta earthquake in California was the presence of the California Conservation Corps that Governor Jerry Brown created and modeled after the WPA and CCC of Franklin Roosevelt. It is composed of workers who have little construction or repair knowledge, but who worked to clear trees, get refrigerators upright, put tarps over roofs, board up windows, and other low-skill but invaluable tasks. This is where the Red Cross and FEMA and the National Guard are worthless ... dealing with immediate problems faced by residents in the affected areas.

It also shows the folly of depending 100% on centrally generated power and centrally distributed gasoline, and using motor vehicles for 100% of the transportation of people and goods. If insanity is continuing to take the same course of action and expecting different results, then we are one insane nation. — *elkhornsun*

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Roofers Face Flood of New State Laws

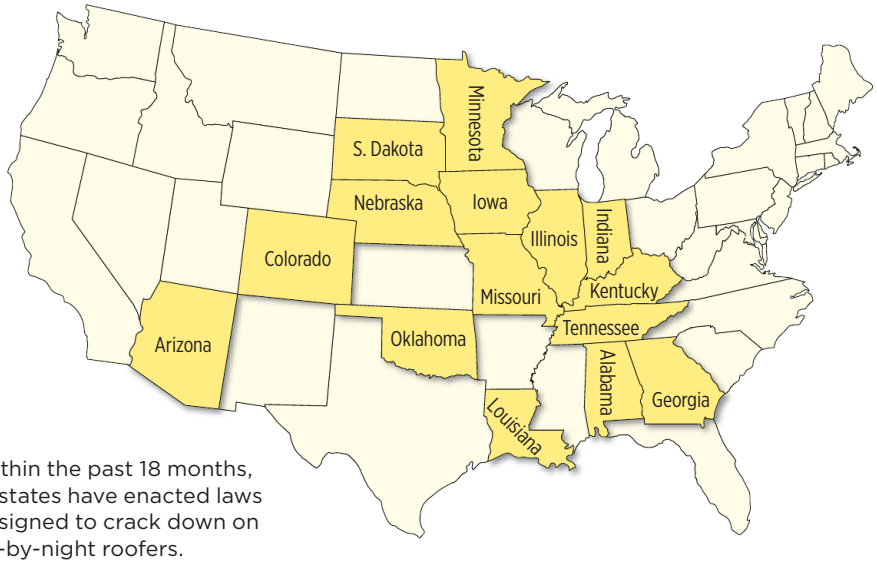
Roofing contractors in more than a dozen states are adjusting their business practices to comply with recently enacted laws intended to protect consumers from unscrupulous "storm-chasers." Alabama, Arizona, Colorado, Georgia, Indiana, Illinois, Iowa, Kentucky, Oklahoma, Louisiana, Minnesota, Missouri, Nebraska, South Dakota, and Tennessee have all enacted such laws within the past year and a half.

The new laws vary somewhat in detail, but most include one or more of the following provisions:

- A requirement that roofers provide written estimates of work to be performed and obtain a signed contract before starting (in several states, including Louisiana and Illinois, the laws cover all remodeling and home-improvement contracting, not just roofing).
- A specified "grace period" — typically 72 hours from when the contract is signed — during which consumers can cancel a roofing contract without penalty.
- An additional grace period — again, most often 72 hours — that begins if and when the homeowner's insurance carrier denies a claim that was to have covered the work in question.
- A requirement that contractors refund any deposit or other payment made by the homeowner if a project is cancelled under either of the 72-hour provisions above.
- A prohibition against waiving or rebating the deductible portion of the homeowner's insurance.

Who benefits? Some contractors support the new laws without reservation. "Conscientious roofers think it's a good thing," says Frederick, Colo., roofer Scott Kawulok. "The Colorado Roofer's Association has been behind it from the beginning."

But others aren't so sure. Shreveport, La., restoration contractor George "Geep" Moore says he understands the reasoning behind his state's law, which took effect



Within the past 18 months, 15 states have enacted laws designed to crack down on fly-by-night roofers.

Future shock. Under a building-code change that took effect on January 1, Boulder County, Colo., builders are required to either: 1) install PV or solar-thermal panels in all detached single-family homes, or 2) upgrade the plumbing or wiring to permit their installation in the future. The revised code also requires a Level 2 240-volt electric-vehicle charging outlet, or wiring or conduit to allow one to be installed later.

Lumber prices on the rise. In an encouraging — if not entirely welcome — indication that the building industry is gathering steam, framing-lumber prices have climbed sharply in recent months, with the commodity price per thousand board feet of softwood framing lumber hovering near the $400 mark, compared with about $280 a year ago. Industry experts expect the upward trend to moderate as large Canadian mills shuttered during the housing bust reopen and take up the slack.

Containerized homes. A Los Angeles–based startup called Connect Homes has added a new wrinkle to the recent architectural fad of converting used shipping containers into housing: The company is designing high-end homes that fit snugly *inside* a standard 8-foot-by-40-foot shipping container. The canned modules can then be shipped anywhere in the world for as little as $5,000, the company says.

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in August 2012: "After a storm, you'll have contractors showing up who will tell the homeowner, 'Yes, that damage will be covered by insurance, and we'll waive the deductible if you sign right now.' Then after they're gone and the claim is denied, the homeowner is out the cost of the new roof." But he's exasperated by the law's complexity and worries that insurance companies, not homeowners, may stand to reap most of its benefits. "We're trying to protect ourselves by rewording our contracts," he says, "but there's still a lot of uncertainty about it."

Denver attorney Daniel Glasser — who recently wrote a two-part feature about Colorado's new roofing law for *Cleaning & Restoration* magazine (restorationindustry.org) — believes that contractors are right to be concerned. For example, he notes that the mandated 72-hour contract-cancellation period could open the door to widespread "poaching" by unscrupulous contractors looking to undercut others on price. (It's technically illegal for a contractor to knowingly interfere with an existing agreement, but such rules are unlikely to matter to fly-by-night operators.)

The law also complicates cash flow by requiring contractors to "hold in trust any payment from the property owner until the roofing contractor has delivered roofing materials ... or has performed a majority of the roofing work on the residential property." To be sure that they're in compliance, Glasser says, contractors should consider keeping initial payments from residential projects in a separate account, and transfer them to an operating account only when a project is substantially complete. — *Jon Vara*

NAHB Petitions OSHA to Reopen Construction Fall-Protection Standard

In December, OSHA announced a three-month extension of its temporary enforcement guidelines for residential fall protection. That marked the fourth consecutive short-term extension of the guidelines since the new fall-protection rule — generally referred to as Subpart M — was fully implemented in September 2011. The guidelines are now set to expire on March 15. (Builders who have grown

comfortable with those repeated extensions should remember that the fall-protection rules themselves are still very much in effect — the temporary enforcement guidelines simply hold out the possibility of mitigated penalties for builders who have made good-faith efforts to comply.)

This latest extension will probably benefit some builders who are still struggling to comply with the rule. But the evident need for yet another extension also lends credence to what critics of Subpart M have been saying all along: that the rule is too complicated and difficult to use effectively on the job site.

Layered protection and a 15-foot limit. Fortunately, there's reason to hope that an easier-to-follow version of Subpart M may be in the offing. On December 7 — at about the same time that OSHA was announcing the latest enforcement-guideline extension — NAHB delivered a 40-page petition to the agency, asking it to reopen and amend the standard itself. In an accompanying letter, the association urged OSHA to adopt "a layered, risk-based approach to fall protection."

Among other matters, the NAHB proposal calls for a reexamination of the working height above a lower level that triggers the need for fall protection. NAHB safety expert Rob Matuga suggests that the 6-foot height limit in the current federal rule hasn't worked very well. "We know from talking to people that it's difficult to get them to take the 6-foot distance seriously. They just don't see it as much of a hazard," he says.

Instead, the NAHB proposal calls for a trigger height of 15 feet for certain tasks. That figure, Matuga notes, was not chosen arbitrarily: Residential builders in California — where a state-administered OSHA standard is in effect — already use a 15-foot limit, as does OSHA's current federal rule for steel erection.

Come together. Sometime this winter, according to Matuga, NAHB and OSHA will likely meet to discuss the proposal. And while any actual changes to the rule probably won't be finalized for years — if they happen at all — the two organizations have successfully teamed up on the same issue in the past. (NAHB, in fact, spoke out in favor of scrapping the old interim fall-protection rule in favor of Subpart M.)

"If we can make the standard easier to comply with, that will be better for everyone," Matuga says. — *J.V.*

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by Gary Striegler

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The hood that's shown in the photos was part of a modest kitchen upgrade. It was designed to fit between existing cabinets and consists of a rectangular base that supports the fan and a sloping cap that conceals the ductwork.

To work up the design, I made a full-scale drawing on a sheet of plywood. The dimensions for the bottom were determined by the available space between the wall cabinets. The slope of the top section was governed by the size of the ductwork.

I used the drawing as a pattern to lay out and cut the ¾-inch by 2-inch clear poplar that would form the frames for the three facets of the top section **(1)**. I assembled these frames on top of the drawing, using a Kreg jig and pocket screws to form sturdy butt joints, then back-beveled the bottom of each panel so it would rest squarely on the base **(2)**.

The visible portion of the base was formed by three pieces of ¾-inch by 9-inch poplar; the corners were mitered and fastened with brads and glue. A 5-inch-wide poplar stretcher on the back tied it all together **(3)**. Last, a solid piece of ¾-inch birch veneer plywood (cut out for the hood liner) was inserted at the bottom and fastened to the sides with pocket screws.

The three parts of the top section were butt-jointed and fastened with pocket screws and glue **(4)**. The top was nailed to the base using brads driven through beveled


5


6


7


8

cleats that conformed to the slope of the hood **(5)**, and a stretcher was placed between the tops of the side panels.

I used ¾-inch birch veneer plywood for the recessed panels. The ones on the side were simply cut to overlap the frame, then glued and nailed through the back with staples. I needed to use the front one for access to hook up the blower, so I undersized it by ⅛ inch. Plywood cleats on top of ¾-inch spacers provided a recessed fastening surface **(6)**. I tacked the panel temporarily to the cleats with 23-gauge headless pins, then started cutting trim.

Since none of the cuts for the 1⅛-inch by ¾-inch panel molding were 45-degree angles, I used a scrap piece to trace where the molding met in the corners and to determine the intersecting angles **(7)**. I nailed the side panel moldings tight, but only tacked those for the front. The last thing I did in the shop was fasten a pair of cleats alongside the plywood cutout to support the fan liner **(8)**.

At the job site, I removed the front panel and trim. Then I lifted the hood into position and fastened it to the studs and the side cabinets. After the mechanical contractors hooked up and wired the fan, I was able to replace the front panel and complete the trim. On this job, I made a plywood box to cover the gap between the hood and the sloping ceiling, and trimmed the remaining joints with panel molding **(9)**.


9

***Gary Striegler** is a builder in Fayetteville, Ark.*

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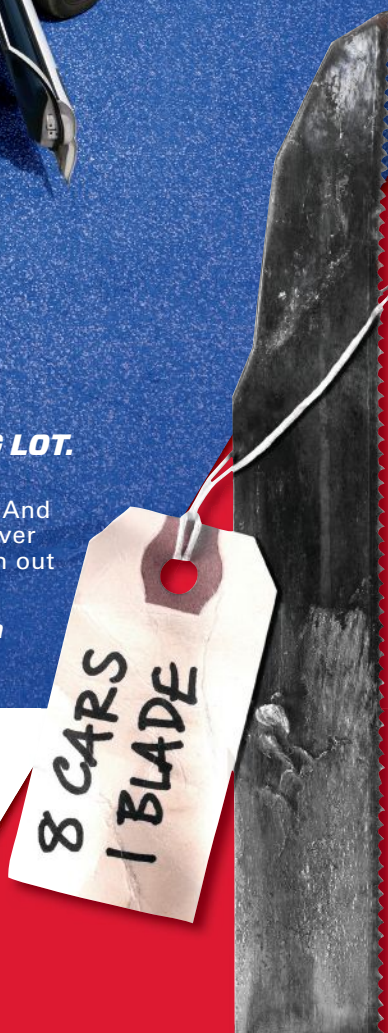

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Improving Door Clearance

by Robert Criner

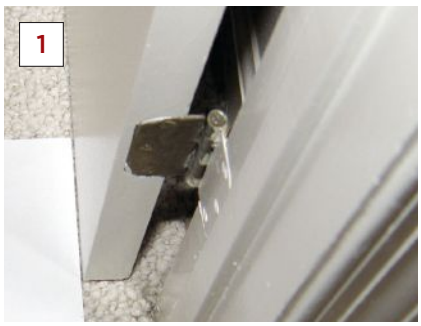
We recently did a complete bathroom remodel, including a curbless shower, for an older client. Because he was beginning to have some mobility problems, we wanted to widen the doorway so he could pass through it with a walker or wheelchair.

Unfortunately, the existing opening took up all the available space, with barely room on the hinge side of the door for a narrow strip of trim **(1)**. There was no way to stretch the budget enough to relocate the wall, so instead we came up with a two-step approach that widened the opening by about 2 inches at very low cost. Here's how we did it.

First, we replaced the existing butt hinges with a set of offset hinges, also known as swing-away or wide-throw hinges. It doesn't get any easier than this — you just unscrew the original hinges and screw in the new ones, using the same holes and mortises. When you're done, the door can swing completely out of the opening **(2)**. Lowe's has these hinges in a variety of finishes, or you can order them from one of the specialty suppliers listed in the box below.

If there's a reasonable amount of open space on the hinge side of the door, offset hinges alone may provide all the clearance you need. But we had so little to work with here — barely more than the 3-inch minimum needed for the offset hinge pins — that we also framed a small recess in the wall after we'd removed the old drywall. This space (which our tile guy later finished to look like a shower niche) accommodates the doorknob, allowing the door to sit parallel to the wall when fully opened **(3)**. If necessary, it will be easy to gain another inch of clearance later by removing the stop molding on each side of the doorway up to wheelchair height.

Robert Criner *owns Criner Remodeling in Newport News, Va.*



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Adapting to Market Price Fluctuations

by Dennis Dixon

Nothing is static in the world of construction materials and services. The marketplace is always changing in response to local and global economic conditions, federal and state legislation, even the weather. To stay viable, your construction business must be able to accommodate those changes.

For an example of marketplace conditions that have an impact on our industry, think about oil prices. They don't just affect the prices of oil-based products; the cost of fuel affects the transportation costs of everything, including getting your crew to and from your job sites. And even when fuel prices are stable, contractors often forget that freight charges for heavy items like steel or glulam beams, granite slabs, brick, drywall, and a host of other materials add costs that must be accounted for in the estimate.

Before Work Begins

Here's a short list of things you can do to avoid pricing surprises in the jobs you are currently estimating.

1. Ask your vendors about cost increases. They purchase materials in quantity based on estimated demand, and will usually see price increases coming long before you do. If you are ordering certain materials that might incur a hefty freight charge, consider adding a "freight adjustment percentage" to your contract. It's especially important to keep these kinds of potential upcharges in mind for special-order materials and change orders.

2. Get current pricing for every job. Preparing an estimate for a new project using last month's quote list could eat into your profit. Even a small change is worth noting, because if the price goes up in one cost category, it may also go up in others. A dollar here, a dollar there, and pretty soon you're talking about real money.

3. Plan for contingencies. My cost history for remodeling averages 7% to 12% in expenditures on top of the contract amount. And that's with careful, thorough, anticipatory estimating. I usually recommend to clients that they have a contingency or backup fund, in addition to the amount they've budgeted for the project. If necessary, I can often support this by backing some portion of the work out of the contract and making it optional.

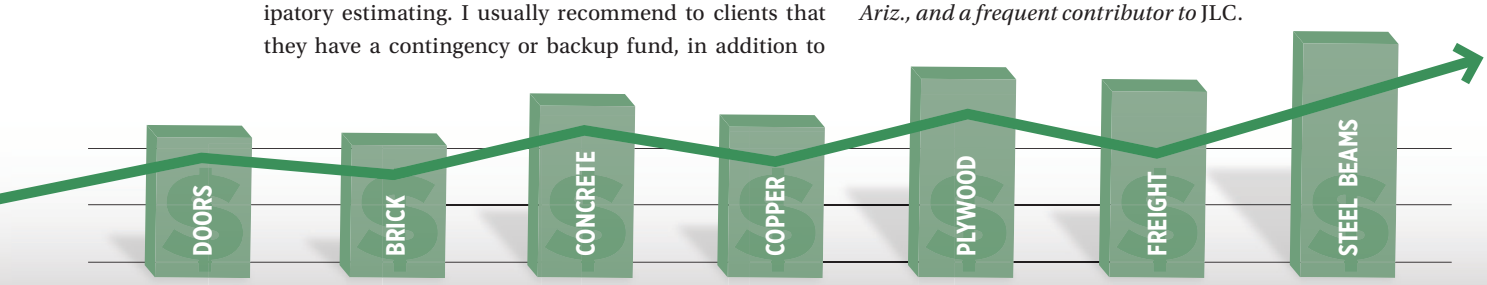
"Not to worry," you may say, "I'm working cost-plus." But you've still given your clients an estimate of what the project will cost, and unless they have literally given you a blank check, cost overruns will come as an unpleasant surprise. If you aren't preparing a line-item budget by cost category, then you're just another "ballpark" estimator. Our clients hire us for our management skills and expertise; ballpark estimators seldom make it to the profit World Series.

After Project Completion

If you finish a job with a significant overrun in one or more cost categories, something was wrong with your job scope or your estimate, or else something is not working properly, like your change-order system. Change orders are particularly troublesome: You're hurt not only by the out-of-pocket loss for unbilled materials and labor, but also by the unpaid cost of any delay in project completion. Because change-order work often extends the completion date, you need to know how much it costs your company to keep a job active. This amount may easily come to $50 or $100 per day or more. Adding a week or two to the schedule can quickly erode your profits.

If you find that pricing for certain items is particularly volatile — as has been the case for copper, concrete, and drywall in recent years — consider adding an "escalation clause" to your contract (see "Managing Material Costs With an Escalation Clause," 12/06). This gives you a built-in way to identify (in advance) items that may fluctuate in price, and ensures that if prices do rise, you aren't left holding the bag.

Dennis Dixon *is a licensed general contractor in Flagstaff, Ariz., and a frequent contributor to* JLC.



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Deck Mounting a Photovoltaic System

With the right design, installation is straightforward and payback time is shorter than ever

by Conrad Geyser

My company has been installing rooftop solar equipment since the 1970s, when the words "solar panel" meant solar hot water, and photovoltaic modules — now commonplace in both residential and commercial settings — were found mostly on satellites, being far too expensive for most earthly projects.

But PV costs have come down to earth. The grid-connected systems we install today typically cost around $4.30 a watt, or about what the PV modules alone cost six years ago. For a 9-kw system like the one shown in this article, that brings the gross cost to $39,000 or so, and municipal, state, and federal incentives may cut the out-of-pocket cost by half or even more (see "SRECS and Tax Credits," next page).

Estimating system output. We use a free solar calculator called PVWatts to develop an accurate preconstruction estimate of a proposed system's output. It's designed for grid-connected systems and is available from the National Renewable Energy Laboratory at nrel.gov/rredc/pvwatts/grid.html. Using it is a matter of plugging in the system parameters and the location and

letting the program run. But because this will give you the expected annual power production on a hypothetical site with full sun throughout the day — and many installations experience partial shading at some point during the solar day — that initial figure has to be de-rated to account for site-specific conditions.

To perform that fine-tuning, we use a solar site-assessment tool called the Solar Pathfinder (solarpathfinder.com). It's a reliable and relatively simple-to-use analog device that lets us factor in local shading from trees and other obstructions. Although more sophisticated — and costly — electronic site-assessment calculators are now available, we've had such good results with our current approach we see no need to change. By the time we've crunched all the numbers, our estimate usually comes in within 5% of the actual production of the installed system — typically on the low side, since we want our customers to be pleased at getting a little more power than expected (rather than the other way around).

Cost and payback. With a kitchen or bath remodel, value is subjective. That's not the case with a PV installation. Our clients tend to be environmentally aware and concerned about issues like global climate change, but at the end of the day their decisions are based on payback expectations measurable in dollars and cents.

To help with those decisions, we provide homeowners with a document that lays out the upfront cost of the system, factors in available incentives and the value of the power produced, and calculates its expected payback time. Most of the systems we install will pay for themselves in five years or less.

Roofing matters. It's important to make sure existing roof shingles have lots of life remaining before covering them with a solar array. We might consider mounting panels on a 10-year-old roof, but if the material is older than that it's a good idea to reroof first. We've removed a lot of solar-thermal and PV systems to permit reroofing before reinstalling them afterward, and this isn't something you want to do more often than you have to.

Interestingly, the roofing beneath the solar array is almost always in vastly better shape than areas exposed to sun, wind, and weather. Unfortunately, unless a house has been designed with available module dimensions in mind, it's seldom possible to extend the life of an entire roof plane by covering it with panels from eaves to ridge. More often than not, obstructions like dormers and partially shaded areas limit the available roof area to some fraction of its overall area.

The project pictured on these pages is typical in that respect. The following photos offer a step-by-step look at how the key details in this installation went together.

SRECs and Tax Credits

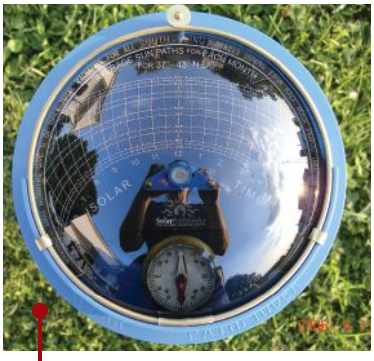
The most obvious financial benefit to a net-metered PV installation is its effect on the electric bill: Every kilowatt-hour the system generates is one less kilowatt-hour the homeowner has to pay for. But other credits and incentives can make residential PV an even better deal. In our area, there are three major sources of funding available to residential PV customers:

• SRECs, or solar renewable energy credits, are available in states that require utilities to provide a certain percentage of their power from renewables. In most cases, it's simpler for the utilities to buy that renewable power from third-party producers — including homeowners and businesses with grid-connected PV systems — than it is to produce it themselves.

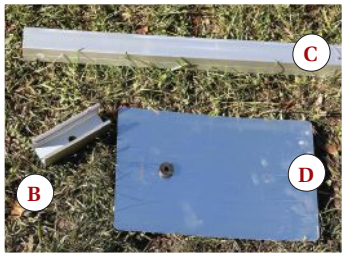
One SREC is equal to 1,000 kwh of electricity, or one megawatt-hour — roughly the amount that a typical 10-kw PV system will generate in a month. Once the system's revenue-grade meter — which tracks the total system production over the life of the PV system — logs 1,000 kwh of production, the owner is credited with one SREC. Normally these are sold through a solar aggregator, which buys the credits from small producers and resells them to utilities. The value of an SREC varies from state to state and in response to supply and demand, but the going rate in Massachusetts is now around $200 each.

• The federal tax credit on a solar system is equal to 30% of the gross cost of the qualifying system. Unlike a tax deduction that reduces the homeowner's taxable income, this is a direct tax credit that is subtracted from his or her tax bill.

• State and municipal incentives may also come into play. For example, residential PV systems in Massachusetts are eligible for a 15% state income tax rebate, and customers of some utilities are eligible for additional rebates of $0.40 to $0.85 per watt toward system installation.



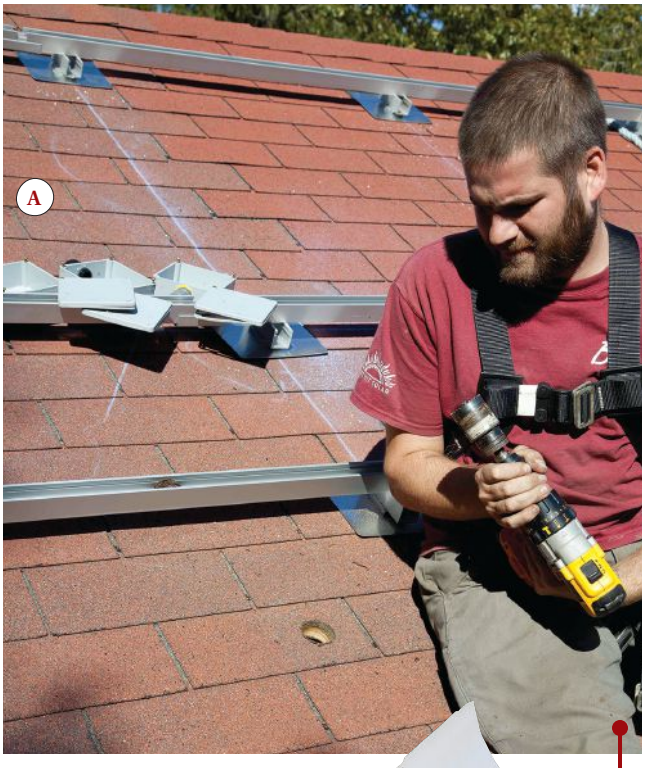
1. The author uses the Solar Pathfinder site-assessment tool at left to evaluate the effect of local shading on a PV array. For optimum power output, the angle of a fixed photovoltaic array should equal the local latitude — about 42 degrees at this Massachusetts site. While the existing roof wasn't a perfect match, it was close enough: PV panels are now cheap enough that it's more cost-effective to install a larger array directly on the roof than to incur the additional cost of angled mounting brackets.



2. After snapping lines marking the position of the rafters, the installer lays out the first extruded-aluminum mounting rails, which will be fastened to each rafter with a 5⁄16-inch hot-dipped lag screw (A). The rails are held off the roof at each connection by a short spacer or "mounting foot" cut from extra railing material (B, C). A manufactured aluminum flashing tab (D) is slipped under the shingle above; its rubber grommet forms a weatherproof seal around the lag.

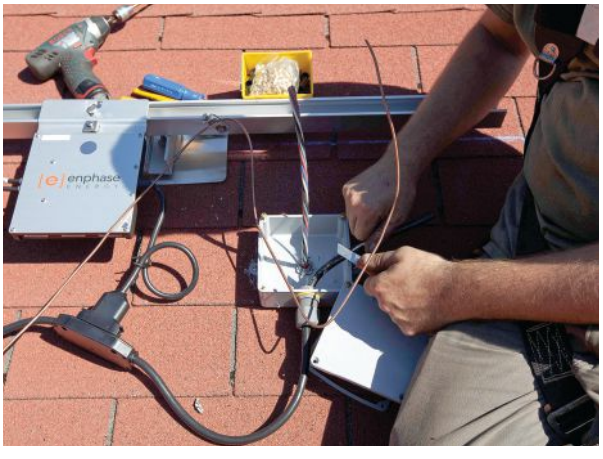
3. Where required, rail sections are joined between mounting feet with splice fittings that allow for necessary thermal expansion and contraction. The fittings add enough flexibility to allow the rails to conform to minor irregularities in the roof plane.

4. Intermodule clips are slipped into tracks as each rail is installed. The clips fit between adjacent modules, securing them to the rails and ensuring a consistent edge-to-edge spacing. Slightly different fittings are installed at the end of each rail.



5. The modules will be grouped in two separate "strings," so only two roof penetrations are required for the entire 38-module array. A waterproof plastic junction box at each penetration is carefully sealed to the shingles with silicone to prevent leaks (A). Two parallel runs of metal-clad cable conduct power from the rooftop array to the service entrance (B). Adhesive stickers identifying the cable as a photovoltaic power source will be attached to the cable at regular intervals, as required by code (C).

6. Each 245-watt PV module is given its own microinverter, which converts the DC output to AC and continuously adjusts the output for maximum wattage. The microinverters also enhance safety by shutting off the flow of power in case of a local outage on the grid. After manufactured module interconnection cables are laid out on the roof (above), a locking waterproof plug at each microinverter is snapped into the adjacent cable fitting, and the cable is connected to the metal-clad cable and module ground wires at the junction box (right).



7. At about 65 inches by 40 inches and 42 pounds, individual modules are easily handled by one worker (far left). Each panel's DC output passes through a pair of wire leads on the back (left).

8. Starting at one end of the mounting rails, workers move modules into position and connect their positive and negative leads to the microinverter input fittings (A). Cables are zip-tied to the rails or module frames as needed to prevent them from rubbing against the shingles or trapping debris (B). Another set of mounting clips is positioned against the outside edge of the module frame, and the sequence is repeated for the next module (C).

9. At the service entrance, the metal-clad cables from the array can just be seen here entering the subpanel at top center. Because the power from the panels has already been converted to AC and synchronized with the grid at each microinverter, there's no need for a large synchronous inverter between the PV subpanel and main breaker box at far left. The utility-grade meter at center tracks the array's power production. The additional box to the right of the meter will contain a data acquisition system, or DAS, which will automatically track production of solar renewable energy credits (SRECs) and send that information to a third-party meter reader.

Trade Restrictions

Installing a photovoltaic system spans a couple of different trades and professions, including roofing, carpentry, and engineering. Most of the remaining work is electrical, and state regulations often dictate who's allowed to do what. In California, for example — where the residential PV industry is well-established — state-licensed solar installers are allowed to do much if not all of a residential installation, including wiring runs.

The situation in Massachusetts, where we work, is more chaotic and less installer-friendly. Thanks to the influence of the electrical worker's union, only licensed electricians are permitted to handle or install any solar components, including racking or any other part that may be used for grounding. This increases costs and doesn't necessarily result in better or safer installations. In fact, because electricians may not be trained in the structural and roofing aspects of an installation, the electrician-only rule may lower the quality of some work. Recently, my company and several others had to take the Board of State Electrical Examiners to court in order to block its attempt to prevent us from contracting this work that we've always done.

There's reason to hope that the state will eventually adopt a more practical licensing system unique to PV installations, although proposed legislation on the subject has been blocked for the past four years.

10. A second meter on the outside wall registers the homeowner's net power use, spinning forward or backward depending on whether the home is drawing power from the grid or supplying it. If more power is produced than used, there's no electric bill that month. A utility-required emergency shutoff switch allows utility workers to confirm that the panels are offline when needed.

11. Layout of the 9.3-kw array (two additional PV modules lie on the far side of the larger gable dormer at right) was based on a thorough shading analysis of the site. Because the structure faces southwest, it receives full sun relatively early in the day for much of the year, but is subject to some late-afternoon shade. (Several trees to the west of the array were later removed to eliminate some shading.)

***Conrad Geyser** is the principal of Cotuit Solar in Cotuit, Mass.*

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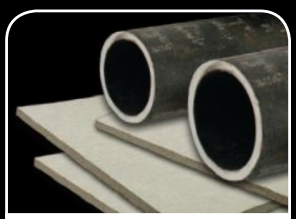

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Building Stem Wall Foundations

Keeping foundations in-house can make scheduling easier and improve job quality

by Tim Uhler

[Editor's note: This is the first part of a two-part story; it provides an overview of foundation layout and describes the author's technique for building footings. Next month the story continues with the completion of the stem walls.]

While I was learning the trades in high school, the carpenters I worked with also built foundations; during one particularly busy period, we formed and poured 10 of them in a month and a half. We were working in a cul-de-sac, and would set up the footings for four houses at a time, then pour them all at once. It was tough work, but it taught me a lot about concrete. About five years ago, I began putting those skills to use again when our company stopped subbing out our foundation work. Now we form and pour all the footings and walls for the homes we build, using the same methods as most of the foundation subs in our area.

Foundation work isn't for everybody. For one thing, it involves an investment in forms and other equipment. Over the years, the company I work for has accumulated about 120 2-foot-by-8-foot forms and an assortment of cut pieces. Currently,

Figure 1. When laying out the footings, the author determines diagonal measurements using the rise/run function on his construction calculator, then refers to those measurements to verify that corners are square. The stretched string on the right-hand side of the photo indicates the outside edge of the first set of footings.

these 1⅛-inch-thick MDO forms cost about $40 each, but we also occasionally find less-expensive used forms that are in good condition — usually from contractors who have been forced out of business. We probably have about $10,000 invested in forming materials and related equipment, though our only specialized tools (in addition to the forms) are rebar cutters, a site laser, and a few levels and trowels.

Being involved in a project from the bottom up keeps our crew busy and allows us to make sure that dimensions are accurate and earthquake hardware is in exactly the right place. This makes the carpentry much easier later on.

Layout and Excavation

The excavator and I begin each new construction project by meeting on site and staking out the hole. I depend a lot on my excavator's experience to keep me out of trouble, especially under tricky site and soil conditions. We seldom have to dig very far, since the ground rarely freezes here and our minimum footing depth is only 12 inches.

Usually we just follow the terrain using common sense when determining the depth of the excavation. If we are trying to match the elevations of any nearby houses, we'll take a number off a siding course or some other fixed point with our laser level and use that to establish a benchmark elevation. In most cases, though, we don't work from a fixed benchmark; instead, we determine wall heights and other elevations from the top of the footing — the vertical rise method.

When the excavator cuts the hole, we make sure it's large enough to fine-tune the location of the house's footprint as we're laying out forms. We stake the property corners and mark the property boundaries with strings, which we leave in place so that the inspector can double-check our setbacks.

Footings

On most projects, we can form footings and tie steel in the morning, schedule the inspection for the afternoon, and pour the footings the following morning.

Reference points. We start by rough-measuring the hole, which allows us to quickly identify most potential problems. Once we're satisfied the hole is big enough, we stake out two long lines that are exactly 90 degrees (perpendicular) to each other. These lines help us keep the footings roughly square as we build them, and serve as a reference for setbacks from the property lines.

To keep our foundations square, we calculate a lot of diagonals. I prefer to use my Construction Master Pro Trig calculator (calculated.com) rather than the 3-4-5 right-triangle method I learned as an apprentice, because it's much faster and far more accurate. I just plug in actual perpendicular wall dimensions and determine each diagonal, using the largest squares possible (**see Figure 1**).

If the foundation has any large odd angles, like a 135-degree or 130-degree dogleg, I ask the designer to calculate these diagonals and include them on the foundation plan. This helps us locate these corners on site, ensures that the angles are

Figure 2. Footing forms are fastened together at the corners with duplex nails; 16-inch metal spreaders keep the sides properly spaced.

Figure 3. Either metal or wooden stakes can be used to hold the forms in place. In hard ground, a metal stake can be used to "predrill" holes for cheaper wooden stakes.

correct, and reduces the time we spend in the field figuring out these details.

Footing forms. Though code in our area allows 12-inch-wide footings for single-story homes, our typical footing is 16 inches wide. We form the footings with 16-foot-long 1x6 #2 pine fastened together with 6d duplex nails, and use 16-inch metal spreader cleats to keep the footings spaced uniformly (**Figure 2**). While we have a bucket of metal stakes, most of the time we fasten our form boards to inexpensive 1x2 wooden stakes (**Figure 3**). If the ground is too hard to pound in wooden stakes without breaking them, we predrill holes by driving in a metal stake and wiggling it back and forth, then pulling it out.

During most construction projects, each subsequent trade in the process works to increasingly tighter tolerances: Dirt guys generally work to within the inch, footing workers to within the half-inch, stemwall builders to within ¼ inch, framers to ⅛ inch, and finish carpenters to 1⁄16 inch (or less). But our goal during the foundation phase is to work within ¼-inch

Figure 4. A single crew member can level the staked forms using a rotary laser. The receiver included with the Stabila LAR250 kit used by the author indicates distance from grade in 1⁄16-inch increments.

Figure 5. Tying the rebar together on top of the spreader cleats makes it easier to get the overlaps and spacing right. Afterward, the spreaders can be temporarily removed and the rebar dropped in place.

Figure 6. Companies that do production foundation work may want to consider the Max cordless rebar tier (maxusacorp.com), which automatically makes a tie in less than a second.

Figure 7. Most contractors cut and bend rebar on site, as shown. An option in some areas is to have a local metal shop pre-cut and pre-bend the rebar.

dimensional tolerances, and to be within 1/16 inch of our target elevation. When we form footings, we're aiming for perfect numbers — even though we know things will get moved around a little because of the nature of working in the dirt (or rain, mud, or snow).

Usually, we start forming with the longest, straightest run. Then two of us work from opposite ends of this run away from each other to assemble the remaining footings. Since most of our stem walls are 8 inches wide, we always add 4 inches to our measurements if the corners are "outside to outside," and use the plan dimension if the corner is "inside to inside." For example, if the longest foundation wall run is 40 feet, the footing will measure 40 feet 8 inches, plus the thickness of the form boards (assuming I am hooking my tape to the forms). If I have time, I try to put all these measurements on the plans themselves prior to forming.

Because 1x6 forms aren't very stiff, we stake the forms every 4 feet to keep them straight. We orient the stakes directly opposite each other, with one stake at the center of all form board overlaps. We initially tack the form boards together with a single 6d duplex nail, which allows us to raise the forms to grade and pivot on that nail.

Before we get the whole footing formed, we square the largest 90-degree angle and stake the form boards so that they're straight but not level or nailed to the stakes. We use this right angle as a reference point for the rest of the footprint.

Once all the footing forms are in place, we double-check the largest diagonals, parallel runs, and lengths against the foundation plan and our calculated diagonals just to make sure we didn't make any mistakes. Then we finish staking in the entire footprint at the corners and where the forms overlap on long runs.

Shooting grade. Old-school builder's levels or transits are accurate but require two people: one to read the level and one to hold the grade stick. Instead, we use a Stabila LAR 250 self-leveling laser (stabila.com), which turns shooting grades and elevations into a one-man job (**Figure 4, previous page**).

Figure 8. To place the rebar at the proper depth in the footing, the author suspends it from the spreader cleats. Here, he's also used a template to accurately locate the 1-inch-diameter all-thread rod needed for an iLevel shear-wall brace.

Figure 9. Areas in the footings that must support point loads are reinforced with rebar following the engineer's specifications.

Figure 10. Here, the author's crew has formed footings for an interior shear wall and for several large piers that will support point loads from the roof.

Whenever possible, I set our laser level up in the middle of the footprint so that I have a sight line to the unit no matter where I am in the hole. I eyeball the footing to see where I think the highest spot is, and take my first reading there. If I set my stick to make sure the minimum depth — typically 8 inches — meets the engineer's or code requirements there, the rest of the footing will also be thick enough to meet code.

When shooting grade, I start with the outside forms. First I raise a corner to grade and nail one stake, then I move to all the pivot points and do the same. Another carpenter follows behind me, using a spirit level to level the inside forms with the outside forms and then tacking them off. Once the entire footing is raised to grade, we nail off the remaining stakes (one nail per stake), adding nails at the overlaps to keep the forms tight.

Bending and tying steel. When there are no engineering plans to follow, we refer to the prescriptive schedules for steel reinforcement contained in our local code. Often, we source the rebar out to a local shop, and it arrives on site pre-cut and pre-bent. The shop tags the rebar, and we just spread it following the tags and their notations on the prints.

We tie the steel together on top of the spreader cleats, which helps us make sure it is spaced correctly (**Figure 5**). In our area, code requires overlaps to be 30 times the diameter of the rebar. Since we most often use grade 60 #4 (½-inch-diameter) rebar, overlaps must be at least 15 inches long. We shoot for 20-inch overlaps so we don't have to worry about failing inspection. We use a minimum of two ties at each overlap, twisting the tie wire with lineman's pliers just enough to keep the rebar tight.

If we're using pre-cut rebar, the shop usually provides us with 30-inch-by-30-inch 90-degree bent steel for all the corners, which requires a lot of ties (**Figure 6**). If we're cutting and bending the steel ourselves (**Figure 7**), we always put 2-foot bends on full-length 20-foot sticks so that

we have to make fewer ties. Once the bar is tied in, we drop it into the footings.

Only after the footing is raised and nailed off do we raise the rebar and tie it to the spreader cleats to keep it suspended in the forms. Then we install any necessary seismic connectors (**Figure 8, previous page**) and tie in our vertical steel to the footing steel, leaving the rebar temporarily leaning against the forms until we place the concrete (**Figure 9, previous page**).

Next, if footings for point loads are called out on the plans, we form them to the specified thickness. Sometimes we have to dig down a little so the pads don't stand too tall in the crawlspace. Typically, we run a wood column through the floor onto the pier pad, though sometimes we'll pour a stem wall on top of an interior footing if an interior shear wall is required (**Figure 10, previous page**). Then we drop in the steel reinforcement and brace the formwork to keep it plumb.

Placing concrete. Most of the time, we use a local line pump contractor to place our concrete. He does all the line handling, which makes our job much easier, allowing us to focus on screeding and troweling the concrete (**Figure 11**). We've used boom pumps before, but the concrete sometimes comes out so fast it can blow apart forms or even steel, and one of our crew has to man the hose.

A line pump pour is more relaxed, and I can keep my eye on the forms. While it takes a little longer — maybe an hour on a typical job — we still save a minimum of $200 on each pour over the cost of a boom pump.

Once the footings are filled, we screed off the tops of the forms and trowel the concrete smooth with a magnesium trowel. A smooth surface helps the stem-wall forms to sit flat on the footings, eliminating gaps that might allow a wet wall mix to leak out of the forms.

Snapping layout. I like to pour in the morning so that after lunch we can snap lines for the stem walls and set the spreader cleats that will hold the underside of the panel forms (**Figure 12**). We place the clips 16 to 24 inches on-center — a spacing that helps keep the forms straight — and push 1½-inch nails through their center holes into the wet concrete to hold them in place (**Figure 13**).

Once the concrete feels firm enough, we strip the footings and break down and stack the form boards to use again for our next footing (form boards last for about 10 footings). *[Story continues next month.]*

Figure 11. As the line pump operator fills the footing form, a crew member follows behind and screeds the concrete level. A second worker then trowels the footing smooth.

Figure 12. Workers lay out the stem walls on the footings, snapping lines while the concrete is still soft.

Figure 13. Form clips are set every 16 to 24 inches along the snapped layout lines. The author holds them in place with 1½-inch Teco nails pushed into the wet concrete; even if rain washes the lines away, the clips will still be in the right position for the stem-wall forms.

Tim Uhler *is a lead framer for Pioneer Builders in Port Orchard, Wash.*

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Cool Tools for 2013

The cream of the crop from the annual STAFDA show

by Bruce Greenlaw

The Specialty Tools & Fasteners Distributors Association staged its 36th annual trade show this past November in Orlando. Open to STAFDA members only, the bustling event makes it easy for manufacturers to show a wealth of construction (and deconstruction) tools and related hardware to distributors and retailers. As usual, *JLC* pounded the exhibit-hall pavement for the allotted 12 hours to see what will be available over the coming year. And as usual, we weren't bored. Here's a sampler of the noteworthy things we saw, including something useful for just about any builder or remodeler.

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1. Dual-Voltage Cordless Tools

Panasonic introduced a ½-inch drill/driver, an impact driver, an impact wrench, and a recip saw that can be powered by the company's existing 14.4-volt or 18-volt lithium-ion batteries or by its new 4.2 amp-hour ones for exceptional runtime. Like the other tools in Panasonic's *Tough IP* line, the dual-voltage tools have an IP56 rating, which means dust intrusion and powerful water jets have no ill effects. The drill/driver shown retails for about $180 for the bare tool or $460 for a kit that includes two of the new 18-volt 4.2 Ah batteries.

Panasonic, 800/338-0552, panasonic.com/cordlesstools.

2. Comfort Level

Stabila's new *R Beam* spirit levels are shaped like a handrail for an easy grip along their entire length. They have three continuous straightedges for scribing layout lines, guiding utility knives, or screeding, and the shock-absorbing end caps are removable so you can carry your layouts into corners. What's more, the levels are supposed to be 10% stronger on edge and 120% stronger when laid on their side than Stabila's Type 196 box-beam levels (while adding only about 10% to the weight). The levels come in lengths of 24, 48, 72, and 96 inches, with one plumb vial on the 4-footer positioned near the level vial for an extra viewing option. R Beam levels cost about 15% more than equivalent Type 196 levels, with prices ranging from about $80 to $260.

Stabila, 800/869-7460, stabila.com.

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3. Compact Ladders

Werner's new *D6200-3 Series* Type IA three-section compact fiberglass extension ladders are about 20% to 25% shorter than equivalent two-section models in the closed position. That makes them easier to store, transport, and maneuver around job sites. They come in five lengths ranging from 16 to 32 feet and cost around $220 to $600.

Werner, 888/523-3371, us.wernerco.com.

4. Value-Added Tool Bags

CLC calls its new *Tech Gear* line "the next generation of tool storage," which isn't a stretch. For instance, the model L234 15-inch open-top tool carrier has an LED light in the handle. The light is powered by two AAA batteries and offers a choice of three lighting levels. You can aim it at your work area or into the bag. And the Tech Gear model A233 18-inch zippered wide-mouth tool bag has two integrated stereo speakers that connect to your digital music player or smartphone, which in turn rides in a clear pocket between the speakers. You can plug the system into an AC receptacle or power it with four D-cell batteries. The L234 costs $70, and the A233 costs $120.

CLC, 800/325-0455, goclc.com.

5. Virtual Grade Rod

Spectra Precision's new *DR400 DigiRod* combines a laser receiver, a laser distance meter, and an angle sensor into a unique new tool that eliminates the need to use grade rods when checking grades with a red-beam rotary laser. Once you set up the rotary laser and follow simple steps with the DigiRod to establish the benchmark, you simply hold the DigiRod above the location you're checking, aim the tool's laser dot on your target, pick up the rotating laser beam anywhere on the 5-inch reception window, and read the elevation on the digital LCD display. Thanks to the angle sensor, the DigiRod can be out of plumb by up to 30 degrees without affecting the results. The tool can also be used as a hand-held distance meter or can mount to grade rods with the included bracket for use as a stand-alone laser receiver. The kit includes a soft case and costs about $700.

Spectra Precision, 888/527-3771, spectra-productivity.com.

6. Cordless Control Joints

BN Products claims that its new cordless *Robo Joiner* makes control joints in concrete slabs twice as fast as manual grooving tools and faster than a saw. Powered by a 20-volt lithium-ion battery, the variable-speed tool works by repeatedly plunging a stainless-steel blade into fresh concrete. I'm told that this up-and-down action and the accompanying vibration pushes down the aggregates and creates a nice cream fill in the bottom of the joint. You can get to work as soon as the concrete can support you, and can expect to run about 80 feet per charge. The kit costs around $700 and includes two batteries, a charger, two bottom plates and blades that create a rolled edge or mimic a saw cut, a hand trowel for finishing, and a case. Visit the website to watch a demonstration.

BN Products, 800/992-3833, bnproducts.com.

7. Tight Ratchets

Ratchet handles have either a round head or a pear head. Pear-heads generally have beefier internal components that can transmit higher torque without breaking, but round-heads typically can advance sockets with a shorter back swing, which is handy for working in tight quarters. In fact, most round-heads boast a ratcheting arc (the number of degrees between ratchet clicks) of 4 to 10 degrees, while most pear-heads range from 8 to 18 degrees. The new GearWrench *120XP* low-profile pear-head ratchets, how-

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ever, use two stacked pawls to engage a 60-tooth gear, yielding an extremely short 3-degree ratcheting arc while exceeding ASME torque-performance requirements. Drive sizes of ¼, ⅜, and ½ inch are available, with prices from about $25 to $50.

GearWrench, 800/688-8949, gearwrench.com.

8. Double Vision

Fading eyesight is a big issue for today's aging workforce. Several manufacturers now make bifocal safety glasses with magnification diopters molded into the bottoms of the lenses so you can clearly see fine print and details without sacrificing impact protection. Lift Safety's new *Style Series Bifocals* — which cost $25 — offer diopter strengths of +1.50, +2.00, +2.50, and +3.00. Two frame styles are available, including the Alias frame shown. Hopefully all the hardware stores out there will get the hint and start stocking these bifocals or their equivalents.

Lift Safety, 877/543-8444, liftsafety.com.

9. Sun-Smart Hard Hats

According to 3M, the sun's UV rays can cause hard hats to become brittle over time and reduce their impact resistance. The company's *H-700* series short-brim and *H-800* series full-brim hard hats that include "UV" in their product numbers have a red "Uvicator" sensor on the back that incrementally changes from red to white as the hard hat accumulates UV exposure. When the sensor turns white, it's time to replace the hard hat. The hats are also supposed to weigh 10% to 15% less than competing models. They come in several colors and have ratchet suspensions, replaceable brow pads, and slots for various accessories. Short-brim models cost about $13 and full-brim models about $18.

3M, 800/243-4630, 3m.com/occsafety.

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10. Composite-Decking Blades

Freud and Trex have teamed up to develop the first saw blade designed specifically for cutting composite decking. According to Freud, the new *Diablo/Trex* carbide-tipped, super thin-kerf blade makes clean melt-free cuts in composite decking and cellular PVC and requires less cutting power than normal. The blade is available with diameters of 7¼, 10, or 12 inches, and costs about $30 to $70.

Freud, 800/334-4107, diablotools.com.

11. Versatile Job-Site Clamp

I can envision installing Stanley's new *2x4 Clamp* on the crossbar of one of my Trojan sawhorses and using it as a vise for various carpentry tasks. I could do it easily without removing sawhorse legs. To mount it that way, you simply slide the clamp heads out of the yellow brackets, slip the brackets over the 2x4, reinsert the heads, and tighten the brackets from below. Screw the brackets to the wood, and you can apply more clamping force. The tool can also serve as a job-site bar clamp with an almost unlimited jaw capacity. It's scheduled to hit the market this spring and will cost about $20 per set.

Stanley, 800/262-2161, stanleytools.com.

12. Autofeed Upgrade

Over the next few months, Senco is recharging its lineup of autofeed screw guns with several new 2-inch and 3-inch corded and cordless models that appear to be a big improvement over their predecessors. The intriguing cordless model *DS215-18V,* for example, is designed primarily for drywall pros. Powered by the same 18-volt lithium-ion battery used by Senco's Fusion cordless nailers, it drives plastic-collated screws from 1 to 2 inches long at a blazing top speed of 5,000 rpm, and is supposed to drive 500 to 700 screws per charge. Deluxe features include a "corner fit" nosepiece that promises to drive screws into corners and tight spaces where competing models can't reach. Available in April, the kit will include two batteries, a one-hour charger, a drywall and wood nosepiece, two drive bits, and a nylon bag. It will cost about $260.

Senco, 800/543-4596, senco.com.

13. Pinpoint Caulk Nozzles

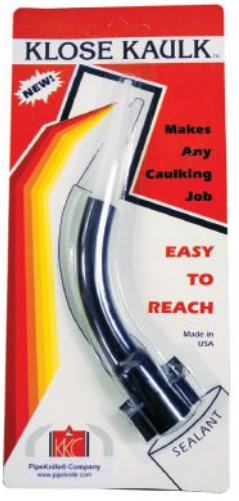
One way to caulk hard-to-reach places is to tape a length of plastic tubing to the caulk-tube nozzle. But various extension nozzles are also commercially available, including the new disposable *FlexNozzle* and *Klose Kaulk* nozzles displayed at the show. The former can accordion up to a length of 12 inches and costs about $10 per three-pack. The latter is rigid, but curves to a length of about 7 inches. It costs about $4 for the black holder and one nozzle, and replacement nozzles cost about $4 per five-pack.

Newborn, 800/638-3983, newborncaulkguns.com.

14. Potent Pinner

Bosch says its new 2.3-pound 23-gauge pin nailer (model *FNS138-23*) has 10% more power than the competition so it can consistently sink long nails into hardwood. It's also advertised as the first pin nailer to feature a dry-fire lockout mechanism that doesn't kick in until the magazine is empty. Other pin nailers with dry-fire lockout leave some nails in the magazine, which can cause problems. The tool's self-adjusting magazine holds headless nails from 1 to 1⅜ inches long. Other deluxe features include a narrow nose for improved access and visibility, a self-cleaning air filter, and plenty of overmold to protect your work. The kit — which includes safety glasses, an Allen wrench, and a case — costs about $160.

Bosch, 877/267-2499, boschfullforce.com.



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15. Aggressive Deck Clips

Hidden deck fasteners typically allow deck boards to move. According to Grabber Construction Products, that's a big mistake. The company argues that the boards should in fact be held securely to provide extra resistance to racking and help prevent decks from collapsing. The new Grabber powder-coated *Deckmaster* deck clips are designed to lock deck boards in place like top screws do, and are installed with beefy #9 x 1⅝-inch screws. Deckmaster G5 deck clips work with any ⅛-inch grooved decking, GTT5 clips work with TimberTech, and the GW5 clips shown work with softwoods and hardwoods. Before you can install the GW5 clips, you need to use the Deckmaster PowerBlade router bit to cut the grooves. Deckmaster clips cost $90 to $105 per 100 square feet of decking, and the router bit costs $25.

Grabber Construction Products, 800/477-8876, grabberman.com.

16. Manual Demo Hammer

Judging by the booth demonstration I saw, Goldblatt's new spring-loaded *Ram Rod* impact tool can break hard materials with minimal effort. You just insert the spike, chisel, or scraper bit of your choice into the quick-change chuck, place the bit where you want it, and push the spring-loaded handle so the "ram sledge" on the shaft delivers a blow to the bit. The tool locks in the closed position for storage and transport. According to Goldblatt, you can use this tool for removing floor tiles, chipping concrete, breaking bricks, and much more. It ships with a 1-inch chisel bit and costs about $150. The other bits cost about $14 to $20. For about $40, you can buy a collar that adds extra weight to the sledge.

Goldblatt Tool Co., 877/876-7562, goldblatttool.com.

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17. Dual-Battery Rotary Hammer

Makita's new model *HRH01ZX2* 36-volt 1-inch SDS-plus rotary hammer is powered by two batteries from the company's flagship 18-volt LXT lithium-ion platform. If you've already bought into that platform, which now includes more than 60 tools, you can add a 36-volt tool that performs like its corded counterparts. The kit costs about $350 and includes a side handle, a depth gauge, a tool bag, and an adapter that has a separate fuel gauge for each of the two batteries (Makita assumes you already have the batteries and charger). If you remove the adapter, you can power the tool with Makita's 36-volt pack instead to reduce the weight of the tool from 11.3 pounds to 9.9 pounds.

Makita, 800/462-5482, makita.com.

18. Portable Dump Truck

The *Hopper Dump Cart* (model C27-10A) displayed by Granite Industries costs $1,825, but my back tells me I want one. Made in Ohio, it's powered by a lead-acid battery that's supposed to deliver about four to six hours of runtime per charge and recharge in about six to eight hours using a built-in charger. It has a 10-cubic-foot high-density polyethylene hopper that can haul 750 pounds on flat ground or 500 pounds up a 1:3 slope; a forward/reverse switch and emergency stop; and airless tires. The hopper tilts manually. Granite also offers an extended-range battery that delivers about five to seven hours of runtime, and other carts are available.

Granite Industries, 877/447-2648, graniteind.com.

19. Raising the Bar

Two new Crescent *Code Red* adjustable pry bars appear to make common demolition chores much less awkward, not to mention more fun. The indexing flat pry bar has a long handle and a pivoting head that locks into 14 positions so you can get the best angle and leverage on your work. It comes in lengths of 18 and 30 inches, and costs about $20 to $25. The adjustable pry bar and nail puller has a crow's foot on one end for pulling nails and prying, plus one fixed and one sliding jaw on the other so you can twist and pull lumber, club drywall, yank long nails more easily, and so on. It comes in lengths of 16 and 24 inches, and also costs about $20 to $25.

Crescent, 800/688-8949, apexhandtools.com.

20. High-Capacity Siding Shear

According to Bullet Tools, its new manual cam-actuated *EZ Shear SST 26* is the only tool that can cut a 4-in-12 pitch on 8-inch fiber-cement siding while producing a clean edge and no airborne dust. That's possible because the tool has a super-sharp 26-inch-long steel blade coupled with an infinitely adjustable fence. The blade is made of a high chromium-vanadium tool steel alloy, and you keep it sharp by honing it in place with the included stone. Besides fiber-cement siding and trim, the tool also cuts vinyl siding (including foam-backed vinyl), cedar siding, and other materials. At the recent *JLC* Live show in Portland, Ore., held a month after the STAFDA show, James Hardie used the SST 26 to demonstrate an efficient way to cut its fiber-cement siding products. The tool costs about $800.

Bullet Tools, 800/406-8998, bullettools.com.

21. Power Caulking

I remember a union carpenter from Iowa raving several years ago about how Milwaukee cordless caulk guns had been terrific for caulking a 10-story exterior rehab. After seeing Milwaukee's new model *2441-21* 12-volt lithium-ion cordless caulk and adhesive gun at the show, I'm anxious to try one. This tool allegedly weighs 40% less than competing models, has the power to dispense all common construction sealants and adhesives, and can empty up to 150 10-ounce cartridges per charge. It has a speed dial and variable speed for applying a consistent bead at a rate of up to 28 inches per minute, and it automatically backs up the plunger to prevent dripping when you release the trigger. It also

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has a built-in spike for puncturing cartridge seals and a hang hook. The kit costs about $150 and includes one M12 battery and a 30-minute charger. You can also buy conversion kits for dispensing quart cartridges or 20-ounce sausage packs. Other kit options and the bare tool are available as well.

Milwaukee, 800/729-3878, milwaukeetool.com.

22. Rebuildable Chalk Boxes

A *JLC* forum thread awhile back discussed clever ways to replace a missing chalk-line hook (beer-can tabs apparently work). A visit to the Tajima booth reminded me that this company's Chalk-Rite boxes can be completely rebuilt, from the hooks and handles to the nosepieces and gears. The *Chalk-Rite II* shown (model CR202B-P) has a 100-foot ultra-thin braided line that's supposed to be ideal for precision work like finish carpentry and tile setting. It has 3x gearing for quick line retrieval, and its aluminum case is sealed with a gasket to prevent chalk leakage. It comes with a trial-size bottle of blue Micro Chalk and costs about $30. Other versions that snap bolder multiple lines are also available.

Tajima, 888/482-5462, tajimatool.com.

23. Fuel-Free Cordless Framing Nailer

DeWalt has yet to publish all the details about the new *DCN690 20V Max* cordless framing nailer displayed at the show. But I did learn that it's the first cordless model powered by a battery only, with no fuel cells required. It has a brushless motor, drives paper-tape fasteners from 2 to 3½ inches long, sinks up to about 650 3-inch nails per charge, can fire in the sequential mode or can bump-fire, and has dry-fire lockout. It also has a rafter/belt hook, is less than 13¾ inches tall so it fits between most framing members, and weighs 9 pounds (which is a bit heavier than the competition). The tool will roll out sometime this spring or early summer with a price tag of about $550.

DeWalt, 800/433-9258, dewalt.com.

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24. A Lighter Wormdrive

Due to launch in April, the Skilsaw *MAG77LT* 15-amp, 7¼-inch wormdrive saw weighs just 13.2 pounds including the cord and blade. That's 2 pounds less than the MAG77 and 4 pounds less than the SHD77. To eliminate weight, Skil says it reduced the length of the motor (by ⅜ inch), reshaped the motor housing, used more magnesium, and made other careful modifications without sacrificing performance. The maximum bevel cut has increased from 51 to 53 degrees, and a multi-function blade wrench stores conveniently in the base. The saw will cost about $220.

Skil, 877/754-5999, skiltools.com.

25. Mixing Machine

One way to mix powdered joint compounds with water is to use a heavy-duty ½-inch corded drill with a mixing paddle. But veteran drywall contractor Myron Ferguson, a regular presenter at *JLC* Live, prefers to use a *Collomix* hand-held paddle mixer. Made in Germany, the two-handled mixers are easier to control, and they have a motor and transmission designed to endure the rigors of mixing. Equipped with the appropriate quick-change paddle, they can mix joint compound, thin-bed mortar, grout, epoxy, paint, and much more. According to the new U.S. distributor, the new 10-amp Collomix model Xo1 is more comfortable to hold, is more powerful, vibrates less, and is quieter than the model it's replacing. It comes with a universal paddle that handles the majority of applications and costs about $320. The KR120HF "bird-cage" paddle shown is ideal for mixing drywall compounds and costs about $50. More-powerful mixers and other paddles are also available.

Sola Collomix USA, 414/471-3883, collomix.us.

26. Fast and Strong Hot-Melt Glue

At the Pam Fastening Technology booth, marketing manager Bill Strother claimed that the company's nontoxic, odorless, and waterproof *PamTite* hot-melt adhesive can bond carpet tack strips to concrete slabs so fast the carpet can be power-stretched in just five minutes. Strother demonstrated the bond strength by gluing a piece of crown molding to tile; within seconds, the bond was so strong the crown split when I tried to remove it. PamTite has a working time of one minute. It has instant tack and fully cures within five minutes. The new PamTite Plus resembles PamTite but has a working time of three minutes and is more resistant to heat and cold. If you make a mistake with either of these thermoplastic adhesives, you can simply melt them with a heat gun and reposition your work. The adhesives are recommended for use in controlled environments, bond to a wide variety of porous and nonporous materials, and appear to have plenty of applications for *JLC* readers. PamTite costs about $13 per pound and PamTite Plus about $17 per pound. The HB 220 hot-melt glue gun for these adhesives costs about $110.

Pam Fastening Technology, 800/699-2674, pamfast.com.

Go to http://jlc.hotims.com for more info

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by Matt Berges and Mandy Metcalf

Lessons Learned on Energy-Efficient Affordable Housing

Practical insights on combining deep energy retrofits with affordable housing for 12 Cleveland homes

Renovations of older, distressed homes throughout the city of Cleveland are meeting improved green standards because of incentive programs and funding opportunities that encourage better building. But what will it take for existing homes to achieve more dramatic energy reductions in line with evolving energy codes and standards? Can we achieve deep energy reductions cost-effectively in affordable housing? We wanted to find out.

Over the past two years at Environmental Health Watch (EHW), we managed a HUD-funded technical study of green retrofits of 12 affordable homes.

Six of the houses were upgraded to EHW's deep energy retrofit (DER) specs to achieve at least 70% energy-use reductions. The other six were renovated to Cleveland's "Green Building Standard," which included affordable green housing standards established by Enterprise Community Partners (greencommunitiesonline.org) and energy-efficiency standards set by Energy Star v.2. We are monitoring energy usage (actual vs. predicted) and indoor air quality (IAQ) in all 12 homes.

This HUD technical study has two purposes: 1) to compare the effects on indoor air quality of deep energy retrofits and Energy Star v.2 retrofits, and 2) to determine the costs and benefits of deep energy retrofits for affordable housing. We are in the data-collection phase of the study now. The construction work is complete, so we can share our experience with implementing the DERs and our thoughts on the challenges and opportunities

All of the houses in the HUD-sponsored technical study were built in the 1920s and '30s, and were in need of complete interior gut renovations (left). The six DER houses received continuous exterior insulation as part of the plan to achieve a deeper level of energy reduction. To save money, the plan was to apply the foam over the existing siding, but after the first house treated this way was tested, the decision was made to strip the remaining homes down to the sheathing (above) to achieve better air-sealing numbers.

presented by these types of retrofits.

The homes were developed by a nonprofit community development organization, Cleveland Housing Network (CHN), for lease-purchase to low-income residents. Other partners in the project included the Swetland Center for Environmental Health at Case Western Reserve University's School of Medicine, and Intwine Connect, a Northeast Ohio tech company.

Some of the key improvements made to these houses include tighter building enclosures, better windows and doors, more efficient mechanical systems, energy-efficient lighting and appliances, energy recovery ventilation, and increased insulation (see illustration, pages 58 and 59).

Although our deep energy retrofits added almost $26,000 to what was already an expensive gut renovation, this kind of investment is necessary to dramatically alter energy usage. We think the extra effort is justified because high-performance houses can save occupants money and improve comfort and indoor air quality while reducing $C0_2$ emissions. DER specs are extreme compared to today's building requirements, but they are in line with proposed future energy codes. And the price will continue to fall as these features become more common practice.

Upgrading the Building Envelope

The six Energy Star houses received well-executed dense-pack cellulose (R-13) blown into wall cavities, and attics were insulated above code levels (R-38 to R-50). Air-sealing was also above average, with final blower-door test-out numbers averaging 1,658 at cfm50 or 6.46 ACH50, which is considered to be in the mid-range for older, renovated homes. Across the six Energy Star houses, numbers ranged from 3.17 to 9.42 ACH50, while HERS scores ranged from 67 to 80, with an average of 71 (see "Measured Performance," page 60).

The six DER houses received substantial insulation upgrades. Rigid foam board was applied to the exterior in two layers (3 inches total) so that seams could be staggered. When done properly, this upgrade drastically improves airtightness, thermal resistance, and durability all at once. Cavity insulation is a great start, but doesn't eliminate thermal bridging — the framing makes up 25% to 35% of a cavity wall, creating thermal weak spots that readily conduct heat to the exterior. Without a good exterior air barrier (the foam board in this case), it is very difficult in an old house to improve air-sealing beyond what was achieved in the Energy Star homes (6.46 ACH50 on average).

The added attention to air-sealing and insulation details (including the basement and attic) in the DER homes achieved an average blower-door test result of 623 at cfm50, or 2.15 ACH50. The numbers ranged from 1.61 to 2.75 ACH50, while HERS scores ranged from 34 to 44, with an average of 38.

Attic. The accessible attic spaces in all six of the DER houses were abandoned, which made it easier to air-seal and insulate to R-60. Storage access was discouraged by removing attic staircases in exchange for tightly sealed attic hatches. No mechani-

cal equipment or ductwork was allowed in these spaces. In some Energy Star houses, the attic staircases were left in place and the stairwells insulated, with a platform provided for storage.

In most of the houses, the attic floors had tongue-and-groove flooring over 2x4 or 2x6 second-floor ceiling joists. Once the second-floor ceiling was drywalled, the ceiling joist bays were dense-packed, creating a pretty good air-seal. More insulation was then blown over the top of the floor (up to R-50 in Energy Star houses, and up to R-60 in the DER houses).

Basement. In a DER renovation, basement details are treated with much greater attention than they are in a typical renovation. Controlling below-slab soil gases, moisture, and thermal losses becomes a necessary upgrade to avoid aggravating these problems in a tight house. Much can be accomplished through perfect air-sealing and insulating, though radon has proved able to bypass even the tightest of assemblies (justifying the expense for below-slab passive radon exhaust systems).

In the case of our six DERs, the existing slabs were torn out so that we could make things right from the ground up. Due to the quality and benefit of the added control layers, it was considered to be worth the added cost.

Upgrading Doors and Windows

For this upgrade spec, we asked our existing suppliers for suggestions on how to achieve the lowest U-factor at the most reasonable price that they could provide. In the DER houses, we ended up with affordable Alside vinyl windows with U-factors between 0.18 and 0.22.

In many cases, we were able to reduce the number of windows to help pay for the better units. North-facing windows were avoided or eliminated when there were more than necessary. Some three-window bay sections were removed and replaced with a flush wall and two upgraded casements, which resulted in easier thermal detailing and reduced heat loss.

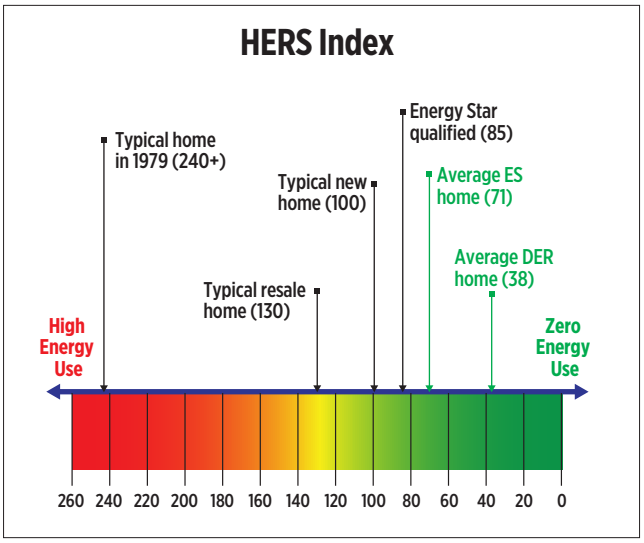
The added foam (and double studs in two cases) created extra-thick walls that raised a question about where to locate the windows: flush with the outside edge ("outie") or the inside edge ("innie"). While I favor the innie for performance and protection from the elements, the outie costs less because it is very straightforward to install, and more in line with standard practices. We ended up using both approaches (see illustration, page 62).

We specified R-7 doors with thermally broken door frames, but due to timing and availability not all the houses got this upgrade.

Hvac Systems

The six Energy Star houses were supplied with typical exhaust-only ventilation, using point-source bath fans to meet the ASHRAE 62.2-1989 ventilation standard. These fans run continuously on low speed and have a motion sensor to boost speed when the bathroom is occupied. In the six DER houses, a balanced energy recovery ventilation (ERV) system was used instead of exhaust-only ventilation.

Heating and cooling. We used three different hvac systems in the 12 retrofitted houses. The standard system in the six Energy Star houses was a natural-gas power-vented 71,000-Btu/hr furnace with 13-SEER AC. The peak heating loads were projected to



A HERS score is a measure of a home's energy efficiency based primarily on the results of diagnostic/performance tests using standards established by the Residential Energy Services Network (RESNET). A lower score indicates greater energy efficiency. According to the DOE, a standard new home that exactly meets the energy code scores 100 on the index. The homes in the HUD-sponsored technical study described in this article score well below that.

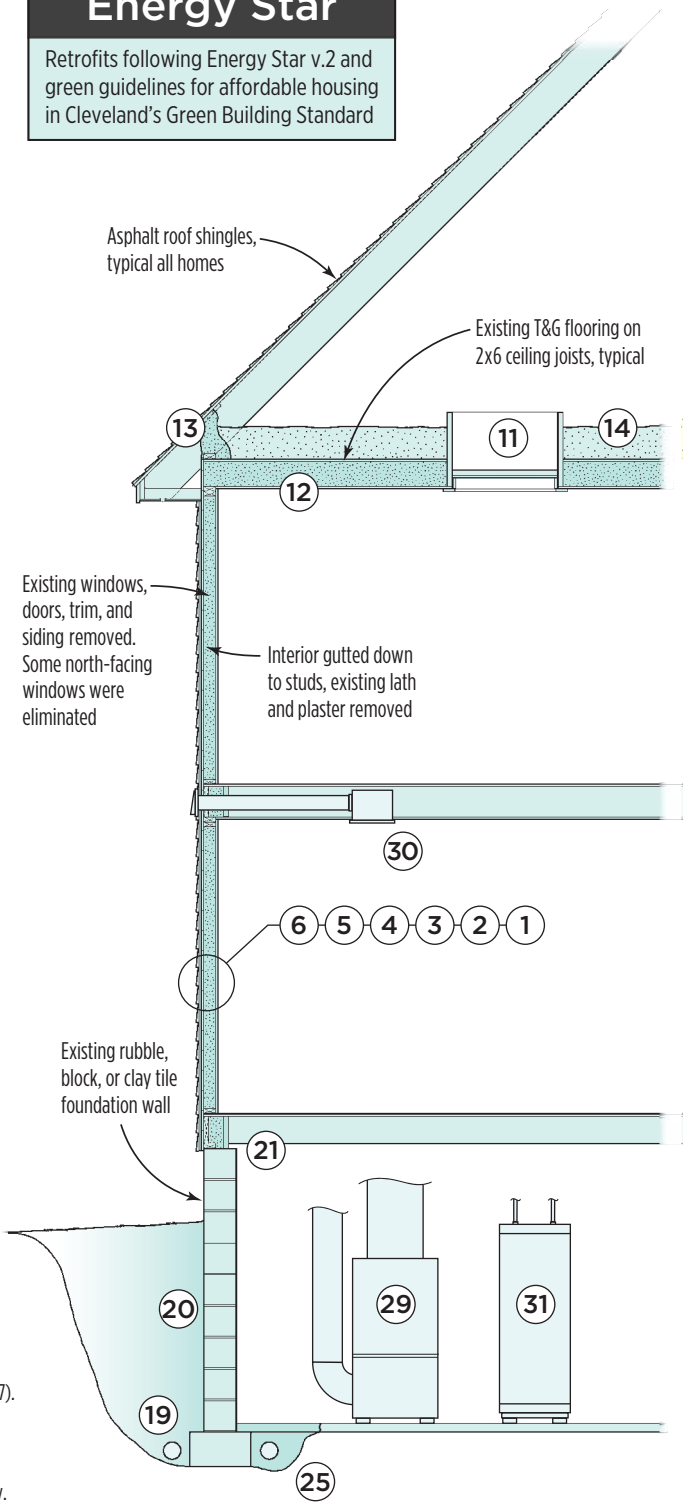
Four of the DER houses got dense-pack cellulose cavity insulation plus exterior insulation for a combined R-28. The other two DER houses received an additional staggered studwall on the inside, creating a double wall that boosted total wall insulation to R-42.

Key Improvements to Test Homes

Six homes in the HUD-funded technical study were renovated to Energy Star standards, and six to a more demanding deep energy retrofit specification. All 12 homes are being monitored to compare actual to projected performance, and to evaluate the costs and benefits of the two different standards.

Energy Star

Retrofits following Energy Star v.2 and green guidelines for affordable housing in Cleveland's Green Building Standard



Building Envelope

Energy Star	(1) Dense-pack cellulose (R-13) blown into stud bays
	(2) Existing board sheathing, seams air-sealed with foam
	(3) Housewrap installed over board sheathing
	(4) Window U-value = 0.3 to 0.31
	(5) Walls furred out with 1x vertical strapping
	(6) New vinyl siding and trim
DER Upgrade	(7) Existing stud bays dense-packed (R-13)[1]
	(8) Two layers of 1½" rigid XPS (R-15) foam placed over existing board sheathing acts as thermal/air barrier. Seams staggered and woven at corners; all seams taped.
	(9) Housewrap installed over foam
	(10) Window U-value = 0.18 to 0.22

Foundation Wall

Energy Star	(19) Existing foundation excavated down to footing, perimeter drains added
	(20) Walls left uninsulated; exterior face waterproofed[2]
	(21) Rim-joist area filled with dense-pack cellulose
DER Upgrade	(22) Foundation walls insulated/waterproofed[3]
	(23) Insulation at grade protected by coil flashing or cement parge coat
	(24) Rim-joist area sealed with dense-pack cellulose encapsulated in pieces of rigid insulation or sprayed with closed-cell

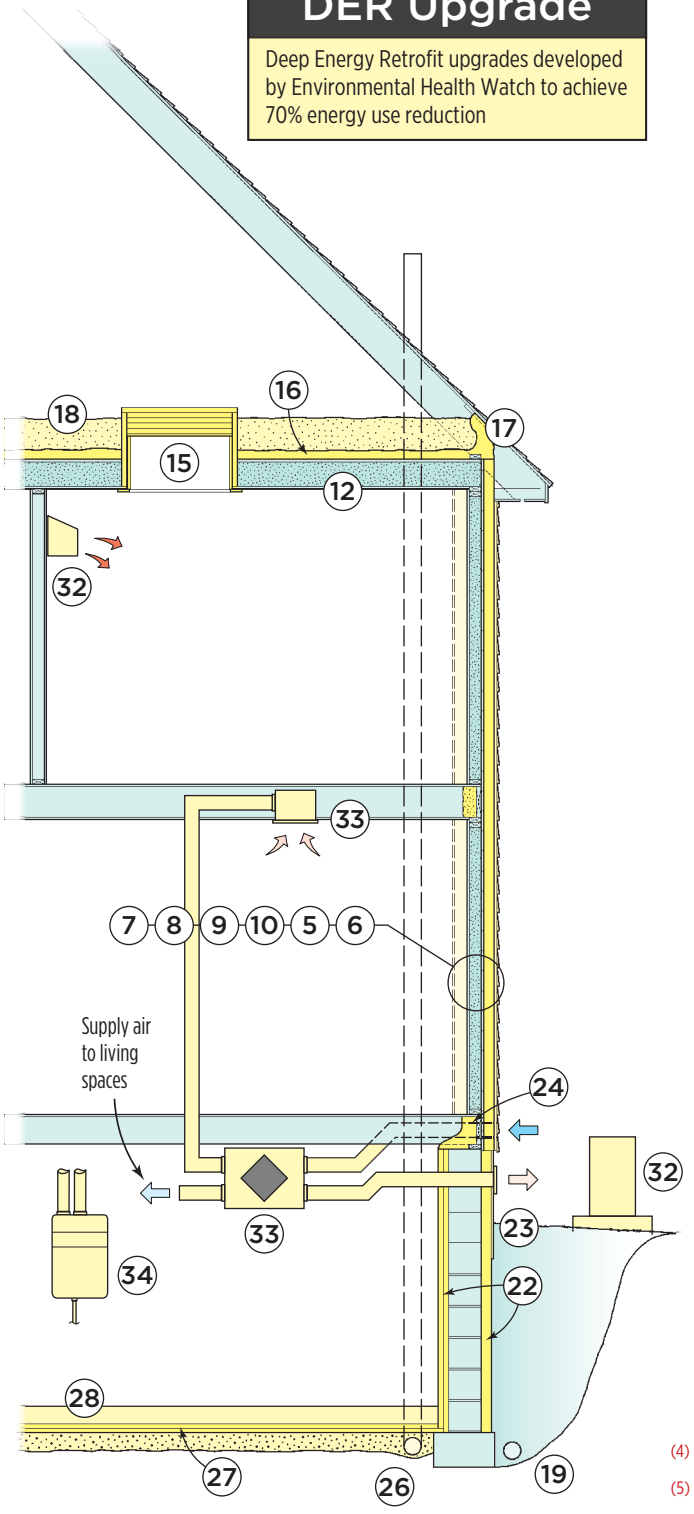
(1) Exterior double studwalls built in two DER homes. Walls insulated with dense-pack cellulose (R-27).

(2) On two Energy Star homes, fiberglass-reinforced plastic (FRP) wall panels were installed to interior side in lieu of exterior waterproofing.

(3) Rubble foundations received 2" to 3" of closed-cell spray foam (approx. R-15) on outside face only. Two layers of 1½" rigid XPS foam (R-15) were installed on both sides of existing block walls. Seams were staggered and woven at corners; all seams were taped. Walls with interior foam were furred out with metal studs and cementitious board. In both cases, the exterior foam served as a drainage plane.

DER Upgrade

Deep Energy Retrofit upgrades developed by Environmental Health Watch to achieve 70% energy use reduction



Attic

Energy Star	(11) Existing attic stairs removed, uninsulated access hatches installed[4] (12) Joist bays were dense-packed (R-20) after ceiling was drywalled (13) Heel portion of rafter bays sealed with dense-pack cellulose (14) Blown-in loose-fill insulation (R-30) installed on top of attic floor
DER Upgrade	(15) New insulated access hatches installed; encased in rigid insulation (R-50) (16) Attic air-sealing achieved with 2" closed-cell foam sprayed across entire attic floor[5] (17) Heel portion of rafter bays sealed with spray foam, connecting the wall and attic air barriers (18) Loose-fill insulation (R-40) blown on top of existing T&G flooring or spray-foam air barrier

Basement Slab

Energy Star	(25) Existing 2" rat slabs cut to accommodate below-slab perimeter drainage[6]
DER Upgrade	(26) Existing slabs removed. Passive subslab radon mitigation systems installed in layer of 4" gravel. (27) Two layers of 1" XPS insulation (R-10) installed on top of gravel, integrated with wall insulation. Seams staggered and woven at corners; all seams taped. (28) New 4" reinforced slab poured over XPS insulation

Mechanicals

Energy Star	(29) **Heat/cooling:** 70-kBtu furnace with a 13-SEER AC (30) **Ventilation:** Point-source bath fans running on continuous low speed, with a motion sensor to boost speed during bathroom occupancy (31) **DHW:** Electric hot-water heater, typical
DER Upgrade	(32) **Heat/cooling:** Combination electric heat-pump/gas hot-water circulation system or mini-split/heat pump[7] (33) **Ventilation:** ERV system; stale air continuously pulled out of kitchen and bathrooms, fresh air ducted and supplied to living spaces and bedrooms (34) **DHW:** tankless condensing boiler

[4] Existing stairs left in place in two Energy Star houses, complicating installation of the thermal barrier.

[5] Two homes were treated differently: An uninterrupted drywall ceiling was installed before interior walls.

[6] Energy Star homes that tested positive for radon received active subslab radon mitigation systems.

[7] Mini-split/heat pump installed in three most efficient DER homes with lowest heat loads.

Measured Performance

House	HERS Score	Air @ cfm50	Sq. Ft.	ACH50	Annual Load (MMBtu)	Projected Load (kBtu/hr)	Projected Operating Cost/yr.
ES 1	80	2,985	2,399	9.42	94.2	47.9	$2,794
ES 2	67	1,167	2,674	3.17	68.9	37.7	2,604
ES 3	71	1,623	2,708	4.47	79.1	41.7	2,639
ES 4	75	1,687	2,250	5.73	75.5	56.3	2,472
ES 5	67	1,197	2,538	8.19	54.4	31.5	2,371
ES 6	68	1,290	2,001	7.76	57.8	31.1	2,269
Avg.	71	1,658	2,428	6.46	71.7	41.03	$2,525
DER 1	37	511	2,268	1.93	5.3	9.8	$1,406
DER 2	37	441	2,091	1.62	4.5	11.7	1,368
DER 3	44	793	2,250	2.68	10.7	15.5	1,858
DER 4	38	832	2,344	2.75	8.2	14.8	1,509
DER 5	38	644	2,073	2.30	6.8	12.7	1,420
DER 6	34	518	2,535	1.61	3.5	11.8	1,552
Avg.	38	623	2,260	2.15	6.5	12.72	$1,519
ES vs. DER	-46%				-91%	-69%	-40%

House-by-house performance data shows that, compared with the Energy Star (ES) houses, the additional steps taken in the deep energy retrofit (DER) houses significantly reduced energy usage and projected operating cost.

average 41,000 Btu/hr in the Energy Star houses.

In the DER houses, projected peak heating loads were reduced by 69% on average to 12,700 Btu/hour. This amounted to a 91% reduction in the annual heating requirement (MMBtu), so we were looking for much smaller capacity systems.

For the first three DER houses, we used fully ducted electric heat-pump and gas-powered hot-water combination systems. These systems use traditional ductwork, with an air handler tied to a heat and AC coil instead of a furnace. Their primary source of energy comes from the electric heat pump. For backup heat (and when this option is more efficient than the outside heat pump), water heated by a Navian 98% efficient condensing tankless hot-water heater circulates through the heat coil/air handler.

In the DER homes, existing slabs were removed so that new plumbing, a passive radon-mitigation system, and rigid foam insulation could be installed. The interior foundation wall foam was applied prior to the slab pour, making it easier to keep the below-slab foam "pan," as shown here, continuous with and connected to the wall foam.

For the last three DER houses (those with double studwalls and the lowest heat loads) we used wall-mounted ductless mini-split air-source heat pumps. This setup relies on point-source heating and cooling, along with minimal heat loss and internal circulation fans for distribution and circulation (see photo, page 63).

Lessons Learned

The experience of installing these different hvac systems taught us some things about what does and doesn't work for energy-efficient affordable housing. The assumption going into the job was that reducing the heat load by 69% would result in cost savings for the mechanicals, and that smaller hvac systems would help pay for the super insulation and other upgrades. In reality, we ended up paying a few thousand more for the smaller-load systems.

The hvac systems presented a number of challenges. Standard systems are clearly easier, despite the fact that they are all too large for the loads that we were trying to manage. You can get

Most foundations in the DER houses needed waterproofing anyway, creating an opportunity to add foam to all of the foundation exteriors. Most received a double layer of rigid foam (far left); in two cases, spray foam — which served as a drainage plane — was the better choice (left).

pretty good efficiency out of a new furnace at a very low cost, so there is not much room for savings with alternative systems. They don't yet make furnaces small enough to be right-sized for super-efficient homes, so we were forced to either make the house less efficient or try out options beyond the typical furnace.

Occupant learning curve. Despite our confidence in the heat-load and system-capacity projections, there was great concern for how the mini-split systems would work out for the average occupant. On paper, they are sufficient to keep the house comfortable, but most people are used to large, oversized furnaces that can blast the house to 80°F in a short time. But mini-split systems work differently. They are sized closer to the projected load of the home, and therefore the system may struggle to keep up with occupant expectations. We provided education about the heating systems, but the families were not necessarily interested in changing their habits just for the sake of this study. Mastering the programmable thermostat was also a challenge for some of the residents, though in many cases, it was device failures that created the problem (the thermostats would not hold the correct time, and they messed up the heat schedule so badly people gave up on programming them).

Also, ongoing maintenance costs of the mini-splits were a concern for CHN, the developer. CHN believes that ongoing maintenance costs will be higher overall, due to the limited number of experienced installers for the newer systems.

Contractor learning curve. The most cost-efficient and energy-efficient option might not be the best option — at least not yet. A typical furnace is robust and can run for years with a dirty filter. It is powerful and oversized, so it reacts quickly to extreme conditions. It is cheap and available, and it is fairly simple for any hvac contractor to install, repair, or replace.

By contrast, the mini-split/ERV system — which is the most efficient and should be one of the most affordable options, considering the simple install and reduced duct work — presented the most problems. Few local hvac contractors and suppliers had experience with this product, and the challenge of getting these systems designed and running properly on the first attempt was more expensive than we expected, reducing our projected savings.

Overall, the hvac upgrade cost on the DER homes (mini-split/ERV system) was roughly $3,000 more than the base system (furnace and exhaust-only bath fans). About two-thirds of this was the cost of the ERV, with the rest going to a consultant for basic commissioning (mainly balancing of exhaust and intake ventilation rates), a process with which the installers and developer were not familiar. (Commissioning — a formal quality-assurance process that ensures the equipment operates as designed — was not seen as part of the standard scope-of-work and was an upgrade, which many of the hvac contractors were unable to provide.)

Ventilation vs. comfort. The original idea of delivering fresh air directly to the bedrooms proved to be problematic in our DER mini-split houses. When the bedroom doors were closed, cool air delivered to the rooms in winter led to complaints of discomfort. We used "bath fans" in the common space near the mini-splits to increase circulation of conditioned air to the bedrooms, but it was not enough to offset the chilling effect of the ERV air.

To correct this, we disconnected the fresh-air supply to the bedrooms, allowing it to dump into the basement instead. This

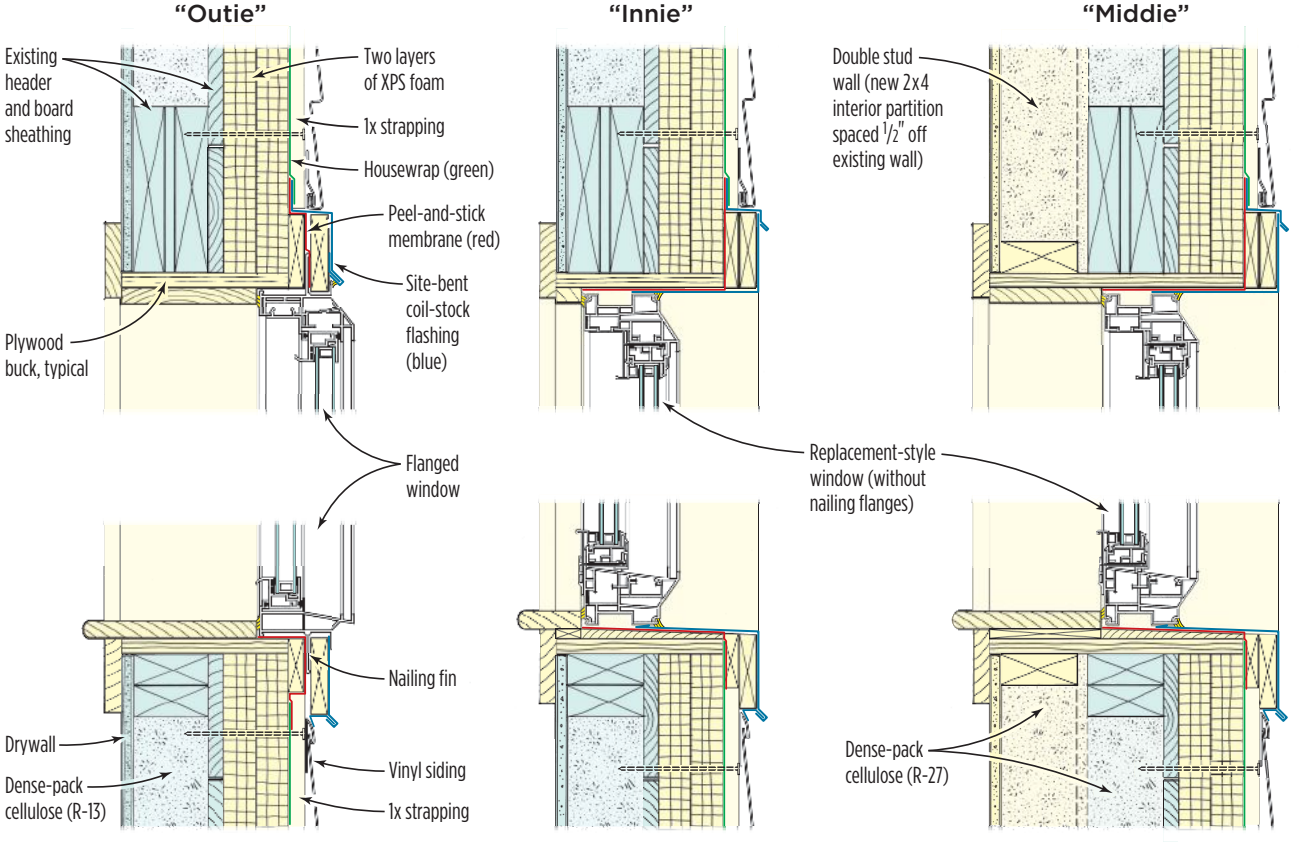
way, the cooler fresh air mixes with backup heat at the point when the heat pump becomes less efficient. In other cases, we diverted the fresh-air supply, dumping it out under or near the mini-split heat source to be mixed there. (In the ducted houses this was not an issue, since the fresh air blows into the cold-air return, where it is further filtered, heated, and mixed with the house air.)

With a more efficient ERV, incoming air temperatures would not be quite as cold. For this project, we were trying to find the balance between price and efficiency and locally available equipment. In the future, however, we would likely use a more efficient ERV, with simplified and reduced ductwork that might balance out the upgrade cost.

Also, occupant education and property management efforts must include some attention to maintenance of the ERV system. If filters are not cleaned, the potential exists for reduced airflow and functionality. While the need to clean filters on an ERV is less frequent than with a typical furnace, the need for ensuring fresh air is much more important in a DER, or otherwise tight house.

Dependence on mechanical ventilation. In a very tight home, occupants depend on mechanical ventilation to deliver fresh air and remove contaminants, moisture, and odors. When ventilation stops working, IAQ suffers. The need to ensure that the ventilation stays on in our tight DERs presented some challenges that we are still evaluating. For example, during a few of our home visits, we discovered some instances where the ERV system was not running. In one case, when addressing a complaint about a "stuffy" house, we found that the ERV unit was unplugged. In another, the occupant suggested that things seemed different since she cleaned her ERV filter; in fact, the ERV was off. As it turned out, two of the six ERV units we installed require that you hit the reset button after opening the ERV cabinet, but we didn't know about this and didn't warn the occupant. These experi-

DER Window Details



Several approaches were used to mount windows in the extra-thick walls. Windows mounted toward the inside ("innies") or middle ("middies") of the wall are better protected from the elements but are difficult to install properly; "outies" are more exposed, but they're easier to install because the details are similar to conventional window alignment. Various types of self-adhering membranes and brake-bent profiles were used to flash the openings.

ences are relevant for any project with an increased focus on airtightness.

Occupant control. The ASHRAE 62.2 standard makes ventilation automatic, taking it out of the hands of the occupant. This has been determined to be a safe approach toward ensuring good IAQ, although there are challenges in that the ventilation rate is certainly too low when there is a house full of people smoking or cooking, and it is probably too high when no one is home. It would be nice to give the occupants more control over their ventilation, if we could trust that they would use it "right." It would be even better if the ventilation controls were based on IAQ levels (for example, if measured CO_2 and VOC levels in the home would turn on the ventilation), with boost switches provided for cooking, showering, smoking, and so on.

Demand-controlled ventilation has long been used in commercial buildings, but now there are some residential systems being developed. Ventilation does consume a lot of energy, and that is something to be considered as part of an overall energy reduction strategy. Under-ventilation can be dangerous, but over-ventilation can wipe out all of the energy savings gained from an airtight, super-insulated shell. For now, ASHRAE 62.2 is the accepted balance between the two.

Cost Considerations

These DER upgrades added nearly $26,000 to what was already a substantial gut renovation. This added cost would be a problem for most market-rate builders and developers, since the sales price of a house is based on its appraisal, which is based on comparable sales. Comparable sales are hard to find in a depressed housing market, so spending this much extra could be considered "over-improvement" from a short-term investment standpoint. For a developer without subsidy, it is impossible to stay in business if costs are higher than sales prices.

Return on investment. Achieving Energy Star standards took the homes from HERS scores in the 180 range to the low 70s. The Energy Star homes initially operated at an estimated average cost of $7,842 per year, and that was reduced to an estimated average cost of $2,525 per year.

Spending the extra $25,775 on the DER homes further reduced operating cost to an average projected annual cost of $1,519, and reduced HERS scores to an average of 38. The simple payback on that investment is 26 years, but rising utility costs and reduced installation costs (as experience is gained and these practices become more commonplace) could shrink the payback period quickly.

We hope that, with enough successful case studies, the energy-savings payoff of retrofit strategies like this one can become a part of how buyers, lenders, and appraisers assign value to houses. There will always be resistance to improved performance specs that cost more up-front but don't immediately translate into higher sales prices. But the DER homes have other benefits as well — including durability and controlled indoor air quality — that are more difficult to measure. Over time, we hope builders can overcome resistance by educating clients on all of the benefits of DER.

In the most efficient DER homes, wall-mounted mini-splits were used in the first- and second-floor hallways. Bath fans were installed nearby to pull conditioned air from the hallways into the bedrooms, but comfort issues led to relocation of air outlets from the continuously running ERV.

Upgrade Costs for DER Houses*

Remove existing siding	$2,000
Misc. framing	$500
Exterior wall foam, mat'ls & labor	$12,600
Under-slab foam, mat'ls & labor	$600
Foundation insulation & finish	$3,000
Window upgrades	$900
Entry door upgrade	$375
Insulation (attic & interior)	$1,000
Tankless hot-water heater	$1,800
Hvac (ERV and commissioning)	$3,000
Total avg. DER upgrade cost	$25,775
*Incl. builder markup	

The largest additional cost in the DER upgrades was for rigid foam insulation at the foundations and slabs and on the exterior walls (siding costs are excluded because siding had to be replaced anyway). At current fuel prices, the total upgrade cost pays back at a rate of about $1,000 per year. The authors consider the improvements to occupant comfort and building longevity to be worth the investment.

Matt Berges, *Green Housing Manager, and* ***Mandy Metcalf,*** *Affordable Green Housing Center Director, work at Environmental Health Watch, a nonprofit advocacy organization based in Cleveland.*

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Products

Heavy-Duty Truss Hangers.

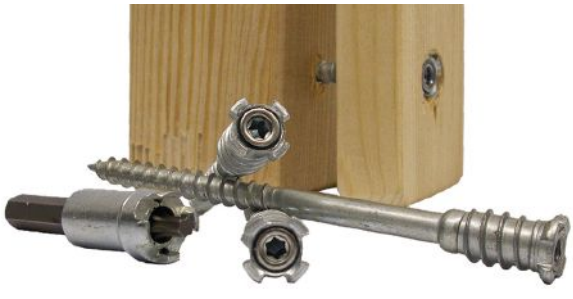
This year's Simpson catalog has three new lines of truss hangers that the National Council of Structural Engineers Associations says have "some of the highest loads in the industry." *HTHGQ Heavy Girder Truss Hangers* ($350 to $400 each) will support two- to five-ply girder trusses on structural posts. *HTHMQ Heavy Multiple Truss Hangers* ($650 to $750 each) are designed for hip-jack connections and will support two or three trusses at angles of 30 to 60 degrees. *HHSUQ Heavy Severe Skew Truss Hangers* ($100 to $125 each) are truss-to-truss connectors for hanging single hip trusses at angles of 45 to 84 degrees.

Simpson Strong-Tie, 800/999-5099, strongtie.com.

Sleek Faucet Option.

For people who like a touch of drama, Moen has added a *Matte Black Finish* option to its Arbor and Ascent kitchen-faucet collections. It's the least costly finish offered on these faucets. The Arbor costs $352 in black matte — about $45 less than the next-highest option.

Moen, 800/289-6636, moen.com.



Shim With a Drill.

The 1/4-inch-diameter, 3 1/8-inch-long *Top Star Shim Screw* has a 3/8-inch-diameter thread around its head. You drill a pilot hole, then — using a special bit made by the company — drive the threaded cylinder and screw into place as a unit. Although the cylinder stays firmly locked in the jamb, the inner screw will turn freely within it, so the installer can drive it in or back it out to adjust the distance between frame and jamb. Since the cylinder sits flush with the surface, you may want to hide it behind a hinge leaf. A six-pack costs $14.

GRK Fasteners, 800/263-0463, grkfasteners.com.

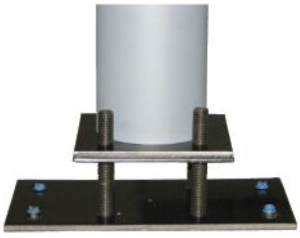
No-Sag Concrete Patch.

Aboweld is a two-part epoxy for concrete repair. It's impermeable, can be applied under water, and bonds to old concrete — which means it can patch anything from swimming-pool walls to concrete stoops. The maker says it won't sag when wet and can be ground with an angle grinder, then sanded to a finish when dry. Standard and "cold weather" (for use below 50°F) versions are available. A two-quart kit costs about $60.

Abatron, 800/445-1854, abatron.com.

For more information about these products, go to http://jlc.hotims.com.

Products



Adjustable Column.

The *Lally Lock* system is a height-adjustable Lally column. It has three parts: a steel-encased concrete column with a coupling nut embedded at the top, a steel top plate, and a steel baseplate/bearing-plate combination with 3-inch adjustment bolts. You bolt the top plate to the coupling nut and fasten the base plate to the bottom of the column with concrete screws. Then you position the base plate over the coupling plate and tighten the bolts to secure the column at the correct height. Columns are sold in 3-inch increments; an 8-foot by 3½-inch column plus hardware costs around $90.

Dean Column, 800/442-3455, deancolumn.com.

Condensation Killer.

It's easy to forget to turn off the bath fan after taking a shower. The *DewStop* switch can help by turning the fan on or off automatically in response to humidity and dew-point levels so it runs just long enough to prevent condensation from forming on the walls and ceiling. The switch can also be operated manually and has a 30-minute timer. A fan-only switch costs about $50, a fan-and-light switch about $60.

GTR Technologies, 360/876-2974, dewstop.com.

Roof-Friendly Solar.

Certainteed's polycrystalline *Apollo Solar Roofing* uses solar cells protected by a layer of plastic rather than glass, making it lighter than many other products. The panels integrate with the roof shingles, so they should be less stressed by wind uplift than rack-mounted systems. At $6 per watt, a 4-kw system costs about $24,000, but tax credits and utility incentives could reduce that considerably.

Certainteed, 800/233-8990, certainteed.com.

Luxury Mini Fridge.

True Manufacturing's new 15-inch *Undercounter Refrigerator* is aimed squarely at the luxury market. It's being positioned as a "professional grade" product with precision temperature control — not surprising, since it's made by a company known for commercial refrigeration. It comes with two adjustable shelves and four door options — solid stainless or wood overlay, and stainless or wood overlay with glass — and costs $2,600 to $2,770.

True Manufacturing, 888/616-8783, true-residential.com.

For more information about these products, go to http://jlc.hotims.com.

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Products

No-Rot Ledger. The new *Deck Ledger* system consists of extruded aluminum ledger boards and joist hangers. The hangers snap onto the ledger and, once in place, can't be lifted out (though they can be moved side-to-side until locked in place). Single and double hangers are available. Ledgers are 8 inches wide and 1/8 inch thick, and come in 5-, 6-, 7-, 8-, and 10-foot lengths. They include built-in bubble levels and ship with 66-millimeter LedgerLok fasteners. The system is compatible with lateral hold-downs, but you will need to drill additional holes. Average cost is about $24 per linear foot including the hangers.

SigmaDek, 403/239-4448, sigmadek.com.

Corner Storage. The *Magic Corner II* is a blind cabinet storage system with front and rear shelf pairs. When you pull the front unit out of the cabinet, the rear automatically positions itself inside the door opening. Other features include a vertical handle that lets you pull the front unit out without bending over, shelves on the rear unit that slide in and out individually, and wire-basket or solid-tray shelving. Left- and right-swing units are available with a storage capacity of 1,138 square inches. The frame and solid shelves shown here cost about $1,530.

Häfele America, 800/423-3531, hafele.com/us/.

Against the Wind. GlassCraft's new *Impact Fiberglass Entry Doors* have been approved for use in the high-wind zones of Florida and Texas. They come in classic French and Prairie Style designs, single- or double-door configurations, and with or without sidelights. The laminated glazing can be left clear or fitted with simulated divided lights or powder-coated wrought-iron grilles. Prehung units include multipoint locking hardware and are priced from $3,215.

GlassCraft Door, 800/766-2196, glasscraft.com.

Easy Wrap. Cutting, aligning, and gluing square-edged post wraps can be a pain, and even interlocking products may require two sets of hands to install. *KleerWrap* eliminates a lot of the hassle and can be put in place by a single worker. It consists of a pre-assembled wrap with one loose panel; you simply remove the loose panel and then glue it back in place once the wrap is on the post. The interlocking joint makes the panel self-aligning. A 4-by-4-by-8-foot wrap costs about $75, an 8-by-8-by-10-footer around $165.

Kleer Lumber, 866/553-3770, kleerlumber.com.

For more information about these products, go to http://jlc.hotims.com.

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Toolbits

Painter's Helpers. Last May, a California painting contractor formed a company to sell two new tools: the *Brush Flex* and the *Mini Roller Flex.* Both consist of a roller or brush on a flexible handle. The handle screws on to the end of a telescoping pole so that the painter can reach awkward or difficult spaces. Now both tools are available in one package: The *Flex Paint Kit* accepts a range of large and small mini-roller and brush sizes and costs $30.

McCauley Tools, 800/685-4911, mccauleytools.com.

Purpose-Built Blades. Milwaukee has added two application-specific Sawzall Blades to its lineup. The *Ductwork Blade* is for installing takeoffs on sheet-metal ductwork, with a tip designed for plunge cuts and a tapered profile for radius cuts. The *Drywall Blade* is aimed at plumbers and electricians working on remodeling jobs. At $2\frac{1}{2}$ inches, it's long enough to easily cut holes in $\frac{5}{8}$-inch drywall, but short enough to minimize the chance of hitting pipes or wires. It has teeth on both edges so cuts can be made in either direction. A five-pack of Ductwork Blades costs $20; a single Drywall Blade goes for $7.

Milwaukee Electric Tool Corp., 800/729-3878, milwaukeetool.com.

Bench Press. Rockwell has adapted its popular JawHorse for use in the shop. The *BenchJaws* vise uses the same foot-pedal mechanism as the JawHorse, but it comes with an L-shaped steel plate (instead of a folding sawhorse) that screws onto a corner of a workbench. The $6\frac{7}{8}$-inch by $1\frac{7}{8}$-inch jaws have nonmarring polyurethane face plates and a clamping range of up to 16 inches. An Extension Jaw accessory extends the range to 24 inches, and a Multipurpose Jaw accessory accommodates tapered and round objects. Cost is $100 (about $50 less than the JawHorse); accessories are $40 each.

Rockwell Tools, 866/514-7625, rockwelltools.com.

Get a Grip. You may be familiar with YakTrax — stainless steel coils attached to a rubber harness that slips over the shoe to provide traction on snow and ice. Those are for winter sports, but now the manufacturer has come out with a product engineered for people who work outside. *Diamond Grip* ice and snow cleats use the same concept as YakTrax but consist of dozens of diamond-tipped steel grippers strung on steel aircraft cable. You won't want to walk on finished surfaces wearing these — they'll scratch even marble tile — but if the remainder of this winter finds you lugging 2x4s across an icy job site, you might want to check them out. They cost $42 per pair.

ICEtrekkers, 866/925-8729, icetrekkers.com.

For more information about these products, go to http://jlc.hotims.com.

Backfill

5,500 Pounds of Pennies

It's not the kind of job that comes along often, but just in case you ever need to assemble a durable commercial floor from real pennies, here's a brief tutorial from Silver Spring, Md., artist and designer Maggie O'Neill. She completed such a project for a popular restaurant in downtown Washington, D.C., two years ago.

(1) First, collect 1 million pennies. The Philadelphia Mint makes 8 million of them every shift, so you'd think it would be simple to buy a certain amount of brand-new matching coins. But that's not how it works. You have to get them in mixed $25 boxes from local banks, a few here and a few there. Then someone has to spend a lot of time tearing open the rolls.

(2) Assemble the pennies into temporary foot-square "tiles" by placing a handful of coins on a lipped plywood form and shaking it gently until they're all lying flat and the surface is completely covered. Complete each tile by sticking a square of adhesive plastic carpet protector — a material familiar to most remodelers — to the exposed surface. Carefully turn the form over onto a stack of previously prepared tiles, separating the layers with sheets of waxed paper.

(3) Spread a thin layer of Latapoxy adhesive on a section of the prepared plywood subfloor. It should be thick enough to make the pennies stick securely to the floor, but not so thick it smears their exposed faces. Working fast, turn a "tile" of pennies onto the epoxy and press it into place. Once the resin has cured, peel off the plastic film. Repeat several thousand times.

(4) Grout the pennies with clear Rock-Kote epoxy. Wear kneepads.

So far, O'Neill says, the completed floor has stood up well to heavy foot traffic, except for an area near the bar that was damaged by a water leak. And she's finally stopped worrying about being arrested for violating the federal law against defacing or mutilating U.S. coins. (Although that prohibition requires fraudulent intent and applies only to coins "in actual use or circulation," it leaves some room for interpretation.) "I guess I'm okay," O'Neill says. "The Treasury Department must know about it by now, and I haven't heard a word from them." — *Jon Vara*

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