Proposal #2

Proposal
Texas A&M AgriLife Research Air Quality Research Program
FY 2014-2015

Title: REDUCING ENERGY COSTS AT CATTLE FEEDYARDS USING FLUIDIZED BED GASIFICATION OF MANURE

Principal Investigator: Sergio Capareda
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Amount Requested per year: $ 80,000 FY 2014; $ 80,000 FY 2015

Executive Summary

Proposed legislation of greenhouse gas emissions may significantly increase the cost of electricity while reducing its availability. This project will examine the energy cost reductions when using a gasification power plant at a cattle feedyard, and determine the derivative economic diversity that cattle feedyards may enjoy as a result, which include: on-site generation of electric power and heat energy, potential revenue from carbon credits, and the sale of excess electrical power back to the grid.

Power generation: Generating electric power at a cattle feedyard with a thermal conversion system fueled with cattle manure will provide sufficient electricity and heat energy to operate the feedmill. The energy content of cattle feedyard manure is assumed to be 5,000 Btu per pound. For a 40,000 head feedyard, approximately 400 tons of manure is generated per day. Since the energy requirement for this size feedyard is 4 MW, only 320 tons of the available manure will be required to generate electric power using a biomass gasifier-power plant system at 10% thermal efficiency.

Waste heat utilization: A 4 MW power plant with 10% thermal conversion efficiency will consume 320 tons of manure per day. The waste heat (90% of the energy in the fuel) is the equivalent of 123 Mcf/hr of natural gas. This heat energy should be sufficient to replace the natural gas or propane requirements for the feedmill, which are calculated to be 120 mcf/day.

Carbon credits. Manure is a renewable biomass and would be considered a carbon neutral energy production system. In effect, all CO_2 equivalents (CO_2e) emitted would be considered as not creating a net increase in green house gases (GHG) to the ecosystem. It is unknown at this point how the “cap-and-trade” and “offsets” will work in the future with regard to emissions of the GHG, but it is possible that the displaced CO_2e that would have resulted had the energy from fossil fuels had been used will be have value as “carbon credits”.

Excess power revenue. Finally, excess electrical power not consumed by the feedyard may be sold to the electrical power utility adding yet another potential economic benefit of an onsite power plant. It is estimated that this would result in approximately, $350,000 annually in revenue. Additionally, the residue from gasification is in the form of activated charcoal, which is marketable in a variety of ways.

The economic advantages of the use of manure to generate electrical power and heat energy are lucrative and provide multiple sources of additional revenue and potentially could make the feedyard totally independent of external energy requirements.

Background:

This goal of this proposed research is to decrease costs associated with electrical power and heat energy requirements at cattle feedyards by evaluating the benefits of onsite energy production. Additional benefits will include the use of manure as a fuel, making it an asset instead of a waste product to be removed at additional cost, carbon credit and renewable energy benefits, additional revenue from the sale of activated carbon residue from gasification, and excess electrical power. Onsite power production offers a unique opportunity for cattle feedyards to become energy independent and diversify their operations and become much more economically viable.

The Biological and Agricultural Engineering Department (BAEN) at Texas A&M has been working on research to generate useable energy from biomass for more than 30 years. We have learned that for such a system to be sustainable, it must be based upon gasification. A patent was developed that consisted of a fluidized bed gasifier that converted biomass to a low calorific value (LCV) gas. The LCV gas passed through a specially designed cyclone series system that removed the "char" and into a staged combustion system used to lower emission concentrations of NOx. Some unique findings of our research were:

1. The ash in the fuel (biomass) has a low melting point.
2. In order to minimize "slagging and fouling", the thermal conversion system fueled with cattle manure was limited to relatively low temperatures (<1500 F).
3. The char from the gasifier could be removed with a cyclone series system.
4. The char was activated carbon that potentially had value for waste water cleanup, fertilizer, and many other commercial uses.
5. The emission concentration of NOx could be reduced to meet new source performance standard (NSPS) of 0.6 pounds per million Btu, thermal input (0.6 $lb/10^6$ Btu) by staged combustion. (The current NSPS for power generation is 0.15$lb/10^6$ Btu.)

Objectives:

1. Develop a system to integrate 1, 2, or 3 MW power plants into existing cattle feedyards to produce electricity and heat energy for the feedmill .

2. Conduct operations research to determine the economic and technical feasibility and quantify the associated benefits of onsite power generation at the cattle feedyard fueled with renewable biomass with a net zero GHG emissions.

Plan of Work:

Objective 1:

Integrating an onsite power plant at an exisiting feedyard site should not be difficult. Research will be conducted on a typical site to determine general location and layout of the power plant relative to the exising facilities. Careful attention will be given to location with respect to module animal areas, manure storage, and the surrounding community.

Integration of the power plant will address to feedmill requirements: replacement of external electricity sources and the use of waste heat from the power plant for use in feedmill operation. External power will be maintained for periods of power plant inactivity and also for the potential of transmitting excess power from the onsite power plant back to the grid.

Physical integration of the drying system must be addressed to determine feasible integration of the onsite power plant and the feedmill if waste heat is to be used for feed production.

Objective 2:

This objective will focus on development and evaluation of alternative scenarios for onsite power production using manure. The scenarios will be evaluated based upon engineering impacts of replacement of external electric power with onsite power and economic benefits. Issues addressed will include (1) initial cost of power plant construction and integration into the feedmill (2) eliminating external electricity costs, (3) energy cost savings resulting from waste heat capture and use, (4) potential year round operation of the power plant and associated labor costs, (5) additional insurance costs, (6) additional revenue from activated carbon, sale of carbon credits, and excess power, and (7) overall economic benefit to the feedmill/power plant operation. The evaluations will be made using systems analysis methods that are being developed with this project.

Decision support software will be refined into a prototype version of software for feedyard management use. Feedyard managers will be able to determine the benefit of adding an onsite power plant to remain in operation during potential power black-outs, reduce costs associated with rising energy costs, and to maximize overall returns.

Expectations or Significance:

At the end of the work proposed for the first year, the following outputs are expected.

Objective 1:

1. Concept for the integration of an onsite power plant into an existing feedmill.
2. A basic analysis of the size of power plant required to meet the current and future feedyard capacity.
3. Systems analysis of manure storage and feeding into the power plant.
4. Evaluation of storage and commercial demand for activated charcoal.

Objective 2:

1. A systems analysis of costs savings on electricity and natural gas.
2. Decision support software to evaluate the potential economic benefits of an onsite power generation system at cattle feedyards.

Budget and Resources:

Project Duration (1st Year):	FY2014	FY2015
Item	Request ($)	Request ($)
Salaries & Wages	80,000	80,000
Operational Costs	0	0
Capital Equipment	0	0
Other		
Travel	0	0
Supplies	0	0
Tuition and fees	0	0
Other	0	0
Indirect Costs	0	0
TOTALS	80,000	80,000

This budget represents only a portion of the real cost of the proposed research. Dr. Capareda and Dr. Parnell will each receive 20,000 each for M.S. student salaries. The remaining $40,000 will be used for partial salary and wages for one assistant research scientist and two student workers. Non-salary costs will be borne by other funding. Additional funding for bio-energy research will be used to supplement this research effort as it becomes available. Funding from multiple sources is critical to making the anticipated progress on the project objectives.