

POWERFUL BREW

Craft brewer derives electric power from wastewater



As sales of craft beer continue to gain market share, a 30-year-old Michigan regional craft brewery has grown to the point where it has achieved name recognition among discerning beer drinkers.

Bell's Brewery, Inc. was founded as a home brewing supply shop in 1983 by company president Larry Bell, who initially brewed his craft beer in a 15-gallon soup kettle. Bell's sold its first commercial beer in Kalamazoo, Mich. in 1985.

After struggling in its early years to sell robust, full-bodied ales against mass-market domestic beer, Bell's alertly noticed the demand for craft beer growing dramatically, and expanded

into new markets. Today, Bell's sells beer across a 22-state area in addition to Puerto Rico and Washington, D.C. Production has grown from 135 barrels (one barrel equals 31 gallons) in 1986 to over 318,000 barrels in 2014.

Bell's opened a new production brewery in nearby Comstock, Michigan about seven miles east of Kalamazoo in 2003. The facility has seen seven major additions and encompasses over 130,000 square feet of space on a 32-acre site. Beers are now brewed using a 50-barrel system and a newer 200-barrel system with a total annual capacity of more than 500,000 barrels. A current construction project will add another 210,000 square feet and give Bell's a total potential annual capacity of about one million barrels.



Altogether, Bell's brews more than 20 beers for distribution, including Two Hearted Ale, Oberon Ale and Hopslam. Last year, its Two Hearted Ale was rated as the best India Pale Ale (IPA) by *RateBeer.com*, which ranks the best beer, breweries and retailers in the highly competitive craft beer industry.

Turning lemons into lemonade

One of the byproducts of brewing beer is wastewater rich in biodegradable materials like unfermented sugar and malt husks. Bell's had been examining alternatives for turning its wastewater byproduct into energy since 2010. Faced with costly new wastewater treatment charges in 2012, Bell's developed a plan of action. The result was a new waste-to-energy facility adjacent to the brewery that launched in December 2014 to treat all wastewater derived from the brewing process.

The bioenergy facility includes three anaerobic digesters which convert the biodegradable contents of the wastewater into a methane-rich biogas and a Cat® G3406 generator set is powered by the methane in the biogas.

The combined heat and power (CHP) generator set produces about 150 kW of

electricity, with 70 to 80 kW dedicated to powering the bioenergy facility's water treatment process. The excess electricity is used to offset the power Bell's purchases from the grid. Heat captured from the generator set is used to maintain the proper temperature in the digesters and heat the water used in cleaning vessels in the brewery. Utilizing the heat from the generator increases the energetic efficiency of electrical generation from 33 percent to between an 80 to 85 percent efficiency rate.

"The process is really about waste migration," says Walker Modic, Sustainability Manager for Bell's. "At the end of the day, we're paying for products like malt and yeast, and we are not using 100 percent of their potential. That potential ends up going down the drain and there's a lot of value left in that so-called wastewater.

"So, we have taken something that was being treated as a waste and converted it to savings and renewable energy. We've reduced the Brewery's water treatment costs while generating electricity and heat—two inputs to our process that we were already purchasing prior to this project," Modic says.

In order to make the project a reality, the Bell's team was able to gain important background information by talking with brewery peers in New York state and California who had replicated the wastewater conversion process, and also with supplier Michigan Cat Power Systems and the engineering firm Newkirk Electric of Muskegon, Mich.

With much of the research and development work completed, 2013 was devoted to developing the scope of the project and doing the engineering, with 2014 dedicated to construction and the December startup.

"We jumped with both feet into a treatment technique with which we had very little familiarity," Modic says, "and knew we were going to be generating a combustible gas, and really had no experience in the treatment or conversion of said gas into renewable energy.

"Experience is hard to come by," he continues. "But in this case, we were able to extract it from colleagues and partners who learned it the hard way. That's always preferable

Continued on page 14





“We’ve been in full operation since the beginning of the year, and the Cat generator set has been incredibly reliable.”

BRAD LEVERSEE
Sustainability Technician
Bell’s Brewery, Inc.

to experiencing those challenges and hardships firsthand. And given Caterpillar’s long history, we felt comfortable that their CHP engine would work consistently, and with minimal intervention required by the team here at Bell’s.”

The Cat genset will run for up to 20 hours a day, then auto mode shuts it down when there is not enough stored methane to keep it running, says Brad Leversee, a sustainability technician for Bell’s.

“We’ve been in full operation since the beginning of the year, and the Cat generator set has been incredibly reliable,” Leversee says. “Any issues we have had are associated with the quality of the biogas, which is really a measure of methane concentration, and we are learning how to assess what the quality looks like, depending on the activity in the digesters.”

Thanks to an automated control system that is a hybrid design by Newkirk Electric and Michigan Cat Power Systems, there have been plenty of instances when having the ability to remotely clear an alarm or restart a compressor has enabled Bell’s staff to continue operations as seamlessly as possible and prevent an extra trip to the brewery in the middle of the night, Modic says.

“The control system enables us to troubleshoot most minor instances remotely,” Modic says. “So we didn’t have to live in that building during the entire commissioning process.”

Combined expertise

Michigan Cat Power Systems and Newkirk Electric’s Theka Engineering division have teamed up on a number of prime power, gas-fueled projects in

Michigan and Indiana. The result is a highly effective pairing of equipment and expertise that provides turnkey projects.

CUSTOMER PROFILE

Bell’s Brewery, Inc.

Location: Kalamazoo and Galesburg, Mich.

Application: Biogas digester

Cat® Equipment: G3406 generator set

“We work exclusively with Newkirk in my group for precisely these reasons: Our projects are on time, on budget, and with no finger pointing,” says Mike Fenton, who works in business development of gas-fueled power systems for Michigan Cat.

“Newkirk’s design team is pretty special—they have a great staff of engineers headed up by John Kirby,

one of the finest power generation engineers that I have worked with,” Fenton says. “He has a great deal of experience in the utilities market, knowing and understanding many of the potential pitfalls.

“We understand each other’s equipment, and how we interact, so that at the end of the day, we’re not looking at the customer with a shortfall in a product offering,” Fenton continues. “We produce a plant that is operational for the long term.”

Modic is satisfied that Bell’s made the right choice in who they chose to partner with for equipment and engineering help.

“Michigan Cat has been great,” he says. “One of the biggest challenges is commissioning, and anyone who has started up a new system knows that something will likely go wrong.

“So having Michigan Cat readily available in our backyard, just a phone call away to provide insight, assistance and mechanical help has been invaluable,” Modic says. “Mike Fenton and his team have answered and responded promptly every time we’ve called.”



INVESTING IN SUSTAINABILITY

Officials at Bell’s Brewery view sustainability as the means for business to thrive through environmental stewardship, economic robustness and social integrity.

“Sustainability is about more than caring for the Earth,” says vice president Laura Bell. “If we are aware of how we impact our surroundings, we can act in ways that provide for economic, environmental and social benefits.”

Here are some examples of Bell’s sustainable philosophy in action:

FARMING. At its farm in Shepherd, Michigan, Bell’s uses no-till farming practices that support surrounding ecosystems by minimizing erosion and the use of water-contaminating fertilizers, while improving soil quality.

REDUCING IMPACT. A modular, extensive sedum green roof above the conditioning warehouse increases insulation efficiency and extends the life of a waterproofing membrane.

Brewing processes produce approximately 50,000 pounds of spent grain daily. A local farmer uses it to feed his dairy cows.

ENERGY EFFICIENCY. High efficiency lighting includes reflective light tubes located throughout buildings that

provide daylight harvesting with occupancy controls.

Outside air is used to cool the cold storage warehouse during colder months.

A kettle stack condenser reclaims 10.6 million BTUs a day.

A heat exchanger not only cools wort so yeast can thrive to ferment healthy beer, it also pre-heats carbon-filtered water that goes into subsequent batches, reclaiming 17 million BTUs a day.

A 16-ton closed loop geothermal field provides heat for the corporate office building.

An 85-ton geothermal field that is roughly the size of half a football field controls the temperature for the entire building using glycol-

filled tubes to exchange heat eight feet underground.

An ammonia-based refrigeration system installed in 2014 will save over a million kilowatt-hours per year.

Energy efficient LED lighting illuminates all exterior areas.

A water heater that is 94 percent overall efficient has been installed.

RECYCLING. All cardboard, paper, stretch wrap, green plastic banding, keg caps, wood, electronics, batteries, copper, stainless steel and black iron from the production process are recycled.

The production facility landfill diversion rate has risen to 93 percent from 50 percent in 2007.

WATER. Sub-meters track water use in the brewhouse, cellar and on both the bottling and kegging lines, reducing water usage.

A cellar C.I.P. (Clean-in-Place) system has reduced the amount of water to clean tanks by about 65 percent.

A new filler vacuum pump design reduced water that goes to drain from 15 to 2 gallons per minute, saving about 2.5 million gallons of water annually.

GOING FORWARD. As part of a constant effort to reduce its impact, Bell’s commitment to sustainability is evident at its new brewhouse.

Heat recycling: A new energy storage system stores 3.3 million BTUs.

A water heater that is 94 percent overall efficient has been installed.

Five large fans reduce the need for air conditioning and heating at the production facility and Logistics Center.

Energy efficient LED lighting illuminates all exterior areas.

A 400 hp process boiler with 84 percent overall efficiency conserves and recycles energy for steam production used in all process heating, mashing, boiling, keg cleaning, and sterilization.



(L to R) Tapping a beer at Bell’s Eccentric Cafe; Bottling line; Fermenting tanks; Green roof.