



The Ultimate Guide to Comfortable Heating

STRATEGIES TO KEEP HOMEOWNERS
COZY ON EVEN THE COLDEST DAYS.

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Providing Year-Round Home Comfort

What makes a home comfortable in the winter?

Surprisingly, there's no simple answer to the question. Every homeowner experiences "comfort" a little differently, and the comfort of a home can be affected not just by the temperature of the air but by a variety of factors, including personal preference, the clothing people wear, the insulation of the building envelope, and even psychology.

Kansas State University professor Frederick Rohles helped stumble upon the subjective nature of comfort in a study he was running, when he found that participants felt colder in one test chamber than another, even though the two chambers were kept at an identical 74 degrees Fahrenheit.

However, he quickly identified the problem: One of the chambers was a walk-in commercial refrigerator, so the study participants felt psychologically colder there. After outfitting the room with carpeting and furniture, Rohles ran the study again. Not only did participants now feel warmer in the redesigned chamber, but simply adding the embellishments was the equivalent of raising the temperature 2.5 degrees.

For builders and remodelers, the findings mean that simply heating the air in a space to a set temperature isn't the only path to comfort. The way homeowners experience the heat in their homes will also play a role in their satisfaction with their home's HVAC.

Propane-fueled heating systems such as furnaces and boilers offer a range of solutions that make the air and surfaces in your homes feel warmer, so your customers will be comfortable year-round.

In *The Ultimate Guide to Comfortable Heating*, we've collected our most valuable resources on heating comfort, identifying a variety of options you can choose to improve the comfort of your projects while also improving your home's energy efficiency, carbon footprint, and overall cost. Let's put together a heating strategy for your home that banishes the chill from even the coldest days of winter.



Propane Furnaces Are More Comfortable: Myth or Fact?

Comfort – or lack thereof – can play a major role in homeowner satisfaction. Our heating research delves into the comfort gas and electric heating systems deliver.

It's a piece of industry lore that's virtually become conventional wisdom: Gas furnaces provide more comfortable heat in the winter than electric air-source heat pumps (ASHPs).

But is it true?

In its comparative analysis of residential heating systems, research firm Newport Partners used sophisticated building modeling software to answer the question with real data. "You hear a lot of industry buzz about heat pumps being uncomfortable in the winter season, especially when outdoor temperatures are cold," says Mike Moore, a consulting engineer with Newport.

"If the air temperature [being supplied at the register] is below your skin temperature, then you are going to have the perception of being cooled."

- Mike Moore, consulting engineer, Newport Partners

THE QUESTION OF COMFORT

As discussed in the introduction, comfort is an inherently subjective measure, so quantifying it can be difficult. The temperature of heated air is a good place to start.

In homes heated by forced-air systems, the temperature of heated air being delivered through the supply registers can have both a psychological and physical impact on occupant comfort. "If the air temperature [being supplied at the register] is below your skin temperature, then you are going to have the perception of being cooled, especially when there is a velocity of air across your body," Moore says. Thus, Newport assumed that when supply air temperatures are at or below typical body temperature – slightly less than 100 degrees Fahrenheit – many people feel cold and uncomfortable.



TESTING THE SYSTEMS FOR COMFORTABILITY

Newport's next step was to quantify how often different heating systems would deliver that cooler, uncomfortable air at the heating register. Moore used two building energy simulation tools supported by the Department of Energy (DOE) to find out.

First, the research team created a model of a new house using the Building Energy Optimization Tool (BEopt) software, which is used by the DOE's Building America program to measure the impact of energy-saving technologies and retrofits. They then used the DOE's EnergyPlus software to run an annual energy simulation across three climate zones. Moore compared the heating supply temperature provided by standard-efficiency propane forced-air furnaces and standard-efficiency ASHPs.

The results confirmed what many contractors and construction professionals had already known anecdotally: Propane furnaces are typically warmer than electric heat pumps. In both mixed and cold climates, the supply air from the ASHP feels cool about 60 percent of the time during the heating season. Propane furnaces, by contrast, provide supply air consistently above 115 degrees Fahrenheit, above the comfort threshold.

The difference in supply air temperature is caused by the different ways the two systems generate heat. Electric heat pumps use a refrigerant to scavenge heat from the outdoor air. As outdoor temperatures fall, there is less heat available to transfer into the refrigerant, so the supply air temperature falls. Standard-efficiency heat pumps will eventually turn to electric resistance heating to raise the temperature. But before this supplemental heat comes on, the supply temperature remains cool and uncomfortable.

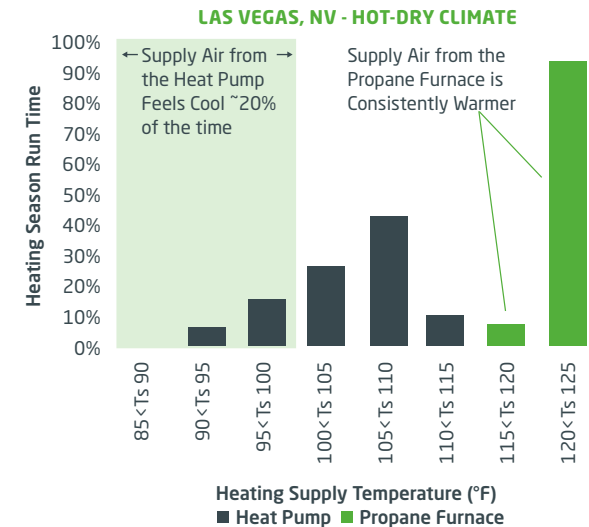
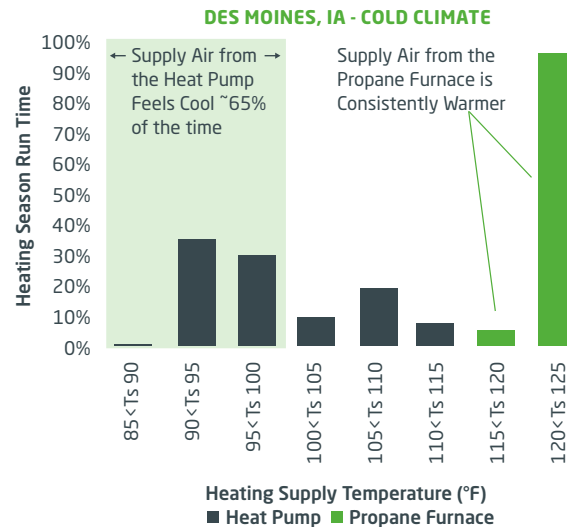
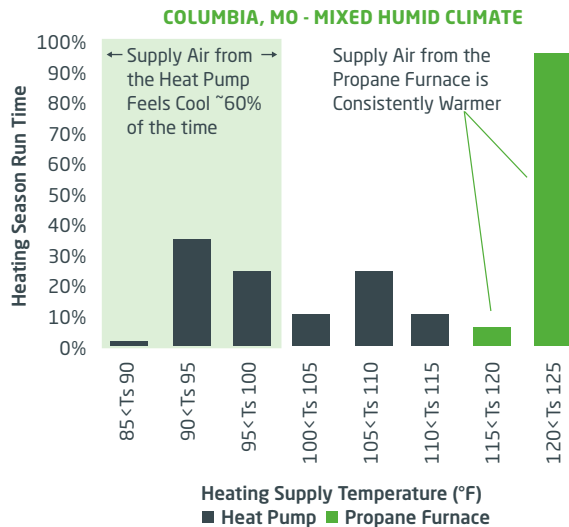
And when it's active, electric resistance heat uses much more power. "You're paying for that comfort – a lot more," Moore says.

Propane furnaces operate independently from outdoor conditions. A propane furnace is simply heating the indoor air with propane combustion, so it supplies a steady, consistent heating temperature of 115-125 degrees Fahrenheit, regardless of outdoor temperatures.

THE VERDICT

So, is more comfortable gas heating a myth or a fact? While comfort is subjective, it's a fact that propane furnaces provide warmer heated air than ASHPs throughout the winter. For many building professionals, that warmer air makes the difference between a contented customer and a dissatisfied one.

Check out more details from the Newport Partners residential heating study in [A Comparative Analysis of Residential Heating Systems](#) on hanleywooduniversity.com.



In Columbia, Missouri (DOE climate zone 4, a "mixed-humid" climate), a propane furnace delivers heated air temperatures consistently warmer than 115 degrees, while heated air from the heat pump feels cool about 60 percent of the time.

In Des Moines, Iowa (DOE climate zone 5, a "cold" climate), supply air from the heat pump feels cool about 65 percent of the winter.

Even in a hot-dry climate like Las Vegas, Nevada, supply air from the heat pump feels cool for about 20 percent of the winter.

Can you heat a home with a tankless unit?

The promising combination of hydronic forced-air heating and propane tankless water heating shows enormous potential for builders and contractors.

When Steve McCoy's furnace reached the end of its life, he didn't want to simply update it with a new one. Instead, McCoy wanted to make his home a showcase for a rapidly advancing technology: hydronic forced-air heating powered by a propane tankless water heater.

As vice president of business development for propane provider Blossman Gas, McCoy sees this technology as not only a milestone for the propane industry but also a major opportunity for construction pros to improve comfort, efficiency, and space savings in new construction and retrofit scenarios.

"What inspires me about the technology first and foremost is the comfort," McCoy says. "In the gas industry, as we're competing against electric for market share, we highlight the comfort that gas provides versus electric and, more specifically, comfort as it relates to register temperature."

Whereas heat pumps deliver register temperatures that can feel cool at around 95 degrees Fahrenheit, below the human body temperature, gas furnaces deliver heated air at around 140 degrees. And air handlers with a hydronic heating loop can reach a cozy level of about 130 degrees.

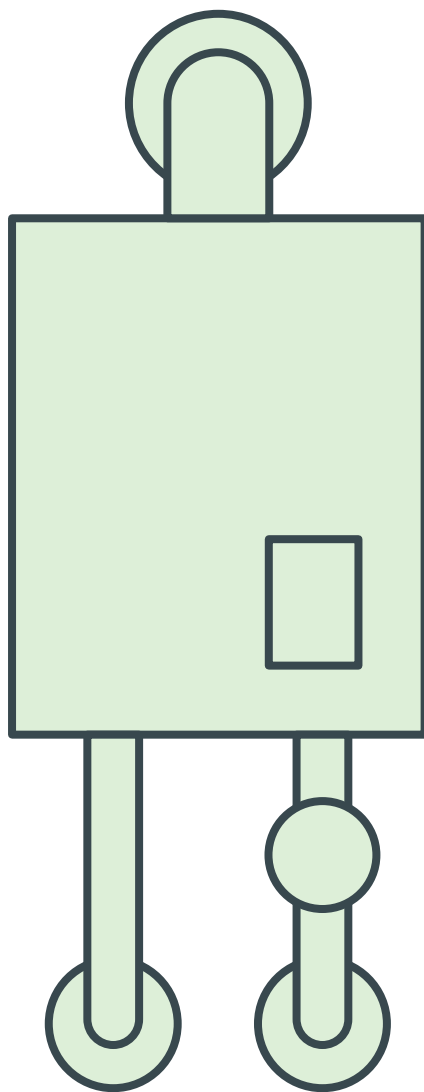


HOW TO HEAT WITH TANKLESS

Hydronic air handlers, sometimes referred to as water furnaces, provide space heating by using a hydronic heating loop to heat air as the blower moves it into the home. Tankless water heater manufacturers such as Rinnai have recently launched air-handling units and controls designed specifically to work with tankless units, which provide several advantages. Tankless water heaters offer reliability and thermal efficiency, with condensing units achieving efficiency levels up to 94 percent. And because they heat water continuously on demand, there's no need to worry about running out of domestic hot water.

In furnace replacement scenarios such as McCoy's, installing the tankless unit can be extremely straightforward because the furnace's gas line and ventilation can be reused. "For an installer of the system, it could save up to 2-3 hours of time installing it by not having to do your venting or additional gas lines," says Blossman Gas regional service pack specialist Damian Kelley, who performed McCoy's installation.

The tankless water heater also allows for a very compact installation, creating space savings by eliminating the need for a separate electric or gas storage tank water heater. "Approximately 200 cubic feet of space was saved in my situation," McCoy says. "So that same 200 cubic feet could be used in new construction to add a closet or simply reduce the size of the structure. With building material prices escalating like they are, it could save some money in new construction."

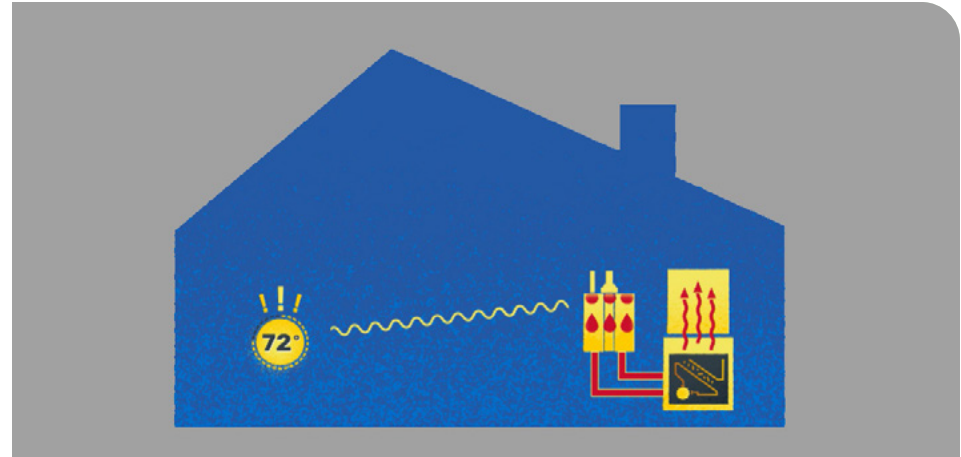


COST SAVINGS VS. ELECTRIC

The hydronic heating system can also provide energy cost savings compared with a heat pump system by eliminating the use of emergency electric heat strips when the temperatures dip. And in McCoy's installation, he found energy cost savings compared with the previous furnace system. Normalized to degree days of heating, the new system reduced propane use from 0.28 gallons per degree day to 0.21.

"That's a significant cost savings, especially in light of it being a COVID winter, when more people were in the home," McCoy says. "I just found that very remarkable. And I'm sure some of that savings has to do with the tankless water heater compared to the tank-type water heater I had, but certainly not all of that."

McCoy's Fawn Lake community, which includes more than 1,000 homes about 20 miles west of Fredericksburg, Virginia, demonstrates the value that propane can bring to a community even 20 years after it was built. About 99 percent of the homes in the community use propane for heating, since it was built outside of the natural gas lines. Today, Fawn Lake homes and other communities without natural gas can use propane to fuel popular gas upgrades like tankless water heaters.



OPTIMIZING HYDRONIC FORCED-AIR INSTALLATIONS

Check out the video series at youtube.com/buildwithpropane.

To learn more about how this innovative technology works and to see how contractors can enhance comfort and optimize their installations for improved performance, check out the series of videos in the “[How to: Tankless hydronic forced-air heating](#)” playlist on the Build With Propane YouTube channel.

In a video on optimizing the installation, Blossman Gas regional service pack specialist Damian Kelley covers a few topics:

- ▶ Tankless location. Installing the tankless water heater close to the air handler helps avoid thermal loss on the plumbing lines as the hot water is delivered to the hydronic loop.
- ▶ Domestic priority switch. When the house has high demand for domestic hot water to the faucets or shower, a priority switch can shut down the air handler to prioritize domestic hot-water demand.
- ▶ Dialing in comfort. Technicians can control the air speed across the coil, the output temperature of the tankless water heater, the air flow through the home’s ductwork, and the flow rate of the hot water to ensure the system is running at the most comfortable level for the customers.

“This technology has an enormous amount of potential,” says Steve McCoy, vice president of business development for propane provider Blossman Gas. “It’s going to take those of us in the industry, as well as HVAC contractors, to go and provide data and real case studies to builders so that they will try the technology. After doing so, I’m confident that they’ll feel the same way that I feel: that this is a wonderful new technology for our industry and will result in a happier homebuyer.”

How to maximize comfort with radiant heating

A plumbing and heating specialist designed his own heating system to make the most of a propane boiler's comfortable, efficient heating.

For Michael Long, there's no question about the most comfortable way to heat a home.

Radiant heating, in which a boiler pumps warm water around the home to keep surfaces at a steady, cozy temperature, has a big advantage, says the owner of [Michael Long Plumbing & Heating](#), a third-generation company in Whitehall, Pennsylvania. So when it came time for Long to build his own forever home, he had no doubt about the heating system he would use. A hybrid heating system with a heat pump and radiant heating from a propane boiler was the way to go.

"The house feels way different when it's the forced air compared to the radiant," Long says. "It's a little more drafty. The floors are colder, obviously. In the dead of winter, when the boiler is running, you can walk around barefoot and be comfortable."

In a sense, Long's home is a comfort showcase. The 4,000-square-foot home, which he was building when his wife learned she was pregnant with twins, was his chance not only to customize the design for his family but also to demonstrate his expertise in radiant heating and custom plumbing. The home's high-performance heating system and a luxurious his-and-hers shower became two of the home's centerpiece features – and both utilize a high-efficiency propane condensing boiler.

When Long compares his propane bills to the electric bills and oil bills from his neighbors, he's found his system to be a lot cheaper to operate.



CHOOSING A HOME FUEL SOURCE

In Long's Lehigh Valley, Pennsylvania, market, natural gas is generally available in urban areas like Allentown but not in more rural areas like the one where he built his home. "I had the choice of either electric, propane, or oil at my house," he says.

But Long says he always recommends customers use a fuel rather than going all-electric, advice that he followed on his own home. "We will not put in an electric tankless water heater," he says. "First off, they take up so much power. A lot of the homes don't have the room in the breaker box. We had some people that had some really bad experiences with the electric ones." And compared with oil, propane and gas systems offer better modulation and control that lead to higher-efficiency systems, he says.

So for his own heating system, two heat pumps provide air conditioning and shoulder season heat. Once it gets cold out, the system switches over to radiant heat from an [Aspen condensing propane boiler](#) from U.S. Boiler. The system includes 10 heating zones and a domestic hot-water zone that feeds a 70-gallon indirect tank. The whole house is zoned with circulators, as Long prefers zoning with pumps over zone valves. To offset the electrical consumption of using a large bank of circulators, Long used Taco's 007e ECM circulators.

The high recovery rate of the boiler-fed domestic hot-water system is key for using the home's 7-foot-by-12-foot full body shower. "There are two showerheads, three rain heads, four body sprays, and a hand shower," Long says. "When we designed the house with the architect, we actually had to make a little wing off of the house for the master bathroom because the original design didn't allow enough room for that big of a shower."



Michael Long's 4,000-square-foot home in Northeastern Pennsylvania features two garages (one for his business and one for personal vehicles) that are heated with radiant heat.

Beyond comfort and domestic hot-water performance, the condensing boiler offers ongoing energy savings. "You're heating water to 95 degrees to heat your house, rather than if you have radiators or baseboard, you're heating it to 180," Long says. "It's really paid off with fuel usage." When Long compares his propane bills to the electric bills and oil bills from his neighbors, he's found his system to be a lot cheaper to operate.

HEATING AND COOKING

Having propane available also allowed Long to include other gas features he and his wife wanted in their dream home. A propane pool heater extends their pool's swim season, and a gas log in the fireplace makes startup a breeze. While the couple initially disagreed about electric versus gas cooking — his wife grew up with electric — Long won the argument and chose propane for a simple reason: "I do all the cooking." He also ran a line to a gas grill and smoker in the outdoor kitchen that accompany a wood-burning pizza oven.

When a plumbing and heating specialist takes the time and care to perfect the shower and heating system in their own home, it inevitably becomes a showcase. Long can now show off his work for clients interested in having the most comfortable option. And for his own growing family, Long has peace of mind knowing the system he designed will always make home the coziest place to be.



Long's heating system includes a condensing boiler, 10 hydronic zones, and two heat pumps for use in the shoulder seasons. A 70-gallon indirect water tank provides plenty of hot water for the multi-head shower in the primary bedroom suite.

Optimizing comfort with geothermal and propane

Minnesota-based HVAC contractor Justin Isaacson shares his experience with using hybrid heating to enhance comfort and efficiency.

For the HVAC system in their lakeside Minnesota dream home, Justin Isaacson's clients had straightforward goals: the best comfort, the best efficiency, and the best overall bang for their buck.

Isaacson, owner of [Ike's Heating and Cooling](#) in Nevis, Minnesota, knew one solution could meet all three of those goals because it's a system he specializes in designing and installing. The 8,000-square-foot home uses hybrid heating anchored by geothermal and a propane furnace and boiler. "This system is going to provide comfort and efficiency that would be unparalleled by any other system," Isaacson says. "It will be year-round comfort."

HYBRID HEATING WITH GEOTHERMAL AND PROPANE

Geothermal heating and cooling are growing in popularity in Isaacson's northern Minnesota market, with about 50 percent of his clients installing ground-source heat pumps. The growth is driven by federal tax credits and rebates from local power companies, as well as homeowners' desire to lower their energy consumption and carbon footprint. Geothermal systems use underground loops to transfer heat to or from the ground, improving their efficiency.

But like all heat pumps, geothermal systems are more efficient at milder temperatures. "Probably the greatest downfall of geothermal would be the fact that in the extreme cold, it is going to have trouble keeping up with the heat loss from the building," Isaacson says. And in his climate, the temperatures can drop as low as 65 degrees below 0 Fahrenheit. "And so that's where the propane system comes in well, to complement the geo," he says.

At his project on the south side of Leech Lake near Walker, Minnesota, for instance, the heating system includes a water-to-water geothermal system, a propane furnace, and a propane combi boiler. The geothermal system and boiler charge a buffer tank and distribute heated or chilled solution to different zones around the house as they call for heat or cooling. The propane furnace kicks in if the geothermal system goes down or can't keep up with the heat demand. It also qualifies the home for a dual-fuel discount from the electric utility. The entire hybrid system, including the propane units, is eligible for a 30 percent federal tax credit.

The supplemental propane systems are critical not only for comfort but for the overall cost of the geothermal system, which Isaacson can size smaller knowing he doesn't need it to meet peak heating demands. "If we were to design that geothermal system to meet the 95-degree design temperature or even further 100 or 125 degrees, which sometimes that design temperature reaches that amount in Minnesota, you would have such a large geothermal system that it would basically cost itself out of the installation," Isaacson says. "I mean, it wouldn't be feasible. So not only the amount of wells that have to be put into the ground but also the size and tonnage of the geo unit would just be ridiculous."

With a more sensibly sized geothermal unit, clients can achieve a faster return on investment, as well as higher levels of comfort when the propane systems kick in. "The propane furnace is going to have a delta-T or change in temperature about double of what the geothermal heat pump would be," Isaacson says. "So the air blowing on your skin instead of being 95 degrees will be 130 degrees, which is going to feel much more comfortable."





TECHNOLOGY TIPS FROM THE PROS



Check out our [Tech & Trends video series](https://www.youtube.com/buildwithpropane) at [youtube.com/buildwithpropane](https://www.youtube.com/buildwithpropane) to get tips from Justin Isaacson on hybrid heating, plus hear from other pros about standby generators, community propane systems, comparing propane and electric heating systems, and more.

BALANCING HYBRID HEATING FOR COMFORT AND EFFICIENCY

In addition to using propane furnaces and boilers in hybrid heating systems, experienced pros can tune their installations to optimize homeowner comfort. Isaacson uses several characteristics to dictate when the supplemental propane heat kicks in. One is to simply set it to come on when the outside air reaches a set temperature. A second is when the power utility has a period of peak demand, requiring homes with dual-fuel electrical rates to shed the load of their geothermal system and switch to propane. A third is run time: When the geothermal has been running for a preset period, perhaps 30 or 120 minutes, the system defaults to the gas furnace or boiler.

The latter point is a smart solution in vacation homes, where an owner might keep their Wi-Fi thermostat set at 60 degrees during the week and then dial it up to 70 when they're driving up for the weekend. "That geothermal isn't meant to recover several degrees," Isaacson says. "That's where the propane is going to kick in and bring it up to temperature and get the people the comfort they desire."

Isaacson also uses zoned systems to optimize comfort and efficiency. Zoned controls allow the owners to keep less-used spaces at a lower temperature to conserve energy while keeping occupied spaces at a more comfortable setting. Hydronic systems, such as the one he installed on the Leech Lake project, can be zoned more easily than forced-air systems, he says. Each zone has a thermostat that communicates with the main control unit when it has a call for heat or cooling. The system's buffer tank is charged by the propane boiler and geothermal system to maintain the necessary water temperature.

The northern Minnesota market is filled with trees, lakes, and beautiful rolling countryside, making it a huge draw for clients to build their retirement dream homes. But the remote area has no access to natural gas, making propane a vital energy source. Going all-electric, Isaacson says, simply wouldn't be feasible.

"A house this size would consume copious amounts of electricity to maintain the building temperature," he says. "And then also the kilowatt per-hour rate would actually be so exorbitant that it wouldn't be feasible to heat a home this size. I mean, it would be thousands of dollars a month versus hundreds of dollars a month to heat a home like this using electricity only."

So it's little surprise that 95 percent of Isaacson's projects include some form of propane heating. With comfort, efficiency, and economics in his favor, it's only natural he's become a trusted area expert on optimizing home heating with hybrid propane and geothermal systems.

For one lakeside project that included geothermal equipment, a propane furnace, and a propane boiler, Justin Isaacson's client was particular about the design of the utility room. "He said, 'If anything has to be perfect, it has to be the utility room,'" Isaacson says, "and he told me that we exceeded his expectations.

Project Snapshots

The [Build With Propane newsletter](#) features case studies, technology updates, and construction trends for builders interested in optimizing the performance of their homes. Check out these snapshots from two builders using propane technology to enhance comfort, and [subscribe](#) for more.

Construction Management Group New Canaan, Connecticut

When Connecticut custom builder Steve Zarrella constructed a five-bedroom home designed for year-round comfort with radiant heating and cooling, he was going where few U.S. builders had gone before. Zarrella used ceiling panels from Italian manufacturer [Messana](#) to radiate heat downward in the winter. In the summertime, the system simply switches to chilled water, eliminating the need for ductwork carrying air-conditioned cool air.

The system's heat is supplied by a heat pump with a propane boiler providing backup heat when the temperature drops below 25 degrees Fahrenheit; the boiler also provides domestic hot water through an indirect tank. A 22-kW, propane-fueled standby generator is also critical to maintaining the home's comfort in the event of a power outage. During an outage, the heating system switches to the propane boiler due to its much smaller electrical demands, and the generator keeps the pumps circulating warm water through the home. The home's general lighting, appliances, and other critical loads are also protected.



Indiana Warm Floors Angola, Indiana

Scott Patton, owner of Indiana Warm Floors, has become an expert in heating pole barns after 30 years in the radiant floor heating business. Pole barns are affordable to build because they save on materials and labor costs, and they can offer large, flexible interior spaces, as well as large doors and windows, to accommodate uses like garages, shops, or storage.

Those distinctive features also mean that pole barns have unique heating needs, Patton says. "A lot of these mega-shops with big bi-fold doors, they have 25- or 30-foot ceilings," he says. Radiant floor heating is an ideal fit for these projects because it localizes the heat to the occupants, rather than spreading it through the expansive interior space. Patton's typical pole barn customer is building on a large piece of land in a rural area that lacks access to natural gas. So Patton often powers these systems with propane boilers, either individually or in combination with geothermal.

Access Additional Resources at Propane.com

Beyond its use in enhancing a home's heating comfort and performance, 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.

ORIGINAL RESEARCH: COMPARISON OF RESIDENTIAL HEATING SYSTEMS

Check out the executive summary of a Newport Partners analysis of heating system performance in locations throughout the United States to get insights on first costs, energy costs, comfort, emissions, and more.

FREE CONTINUING EDUCATION CERTIFIED TRAINING

Try out one of our free online propane training courses and earn credits from the American Institute of Architects continuing education system. "[A Comparative Analysis of Residential Heating Systems](#)" explores the topics covered in this e-book in more depth.

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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.

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