



The Ultimate Guide to Power Generation

A PATH TO MORE RESILIENT HOMES AND BUILDINGS





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Propane: Proven Power for Any Scenario

From the moment you break ground, there's one thing all of your building projects and even completed projects have in common: the need for reliable, affordable power. And with today's focus on the environmental impact of the energy choices we make, we can add sustainable to the list, too.

Propane offers scalability and performance to power any size of project or business. It's the smart choice for towable and portable power on construction sites, for prime power generation in businesses and ag operations, and even standby power that's ready for anything. Discover the difference propane power generation can make in your projects.

PROPANE FOR POWER GENERATION

Why choose propane? The same propane powering a standby generator or Micro-CHP can also power other major appliances. Propane is non-toxic, meaning it won't contaminate soil or ground water, and it's a low-emissions energy source, so it's a more sustainable choice. Finally, propane doesn't degrade over time, unlike diesel or gasoline, making it an ideal standby power fuel.

TYPES OF PROPANE POWER GENERATION

You can count on propane power generation to get the job done, reliably, affordably, and with minimal environmental impact.



1 PRIME



2 STANDBY



3 TOWABLE & PORTABLE



4 MICRO-CHP



5 MICROGRID



Propane Means Power Anywhere, Anytime

HEAVY-DUTY COMMERCIAL AND INDUSTRIAL USE

Propane prime power generators are exactly what they sound like: The primary source of power for heavy-duty commercial and industrial applications that are isolated from a central energy grid. These include everything from ag and mining operations to microgrids and even off-grid military bases.

Typically, these locations will still have some access to electricity, up to a certain threshold. Once that threshold is reached, the prime power generator makes up the difference for what power is needed. In areas or times when overloads to the grid may occur, these prime power systems can offset load demand, to the benefit of the utility and the user alike.

What Propane Prime Power Can Do

- Supply primary power in locations with no access to the electrical grid, or at times when cost or reliability make reliance on the grid impractical.
- Keep an operation running affordably and sustainably. Propane is a non-toxic, low-emissions energy source that can be put to work anywhere.
- Operate 24/7 almost indefinitely. Propane prime power generators have lifecycles from 30,000 hours up to 40,000 hours.



Protection Your Customers Can Count On

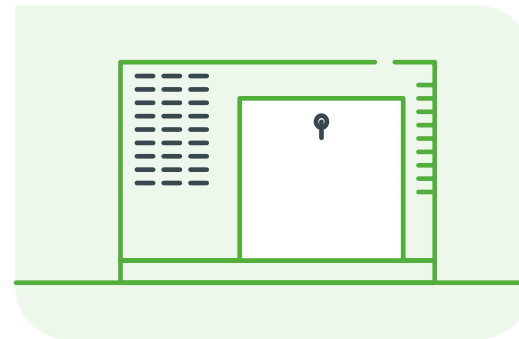
RESIDENTIAL AND COMMERCIAL USE

A reliable propane standby generator is a key part of resilient design. When the power is knocked out, standby power kicks in almost instantly, so there's no disruption in heating or cooling, lighting, refrigeration, and other critical building systems. These permanently installed units are quiet, efficient, clean, and can operate for weeks until power is restored. For homeowners, a standby generator means keeping the family safe, secure, and comfortable. For a business, it can prevent thousands of dollars in losses and help keep the doors open.

Propane may be the ultimate standby generator energy source. Not only is propane safer to work with than gasoline or diesel, it doesn't degrade over time like those other fuels. It's always ready at the moment it's needed most.

What A Building Protected By Propane Standby Power Can Do

- Resist hazards brought on by major disasters, such as damage to electronics, spoiled food, loss of heat or air conditioning, and more.
- Prevent disruption to a home or business. Propane standby generators begin operating in as little as 10 seconds after a main power outage.
- Reduce the magnitude or duration of a disruptive event to a property.



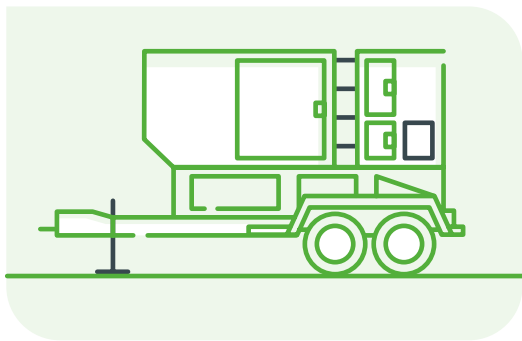
Power On-The-Go

RESIDENTIAL AND COMMERCIAL USE

When you need power on a temporary basis, propane towable and portable generators have you covered. You'll find these units hard at work powering tools and equipment on job sites, as well as protecting homes and businesses after power outages. Towable units are typically more powerful than the smaller portable generators, though a portable unit can power almost as much as a standby generator. Propane-powered portable generators are 98 percent cleaner than diesel-fueled equivalents.

Why Choose Towable/Portable Propane Power Generation

- Because they're not permanently installed, they can be moved and used nearly anywhere, providing power as needed.
- Propane portable generators are less expensive to operate than diesel-fueled units.
- Towable propane-powered generators are quieter than diesel and able to store fuel for longer run times in between refueling.



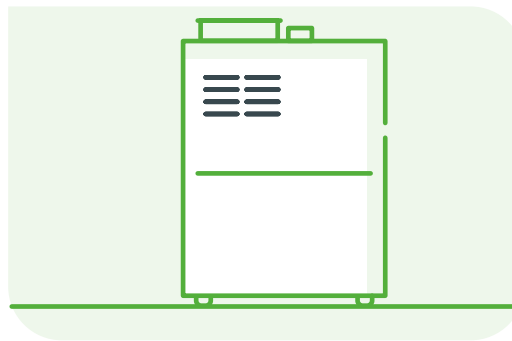
Deliver the Power and the Heat

RESIDENTIAL AND COMMERCIAL USE

Combined Heat and Power units (CHPs) have been around for a long time. With the introduction of small, powerful micro-CHPs, these units are growing in popularity for homes and businesses alike. Propane-powered micro-CHPs create electricity for a home or business using a built-in generator, and at the same time, capture the heat from the generator to produce hot water. What's more, in some markets, micro-CHPs powered by propane can generate more affordable electricity than the local utility provides.

Other Benefits of a Propane Micro-CHP System

- Designed to run indefinitely, they're an ideal choice for any building with a high thermal load.
- Propane Micro-CHP units produce far fewer harmful emissions compared with electric grid power, which is typically produced by coal.
- The hot water the Micro-CHP produces can be used for laundry, heated driveways and sidewalks to remove snow, hot tubs, pools, and more.



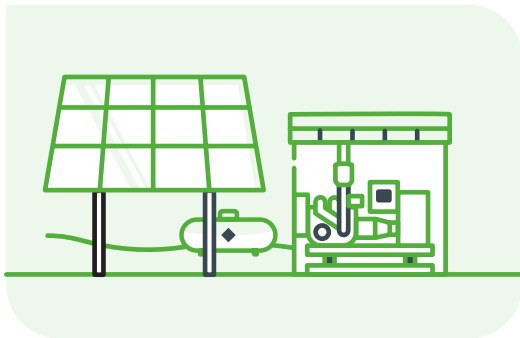
A Local Grid with a Propane Backup

RESIDENTIAL AND COMMERCIAL USE

Another power option that's seeing increased use is the microgrid: A miniature power grid system designed to efficiently distribute power to nearby homes or buildings. While a microgrid's primary power supply is the main electrical grid, it can also operate independently should the main grid fail, thanks to renewables such as solar or wind, as well as backup energy sources including propane. As a result, a microgrid is more resilient, as well as affordable, sustainable, and safe.

The Advantages of a Microgrid

- Unlike a standby generator, a microgrid can supply power to multiple buildings or even an entire community in the event of a planned or unplanned main power grid outage.
- By collecting and storing electricity from solar panels and wind turbines, the microgrid only uses its propane generator as needed, making it incredibly efficient and environmentally friendly.
- Every aspect of the microgrid's performance is locally controlled at a centralized station.



A Differentiator for Building Pros

By choosing propane, you're literally empowering your customers and building your authority as a trusted partner. We're here to show you how to make the most of the new generator technologies and products available on the market and incorporate them into your business. In the sections that follow, we'll provide guidance and advice from pros designing cutting-edge applications that combine propane with renewable resources like solar power and waste heat – both on and off the grid. And we'll show examples of innovative projects using propane to run more reliably and more efficiently. With these strategies, your next project won't require a leap of faith. This is a proven roadmap to a more resilient future.



Bundle Propane Generators and Appliances For More Affordable Protection

Make propane generators an easier sell by using propane, rather than power-hungry electricity, for critical systems.

Until recently, home and business owners who wanted reliable power – even during planned or unplanned blackouts – had to choose a few select applications that would remain running during a power disruption. For example, freezers or heat could keep running, but everything else had to be shut down.


Today, however, improvements in generator load-monitoring technology have made it possible to keep power flowing throughout a home or business, even as demand surges and shifts. Now, if a generator gets to the point of overloading, it can automatically shut off non-essential appliances and bring them back on when demand subsides.

“If you had asked me four years ago, I would say we were doing mostly partial-house installations,” says Bob Camper, owner of AllInstall LLC, a Virginia-based installer of Generac standby generators. “We’d put in a subpanel with critical systems wired into the panel: heat, water pump, and refrigerator. Now, every machine we install can do load monitoring.”

“These generators have a load monitoring switch with four levels of priority,” Camper explains. “If a generator overloads, it immediately will drop off the four biggest electric draws, then reapply them one at a time to make sure it doesn’t overload. For example, a 20-kW generator, which normally puts out 82 amps, can bump to as much as 125 amps to start an air conditioner, although it can’t sustain that. If more than 80 amps are drawn for more than three seconds, then we’ll automatically drop what we’ve selected to protect the generator.”

Likewise, these propane generator features make it easier for commercial buildings to achieve more comprehensive protection without having to go through the fuel storage, maintenance, reliability, and emissions challenges of diesel-fueled generators.

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COMPLEMENTARY PROPANE SYSTEMS

Builders and remodelers can also combine a propane generator with a suite of propane appliances to provide residential and commercial clients with whole-building standby protection at an affordable price. When critical systems such as space heating and water heating are fueled by propane or natural gas, the standby generator can typically be downsized – and made more affordable – because it isn't running power-hungry electrical heating appliances.

Customers can save as much as \$2,000 on the generator, according to Dave Dawson, CEO of Smart Homes of Virginia, a generator installer based in Charlottesville. "On a typical electric indoor air-handler, the emergency heat strips will take as much as 10 kW or even more if the emergency heat kicks on," Dawson says. "So it takes a big generator – or they have to do without that heat or risk shutting the generator down."

Alternatively, if the furnace runs on propane or natural gas, it uses minimal electrical power, he explains. "Not only does the heat come on when they want, but also instead of a 20-kW [generator], they might get away with a 14-kW, which will allow them to save \$1,500, even \$2,000 or more on a generator."

BUNDLING FOR SAVINGS

As installers do the energy-consumption audit needed to properly size a generator and pipe the house for propane, remodelers can offer homeowners the opportunity to convert other major systems to propane or natural gas to maximize energy efficiency and cost savings.

"It does make a big difference if they have at least one or two gas appliances," Camper says. "Because we're going to be doing a gas line to get the propane to the generator, it's an ideal time to upgrade heating, water heating, and cooking appliances. I'm encouraging people to switch to gas, to put in a gas heater, a gas tankless water heater in lieu of a water tank, and a gas cook stove." Most of Camper's customers live in rural areas and use propane to fuel their generators.

"About half our customers have buried tanks or will have us do so when we do the generator installation," he says. Both installers stress the importance of having a certified professional size and put in a whole-house generator because of the computerized load monitoring system that comes built into the switch. "If you overload generators you can easily burn them out, and then you are talking a couple of thousand dollars to fix them," Camper says.

Propane Partners

By choosing propane for these building systems, you can reduce the load on the generator, and possibly even spec a smaller, more affordable generator. Most propane appliances require backup power only for the electronic ignition, if at all.



SPACE HEATING

Propane forced-air furnaces provide airflow up to 25 degrees warmer than the average electric heat pump and typically last twice as long.



WATER HEATING

Condensing tankless water heaters can provide energy savings up to 40 percent over conventional electric water heating systems, while providing endless hot water delivery.



FIREPLACES

A propane fireplace provides more than ambiance, it's an ideal secondary heat source that's much cleaner and more efficient than a wood-burning fireplace.



COOKING

Eating out every night of an outage can add up financially, and who wants to go out in a storm anyway? Propane cooking appliances won't strain your generator's capacity.



CLOTHES DRYING

For hotels and other buildings with laundry facilities, propane dryers keep the fresh linens coming in a power outage.

Generators are Joining Batteries in Energy Storage Solutions

With new technologies on the market, propane standby generators can enhance energy storage systems for a better home-resilience package.

Jayson Waller has grown a thriving business in energy efficiency and solar panel installation in recent years. His Mooresville, North Carolina-based company, Powerhome Solar, has bloomed from 15 employees in 2015 to 950 employees and 16 locations in 10 states today. But this year, Powerhome has a major marketing initiative around a new package offering: energy storage systems and standby generators.

The initiative reflects a new viability for the combination of solar panels, battery systems, and standby generators to create a complete home-resilience package. It also solves a major pain point for residential solar customers. Homeowners with solar photovoltaic panels want their renewable energy to keep flowing when the power goes out, and they're often surprised to learn that their solar inverter has to shut down for safety reasons when the utility power goes out.

A home energy storage system solves that problem by allowing the inverter to island itself from the grid and continue to charge the home's batteries. Adding a propane standby generator offers even more independence, creating an additional form of onsite energy storage that provides power to the home after the battery is drained so homeowners can protect their whole home for much longer.



Generac's PWRcell energy storage system includes PWRview energy monitoring technology. It can protect a home during a power outage and allow homeowners to time-shift their energy usage to save on utility costs.

GENERATOR INTEGRATION GOES MAINSTREAM

In the past, combining solar panels, batteries, and a standby generator was a bit like a science experiment. Contractors generally had to configure their own system, bringing in one company's inverter, another company's battery technology, a third company's solar technology, and an off-the-shelf generator.

Generac, a major standby generator manufacturer, took a big step toward resolving that challenge in 2019 when the company acquired energy storage system manufacturer Pika Energy and energy management technology company Neurio Technology to create PWRcell, a new solar-plus-storage system that easily integrates Generac's standby generators.

"What we've seen is a desire from customers to have more diversified solutions," says Adam Schroeder, product manager for Generac's clean energy solutions group. "People are looking for different solutions to maintain resilience and reduce the costs that they pay for electricity."



RESILIENCE WITH ENERGY STORAGE

Several trends have aligned to put energy storage systems in the spotlight. One is economic. Electricity costs in some states are rising high enough to turn solar systems into a sensible investment, and customers are looking for a way to flatten the cost of their power as utility companies introduce new tariff rates and structures. Another is environmental awareness as homeowners look for ways to use renewable energy to reduce their carbon footprint.

A third factor is resilience – the ability of homes and buildings to adapt to disruptions ranging from ice storms to wildfires and hurricanes. That factor is becoming even more prominent as utilities in California and other wildfire-prone regions institute preemptive public safety power shutoffs to reduce wildfire risk. For customers seeking resilience, energy storage systems offer a way to keep the solar energy flowing – but with inherent limitations.

“For customers who experience long, extended outages, solar and storage is not the best solution,” Schroeder says. “Generac happens to manufacture the world’s best solution, and that is a home standby generator.”

Standby generators continue to provide power regardless of the weather conditions. When it’s cloudy or there are thunderstorms rolling through, homeowners can’t rely on their solar panels to top off their batteries. Think of it like a pump and a bucket, Schroeder says. An energy storage system provides a bucket of power that can operate through a couple hours of power outage – maybe even a day if the sun is shining and the homeowner uses electricity sparingly. But the bucket can only last so long. The ultimate solution combines the energy savings of a solar-plus-storage system with the additional resilience of a standby generator.



Generac is introducing the ability to integrate the company’s home standby generators with its solar-plus-storage system.

REDUCING ELECTRICAL LOADS FOR IMPROVED PERFORMANCE

In addition to solar and energy storage systems, Powerhome offers energy-efficiency services such as blown insulation and LED lighting. These services make the entire solar-plus-storage system more cost-effective, Waller says. “We provide an energy-efficiency audit to make the home more efficient, so we don’t have to sell them a lot of solar. We can sell them less.”

Moving a home’s major energy uses, such as heating and water heating, from electricity to propane can have a similar effect, Schroeder says. “The more you can take off of the system requirements in terms of electrical load, the easier it’s going to be,” he says. “So that battery storage system, on a 2,000-square-foot house that’s all-electric, will only last 4-8 hours. If you have a house that has propane heating, propane stove and dryer, and all of that, then you can maybe stretch that out to be 12 hours or a day.”

Both Waller and Schroeder agree it remains difficult to disconnect from the grid entirely, at least for a homeowner’s primary dwelling. But as utilities implement time-of-day pricing, more homeowners may be interested in smart energy management systems that can draw power from the batteries and then switch over to the generator instead of drawing on the grid during peak rate periods.

While the practice of combining solar, storage, and generators is still in its infancy, companies like Powerhome and Generac are working to make it a more mainstream solution. Schroeder can envision generators designed and purpose-built for energy storage applications in the future – one more step that would turn solar, batteries, and propane standby generators into a resilience solution for the masses.

BATTERY STORAGE SYSTEM

PROPANE HOME

12-24

HOURS

VS.

ELECTRIC HOME

4-8

HOURS

Propane and Solar Provide Remarkable Savings for Off-Grid Mining Camp

Solar photovoltaics backed by a propane generator provide \$3 million in lifetime savings.

Despite nearly a century of mining activity, a mining project called the Stibnite Gold Project in central Idaho contains valuable deposits of gold and other minerals, such as antimony. Mineral exploration firm Midas Gold set up an exploration camp on the site, which it has been studying since 2009 with the goal of opening a world-class mine. The camp includes a core shed, maintenance shop, fuel depot, several office trailers, and a handful of year-round staff members.

The company is currently conducting environmental baseline work on the project site and preparing a plan of operations as it works to secure permits for the mine.

THE OFF-GRID CHALLENGE

Midas Gold's exploration camp is remote, even by Idaho standards. Located 100 miles northeast of Boise, along the boundaries of the Frank Church Wilderness – the largest contiguous wilderness area in the Lower 48 – the site is "at the edge of nowhere," as the company describes it. In fact, the nearest electrical grid power is 15 miles away, in the 60-person town of Yellow Pine.

Midas Gold plans to connect to the grid when all the permits are secured. In the meantime, the camp must use onsite power generation. In the early days of the camp, that meant using large, fuel-hungry diesel generators to power the camp's lighting, computers, engine block heaters, and other essential equipment.

In addition to being expensive, the smelly, inefficient diesel units weren't a fit with the company's environmental objectives. The camp required an off-grid power solution that would reduce both emissions and costs.

THE PROPANE AND SOLAR SOLUTION

To overhaul the camp's power usage, Midas Gold worked with clean energy consultant Kelley Dagley to design and build a new power system around two clean sources of energy: solar photovoltaics and propane.

The highly automated system is one that could be used by any business operating off the grid. The company installed a 12-kW solar array on the roof of the camp's fuel depot (the solar capacity will likely double) alongside an 80-kWh battery for power storage. A 15-kW Generac EcoGen propane generator, designed specifically to work with off-grid renewable energy applications, kicks on to recharge the battery when additional power is needed. Together, the solar inverters and propane generator provide the same peak power capacity as a full-size prime diesel generator.

The Midas Gold exploration camp is jointly powered by a 12-kW solar array and a 15-kW propane generator designed specifically to work with off-grid renewable energy.



“Originally we considered a diesel generator, but it was harder to come by one that would work well with a renewable energy system, that was also affordable, and that was spec’d to meet EPA Tier 4i emissions regulations,” says Dagley, who is also vice president of the Idaho Clean Energy Association. “The EcoGen is specifically designed to do exactly what we’re using them for, which is a backup to solar generation. And it meets all the EPA standards.”

Today, the camp is run completely on solar and propane; solar is also used to power two microwave relays and an air monitoring station. To improve the camp’s energy performance, Midas Gold took a number of steps to reduce its electrical usage. Motion sensors shut off lighting when not in use, and a remote power monitoring system can shut down the power to unnecessary equipment, like engine block heaters on equipment that won’t be used for weeks.

The poorly performing electric heat pump in the main office trailer was replaced with a propane furnace that performs better in cold weather. Even when the temperatures dip into the negatives, Dagley says, “It’s toasty warm.” In all, the camp was able to reduce its usage to about 30 MWh per year.

MILLIONS IN FUEL SAVINGS

Dagley used sophisticated solar modeling and examined diesel prices 20 years into the future to calculate the ROI on Midas Gold’s investment. The results were remarkable. The propane generator itself cost less than \$5,000; the entire solar and propane power system cost about \$169,000. That investment yields a 27 percent tax-free dividend in the first year, growing 7 percent every year for 25 years. The capital payback is in just over two years, including a 30 percent tax credit in the first year. The company expects to save about \$3 million in diesel costs over the life of the project.

PROJECTED LIFETIME SAVINGS

\$3 MILLION

PROPANE IMPROVES CAMP LIFE

“The quality of life around the core shed area has improved greatly,” Dagley says. “It’s quiet most of the time, because now the propane generator comes on only as needed, plus it runs quietly. It operates at full capacity, so it doesn’t have to run nearly as long — unlike the diesel generator idling 24/7, which puts out a little bit of a stink. Propane is a lot cleaner just from a usability standpoint.”

MEETING ENVIRONMENTAL OBJECTIVES

In addition to reducing carbon emissions by eliminating the use of diesel fuel, the company has also reduced the chance of a diesel fuel spill while hauling the fuel alongside the East Fork of the South Fork of the Salmon River and other area streams. “Every fuel truck we keep off the road reduces risk, and we view propane transportation as a safer alternative in the event of a traffic accident,” says Jeff Root, Midas Gold’s Land Manager.

“Despite improved environmental performance by the modern mining industry, mining companies still face negative perceptions,” says Bob Barnes, Midas Gold’s COO. The exploration camp will serve as an example for the environmentally friendly approach the company is committed to. “As we go into the permitting process, taking a sustainable approach reflects how we want to run the project now and in the future,” Barnes says.



Midas Gold staff pose with the EcoGen propane generator.
From left to right: Chuck Eilers, Lead Equipment Operator; Kelley Dagley, Dagley LLC; Bob Barnes, COO; Richard Moses, Field Operations Manager; Layne Mouritsen, Field Operations Supervisor.

Reliable Power Makes Happy Campers

The camp is isolated, yet propane keeps campers warm and well fed in any weather.

For Anthony Gronski, summer camp is a training ground for life. The executive director at YMCA Camp Woodstock, a summer camp and retreat center in Woodstock Valley, Connecticut, says today's kids are so electronically connected through texting and their phones that it's difficult for them to learn to build relationships face to face. Summer camp offers an opportunity to disconnect from the internet and bond with friends in a positive environment where kids can be kids.

The camp's remote location, on a pristine 75-acre lake surrounded by woodlands and farms, is an ideal setting to create that environment. So even though there's no natural gas available and the electric grid can be unreliable, Gronski wouldn't change a thing. The camp simply turned to propane to fuel the generators, heating systems, and cooking appliances that keep them running in any weather condition.

For institutions and retreats like Camp Woodstock that consider a remote location to be a selling point rather than a turnoff, propane can play a unique role in offering high-efficiency heating systems and reliable power sources that wouldn't be available otherwise. That's particularly vital for non-profit organizations like the YMCA, where lost revenue from a weekend without power or uncomfortable and upset guests can wreak havoc on an operating budget.

BACKUP POWER PROTECTS BUDGET AND CAMPERS

Camp Woodstock, for instance, offers \$177,000 in financial aid and scholarships to campers each year. But losing a week of summer camp to a power outage could result in up to \$300,000 in losses – and that's not even including the loss of income from families who decide not to return.

To avoid that scenario, the camp employs eight propane generators, six mobile and two permanently installed, to keep the camp running in an outage. "Out here, we lose power," Gronski says. "We're mainly wooded and pretty much the way it was since it was incorporated in 1670." Because the nearby community is so spread out, it's frequently the lowest on the priority list when power is restored. "We were the last ones to get power the last time it went out. Everyone here is prepared for it. Everyone has generators."

Check out the video about camp woodstock at:
propane.com/commercial-buildings-and-construction



Learn more at propane.com 13

"The generators are critical to maintaining the camp's lighting, refrigeration, heating, and particularly the pumps for well water. "That's just such a comfort to have generators set up, because two things that really can stop camp is water and septic," Gronski says. "So those generators keep us operating and keep water flowing in both directions."

Gronski recalls one Labor Day weekend when the camp was hosting its family camp, one of the most popular and busy weekends of the year, and a hurricane came through and knocked out power for most of the state. "We immediately started calling all the families, letting them know, 'Hey, we're going to be operating. We've got generators. We're not going to let this prevent your family from having this weekend.' So we have the generators going, the families came out, and they had a great weekend. And really, that's one of the weekends I take the most pride in."

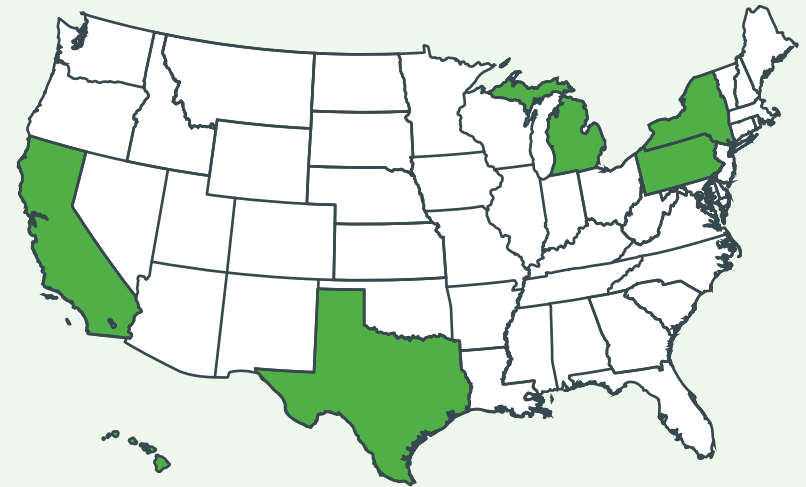
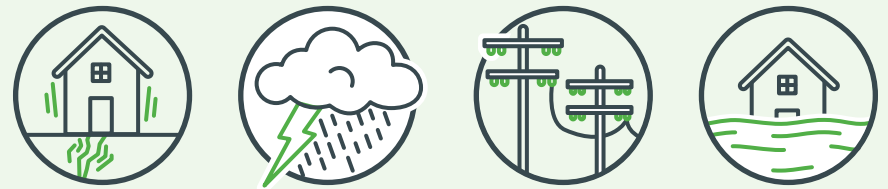
"I remember the last meal, one of the participants who has been coming to family camp for 30 years mentioned that the hum of the generators was a comfort to fall asleep to."

In addition to reliable power, Camp Woodstock uses propane throughout the 42 buildings onsite, including lodges, cabins, and meeting spaces. All of the buildings use propane furnaces or boilers for space heating. Three centralized bathhouses use boilers for hot water, and the lodges use propane storage tank water heaters for their bathrooms. Two of the lodges also have propane fireplaces.

Just as crucial to the success of the camp, however, is a dining hall that serves three meals a day to 400 people onsite. The kitchen uses propane to fuel convection ovens, grills, and a large kettle that can handle 40 pounds of pasta. "It's really critical that our dining hall can maintain operation, regardless of the weather, without power," Gronski says. "We really rely on the propane to continue to flow even when we lose power."

"We were the last ones to get power the last time it went out. Everyone here is prepared for it. Everyone has generators."

Common Causes of Power Outages



These five states had the most weather-related outages between 2008 and 2014, according to findings by B2B International Research¹: California (525 outages), New York (399), Texas (335), Michigan (328), and Pennsylvania (294).

1. Power Outage Impact Research, B2B International – 2015.

Micro-CHP Pushes The Efficiency Boundaries

New cogeneration products offer energy cost savings and fast ROI without massive size and upfront cost.

Cathy Ahern has a laser focus on efficiency. As director of facilities and grounds for Finger Lakes Community College (FLCC) in Upstate New York, she calls on her background as a consulting engineer specializing in HVAC, testing the boundaries of cutting-edge technology.

So when FLCC undertook a boiler replacement project as part of a New York State Energy Research and Development Authority study, Ahern saw more than an opportunity to simply upgrade the building's 25-year-old copper fin boilers. Ahern worked with energy auditor Bill Coe, director of project development for EMCOR Services Betlem, to engage boiler manufacturer Lochinvar for alternatives that would push beyond high-efficiency condensing boilers.

The team developed a cutting-edge solution: Integrating a micro-CHP (combined heat and power) cogeneration system that would generate both electricity and hot water, surpassing the energy savings of even the most efficient boilers.

REPLACING BOILERS WITH CHP

CHP systems have traditionally been associated with large-scale energy users such as manufacturing facilities. But Micro-CHP systems such as Lochinvar's XRGI 25 produce less than 50 kW (the XRGI 25 produces 24 kW and 163,000 Btus of heat), providing a sensible return on investment in traditional boiler replacement scenarios.

FLCC's Canandaigua campus, a 500,000-square-foot building with a library, gymnasium, classrooms, and lab, was previously served by two antiquated boilers and a very large storage tank. With a \$17,000 design/build incentive from its local utility, the school installed two Lochinvar Knight 399,000 Btu/hour high-efficiency boilers and two hot-water storage tanks. The micro-CHP unit will prioritize domestic hot water while also supplying space heating. They'll be able to run the CHP system year-round by providing hot-water reheat to the building's variable air volume boxes to control humidity and condensation.



Building owners can generate significant energy cost savings by generating electricity on site through propane or natural-gas-powered micro-CHP units. The EMCOR Services Betlem study estimates the school will reduce its annual electric bill by \$11,074 per year. "If we have a typical condensing boiler, that can get up to 98 percent efficiency, and there's only 2 percent additional energy savings that we could try to achieve for a customer," Coe says. "But by looking at generating electricity off of the boiler, using the waste heat, we can capture a more holistic approach and increase energy cost savings."

In some ways, FLCC isn't even the best example of a cogeneration application, since the school has very low electricity rates from its utility. Cogeneration projects typically have an ROI of four years or less, but the payback can be significantly faster in areas with a wide "spark spread," or difference between low-cost propane or natural gas and high costs of local electricity.



Finger Lakes Community College in Canandaigua, New York, reduced its electric bill by an estimated \$11,074 per year by generating electricity on site with micro-CHP.

EMISSIONS SAVINGS THROUGH ON-SITE GENERATION

Micro-CHP systems also improve a building's carbon footprint over a typical high-efficiency boiler by generating power locally, rather than purchasing it from the grid, which is less efficient and potentially fueled by dirtier energy sources such as coal. "That is a significant benefit, avoiding whatever the efficiency is at the power plant, as well as the transmission line losses to the point when it gets to the building," Coe says. "That's much, much more efficient to generate that electricity on site, which equates to a lower carbon footprint."

Like just about every university, FLCC has committed to sustainability and environmental goals, but the relevance of the school's energy-reduction actions are particularly acute given the prominence of the school's well-known conservation college. Ahern has even lectured for the school's sustainability class, and one of the professors has integrated cogeneration into his curriculum. "I think that we have a group of students who are very aware because of the conservation program that it's not just, 'Oh, it's cool,' but it really becomes part of what they do and what they believe," Ahern says.

APPLICATIONS WITH LARGE HOT-WATER LOADS

FLCC's system is fueled by natural gas, but as a propane customer at home, Ahern can see plenty of applications for propane micro-CHP systems in more rural areas. Coe has looked at several projects for dairy farms and breweries that have high year-round domestic hot-water loads where propane micro-CHP systems would be a great alternative to propane boilers. "Some of the farms around here really struggle to get power into their facilities because they're located so remotely off the grid," he says. "So being able to generate power at the same time may help to offset some of the power that's required from the local utility."

Lochinvar, which brought its micro-CHP technology to the United States from Denmark-based EC Power, is seeing strong interest from government facilities with emissions reduction goals, as well as hospitality businesses with self-imposed environmental mandates.

Lochinvar's unit provides supplemental, rather than backup, power – it operates only when grid power is available. But some CHP systems on the market can also serve as a backup power source, enhancing a facility's resilience during potential grid outages. Olsen suggests facilities and designers visit the U.S. Department of Energy's Combined Heat & Power eCatalog to search for CHP units by power output, fuel type, physical footprint, and other parameters. Olsen plans to add the XRGI to the database as a propane unit. With several other micro-CHP products in the pipeline at various stages of product development, it's likely that more products will soon join the list.



Off the Grid, with Peace of Mind

A home powered solely by solar panels and a propane generator protects the environment — and takes care of the neighbors.

When the power's out in their neighborhood, Patricia Seaward's neighbors grind their coffee beans at her house. Her coffee grinder, and the rest of her off-grid home in Barbers Island, Maine, keeps running in any weather condition thanks to two resilient sources of power: solar and propane.

Independent by nature, Seaward chose the off-grid lifestyle after a career working at the Maine Department of Environmental Protection.

"Once I received a quote from Central Maine Power, I realized that the components for solar electricity were only a few thousand dollars more than being grid-tied," she says. "I rationalized where I worked and decided that I could lead by example. It was more the philosophy, doing my part for the environment, that attracted me."

Seaward hired Albert Monaco, an electrician experienced with solar generation, to design her home's off-grid, battery-based system. Monaco, owner of Oyster Creek Electric and Solar Options in Alna, Maine, installed a 2.5-kW solar photovoltaic array to power the home and charge the batteries.

But for peace of mind, and with the size of her roof limiting the number of solar panels that could be installed, both Monaco and Seaward knew the home would need a source of backup power. "Because of the days being so short in our winters, on some days you can't produce enough power [with the solar panels]," Monaco says.



The home's domestic hot water and in-floor radiant heat are provided by a propane boiler, while a propane soapstone heater can be manually operated between seasons.

To keep the home running year-round, Seaward turned to propane backup power as the most cost-effective and environmentally friendly option. "My job at the Maine Department of Environmental Protection entailed working with homeowners whose wells were at risk or contaminated by various petroleum products," she says. "As I live on the top of a hill, any petroleum spill could impact more than my property."

Her neighbors would have little use for their coffee grounds if their water supply was contaminated, and diesel fuel has the potential for contamination from spills and leaks that are retained in the soil. Propane doesn't spill, pool, or leave a residue, so it's not harmful to soil or water in the unlikely event of a tank leak. Seaward also considered wind-generated backup power, but the cost was prohibitive.

Monaco installed a 2-kW propane generator with the start mechanism tied into the voltage of the batteries. When the batteries are depleted to a certain voltage, the generator automatically kicks on until the batteries are replenished to 80 percent.



PROPANE VS. DIESEL

In addition to its environmental benefits, propane has several other advantages over diesel, Monaco says. First, propane tanks are available in large sizes, so timely refueling isn't a concern. "Most people have a tank that will run them 100, 200 hours, and that usually is about the run time for a year," he says. Second, "Propane is also a whole lot cleaner, so maintenance on the machine is a lot less than if you were running on gasoline."

Propane also powers Seaward's refrigerator, a clothes dryer, a manually operated soapstone heater for between seasons, and a boiler that provides hot water for domestic use and in-floor radiant heat. By using propane in all five applications, the home provides maximum performance, comfort, and efficiency.

Monaco says Seaward is far from the only local homeowner who has decided to leave the grid behind – in fact, his home is off the grid, too. The local power company now has an owner in a foreign country and has cut back on local employees capable of quickly restoring power in an outage, he says. "We had a little snowstorm up here this winter, and we had winds 40, 50 miles per hour. But some people were out of power for three or four days because they just don't have the manpower."

Monaco and Seaward won't have to worry about an electrical bill in retirement, and remaining blissfully unaware of power outages is also a major advantage. "I'll go down to the local coffee shop and realize, 'Oh, the power's out?'" Monaco says. Owning one of the only homes with power has its perks. "That's a real nice benefit right there."

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- Financial demands
- Dangerous excesses of heat or cold
- Lack of phones, email, and communication
- Inability to cook
- Loss of showers and bathrooms



Ward Cedar Log Homes of Houlton, Maine, supplied the northern white cedar for siding and purlins and pine for interior walls. The galley kitchen, designed for greater efficiency, includes a three-burner stove, broiler, and oven fueled by propane.

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