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Project Title: Diamond K Feeds Methane Digester Project
Milestone Number 4

RDF Contract Number: EP-51 Report Date: Mar 7, 2014

Congressional District: Minnesota 1st

Project funding provided by customers of Xcel Energy through a grant from the Renewable Development Fund.

Executive Summary:

The electrical generation project at Diamond K Feeds, LLP was completed in December of 2013 and the generator was commissioned for service on December 31, 2013. We are very happy to be finished with the construction and are excited to begin the production phase. Our family sees this use of methane gas from livestock waste for the production of electricity as a stepping stone in the future of green energy. With this process we will be embarking on a journey to enhance the value of agriculture in our country to provide for an ever-increasing world population. We must find ways to produce more food and energy to supplement our finite natural resources.

The multi-use of livestock waste is a perfect example of the things we need to do to develop new sources of energy. We will be taking a product that is readily available, which means we won't have to spend time sourcing raw materials. The digestion process will capture methane gas that is produced in the decomposition of the product and turn it into a resource rather than an ozone depleting element. The product that remains after the gas is removed is still used as fertilizer on our crop land. However, it is an enhanced version in that it has already gone through the composting process in the digester to make it ready for plant uptake that normally has to take place over a three year period in the soil. This lessens the impact that using livestock waste as fertilizer can have because it is much less likely to be washed away. This starts the cycle all over again to provide both food and fuel for use by everyone.

Technical Progress:

<u>Manure Collection</u>

Manure is scraped out of the barns three times each day and pushed into one of twelve 8' deep collection gutters at the ends of the three free-stall cattle barns.

Photo 1 – A skid loader scrapes manure from the barn alleys into collection gutters

Manure from all collection gutters flows via gravity through a 24" PVC pipe to a 30 x 30 x 12 concrete, central collection pit that holds the manure from all three barns. In this collection pit the manure is mixed and prepared for delivery to the digester vessel. A 6" piston pump powered by a 5 HP motor moves the manure to the digester through an underground pipe.

Photo 2 – Central collection pit and agitator to mix manure from barns

Methane Production

Once in the digester the manure is mixed by four 15 HP prop-style agitators, running intermittently, to promote the bacterial break down of the organic material for a more complete digestion process. The ideal theoretical retention time is 22 to 25 days for gas production. The digester is covered with a sheet of HDPE plastic, then a layer of insulation and then an additional sheet of HDPE plastic. The digester maintains a 100 degree

temperature, which is the optimum for methane gas production, using hot water which comes from the cooling of the engine that produces the electricity. The water flows through a closed loop system back and forth from the engine to the digester vessel.

Photo 3 – Methane digester

Methane gas that forms rises to the top of the digester and is captured in a specially designed, sealed, floating insulated cover. Captured methane flows through an underground 8" PVC pipe 350 feet to the engine building. There is no storage capacity for the methane gas so any excess gas that can not be used by the engine is flared off.

Photo 4: Methane collection

After the manure leaves the digester it flows to a concrete reception pit. Solids are separated from the liquid with a screw press separator. Liquids are retained in storage ponds until the appropriate time to be spread on the crop land for fertilizer. Solids are stockpiled and used as bedding in the free stalls for the cattle.

Photo 5: Methane Compression

A small turbine pump inside the engine building pulls the gas from the digester and compresses the methane gas to a combustible fuel that is metered and utilized by a 1,462 cubic-inch, internal combustion engine.

Electric Power Generation

The 8-cylinder engine is designed to burn biogas and powers a 300 kilowatt generator. Electricity that is generated is delivered to an interconnection point with Xcel Energy for public consumption.

The engine is cooled with water which flows in a continuous loop to the digester to maintain the temperature there then returned to the engine for cooling. The coolant water is approximately 180 degrees as it comes off the generator. Since excessive heat would kill the anaerobic organisms in the digester, the hot water is cooled to 100 degrees before it is piped to the digester to maintain an optimal digester temperature. Excess hot water is directed to the dairy facility to replace water heated by fossil fuels that is necessary for cleaning the milking equipment and heating the building. When fully operational the dairy will use approximately 35% of the production. The remaining 65% will be sold to Xcel Energy for the grid.

Photo 6: Engine and 300 kW generator

Additional Milestones:

The last milestone, which is final inspection, operational training, and presentation to the RDF board, is yet to be scheduled.

Project Status:

Project construction is complete, the generator has been commissioned, and the facility is operational.