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PROPANE The Ultimate Guide to Zero Net Energy Building User Guide

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The Ultimate Guide to Zero Net Energy Building

The Ultimate Guide to Zero Net Energy Building With Propane
STRATEGIES THAT WORK FOR YOUR MARKET — AND THRILL YOUR CLIENTS.

The Growing Market for ZNE

Zero net energy (ZNE) construction represents a vast opportunity for builders and architects. Although ZNE and zero energy ready (ZER) homes make up less than 1 percent of the residential market, the category represents a market opportunity of $33 billion by 2037, according to the Rocky Mountain Institute.1 A 2020 inventory of zero energy homes from Team Zero counted 28,000 homes, up 26 percent from the previous count in 2018, with another 30,000 in the pipeline.2

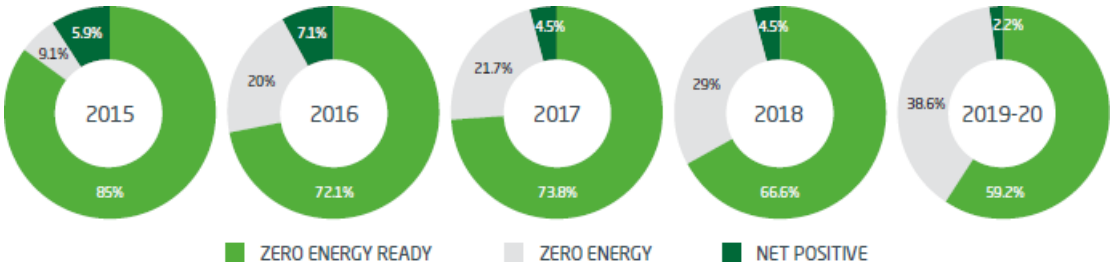
1 Peterson, Alisa, et al. The Economics of Zero-Energy Homes. (Rocky Mountain Institute, 2018.) 2 EEBA Team Zero. Zero Energy Residential Buildings Study. (2020.)

So what is a zero net energy home? In the simplest terms, a ZNE home produces as much energy as it uses, most commonly using efficient construction methods and solar photovoltaic panels. As you'll see, the term can be defined and measured in different ways. But achieving ZNE performance involves a whole-building design approach to consider all of a home's systems — the building envelope, mechanical systems, and lighting and appliances — in an integrated way.
Now is the time to educate yourself about ZNE construction, both to meet customer demand and keep up with your competition. A survey performed by Harris Insights & Analytics for the Propane Education & Research Council (PERC) found that 83 percent of homebuyers and

89 percent of builders are likely to consider a ZNE home for their next purchase or build. And about the same number — 81 percent of homebuyers and 84 percent of builders — are very or somewhat willing to pay more for a ZNE home.
That's why we've developed "The Ultimate Guide to Zero Net Energy Building With Propane." This e-book collects our most valuable resources on ZNE projects to help you define what ZNE means for your project and examine how factors such as energy prices, net metering policies, solar resources, incentives, and your budget affect your choice. You'll see that getting to zero doesn't mean giving up desirable and high-performance gas systems. So let's find a strategy for getting to zero that works for your market — and thrills your clients.

Percentage of Units by Energy Performance

3 Propane Education & Research Council. (2019, August 14). PERC Study Reveals ZNE Favorability and Willingness to Pay More Among Residential Customers [Press release].



Source: Zero Energy Residential Buildings Study, EEBA Team Zero

Defining Zero Net Energy

Here are a few ways ZNE homes are measured.

Site energy
The energy consumed by the house is equal to the energy produced by the home's renewable energy system, typically over an annual cycle.

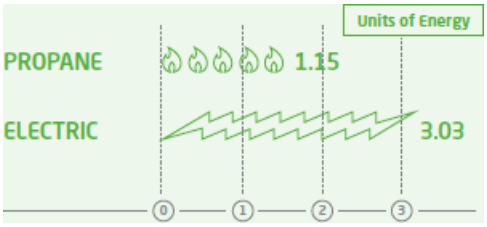
Advantages: Easy to understand and can be measured at the house.
Considerations: Doesn't account for the upstream losses of different energy systems or the use of off-site renewable energy, which may be more appropriate for homes that aren't suited for solar.

Zero dollar utility bill
The net energy cost for the home is zero, after accounting for both energy use and energy production at the house.
Advantages: A zero dollar energy bill is what many consumers envision when they hear "zero," and many homeowners would prefer this economic payback.
Considerations: Achieving this can be a difficult target due to utility fees, weather, and homeowner behavior, and limits on net metering may make it difficult to zero out the bill by selling electricity to the grid. for homes that aren't suited for solar.

Source energy
The energy consumed by the house — including associated losses and efficiencies associated with extracting, generating, and distributing this energy — is equal to the energy produced by the home's renewable energy system.
Advantages: More fully accounts for overall resource efficiency and encourages more efficient generation and transmission of energy.
Considerations: Can be more difficult to communicate and will change over time as the upstream energy choice portfolio changes.

Zero energy ready (ZER)
The energy consumed by the house, as measured at the house, can be offset by renewable energy.
Advantages: Easier to communicate; allows for on-site or off-site renewable energy; and is more flexible in terms of building systems, energy choice, and utility policies. **Considerations:** Pros may want to get more specific about how close a home is to achieving zero energy.

Source Energy Ratios



Source energy factors offer a way to compare the amount of source energy needed to deliver a unit of energy on site. For every unit of electricity used on site, 3.03 units of source energy in the form of a fuel like natural gas or coal must be extracted to generate and deliver that electricity. Propane requires 1.15 units of energy at the source, accounting for losses from extracting, processing, and distribution.
Based on national averages. Source: GHG and Criteria Pollutant Emissions Analysis. Gas Technology Institute for PERC, 2017.

Learn more at propane.com 4

Strategies to Achieve Zero Net Energy

Focus on the building's envelope.

1 Insulation quality
2 Insulation quantity
3 Air sealing
4 Window performance

5 House orientation

Include high-efficiency propane systems.

6 Propane furnace
7 Propane water heater
8 Propane cooking
9 Propane fireplace
10 Propane clothes dryer

Trim other energy use

11 Energy Star appliances
12 LED lighting
13 Energy monitoring devices

Proven Results

Using propane and other strategies including solar cells, this home earns $343 annually selling excess energy. · 1,912 square feet · Super insulated · R-5 triple-pane windows · 96 percent efficient propane tankless water heater · HERS without solar: 34 · HERS with solar: -21

Other Propane Benefits

Propane is not only energy efficient, it lowers first costs and emissions. It is also highly effective in any area of the country for a variety of temperatures.
Standby Generator A propane standby generator provides resilience for ZNE homes by protecting the home's power when the sun isn't shining.
67% FEWER EMISSIONS With a propane tankless water heater compared with electric storage tank models.

FIRST COSTS
of high-performance systems:

Propane furnace and AC: $11,000

Ground source heat pump
(GSHP) closed loop: $34,000

Learn more at propane.com 5

Mixed-Fuel Options for Mechanical Systems

A common misconception is that ZNE and ZER homes are all-electric.

In fact, mixed-fuel solutions are popular in this type of project because they give homeowners the opportunity to lower their monthly utility bills while still reaping the benefits of gas. Mixed-fuel systems typically offer lower first costs and reduced ongoing energy costs and emissions, and they allow for hybrid systems tailored to a project's unique needs.

In high-performance projects, the building's heating and cooling loads are greatly reduced through the highly insulated envelope and extensive air sealing. So overinvesting in heating system efficiency may not be optimal and could divert dollars that would have a greater impact elsewhere in the home's design.

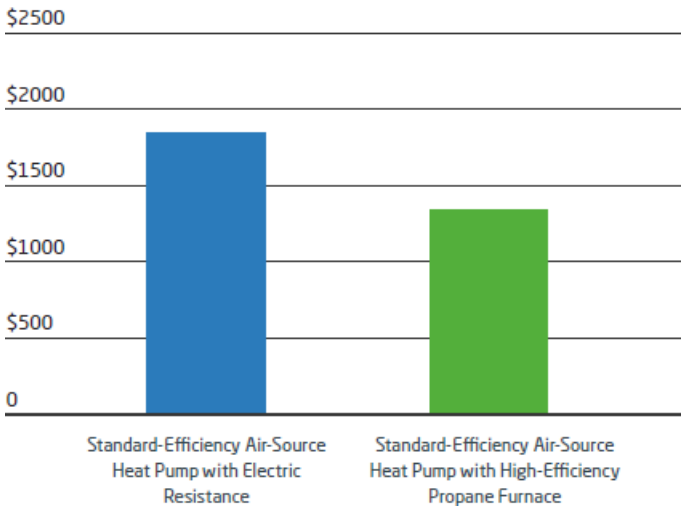
For instance, ground-source heat pumps are traditionally very efficient but also have very high first costs. Based on a detailed heating systems analysis performed by PERC, a ground-source system for a typically sized home would cost almost $35,000, compared with around $11,000 for a high-efficiency propane furnace. So while the ground-source system was found to produce cost savings, the magnitude of these savings in a high-performance home with much lower loads would be smaller and extend the payback period significantly.

Another option would be a dual-fuel or hybrid heating system that combines an airsource heat pump with a high-efficiency propane furnace. The propane furnace can replace the inefficient electric resistance backup heat in cold outdoor temperatures, providing improved comfort and saving hundreds of dollars per year.

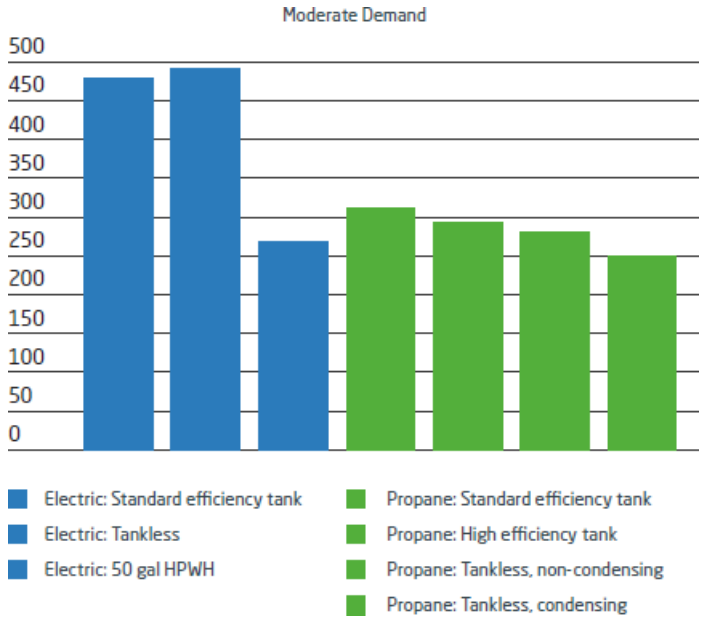
Another alternative with a light footprint is to use an air handler with a hydronic coil and a propane tankless water heater. Hot water from the tankless unit serves as a highly efficient heat source for the forced-air system while also providing on-demand domestic hot water — without the need to install venting and gas lines for a separate heating system.

Energy savings is an important goal in all ZNE and ZER homes. In mixed-fuel homes, propane water heaters can offer significant energy cost and source energy savings. In a typical house in a mixed climate, a propane condensing tankless water heater offers the lowest annual energy cost of any system, providing savings of $120 a year over a standard electric storage tank and even offering savings compared with a heat pump water heater. Plus, condensing tankless water heaters are widely available, provide space savings due to their compact size, and offer affordable upfront costs.

Annual Heating and Cooling Costs for New Homes, Cold Climates



Annual Energy Costs for Water Heating in Mixed Climates



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Meeting Your Clients' ZNE Goals

When David Knight meets with his clients, they're asking about zero net energy a lot — on almost every job.

Knight's Carmel, Californiabased mechanical engineering firm, Monterey Energy Group, performs energy compliance work and HVAC, plumbing, and solar design for about 1,000 custom homes throughout California each year. Every project starts with a conference call or meeting with the homeowner, architect, and builder to discuss project goals, budget, and timeline.

"Very often it comes out that their goal is to be truly net zero energy," Knight says. "They truly want to produce as much energy as they consume." Other times, he says, customers "just want a nice, efficient house, and they want to do what they would consider the greatest value." They want to be comfortable, efficient, environmentally balanced, and healthy, and they want to be able to afford it.

Understanding a customer's ZNE goals requires further discussion, Knight says. Does a client want to zero out their electric consumption? "That's easy to do, cost-effective to do," he says. "It's not going to ruin anyone's budget. And I would argue it makes all the sense in the world."

The conversation gets more nuanced — and much harder — if the client wants to zero out all energy consumption, including domestic hot water and space heating. "It's not impossible to do, but it does cost more upfront, takes up more space," Knight says.

CALIFORNIA ENERGY CODE

Enacted at the beginning of 2020, California's new energy code is frequently referred to as a zero net energy code, and it falls closer to Knight's first option, zeroing out electric consumption. "A lot of people were thinking that the zero net energy code was mandating all-electric homes," he says. "It's not." In reality, the new code is neutral for propane, gas heating, and water-heating systems.

So rather than focusing solely on electric systems, Knight specifies systems based on the design, energy cost, and comfort goals of the project. In modern homes, for instance, there's usually very little room left over for extensive ductwork. One option he frequently employs, especially along the California coast, is radiant floor heating. "Architects love radiant floor-heating systems," he says. "It's silent, it's invisible, it doesn't take up much space. The clients like it because it's very, very comfortable."

Energy costs are another important consideration. California has very high electric costs, so trying to use grid electric power for domestic hot water and space heating will usually cost a fortune. Instead, Knight typically evaluates propane and natural gas heating systems against the amortized cost of solar panels powering a heat pump.

In forced-air systems, propane and gas furnaces still have a comfort advantage over heat pumps, Knight says. “On the furnace side, they just put out warmer air,” he says. “And so the comfort level tends to be better.” And with the climate being so mild in most of California, the payback of geothermal heating systems is rarely worth the high upfront costs.

Photo courtesy of Studio Schicketanz.

WATER HEATING THAT MEETS HIGH EXPECTATIONS

Californians have high expectations for their domestic hot-water systems, Knight says. “They’re used to an unlimited amount of hot water that turns on in a few seconds from the time they hit the switch. And the biggest challenge for going all-electric is domestic hot water. Because there just really isn’t a domestic hot-water system that’s going to perform that way.”

Whereas a propane tankless water heater can provide 200,000 Btus per hour of heating, keeping the hot water coming indefinitely, electric storage tank water heaters have a much slower recovery rate. “With electric, you can add enough storage to make it so that they can get through, but it takes up a lot of space, and we’re already always fighting for space,” Knight says. Even if a home can manage to fit two 50-gallon electric water heaters, homeowners will need to wait a couple hours for the tanks to heat up again if they use up the stored hot water.

“What we like to tell people with a gas unit is that we defy them to run out of domestic hot water,” Knight says. “We do not say that with electric units. And some people are happy with that, but many aren’t.

” In the end, the mechanical system design comes back to the project budget and goals. That means it’s incumbent on builders, architects, and engineers to both understand their clients’ needs and educate clients on their recommendations. “We give them their options and the relevant benefits and features of different systems,” Knight says. “I almost always say, `Look, given this house, and given what you’ve told us about your goals, if this was my house, this is what I would do.'” By accruing deep education and experience across a variety of mechanical systems, Knight assures his firm is equipped to design a system appropriate for his clients’ dream home.

WATCH THE VIDEO
Visit youtube.com/buildwithpropane to see David Knight explain how he designs the mechanical and domestic hot-water systems on his projects to meet each client’s needs.
Learn more at propane.com 8

A Zero Energy Ready Mountain Chalet Remodel

Bill Owens has been closely involved with the green building movement for more than two decades.

As a highly respected remodeler and active member in the leadership of the National Association of Home Builders, Owens has kept himself on the leading edge of energy efficient construction technologies. So it was only natural that when he remodeled his own “forever home,”

Owens designed the home to be zero energy ready, with a predicted Home Energy Rating System (HERS) Index rating under 30. Owens is president of Owens Construction, a design-build remodeling firm in Worthington, Ohio, but his new home is a renovation of a 1970s mountain chalet outside of Flagstaff, Arizona. Contrary to the common perception of Arizona, the home is in a dry, high mountain desert environment at 7,000 feet of altitude, so it experiences extreme temperatures and an average of 100 inches of precipitation each year, mainly in snow.

That climate, combined with the home's remote, semi-rural location, led to Owens busting another common perception — that zero energy homes must be all-electric. In fact, to achieve the comfort, resilience, and efficiency Owens had in mind for his dream home, going dual fuel with propane created an ideal energy solution.
For his zero energy ready home in Flagstaff, Arizona, remodeler Bill Owens used extensive spray foam insulation to achieve a tight, well-insulated envelope.

Learn more at propane.com 9

ULTRA-EFFICIENT TECHNOLOGIES AND MATERIALS

The project, which was also Professional Remodeler's 2019 Model ReModel, includes many of the technology and building material hallmarks of modern ultra-efficient homes.

Owens used continuous 2-inch foam insulation on the outside of the house, along with a reflective barrier that reduces heat flow. In remodeling a home with existing 2×4 construction, the team used a combination of open-cell and closed-cell spray foam insulation. That included 45 inches of closed-cell spray foam around the existing crawl space and about 8 inches of spray foam in the attic to achieve close to an R-50 insulation value. He went back to pay special attention to reduce air infiltration around windows and used energy-recovery ventilators to provide efficient ventilation for a home with about 1 1/2 air changes per hour.

With a home that well-insulated, a high-efficiency mini-split heat pump system can handle the heating load in moderately cold conditions. But temperatures on the mountain can drop as low as -30 degrees Fahrenheit. Plus, Owens didn't want his standby generator to be huge enough to run all the heat pumps during an outage. A hybrid heating solution with Goodman propane furnaces for the first floor and crawl space was an ideal solution.
"I just didn't want the house freezing up on those cold nights," Owens says. The crawl space furnace also heats up the hard floors above the crawl space, which are necessary in the dusty Arizona environment.

Using a propane backup furnace and tankless water heater allowed Owens to specify an affordable standby generator, since it didn't have to be sized to operate the home's mini-split heat pumps.

With backup propane heating in place, Owens could install a right-sized propane standby generator to handle the electrical needs of the furnaces, water pumps, refrigerator, and smart home features such as the smart water valve protecting against leaks.

"We're literally at the end of the grid," Owens says. "I am the last house on about 2 miles of electric overhead running through a national forest. If a big snow storm takes down a tree, I could be affected. I'm pretty low on the web to come back and get picked up again."

TANKLESS WATER HEATING HELPS ACHIEVE GREEN RATING

Another feature that lends to both the low HERS rating and the lower load on the generator is a Navien propane tankless water heater. “The Navien was an easy choice just because we were trying to get a robust NGBS Green rating out of it,” Owens says. “There’s no electric unit out there that’ll keep up a whole house. Plus, it’s fairly frequent that we’re out of town, so we just didn’t want any [hot water] storage in there.” The tankless unit includes a programmable recirculation loop to minimize wasted cold water dumped down the drain in a state where water is precious.

In addition to energy-efficiency features, propane fuels several of the home’s most appealing lifestyle amenities. Owens plans to install a propane fire feature on the enclosed porch, a safer approach than open wood fires in a state with frequent fire restrictions and a site bordering a national forest. The home will also have propane cooking, both on an outdoor grill and on the kitchen cooktop.
“I like induction, but I don’t like it nearly as much as the propane,” Owens says. “I’ve checked with our energy rater, and he basically said that you get such a clean-burning fuel with propane that that’s not considered a detriment if you have the exhaust hood. It doesn’t work against you on the points for the green rating.”

Building to zero energy standards does come with a higher cost, Owens says, but the payback comes both in long-term energy cost savings and immediate comfort improvements. “This house is so tight that we don’t notice when the wind’s just howling or when we’re getting huge temperature swings out there,” he says.

The experience has also bolstered Owens’ support for dual-fuel homes with both electricity and natural gas or propane. Trying to run his home purely on solar and battery backup, in a state with disincentives for solar installations, would have been cost-prohibitive. “In a fairly severe environment or environments that are enough away from the grid, there is no perfect panacea with just one energy source,” he says.

WATCH THE WEBINAR

Learn more about the latest in ZNE trends in the Propane Presents Technology Series webinar featuring Bill Owens; David Knight; and Matt Evans, a certified home energy rater with Newport Ventures. Visit propane.com/ppt-series.

Project Snapshots

Available at Hanley Wood University, the “Introduction to Net Zero Energy Homes and Opportunities to Leverage High Efficiency Propane Systems” training course highlights several additional zero net energy and zero energy ready project examples. Check out the course to learn more about the current ZNE housing market, the general design approach to ZNE dwellings, and the opportunities to integrate mixed-fuel home designs in ZNE projects.

MODULAR LIFESTYLES Irvine, California
Modular Lifestyles has built more than 75 ZNE modular homes designed with solar/battery and a high-efficiency propane tankless water heater. Not only do the company’s homes have an affordable purchase price of $75,000, but the average customer needs only 20 gallons of propane per year. Pairing a renewable energy system with propane — a portable, resilient fuel — has proven to be a solution that helps meet California’s increasingly severe housing affordability challenges.

BROOKSIDE DEVELOPMENT Derby, Connecticut
Incorporating propane appliances into its projects allows Brookside Development to reach energy benchmarks that meet ZER requirements. Plus, because propane appliances are so efficient, using propane helps customers afford new homes in a competitive market. Brookside Development has built three ZER homes in Connecticut with a suite of high-efficiency propane appliances, including a propane furnace, tankless water heater, fireplace, and cooking range.

BPC GREEN BUILDERS Wilton, Connecticut
Chris Trolle, co-founder of BPC Green Builders, has built 11 zero energy projects to date, about half of which use propane. One of those projects is a ZER, LEED Platinum lakeside home in New Fairfield, Connecticut. The project has a highly insulated, airtight envelope featuring double-wall construction with R-33 blown cellulose insulation and an R-72 roof. To keep the home warm during Connecticut's cold winters, a 90 percent AFUE propane boiler with a 40-gallon tank serves an in-floor radiant heating system on the first level. It also provides domestic hot water.

STUDIO SCHICKETANZ Carmel, California
Most of the clients at Mary Ann Schicketanz's boutique architecture studio want to achieve net zero performance. The Lobos View project exemplifies her environmentally sensitive design approach, with the home carved into a small, hillside lot overlooking the Pacific Ocean. To overcome the site's unreliable power grid, Schicketanz specified a whole-home propane standby generator. A propane stovetop, fire pit, and pool and spa heater provide added luxury without sacrificing sustainability and energy efficiency goals.
Learn more at propane.com 11

Access Additional Resources at Propane.com

Beyond its use in zero net energy homes, propane fuels a variety of innovative and high-efficiency technologies throughout the home. Visit propane.com to learn more about how propane can make your projects more desirable — and profitable.

INTERACTIVE FEATURE: BUILDING A ZERO NET ENERGY HOME WITH PROPANE Check out this immersive page featuring video interviews, graphics, and research data to see how builders and designers are achieving ZNE performance with propane.

FREE CONTINUING EDUCATION CERTIFIED TRAINING Boost your bottom line by taking one of our free online propane training courses and earn credits from the American Institute of Architects continuing education system and Green Business Certification Inc.

BUILD WITH PROPANE NEWSLETTER Sign up for the residential edition of the Build With Propane newsletter to stay informed on the latest news, techniques, and incentives for propane building.

SUBSCRIBE ON YOUTUBE Don't miss the latest videos featuring ZNE home case studies; new technologies; and interviews with builders, architects, and remodelers.
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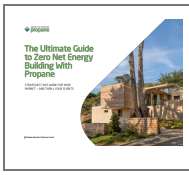	PROPANE The Ultimate Guide to Zero Net Energy Building [pdf] User Guide Ultimate Guide, Net Energy Building, Energy Building, Building

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