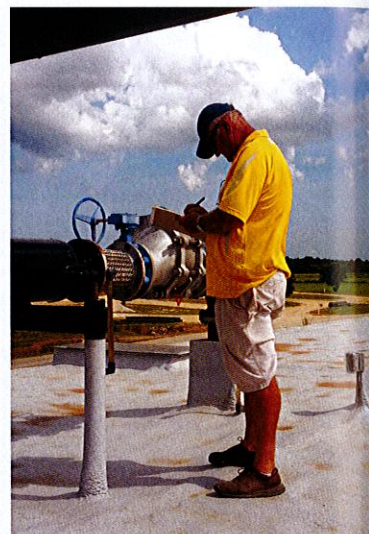
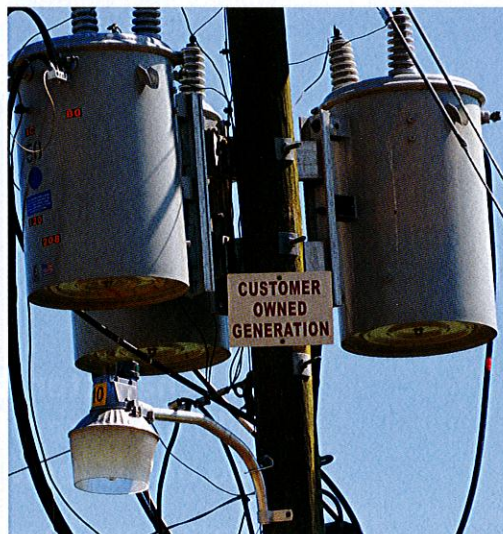


Future Bright for Swine Waste-to-Energy Technologies

This article was written by Angie Maier, NCPC's Director of Policy Development & Communications. Maier oversees NCPC's government affairs efforts and serves as the Council's lead lobbyist where she has worked directly to support and defend waste-to-energy legislation. In addition, Maier has been called to testify before the NC Utilities Commission in support of the program and to represent the interests of the pork industry.



2007 was a pivotal year for North Carolina's pork industry. Two significant laws were passed that year. One made permanent a decade-long moratorium on the construction of any new swine farm or the expansion of an existing swine farm that uses a lagoon-sprayfield system. The other was Senate Bill 3, which established North Carolina's Renewable Energy Portfolio Standard (REPS).

The REPS created a clean energy market in the state, directing the state's electric providers (or utilities) to purchase a specific amount of energy from renewable sources. That amount, expressed in terms of a percentage of their overall total energy portfolio (coal, nuclear, etc.), gradually increases, eventually topping out at 12.5 percent by the year 2021.

In addition to requiring a certain percentage of electricity to come from renewables, the law also has carve-outs, or "set-asides," for energy created from solar, swine waste and poultry waste. By the year 2018, the law calls for .20 percent of all electricity sales to come from energy generated from swine waste. That is the equivalent of around 284,000 megawatt

hours (MWh) of electricity. North Carolina is the only state to have a swine waste set aside as part of a renewable energy law.

Passage of these two laws in the same year is significant because, as lawmakers were telling hog farmers to move away from using lagoons as a method of waste treatment if they wanted the industry to grow, those farmers were simultaneously trying to convince them that there was value in lagoons, beyond just organic fertilizer.

We were given a chance to prove that value, but it was not without opposition. Environmental activists tried to block inclusion of swine waste in the legislation that created the REPS, even convincing some lawmakers to attempt to amend the bill just before final passage in the North Carolina House of Representatives. That was in 2007. But in 2013, when the REPS law was under attack at the state legislature, it was the pork and poultry industries that ultimately saved the entire law from being repealed.

The REPS law promotes the advancement of renewable energy technology by requiring the utilities to purchase electricity made from renewable sources. Even though methane digester technology is not new, the application of that process



on swine farms is still relatively new, so costs have not yet come down enough to be competitive with cheaper forms of energy. So, without the REPS requirement, a farmer or developer would have a very difficult time selling that electricity at a price that allows for cost-recovery of their investment in the technology.

To meet the law's requirements, electric utilities must secure Renewable Energy Certificates (REC), which are tradable financial certificates and are equal to one MWh of electricity. So, for every MWh of electricity produced from swine waste, one REC is created. Utilities may purchase swine RECs or develop their own, and to comply with the law, they must secure 91,000 swine RECs by the end of 2014. That required amount continues to increase, reaching 284,000 swine RECs by 2018.

The REPS law is indeed working to foster development of renewable energy. Within five years of the law's passage, the cost of implementing solar has been cut nearly in half. Swine waste-to-energy projects have progressed at a much slower pace, but the law has still facilitated a number of efforts. To date, there are six on-farm projects that are selling electricity back to the grid and will generate an estimated 15,500 RECs this year. There are many more projects in the pipeline.

Because the effort has been slow-going, the utilities have been unable to meet the required amount of electricity derived from swine waste. Two years in a row, the utilities have been granted a reprieve by the North Carolina Utilities Commission (NCUC) to delay their compliance with the swine set aside in the REPS law. NCPC participated in both of those proceedings before NCUC to ensure the interests of the pork industry were represented.

Early Adopters

Almost a decade before passage of North Carolina's renewable energy law, Julian Barham was already creating electricity from swine waste. An engineer by training, Barham had a vision in 1995 to build a biogas generator on his 4,000-sow, farrow-to-wean operation in Zebulon. With some technical assistance from North Carolina State University and AgSTAR (a partnership between USDA, the U.S. Department of Energy and the EPA), Barham was creating electricity a few years later.

Barham's system included a covered, in-ground, anaerobic digester. The cost of that first system, including three different lagoon covers, was around \$300,000.

The electricity generated was used on the farm and any additional power not consumed on the farm was sold back to the grid. Waste heat from the generator was used to produce hot water to heat mats under the farrowed pigs which replaced the need for heat lamps.

In 2003, Barham stopped generating electricity for sale when he was unable to secure a mutually beneficial contract with the utility. Unfortunately, because the renewable energy law was not yet in place, he did not have the benefit of being able to earn RECs for the electricity he generated, which would have produced an additional revenue stream.

The first swine waste-to-energy project in North Carolina to earn RECs was on the Loyd Ray Farms, a feeder-to-finish, 8,640-head farm in Yadkin County that grows on contract with JC Howard Farms. The project, which began operating in 2011, is a joint venture between Duke University and Duke Energy, and generates around 500 RECs each year.

In addition to earning RECs, the waste management system also meets the environmental performance standards required for a new or expanding farm. The system consists of a covered, in-ground anaerobic digester that captures methane and turns it into electricity. The electricity generated is used to power components of the waste treatment system as well as some of the barns. Duke Energy is able to claim the RECs generated.

After digestion, the liquid goes into an aeration basin and through a nitrification/denitrification process that removes the ammonia. This additional step is necessary for the system to be able to meet the criteria for an environmentally superior technology.

The farmer incurred no out-of-pocket expenses in this endeavor. A portion of the total cost of the \$1.2 million system was paid for by funding available in the North Carolina Lagoon Conversion Program and with a \$500,000 Natural Resources Conservation Services (NRCS) grant. The remaining cost was picked up by Duke Energy and Duke University. Google Inc. also agreed to share in operation and maintenance costs in exchange for a portion of the carbon offsets generated at the farm.

Tom Butler of Butler Farms, a 7,550-head finishing operation near Lillington, got into the green energy business by first covering the farm's two existing lagoons and flaring the methane in 2008 to earn carbon credits. Then, in 2012, the

Understanding the Numbers

1,000 kilowatt hours (KWh) = 1 megawatt hour (MWh) = 1 Renewable Energy Certificate (REC)

In 2012, the average annual electricity consumption for a US residential utility customer was 10,837 KWh.*

* Source: U.S. Department of Energy

farm installed a covered, in-ground, anaerobic digester and began creating electricity. Manure from the barns first flows into the digester where biogas is collected. Before being used in the generator, the biogas is scrubbed to remove hydrogen sulfide gas. The waste heat generated in the process then cycles back into the digester to retain an optimal temperature for biogas production. Effluent from the covered lagoon digester is sent to one of two covered overflow lagoons that were part of the farm's original lagoon system.

Butler, a contract grower for Prestage Farms, has also installed two solar panels that power the generator making the whole process even more energy efficient. The electricity created is then sold to the local electric cooperative.

In the future, the farm is considering adding off-farm food waste to the digester to increase the biogas production.

Last year, Butler Farms generated 200 MWh of electricity (or 200 RECs), and with some planned improvements, including a new scrubber system for the biogas that will scrub the gas, dehydrate it, remove the sulfur and cool it to a temperature of around 65 degrees F (down from the current temperature of 125 degrees F), he hopes to increase that amount to as high as 300 MWh.

In 2012, L.D. Black also added a generator on his Harnett County farm, which already had two covered lagoons. Black's 5,880-head gilt multiplication farm is about "three miles across the woods" from Butler's farm and the two are cousins. They have worked very closely on their respective ventures to be able to help and learn from one another. Black is also on contract with Prestage Farms.

One example of a lesson learned was with the location of the generator in relation to the digester on Butler's farm. When Butler had trouble with moisture in his biogas, they learned that piping the gas to a slightly higher point on the farm would have allowed a lot of that moisture to settle out of the biogas before it was used in the generator. They corrected the design on Black's farm.

Black has a different system than Butler. He has a digester installed on one of the farm's original covered lagoons. In 2013, he produced around 80 MWh of electricity, but hopes to increase that production to as high as 125 MWh in 2014.

Additional Models Emerge

In late 2013, the largest swine waste-to-energy project to date in North Carolina began operation. The project, comprised of 10 separate but adjacent finishing farms owned by Murphy Family Ventures, was developed by Revolution Energy Solutions (RES), a company that specializes in the development of agricultural-based renewable energy technology.

What is a Renewable Energy Certificate (REC)?

RECs are tradable financial certificates and are equal to one megawatt of electricity, or an energy equivalent, that is generated by an eligible renewable energy resource or saved due to an energy efficiency measure.

Located in Duplin County, the project has multiple on-site tank digesters that utilize manure from nearly 74,000 hogs, enough methane to produce around 10,200 MWh of electricity annually and power upward of 738 NC homes.

In comparison to the other endeavors, both the size of the RES project, as well as the financial model with which it was developed, sets it apart as a very different approach to creating electricity on swine farms. The owner of the farms incurred no cost in the construction of the project, including the reconstruction and retrofitting of barns with a scraper system. Similarly, daily operation and maintenance is also the responsibility of RES. The capital for the project came largely from outside investors, and although the availability of state and federal tax credits were key to pulling it all together, no grant funding was used. Since RES owns the project, they profit off of the electricity sales and the RECs earned.

Al Tank, CEO of Revolution Energy Solutions and former CEO of the National Pork Producers Council, says development efforts that are underway could result in an additional 55,000 MWh of production from swine waste in this state.

In early April, Governor Pat McCrory toured the project along with North Carolina Commissioner of Agriculture Steve Troxler and Secretary of the North Carolina Department of Environment and Natural Resources, John Skvarla.

"Agriculture Commissioner Troxler, DENR Secretary Skvarla and I were able to see firsthand the innovative technology being used to boost two important sectors in North Carolina: agriculture and energy," said Governor McCrory. "We have been committed to pursuing an all-of-the-above energy policy aimed at providing needed jobs and energy for North Carolinians and aiding in our country's energy independence. The innovative technology I toured in April is capable of doing just that, while protecting our environment and utilizing the resources of our thriving pork and agricultural industries. This kind of innovation and collaboration will be a big factor in helping North Carolina's economy improve."

Troxler was also impressed by what he saw. "I think it's wonderful that swine waste is being used to power farms and homes in NC," he said. "It's amazing what individual farmers and companies like Revolution Energy Solutions are accomplishing."

Storms Hog Power

The most recent project to start earning RECs is on a farm owned by Billy Storms in Bladenboro. Storms, a contract grower for Murphy-Brown, LLC, has a tank digester that utilizes manure from more than 28,000 finishing hogs. The electricity created is sold to the local electric cooperative and it will generate an estimated 5,000 RECs annually.

In addition to manure from the hog houses, Storms is adding mortality from the hog farm and from the 16 chicken houses that are also part of his farm. This has eliminated the need to buy propane to incinerate chicken mortality and is saving him \$1,000 a month because he no longer has to pay for his swine mortality to be picked up. He is also adding dissolved air flotation (DAF) sludge from the Smithfield Clinton plant and the Prestage Foods turkey processing plant in St. Paul.

CODIGESTION

Swine waste is an excellent base to which other feedstocks can be added for digestion. Sweet potato scraps, animal mortality, DAF (dissolved air flotation) sludge, even baked goods can be added to a digester. The overall biogas yield can increase anywhere from three to 10 times over using swine waste alone, depending on what other feedstock is added.

Storms says he got interested in doing this after reading about small-scale digesters that were using different types of waste to generate methane and create electricity.

"I knew that hogs put out a lot of methane, and I knew I had a lot of hogs," Storms said, then adding, "I've always been a daredevil, I guess."

The process was not easy, but Storms says he was fortunate to have a good team behind him helping him navigate things like the financing, permitting and negotiating with the power companies. That team included longtime industry environmental leader and former NCPC board member Dr. Garth Boyd.

"It was a long battle, but somebody has to go first," Boyd said about Storms.

Storms is not worried about the return on his investment. He says he will easily make his money back with the combination of selling the electricity and the accompanying RECs, selling carbon credits, money saved from previous mortality costs and with payments for taking the DAF sludge from the plants.

Assessing the Future

The use of methane digesters provides many benefits beyond the additional income from selling electricity, many of which are not directly monetized.

"We should be talking about it in terms of 'waste-to-value' instead of 'waste-to-energy' projects," said Tank.

Indeed, these ventures save farmers money formerly spent on other energy and fuel needs. Waste heat from the generation process can be used for heating barns, water and greenhouses, or even used for drying grain.

The digestion process also destroys all pathogens, and some even say that solids are significantly reduced as well. Further, digestion changes the nutrient profile of the remaining effluent, and the plants use those nutrients more readily, something Butler describes as "the difference between dishwater and a milkshake to you and me."

Finally, using a covered digester to capture methane is almost certain to be a major component of any environmentally superior technology that would meet the performance criteria required for a new or expanding farm, according to Dr. Mike Williams, head of the Prestage Department of Poultry Science at North Carolina State University and director of the Animal and Poultry Waste Management Center.

But, even though there are benefits to adding a digester on a farm, it is not something that would work on every farm. There are numerous considerations, ranging from financing a project to whether the farm is in a location that would make it possible to even sell electricity back to the grid.

Williams also notes that since there is no volatilization of ammonia in contained anaerobic digestion as there would be in an open-air lagoon, there will be much higher nitrogen content in the effluent potentially requiring more land in a farmer's waste utilization plan.

In fact, according to a NCPC-funded study conducted in 2007 by Mark Rice, an extension specialist in Biological and Agricultural Engineering at NC State, nitrogen concentration in a covered lagoon can increase nearly two-fold. But, the hydraulic load is diminished without the addition of rainfall.

Despite the many challenges folks have encountered along the way, the future looks promising for swine waste-to-energy technologies. Even beyond the kinds of projects we have seen thus far, there are increasingly more opportunities, including the possibility of liquefying the biogas for use as fuel in vehicles or for injection into existing natural gas pipelines.

According to Tank, "We are at the very beginning of 'waste-to-value' in the swine sector, and the North Carolina industry has the potential to be the undisputed leader in the US."

The slow start has made the swine waste set-aside portion of the REPS law particularly vulnerable to criticism that the law is not working and should be repealed, but NCPC will continue to work hard to protect the law.

Kraig Westerbeek, VP of environmental compliance at Murphy-Brown, LLC, agrees with that approach. "If we don't fight to keep this law in place, we will never have this kind of opportunity again," he said.

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