



The New Belgium brewery uses a 500 kWh Guascor biogas engine in a CHP application, located in an engine room next to the brewhouse.

# HOPS, MALT, YEAST, WATER ... AND METHANE?

System upgrades from Woodward puts craft brewer's cogeneration system back online

**BY CHAD ELMORE**

**N**ew Belgium Brewing has won nearly 100 awards for everything from beer to the manner in which it treats its employees (with just over 500 people and growing, the company has had very little turnover over the years) as well as the environment. One part of its 10-item company core values and beliefs statement is, "Environmental stewardship: Honoring nature at every turn of the business."

Founded in 1991, the employee-owned company in Fort Collins, Colo., is the third-largest craft brewery in the U.S., as rated by the Brewers

Association (based on 2012 beer sales volume), and the eighth-largest overall among brewing companies in the U.S. In 2012, it produced 764,424 barrels (or 23,692,184 gal.) of beer that was sold in 31 states.

The company plans to decrease its use of water per barrel of beer produced by 10% and curtail greenhouse gas emissions 25% by 2015. The path to that goal has included the installation of an 870-panel, 200 kWh photovoltaic array on the roof of the brewery and two engine-driven generators that burn biogas captured from its own process water treatment

plant, built at the northeastern edge of the brewery's 51-acre campus.

All of its production wastewater is pumped through a series of aerobic and anaerobic basins that produces methane gas as a byproduct. From there, the water goes through a clarifying process to further remove solids before it goes to the city sewer system.

Rather than flaring off the gas, the brewery installed a pair of large gas balloons to capture and store the methane. After working through a few configurations, it now uses the gas to fuel an engine gen-set and a combined heat and power unit (CHP).

When the first 27,545 cu.ft. sphere reaches capacity, gas automatically fills the second sphere. Gas is drawn from them in the reverse order before the cycle begins again. The energy content of the biogas is about 90% that of natural gas.

"The methane we get is very consistent, unlike landfill gas, and the microbes like the process water," said Craig Skinner, plant engineer, New Belgium. "It contains a lot of yeast and sugar starches from the fermentation process that goes down the floor drains."

The brewery uses Guascor biogas engines, one an SFGLD-240 inline eight-cylinder unit rated 262 kWh and the other an SFGLD-480 V16 rated 500 kWh to produce electricity. Both engines have a bore and stroke of 152 x 165 mm. Water flows through the engine's water jackets to cool the engines, and the brewery captures the 185°F water for use in its process.

"The 500 kWh engine only runs when the balloons are full. When the second balloon gets to the 80% level, the engine comes on and burns biogas," Skinner said. "It runs two or three times a day for four hours, depending on how much methane we are making."

A few years ago, the brewery's original 262 kWh CHP was moved to the water treatment plant where it now uses methane to strictly produce electricity. "The old CHP wasn't enough to supply the entire facility, so now this generator just feeds the water treatment plant," Skinner said. "Most of the time, it creates enough power to run this plant."

Between the two cogeneration units and the solar array, New Belgium produces nearly a megawatt of power, but it consumes between 1200 to 1500 kWh. "If we were to produce more than we consume, the excess power would go back to the grid," Skinner said. "But there have only been a couple of times that we were producing more than we can consume."

The original plan was to use the smaller biogas-fueled engine for peak

shaving through a curtailment agreement with the local utility company, but the first system they used had a lot of problems. "To qualify for the rate curtailment, the generator needed to be up and ready to meet the peak demand," said Paul Wilhelm, account manager, Woodward. "But they had problems with the control and protection system that was used initially and major repairs

to the engine had been made twice. Then someone at New Belgium called Woodward and we got involved."

Wilhelm said the end result has made the application a showpiece for Woodward as well as New Belgium. "Woodward products now control every aspect of the system, from the air/fuel ratio and speed control, ignition and

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## POWERFUL INSULATION FOR POWERFUL ENGINES

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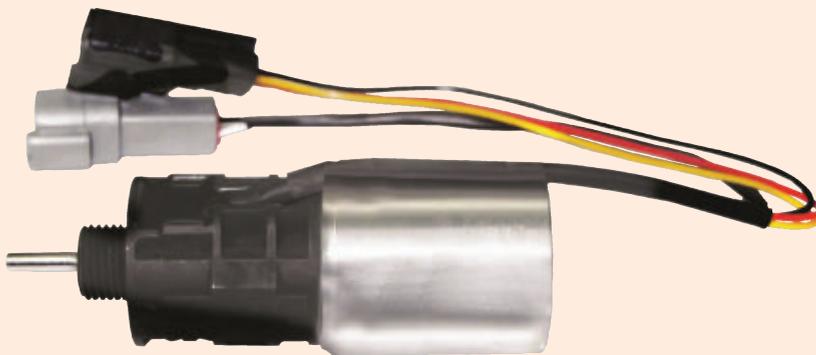
Biogas is stored in two large balloons near the water treatment plant. The outer layer is a hard shell, while inside a blower ensures that positive pressure is maintained between the shell and an interior membrane. When the methane is being used, the pressure collapses the balloon and pushes the methane out.

knock detection, to automatically paralleling the generator,” Wilhelm said. “Since the retrofit, the gen-set has been running without issues for two years. And, it turns out that their digester produces more high-quality gas than planned, so they’re not just using it for peak shaving, but are base loading that engine all day.”

The Woodward E<sup>3</sup> Full Authority lean-burn gas engine control system was chosen for its ability to handle changes in biogas composition, speed and air/fuel ratio control. Other Woodward components that the new system uses are IC-920 high-energy ignition control to provide ignition energy, a detonation detection control to reduce knock, a Flo-Tech

## Electronic Fuel Control For Small Diesels

Woodward APECS 4800 system designed to provide greater precision than mechanical controls



The Woodward APECS 0154 LAPS (linear actuator with position sensor) actuator works with the APECS 4800 controller to accurately control fuel flow on small diesel engines.

**F**or several decades, mobile industrial and stationary diesel engine applications have used mechanical governors to control fuel pump output. While traditional injection pump technology offers a proven, reliable, low-risk means of delivering the proper amount of fuel to the engine, the mechanical governors that control them can be limited in terms of precision and functionality. Electronic solutions continue to grow in popularity as

manufacturers look for simple, lower-cost ways to add precision fuel control to small diesel engines.

Woodward Inc. developed its APECS (Advanced Proportional Engine Control System) family of speed control solutions to meet the requirements of today’s diesel engines. Its new APECS 4800 controller provides full authority control or fuel rack limiting with position feedback for mechanically actuated PFR-style diesel injector pumps

on engines up to 50 hp. It combines a digital electronic controller with a linear actuator to provide fuel control.

“When combined with an actuator to translate the electronic signal from the controller into an action that operates the injector pump, electronic governor control offers precision and functionality,” said Marty Chiaramonte, product line manager, Woodward, Loveland, Colo. “Although electronic fuel rack governing is nothing new, the requirements that are placed on electronic controls and actuators for operating traditional pump-type fuel systems continue to expand.”

Such requirements include tighter speed regulation, improved engine responsiveness, reduced smoke emissions, altitude compensation, improved subsystem interaction, enhanced diagnostics, engine health monitoring, and fault information.

The 4800 digital controller provides isochronous speed control, actuator position control, torque limiting, glow plug control, CANbus J1939-based communications, and additional engine management and protection functions

## POWER GENERATION

integrated throttle body to control engine speed and load, two TecJet gas valves to control the blending of fuel gases, as well as a Deltec gaseous fuel mixer to mix fuel and air.

The company's easYgen parallel-gen-set control system provides generator protection and maintains the base-load kilowatt and power factor settings for the brewery. It also communicates generator power output information to the E<sup>3</sup>, which provides closed-loop feedback for emission control instead of using oxygen sensors to keep the engine's emissions in compliance. Woodward said this reduces maintenance costs, as oxygen sensors are prone to fouling in digester gas applications.

to optimize engine operating efficiency, said the company.

The controller also provides NO<sub>x</sub> emissions control with EGR valve control and particulate material reduction through smoke limiting and altitude compensation. This helps OEMs meet the particulate matter limits set by the U.S. Environmental Protection Agency (EPA) Tier 4 emissions requirements or the European Stage 3B standards for engines under 25 hp, Woodward said.

Overfueling is a significant cause of particulate-laden black smoke. An engine is susceptible to this condition during starting, load transients, and turbocharger delays. The APECS 4800 controller helps alleviate the causes by maintaining the engine's optimal air/fuel ratio throughout the operating range, even at high altitudes, said the company.

"Black smoke comes from too much fuel relative to available air," Chiaramonte said. "As I travel through countries such as China, India and Brazil, I see a lot of small tractors that use a mechanical throttle. They work, but to start the engine an operator will usually throw the fuel rack wide open and grind on the starter until the engine gets enough fuel. That causes overfueling on a starting event. We

The easYgen can remotely start the engine, automatically synchronize the generator, and close the generator breaker to the utility with soft loading and unloading interchange. It easily interfaces with the brewery's supervisory control and data acquisition (SCADA) system, which uses the Wonderware system platform from Invensys Operations Management, Plano, Texas. The application also uses Woodward's LogicsManager built-in programmable logic functionality in the easYgen, allowing the user to create complex system control programming without a separate PLC device.

The 500 kWh Guascor CHP was recently added to keep up with the  
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know where that fuel rack needs to be to start the engine, so APECS controls that fueling event electronically."

When the engine's coolant temperature is below a preconfigured level, the start fuel is limited so the engine's fuel rack cannot go beyond a preset position until the coolant temperature rises. It works the same for the instantaneous application of a load. The controller looks at the engine's speed, ambient pressure or manifold absolute pressure (MAP), and the actuator position to limit the fuel rack's position. As the speed and pressure increases, the limit point also increases at the response rate of the control algorithm. These algorithms work to keep the visible smoke to a minimum and also provide altitude compensation to optimize air/fuel delivery.

The controller's torque-limiting capability also prevents excessive smoke. Based on actuator position, torque limiting sets the maximum amount of fuel according to a configurable speed and fuel-limiting curve. A second function of the torque-limiting feature is that it prevents possible engine damage if the engine is overloaded at a particular speed, said the company.

Algorithms in the APECS 4800 also  
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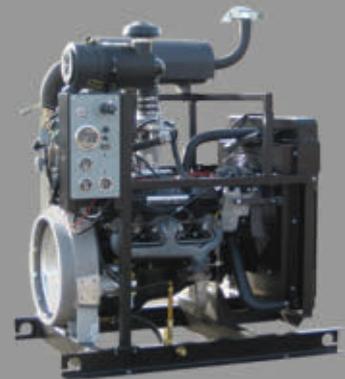


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Biogas is piped from the gas balloons near the company's dedicated process water treatment plant (PWTP) into the engine room.

digester or the utility. This system also includes an IC-922 high-energy ignition control to provide ignition energy, a ProAct integrated throttle body to control engine speed and load, two TecJet gas valves to control the blending of fuel gases, and a Deltec gaseous fuel mixer to mix fuel and air.

"The E<sup>3</sup> seamlessly transitions the air/fuel ratio to account for differences in the quality of the two fuel gases," said John Felts, senior staff application engineer, Woodward. "When their fuel-blending engine switches between the utility's natural gas and digester gas you can't even hear or feel the transition. The engine doesn't even change pitch."

While the brewery effectively saves resources by producing its own electricity and hot water along with disposing of its own process waste, Skinner said most of the value lies in simply doing the right thing. "For us it goes back to being a responsible company," he said. "We do a lot of things that aren't necessarily done to make money, such as putting in our own water treatment plant. We were sending so much waste water into the municipal system that the city said,

'OK, we can't handle all of your waste, so you need to either pay us more so we can put in the infrastructure or you need to give us cleaner water.'

"It would have cost less to give the city more money, but instead we built a water treatment plant on-site and hired people to run it. Then we decided to capture the methane to run in our cogen units. To operate

sustainably and do the right thing is part of our core values and beliefs. Even though there may not be a five-year ROI, we did it because it was the right thing to do. That's what we are all about." **dp**

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