

Biogas Advances in the US

Producing a range of end products from a seemingly endless list of resources, methane-based energy project development is picking up in the country.

By Anna Simet and Katie Fletcher | January 27, 2017

Cattle, poultry and swine manure, dinner scraps, wastewater treatment plant sludge, vegetable canning and potato processing waste, beer-making residuals, landfilled trash and the list goes on indefinitely, materials that most people would seek to dispose of are becoming hot commodities in the developing U.S. biogas industry. While seemingly infantile when compared to other countries' mature methane-derived energy sectors such as Germany, recent years have seen a development boom inspired by a variety of factors, including the U.S. renewable fuel standard.

The U.S. is currently home to over 2,200 operational biogas-producing sites, according to the American Biogas Council, including 171 on-farm digesters, 1,500 digesters at wastewater treatment plants—only 250 of which use the produced biogas—563 landfill-based energy projects (26 pipeline, 537 electricity), and there are well over 11,000 potential sites for new projects, prospects being eyed by both domestic and foreign developers.

Different states and regions will soon or have recently become home to new projects that produce a variety of end products, from electricity to renewable natural gas, based on available feedstocks, incentives/funding and power prices, as well as building momentum to reduce waste and create renewable energy. The following is a roundup of some of the projects to come online or begin construction during the past year.

US West

In dairy country, digesters have a history. While that history isn't exactly rosy, the tides have changed, and a considerable force behind a new wave of interest and development can be attributed to California state grants that have and will continue to fund tens of millions of dollars worth of digester projects, policy and initiatives to improve state air quality, and, at least in part, to brothers Daryl and Kevin Maas, who own companies Farm Power Northwest and Maas Energy Works, which collectively own or operate 11 existing projects, with many more in development. "We got our start up in Washington—we operate five digesters between there and Oregon, and in 2010, we started doing some work in California, and realized there was a large market," [Daryl] Maas says. "It's the largest dairy state in the country, but there wasn't much of an industry there. It had been plagued by one-off projects that ran for a year or two and shut down, there wasn't a lot of support after start-up. After our experience in Washington and Oregon, we knew we could help the farmers down in California."

Just this year, Maas Energy Works brought online two new digester projects, and completed a revamp of an existing digester that had previously shut down. The Verway-Hanford covered lagoon digester project in Hanford, California, fired up in October, is the largest dairy digester on the West Coast. "There's currently 1 MW installed, but the dairyman plans to install an additional 2 MW," Maas says. "Right now, we're making more fuel than we can burn, but getting these engines on the grid takes a long time. At any given time, they're pulling from or sending power to the grid, and zeroing out their consumption and charges. The rest of the gas is flared off right now, but we'll make power with it as well when we get the other generators online."

The Open Sky Ranch Dairy Digester, a Riverdale, California, covered lagoon project that came online in September, has a single 800-kilowatt (kW) engine that Maas says "is running as hard as we want it to right now, but there's excess gas. If all goes well, we'll install another 800-kW engine later this year."

The Open Sky engines are Dresser Rand by Guascor, but Maas says engine supplier selection is left up to the farmer. "We don't always use [Dresser Rand], but it's a popular engine," he explains. "We also use Caterpillar engines, and one of our projects may use a GE engine going forward—we do look at all of them. Although we do own a couple digesters in California, most of the projects we're involved in are owned by the dairymen—we work for them and manage the project for them—and each dairyman has its own way of making decisions."

With a variety of reputable companies to choose from, Maas says it often comes down to cost. "We really like Dresser Rand, it's good to work on and efficient, economically speaking. The Caterpillar is a more expensive motor, but it tends to last longer, the same thing goes for GE." He emphasizes that Maas Energy Works does not sell digesters, equipment or a technology. "We're technology neutral, and we can hire who we want to," he says. "We recommend vendors and contractors to the farmer, but most have some of their own experience that isn't unique to a digester—for example, an earth mover. They can hire locally, and we direct how the work should be done. Same for the mechanical work, the welding. We try whenever possible to get the local farm equipment vendors...that's really important. When things age, you have to have long-term support that is reasonably efficient economically, and you don't have to be calling other time zones for help."

Maas says on top of the aforementioned projects, the company has two more under construction that will come online in early 2017—the covered lagoon, Verwey-Madera Dairy Digester in Madera, California, and another in Kittson, California, as well as several working through permitting and financing. "There's a lot of activity out here, the farmers are very interested in the technology," Maas adds. "In our opinion, they've just been waiting



for developers who they trust and technologies they believe will work, because a lot of them have been burned in the past—permitting, operating and financing issues. We're operating 11 digesters, and some have their problems, but they keep running, and overall, we've been able to show these things perform."

Off farms, there are many biogas projects of different kinds developing in California and the west. DMT Clear Gas Solutions, supplier of a membrane-based gas separation technology, is working on a new system in Chino, California, alongside ES Engineering. "They operate a digester for solid food waste—the biogas is sent through gas turbines," explains DMT's Robert Lems. "Starting in March, we will install a system that takes about 50 standard cubic feet per minute (scfm) of this gas and turns it into compressed natural gas (CNG) for a small, local CNG station that is privately used to fuel cars and trucks," he says. DMT is also involved in new biogas projects with Hawaii Gas, as well as Carbon Cycle Energy (see Northeast).

LA Sanitation and engineer/builder Constellation Energy's Hyperion Treatment Plant Cogeneration Project is nearing completion in Playa del Rey, California, with all major equipment installed. The egg-shaped anaerobic digester will take in municipal sewage, ultimately producing up to 6,000 scfm of biogas that will be used to create 25 MW of electricity and steam. Gas produced at the wastewater treatment plant (WWTP) is currently used for power generation at the nearby LADWP Scattergood station, but the new generation plant will provide all the process heat and electricity required by the WWTP.

Further south, Ameresco and the city of Phoenix, Arizona, have teamed up for a project at the city WWTP. Under terms of the project, announced in August, Ameresco will build, own, operate and maintain the facility, which will process raw biogas into renewable natural gas (RNG). "Ameresco will deliver the RNG into the Kinder Morgan Natural Gas Transmission Interstate Pipeline for sales to third parties that will use it for transportation fuel," explains Michael Bakas, executive vice president of Ameresco. With a project size of 3,250 scfm capacity, the project is expected to be largest of its kind in the nation. The project is currently expected to be operational by late 2017.

Of the 49 small-scale energy plants/solar photovoltaic installations that Ameresco owns, 24 are landfill gas plants, and two are wastewater biogas plants. Unlike typical project developers, Bakas says, Ameresco is armed with everything it needs to round out a project, including development, permitting, engineering, financing, construction, operations and maintenance. "This affords Ameresco a competitive advantage, to be able to work with our clients to develop a comprehensive project that addresses their objectives, whether Ameresco owns the energy asset, or our client does. Likewise, being product-agnostic and having a solid distribution base in many markets, we are able to put remote projects together to the benefit of our customers. A good indicator of this is that we've brought online many projects that others had attempted but failed to develop."

After completing a biogas fuel cell project at its IKEA Emeryville, California, location over a year ago, home furnishings retailer IKEA launched additional projects at four more of its California stores, expanding its fuel cell portfolio to 1.3 MW with a system in East Palo Alto, Costa Mesa, Covina and San Diego). The last of the installations, which were contracted to fuel cell supplier Bloom Energy, came online in mid-January.

US Midwest

In the Corn Belt, ADM's RNG project with utility Ameren Illinois will utilize byproduct from its corn processing facility's wastewater treatment system in Decatur, Illinois. The project will allow Ameren Illinois to distribute RNG from ADM's corn processing facility into the interstate pipeline system, not long after Ameren's recent completion of a new, \$5.3 million gas control center in Decatur. The project partners are targeting completion of construction in May 2017.

Also in Illinois, the Orchard Hills Generating Station near Rockford fired up its 16.3-MW landfill gas-to-energy project in October. The facility, powered by six 620 GE Jenbacher engines, is owned by Hoosier Energy, which uses the power internally to supply its members. EPC contractor Ameresco is operating the project for Hoosier, according to Bakas. The project marks Hoosier's third operational landfill gas plant, after the 4-MW Clark-Floyd Landfill Gas Plant in southern Indiana and the 15-MW Livingston Landfill Gas Plant near Pontiac, Illinois.

Wisconsin is already home to about three dozen on-farm digesters, most funded at least in part via state grants/incentives, and the state is readying to fund a roster of new digester projects with up to \$20 million, as the Wisconsin Department of Agriculture Trade and Consumer Protection announced it would issue a request for proposals for new cow waste digesters in January. With a goal of addressing water quality, the initiative is targeted at business consortiums and farmers interested in utilizing anaerobic digester technology to build, operate and maintain a system.

And perhaps one of the most notable biogas projects to begin producing fuel in 2016, in July, Roeslein Alternative Energy and Smithfield Hog Production achieved production of RNG at the Ruckman farm site for delivery to the national pipeline from its \$120 million swine waste-to-energy project near Albany in northern Missouri. The project, launched in 2013, has been broken into two phases. Phase one involves the installation of impermeable covers and flare systems on 88 manure lagoons located on nine hog finishing farms, two of which are now producing RNG, and phase two involves installation of equipment to remove biogas impurities—a pressure swing absorption technology provided by Guild Associates—to create pipeline-quality RNG.

Over the next few years, phase two will continue with construction of biogas cleaning systems and commencement of RNG production at the remaining seven farms within Smithfield's operations. Duke Energy in North Carolina has agreed to purchase one-third of the nine farms' RNG to help meet clean energy requirements for power generation with a 10-year contract, and RAE is also selling gas to the vehicle fuel market with Element Markets. "For the balance of gas we have to sell, vehicle is the target because of the current RIN (renewable identification number) market—D3 RINs are pretty attractive—but there are other markets we will look at," says Chris Roach, director of RAE. "Right now, the electricity market for RNG is still running at about half the value of the RIN market, so it's secondary for us."

RAE plans to supplement the hog manure feedstock with biomass harvested from restored prairie grasslands to produce additional RNG, and is planning an above-ground digester system for the grass. Additional companies involved in the project include J-W Power Company, Martin Energy Group, French Gerleman, Polsinelli PC, Industrial & Environmental Concepts Inc., Power Solutions International, and Cummins Engines.

US Southeast

Developing and operational biogas projects are on the rise in the Southeast U.S., from Virginia to the southern tip of Florida. States like North Carolina, Florida and Georgia are home to 177 operational biogas projects combined, with the potential to reach as many as 1,300 additional biogas projects based on the estimated amount of available organic material in the states, according to the ABC. North Carolina takes the lead with 75 operational facilities and the potential for a whopping 899 new projects, mostly agriculture-based. Some of this potential can be attributed to North Carolina's state renewable portfolio standard (RPS) and the North Carolina Environmental Policy Act.

There are also state funding opportunities. For example, state tax credits for alternative green energy projects helped bring both Blue Sphere's Charlotte, North Carolina, and Johnston, Rhode Island, projects to where they are today, says Blue Sphere CEO, Shlomi Palas. The company has deployed the Italian company Austep S.p.A. as both its technology provider and engineering, procurement and construction (EPC) contractor for these U.S.-based projects.

In Charlotte, the approximately \$27 million, 5.2-MW food waste-based biogas plant is now connected to the grid, and all three generators have been in operation since mid-November. Power generated from this facility will be sold to Duke Energy through a 15-year power purchase agreement (PPA). According to Palas, as of January, continuous work is being done at the facility. "It will take approximately three to four months to get to final completion," he says.

While Blue Sphere's project is in the process of ramping to full capacity, about three-and-a-half hours away in Duplin County, North Carolina, near Warsaw, Carbon Cycle Energy LLC (C2e) broke ground in December on a swine waste-to-RNG project dubbed C2e Renewables NC. C2e expects the plant to be the largest, standalone biogas facility in the U.S. "Being the first to develop a biogas project of this scale came with a multitude of challenges," according to a company spokesperson, who added that aligning the array of moving parts involved in order to successfully obtain financing for a project of this magnitude has been quite formidable at times.

In addition to swine manure, the \$100 million facility will use industrial food processing waste as substrates. "Duplin County was chosen for its large concentration of hog farms, meat and food processing plants and proximity to the natural gas pipeline," a company spokesperson says. "It is an area that will benefit from improved disposal of organic waste for minimized odors, as well as water contamination abatement."

It's expected that the plant will utilize in excess of 750,000 tons of organic waste annually, and at full capacity, produce 6,500 dekatherms of RNG daily, enough fuel to generate 290,000 megawatt-hours (MWh) of power. Raw biogas will be upgraded on-site using DMT Environmental Technologies' proprietary design of the gas purification unit operations developed specifically for the facility. From there, gas will be injected directly into the natural gas pipeline system.

Duke Energy is the contracted RNG purchaser under a 15-year contract for use at four of its power stations. Another unnamed biogas customer will be purchasing the biogas and converting the RNG to electricity as well.

C2e has long-term contracts secured for both biomass feedstock supply and for biogas sales. "In addition to helping Duke Energy to meet its North Carolina RPS requirements, we are also helping our suppliers to meet various environmental requirements of their own," the C2e spokesperson states. Swinerton Builders is serving as the EPC contractor for the project. The site began being cleared immediately following the Dec. 11 ground break, and is expected to be producing gas during the fourth quarter of this year.

Besides C2e's large swine waste project, Duke Energy finalized a second deal in 2016 to buy captured methane gas derived from swine waste at a project in Kenansville, North Carolina. This planned project will be built at the heart of Smithfield Food's pork operations and, via a number of digesters built by Optima KV LLC, will produce about 80,000 MMBtus of pipeline-quality captured methane a year, which should yield about 11,000 MWh of renewable energy for two of Duke Energy's power plants annually.

Moving outside of North Carolina, Georgia's 23 operational landfill gas (LFG) systems in 2015 were joined by at least three landfill-gas-to-energy (LFGTE) facilities in 2016. Republic Services Inc. and Mas Energy LLC worked together to place these facilities at three landfills surrounding metro Atlanta, near Buford, Griffin and Winder. "Mas Energy decided to construct the projects in the chosen locations because we obtained a PPA with economically viable returns, support from the local community and we had a long standing positive relationship with Republic," says Michael Hall, principal and chief development officer with Mas Energy.

Republic Services' director of engineering, Brian Martz, says they decided to proceed with the projects because of the "opportunity to beneficially use landfill gas at three sites simultaneously in the same market with reliable and valued direct and indirect partners."

Construction was completed between January 2015 and March of 2016, and all sites were completed by May and operational by September. According to Hall, the plants have been operating well and are able to utilize all of the gas made available by Republic. Combined, these facilities are capable of generating 24.1 MW of electricity for Georgia Power under a 20-year PPA. "The projects help meet Republic's initiatives of beneficially reusing LFG and Georgia Power's initiatives of procuring renewable energy," Martz says.

Republic designs and installs an extensive and complex network of wells, pipelines, pumps and blowers that create a specific vacuum to carefully extract the generated gas from the landfill, Martz explains, without causing adverse conditions to the anaerobic decomposition process.

Each site has the same basic design. According to Hall, the projects utilize Unison skids for gas compression and dehydration, Willexa systems for siloxane removal, 11 GE Jenbacher engines (J 616 models) to produce electricity, and Miratech CO Catalyst and SCR to remove carbon monoxide and nitrogen oxides. "The advantages to the standard design include interchangeable spare parts, familiarity with site operations between each operator and ease of training new employees," Hall says. "We were also able to utilize volume pricing to decrease the overall project costs."

The assets are owned by Cube District Energy LLC, a portfolio company of I Squared Capital. Mas Energy is providing operations and asset management, in addition to its responsibility for the day-to-day operations of

the assets. Nixon Energy Services, a GE Jenbacher distributor, provides daily operation and all maintenance services. Crowder Construction Co. was also an involved partner on these projects, as the design/build contractor. According to Martz, these projects bring their total number of operating LFG projects to 71. He says Republic has a sustainability goal to develop at least two LFGTE projects per year through 2018.

Another LFG project at Florida's Orange County landfill announced plans to double its size to the nominal flow capacity of 8,000 scfm in 2016. SCS Engineers was hired by the Orlando Utilities Commission to double the capacity, and the treated LFG is piped to Stanton Energy Center and cofired at the coal-fired power plant. According to ABC, toward the end of 2015, Florida had 63 operational biogas projects with the potential for 230 more.

US Northeast

The Northeastern region of the U.S. has been considered the nation's most economically developed, densely populated and culturally diverse region, ranging from the northern tip of Maine southwest to Pennsylvania. The region's population has served as a driving factor behind a number of states implementing legislation to control waste, especially at large waste generators and collectors of waste like landfills, supermarkets and farms. Connecticut, Massachusetts, New Jersey, New York,

Pennsylvania, Rhode Island and Vermont have a combined 542 biogas plants, with the potential for over 1,000 additional biogas plants based on the amount of available organic material, according to ABC's August 2015 data. Out of the group, New York and Pennsylvania come out on top with 216 and 173 operating biogas plants, respectively, and the potential for over 300 additional plants in each state.

Throughout 2016, there has been a host of developing biogas projects. In mid-April, the Stop & Shop Supermarket Co. LLC celebrated the opening of its facility in Freetown, Massachusetts, which will process an estimated 34,000 tons per year of inedible food products from all of Stop & Shop New England's 212 stores that cannot be sold or donated to regional food banks or local farms into 1.25 MW of electricity. In July, Vermont Technical College's anaerobic digester (AD) named "Big Bertha" began operating at full capacity, transforming 16,000 gallons of cow manure and organic matter from Vermont farms and brewery waste from the Alchemist and Long Trail Brewing Co. into 8,800 kWh of electricity daily. The following month, American Organic Energy solidified its core engineering team to construct its AD facility on Long Island, New York. Louis Perry Group, a CDM Smith Co., in conjunction with GE Power & Water, the Eggersmann Group of Germany and Green Arrow Engineering will contribute to the project. Once fully operational, the facility will recycle food waste to produce vehicle fuel, electricity, compost and clean water.

As noted, Blue Sphere's Charlotte facility has begun operating, and its Johnston, Rhode Island, plant is nearing completion. Austep Group's U.S. subsidiary, Auspark LLC, as EPC contractor, is going through the phases needed to bring the 3.2-MW Johnston facility to the testing and commissioning phase, according to the company's November project update. The approximately \$19 million facility will sell its power to National Grid via a 15-year PPA once complete.

Ohio has an RPS standard that Rumpke Waste & Recycling and Energy Developments (EDL) LFGTE facility at Rumpke's Brown County landfill will participate in. Shovels broke ground in November on the \$8 million project, which will generate 4.8 MW of electricity for sale to American Municipal Power Ohio. LFG is piped to Caterpillar 3520 reciprocating engines, each with the capacity to produce 1.6 MW of electricity. According to Dennis Bollinger, vice president of commercial and regulatory affairs with EDL, the project site was selected for a number of reasons. He says the landfill was capable of supporting the generation capacity that EDL needed to install in order to meet its minimum thresholds, and Ohio is a strong focal point for the company's energy developments. "It's taking an otherwise wasted resource and using it for beneficial use," Bollinger says. "If we weren't there, the gas would just continue to be flared and it would be of no value to anyone." The project is expected to be operational by April.

Toward the end of 2015, Connecticut only supported 14 operational biogas systems, 10 of which were at WWTPs, but the state has the potential to quadruple this number. Quantum Biopower is one company helping the state reach its potential with the state's first food waste AD system out of a potential six ABC estimates could be built based on available state resources. Quantum decided to construct its digester on 60 acres of land in Southington, at one of three locations where its sister company, Supreme Forest Products, operates green waste recycling; taking in brush, stumps, leaves and recycling it into usable, sellable products like mulch, compost and soil. "Based on the food diversion mandate and proximity to major highways, Southington is ideally located in the center of Connecticut. Plus, we were welcomed with open arms by the people of Southington, and we're proud to call it home," says Brian Paganini, vice president and managing director of Quantum Biopower.

According to Paganini, the president of Quantum had a vision many years ago about creating compost blends that were infused with organic nutrients. He was willing to financially support the project, as he saw digestion as a way to accelerate the composting process and create unique organic compost blends from the residual materials. Building off that vision, there were a number of factors that drove this \$14 million project, including successful lobbying efforts. "We worked very hard with both the environment and energy committees in the state legislature to support programs that lead to digester development," Paganini shares. Of particular note, he adds, Quantum worked closely with ranking members of the general assembly's environment committee to support the passage of Connecticut's Virtual Net Metering Program. Connecticut was the thirteenth state to adopt the program, which allowed Quantum to sign a 20-year PPA with the town of Southington to power five of their government buildings. Not to mention, the Department of Energy and Environmental Protection acted as a project partner, working with Quantum to permit and construct this first facility. "We will continue to partner with them to help develop digestate management standards in Connecticut and assist them in formalizing operator's certifications for digester operations in the state," Paganini says.

Quantum was able to overcome hurdles with permitting, technology, application, construction and energy offtake to bring its first facility to the early stages of startup and operation this year. At full ramp-up, the plant will take in 40,000 tons of food waste annually—about 150 tons per day—via its low-solids digester. The AD system uses a two-stage process, and a nutrient recovery and removal process, which allows the company to take a wide range of food waste; packaged, contaminated, clean food waste, liquid source separated organic streams, etc. Customers sending waste to the plant include Shop Rite, the Aqua Turf, the Farmington Club and Bozzuto's, one of the largest privately held food distributors in the region. Paganini says there were two

reasons why the company focused heavily on organics preprocessing during the project's technology diligence process. First, as a merchant facility—the first in Connecticut—Quantum wanted to be built for feedstock flexibility to offer customers a complete solution. Second, Quantum was seeking a process that would remove the majority of inorganic material, ahead of digestion, so its downstream digestate was free from contaminants. “This ensures that when we make our compost, we are limiting the amount of contaminant materials,” Paganini says. The project will produce roughly 8,000 tons per year of a nutrient-rich organic compost blend, and the company plans on leveraging the market channels they currently have in place to market a premium-grade compost product to meet the needs of a growing organic compost movement, according to Paganini.

The plant has the capacity of generating 1.2 MW of power, equivalent to about 750 homes' electricity use for one year. However, this permitted capacity could be an issue for Quantum moving forward, as Paganini points out that they're filling up their capacity fast. The company is considering a phase two plan to expand the facility's footprint to avoid any future problems the capacity limit could cause.

This project provides critical infrastructure for adherence to the state food mandate, Paganini shares, which means that if a large food producer (greater than 2 tons per week or 104 tons per year) is within 20 miles of Quantum's facility, then they are mandated to divert food waste out of their waste stream. Also, Connecticut has a goal by the year 2024 to reduce, reuse and recycle 60 percent of its generated waste. Currently, the state is diverting 32 percent, and according to the state's 2015 waste characterization report, food waste is the largest portion of Connecticut's waste stream (20 percent or 500,000 tons) and the least recycled.

Construction of the biogas plant took eight months, and Quantum capitalized on the construction background within its group of companies to build it, with the knowledge that this would be one of more to come. According to Paganini, Quantum is currently vetting five projects along the East Coast for further development. “We no longer need to look at the successes of our European colleagues because real growth, in the biogas industry, is taking shape here in the U.S.,” Paganini says. “As more states implement food diversion programs and recognize digester methane as a renewable baseload energy source, the runway becomes longer and more defined for future project growth. It's a great time to be part of such an exciting industry as it takes shape right in front of our eyes.”

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