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# LOYD RAY FARMS – BOONEVILLE, NC

*WIN-WIN FOR LOYD RAY FARMS, DUKE ENERGY, AND GOOGLE*

## SYSTEM DESIGN

Loyd Ray Farms is a feeder-to-finish swine farm located in the Piedmont region of North Carolina. The farm operation has nine barns housing 8,640 swine. In 2011, the construction of an innovative waste management system was completed, which included a lined and covered anaerobic digester basin. The system also boasts a lined in-ground aeration basin for treatment of other waste products and reduction of odors. The digester was constructed as part of a demonstration project to avoid the emission of methane from the farm's waste stream and to produce renewable electricity from swine waste in fulfillment of North Carolina's Renewable Energy and Energy Efficiency Portfolio Standard (REPS), which is the only REPS in the country to include a specific set-aside for swine waste-derived electricity.

The anaerobic holds about 2.1 million gallons of manure and wastewater. Two plastic curtains, or baffles, extend the length of the digester basin. The digester operates at ambient temperature and has an average hydraulic retention time of 15 days. Effluent from the digester flows by gravity to an in-ground lined aeration basin of approximately 1.1 million gallons.

Each barn is emptied and flushed to the anaerobic digester once each week; the covered basin digester receives approximately 400,000 gallons of influent per week. The flushed waste enters the digester, where biogas production occurs. Upon leaving the digester, the liquid stream of the remaining waste product enters into an aeration basin, where pathogens, heavy metals and nutrients (e.g., nitrogen and phosphorus) are removed. A portion of the treated liquid wastewater stream is recycled back to the barns as flush water for filling the pits beneath the animals. The rest is sent to the original storage lagoon for eventual use as irrigation-quality water.

Biogas production for electricity from the covered basin is estimated to be 50,400 ft3/day. The biogas is piped to a 65 kW microturbine to generate electricity, with the gas pretreated in a conditioning skid that dehumidifies and cools the gas and filters particulates larger than 5 microns. Notably, the gas does not need to be scrubbed for hydrogen sulfide (H2S) removal because the microturbine can withstand a relatively high concentration of H2S. The system also has a backup flare that is used to burn the biogas when gas production exceeds the microturbine's capacity. Gas production thus far has been so great that the flare is often in use at the same time as the microturbine to alleviate pressure on the digester cover; the project team has considered installing an additional microturbine.

The total turnkey cost of the innovative waste management system was $1.2 million, including both the electricity-producing components (digester, gas conditioning equipment, and microturbine) and the environmental system (aeration basin and jet aeration system). External sources funded the entire system; the farm operator incurred no out-of-pocket expenses for construction, and is not responsible for operation and maintenance. Those external sources include:

- The North Carolina Division of Soil and Water Conservation's Lagoon Conversion Program: $115,000 (agriculture cost-share program that contributed the funds as a grant to the farmer).
- The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service's (NRCS) Environmental Quality Incentives Program (EQIP), through NRCS's Cooperative Conservation Partnership Initiative (CCPI): $385,000 (agriculture cost-share funding to the farmer).
- Duke University and Duke Energy: $700,000 (capital costs and are jointly responsible for O&M costs for a period of 10 years). Duke University provided funding as part of a three-party cost-sharing agreement with Loyd Ray Farms and Duke Energy, with the university receiving any carbon offset credits generated by the project. For the university, the farm's system represents a demonstration and research project. Per the agreement, Duke Energy provided funds from its research and development pool and will receive all renewable energy certificates (RECS) achieved by the system over the life of the project.

- Google, Inc., in collaboration with Duke University, agreed to share O&M expenses in return for a portion of the carbon offsets.

The generated electricity is used on-farm to operate the system and to serve the electricity needs of five of the nine barns. Any excess electricity is sent to the utility via the electricity grid. While the farm receives no payment from the utility, the operator still estimates that the farm saves an average of $200 per month in electricity costs.

## PROJECT BENEFITS

The Loyd Ray Farms' anaerobic digester-based system produces benefits beyond electricity production and carbon offsets. It qualifies as an innovative animal waste management system, which yields significant water and air quality benefits. The farm now substantially eliminates ammonia (NH3) emissions, heavy metals, pathogens, nutrients, and odors and completely eliminates the discharge of waste to surface and groundwater. The specific North Carolina environmental performance standards that the project meets include:

- Eliminate the discharge of animal waste to surface water and groundwater through direct discharge, seepage, or runoff.
- Substantially eliminate atmospheric emission of ammonia.
- Substantially eliminate the emission of odor that is detectable beyond the boundaries of the parcel or tract of land on which the swine farm is located.
- Substantially eliminate the release of disease transmitting vectors and airborne pathogens.
- Substantially eliminate nutrient and heavy metal contamination of soil and groundwater.

Per North Carolina state regulations, the construction of new waste lagoons is prohibited. Rather, new farms must construct innovative waste management systems to be permitted, while no existing farm may expand its operations (i.e., add more animals beyond its permitted capacity) unless it installs an innovative waste management system. Because the covered-basin anaerobic digester is part of an innovative waste management system, Loyd Ray Farms is in a position to expand its operation at a time when other farms may not, which means that it may be able to increase its productivity by as much as 20 percent.

In addition, the innovative system is expected to allow Loyd Ray Farms to convert its sprayfields, where only hay and grasses are currently grown to uptake the high nutrient content of untreated waste from the lagoon, into cropland where higher value cash crops such as corn and soybeans can be grown. The cleaned water effluent from the aeration basin is used to flush the barns and re-charge the pits, replacing the ammonia-laden wastewater previously used from the lagoon. Cleaner water for flush, spray water for cleaning the barns, and pit recharge leads to cleaner air in the barns and is expected to improve the health of the pigs and reduce mortality rates by decreasing their exposure to pathogens and ammonia emissions.

The digester-based innovative system reduces greenhouse gases and produces clean, renewable energy, which each earn marketable environmental credits. Carbon credits are earned via reduction of methane emissions, which will be registered and verified to the Climate Action Reserve (CAR) Livestock Methane Protocol. The carbon offsets for Loyd Ray Farms will be the first North American swine farm-based offsets to be registered with CAR. Notably, offsets that comply with the CAR Livestock Methane Protocol are recognized as one of four compliant offset types under California's cap-and-trade program. In addition to the offsets, the gas collected off of the digester is used to produce renewable energy that earns renewable energy certificates (RECs) through North Carolina's REPS. The system is expected to generate carbon offset credits of approximately 5,000 metric tonnes of carbon dioxide equivalents per year and produce enough electricity to earn approximately 500 RECs per year.

- **Population Feeding Digester:** 8,640
- **Baseline System:** Storage Lagoon
- **Digester Type:** Lined and Covered Basin
- **System Designer:** Duke University
- **Biogas Generation:** 50,400 $ft^3$/day
- **Biogas Use:** Electricity
- **Receiving Utility:** Surry-Yadkin Electric Membership Corporation