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HOW LAWSUITS COULD IGNITE AN ENERGY MARKET: THE CASE OF ANAEROBIC DIGESTION

Catherine Keske, *Colorado State University*

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Abstract: This article focuses on anaerobic digestion—a technology that converts biomass into methane that can be captured and used as biogas, or that can be converted into electricity through a generator. The biogas and electricity can be used at the facility where the biomass is collected, or the electricity could be sold to the grid if net metering policies are available. Currently, anaerobic digestion is not feasible in many areas of the nation, including the U.S. West, where energy prices are relatively low. This article demonstrates how anaerobic digestion can help agricultural operations avoid the costs associated with a nuisance lawsuit. When nuisance lawsuits are imminent, it becomes economically feasible to utilize this alternative energy technology. Technological innovation has been conducted on sites that have specifically used anaerobic digestion to avoid lawsuits. Engineering innovations, such as two-stage dry digestion, can improve economic feasibility of all anaerobic digesters, which will result in increased adoption of the technology.

ARTICLE: HOW LAWSUITS COULD IGNITE AN ENERGY MARKET: THE CASE OF ANAEROBIC DIGESTION

Catherine M.H. Keske[1]

I. Introduction

It is well established that the tort system is commonly used in environmental policy to drive costs to the point where a party is forced to forego—or adopt—practices desired by the opposing party. This is frequently chastised by economists as an inefficient approach to environmental policy, and detrimental to technological innovation.[2]

This article demonstrates that it is possible for lawsuits to ignite a market for an innovative energy technology that otherwise would be too costly to implement. For example, early adopters of a technology might be able to create conditions that make that technology feasible, because they are motivated to settle a nuisance lawsuit. Lessons learned from the implementation of such technology can yield engineering improvements that would decrease the capital or operating

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[1] Catherine M.H. Keske, Ph.D. is an assistant professor of agricultural and resource economics at Colorado State University's Department of Soil and Crop Sciences. She is also an adjunct professor at the Denver University Sturm College of Law. Dr. Keske's research program includes energy economics and the interface between law and economics.

[2] See in general, W. Kip Viscusi, The Social Costs of Punitive Damages against Corporations in Environmental and Safety Torts 87 Geo. L.J. 285 (1998-1999).

costs of the technology. In other words, a nuisance lawsuit can serve as the mechanism to make a technology economically feasible and commercially available.

This article focuses on anaerobic digestion—a technology that converts biomass into methane that can be captured and used as biogas, or that can be converted into electricity through a generator. The biogas and electricity can be used at the facility where the biomass is collected, or the electricity could be sold to the grid if net metering policies are available.[3] In addition to energy generation and greenhouse gas reduction, anaerobic digestion also reduces odor—an important consideration for agricultural operations, including swine and dairy facilities. This article presents the author's original research illustrating that mitigating imminent nuisance lawsuits can potentially can make anaerobic digestion technology economically feasible in the U.S. West.[4] Implementation of anaerobic digestion technology for purposes of lawsuit mitigation has already led to improvements in engineering innovation that might make the technology more widely available in the western United States. In other words, mitigating nuisance lawsuits could ignite the market for anaerobic digestion technology.

[3] Some utilities have "net metering" policies, where small energy generators (like those with an anaerobic digester), can offset their energy consumption by producing their own electricity. The value of the energy offset varies by utility.

[4] Much of the original research in this article is based upon original findings presented in a report to the Colorado Governor's Energy Office. See Catherine M. Keske, Economic Feasibility Study of Colorado Anaerobic Digestion Projects (2009), available at: http://soilcrop.colostate.edu/keske/index.html

II. Anaerobic Digestion Energy Technology[5]

Anaerobic digestion is a biological process by which microorganisms convert organic material into biogas, containing methane and carbon dioxide. Biogas produced by this process can be utilized to generate electricity or can be cleaned up and supplied to natural gas lines. A presentation of this bio-chemical process is shown in Figure 1.0. This figure illustrates that in the digester, organics are removed as they are converted to methane while nutrients (nitrogen and phosphorus) are conserved. The end product is a low odor, high nutrient, stabilized waste suitable for land application as fertilizer.

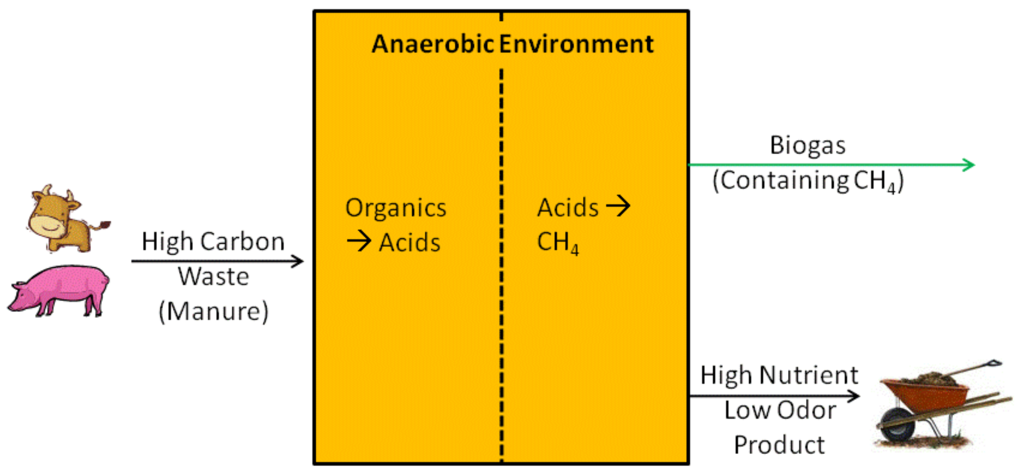
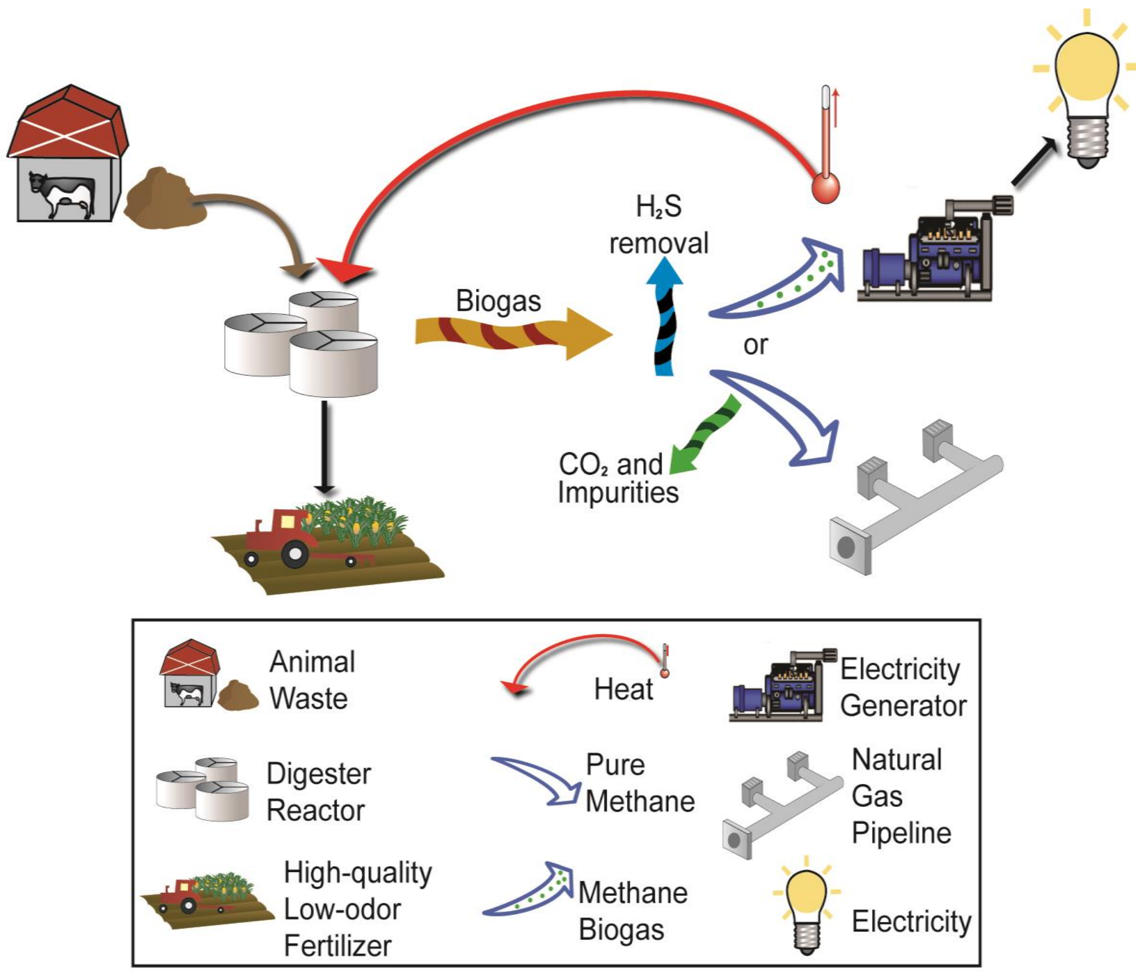


Figure 1.0 Depiction of Anaerobic Digestion Process

Anaerobic digesters are typically large reactors constructed of either concrete or steel. The volume of the reactor depends on the volume of wastes to be processed in the system. With

[5] Technical material presented in Section II was first published by Catherine Keske and Sybil Sharvelle, In: Technical and Economic Feasibility of Anaerobic Digestion: (Sybil Sharvelle and Catherine Keske, Eds.), Montana State University Extension (2011) URL: E3Ainfo.com . Final website address is still pending.

most conventional digesters, a holding time of 20 - 30 days is required to convert manure solids into methane. Methane gas can be utilized onsite, serve as fuel for an electricity generator, or be purified and supplied to natural gas lines (Figure 2.0). Recently, there is a growing interest in purification of biogas for resupply to natural gas lines due to high maintenance requirements for electricity generators. This requires that all gas components aside from methane are removed.



Prepared by Sarah G. Lupis, Institute for Livestock and the Environment (www.ile.colostate.edu), Colorado State University.
Symbols courtesy of the Integration and Application Network (ian.umces.edu/symbols/), University of Maryland Center for Environmental Science.

Figure 2.0 Anaerobic Digestion System Configuration

Dilution of waste with water is most practical when there is an available source of wastewater; therefore, it is not uncommon for anaerobic digestion technology to be implemented at waste water treatment plants.[6] The improvements to air (including odor reduction) have led several agricultural operations to implement anaerobic digestion in different areas of the country, but with mixed success. As reported by U.S. EPA AgStar, 18% of the anaerobic digestion units built for agricultural farms have been shut down for technical and economic reasons.[7] The majority of the anaerobic digesters still in operation are in the eastern U.S., where water is more abundant. In arid climates animal wastes, as collected, can have very high solids content because waste management methods applied at dairies located in the arid west differ from other parts of the United States. For example, water is not usually utilized to flush dairy barns in Colorado as is done in areas where water is plentiful. Instead, manure is often scraped from concrete floors or dry lots. While dairy waste has a solids content of 10-14% as excreted, solids content has been measured as high as 90% on dry lots in Colorado. For wastes containing more than 20% solids, substantial quantities of water may be required for anaerobic digestion. This can add to the cost of operating the digester. In addition, when clean groundwater is added to an anaerobic digester, it will adsorb nutrients and pathogens which may then create more Removal of rocks, soil, and sand typically involves addition of water to the waste and subsequent settling of the particles,

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[6] U.S. Department of Energy, Federal Energy Management Program, Biomass and Alternative Methane Fuels (BAMF) Super ESPC Program, ORNL 2004-02594/abh (July 2004), Available at: http://www1.eere.energy.gov/femp/pdfs/bamf_wastewater.pdf

[7] U.S. Environmental Protection Agency AgStar Program, Project Report (July 2011), available at: http://www.epa.gov/agstar/projects/index.html. Last Accessed August 8, 2011. Statistics do not include those reported under construction.

thus adding complexity, capital cost, and additional maintenance for an AD system in the western United States.

III. Economic Feasibility of Anaerobic Digestion Technology

This section presents an enterprise budget of the cost of installing and operating a large anaerobic digester in Colorado. The budget illustrates that anaerobic digestion technology is only possible in the western United States under the very best conditions, which are unlikely to reflect present market conditions.

While there is potential for a positive rate of return on co-digestion projects in the state of Colorado, values used in the enterprise budget reflect only a 3.66% annual return on investment, which is a rather low of a return given the high amount of risk that the operator must incur in capital costs[8]. In order to achieve a positive return on investment, several key assumptions must be met, including carbon credits being sold at $5.50/tonne, with reasonable control of production costs.[9] It is also assumed that revenues could be generated from selling electricity to the grid for a price of $0.07 per kWh.[10] At present, economic conditions required for a positive AD project

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[8] Duane Griffith, Chapter 5 In Applied Risk Management in Agriculture, Dana Hoag, Ed., (2009).

[9] The Chicago Climate Exchange traded carbon dioxide between $0.10-$0.25 per metric tonne, for two years, before it closed at the end of 2010. See Matthew DeBord. The Fall and Rise of the Carbon Coalition, July 27, 2011 at http://www.huffingtonpost.com/matthew-debord/the-fall-and-rise-of-the-carbon-coalition_b_910442.html These prices are far lower than the price required for revenues from carbon markets, which are necessary for this budget. However, it can be argued that the social cost of carbon should be much higher and that $5.50 per metric tonne is the low point when all social costs are calculated. See Catherine M.H. Keske, Terry Iverson, Sam Evans, and Gregory Graff, Designing a Technology-Neutral, Benefit-Pricing Policy for the Colorado Electricity Sector, (December 2010). Available at: http://soilcrop.colostate.edu/keske/index.html

[10] Price per kWh in Colorado for energy buy-back is approximately $0.02. Keske *supra* 4.

return are not favorable, which would cause the digester to operate at a substantial loss. Furthermore, due to the very small number of AD projects in the region, variations in the data may be observed when more AD units have been installed.

Figure 3.0 Anaerobic Digestion Enterprise Budget

	Units	Amount	Expected Economic Conditions
Revenue			
Sale of electrical power			
Energy and VOM Payment	kVA	68,657,404	$4,394,074
Capacity Payment	kW	94,069	$893,656
Sale or use of Carbon Credits	CO2	22197	$2,563,754
Total			$7,851,483
Production Costs			
Utilities			$78,971
Feedstock Procurement			$1,039,030
Bio-mass waste licensing fee			$150,000
Waste Disposition Operating Cost			$122,000
Water utilization			$461,727
Compensation & Benefits			$342,000
Feedstock Mangement			$165,000
Operational Mgmt & Suprv.			$250,000
Maintenance and Upgrades			$400,000
General and Administrative			
Lease Agreement for Land			$100,000
Insurance (General Liability)			$50,000
Legal and Accounting			$20,000
Total			$3,178,728
Earnings Before Interest Taxes & Amortization			**$4,672,755**

Interest	$1,037,350
Amortization	$263,368
Depreciation	$2,671,832
Taxable Income	$700,205
Income Tax (40%)	-$280,082
Producers Tax Credit ($0.019/kWH)	$280,082
Net Income	**$700,205**

As previously stated, the net income for the expected economic condition is positive ($700,205), but the return is low. A review of published reports and interviews with agricultural producers and technology providers implied downward variability in production revenues (e.g. tipping fees, energy production, energy prices per kWh) and costs (e.g. maintenance fees, unexpected downtime).[11]

Low electricity prices, such as typical net metering prices at $0.02/kWh, make it more difficult to justify a digester investment.[12] Return on investment takes longer when electricity costs are low and the value of selling excess electricity produced or offsetting consumption is also lower. In the intermountain west, electricity costs are generally lower than the eastern United States. This is primarily due to relatively inexpensive coal and hydroelectric resources that are available for electricity generation. While the environmental damages resulting from

[11] Keske *supra* note 4 at 26-43.

[12] Keske *supra* note 4 at 46-50. Also see Eliabeth R. Leuer, Jeffrey Hyde, and Tom L. Richard, *Investing in Methane Digesters on Pennsylvania Dairy Farms: Implications of Scale Economies and Environmental Programs.* Agricultural and Resource Economics Review 37(2): 188-203 (2008).

burning coal could be factored into future energy policy, the current price per KWh of electricity is low compared to other regions of the country.[13] Appendix A further elaborates on the revenue assumptions built into the enterprise budget model.[14]

Interviews with technology providers and agricultural operation managers (as well as preliminary data analysis of the Aurora Organic Dairy)[15] indicate AD systems for a Colorado single farm project are not economically viable at this time, unless there is a key cost savings from lawsuit mitigation.[16]

IV. Nuisance Lawsuits as a Means for Making Anaerobic Digestion Economically Feasible

Both technology providers and agricultural operators affirm that anaerobic digestion units effectively reduce agricultural odors that often prompt nuisance lawsuits.[17] Anaerobic digestion units can provide a measurable reduction in odor, in addition to playing a role in the management air emissions, water quality, and waste management.[18] Proper management of all of these

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[13] Keske *supra* 9.

[14] Revenues and costs are summarized in Keske *supra* note at 44-50.

[15] Sybil Sharvelle, *Final Report on Results from Waste Characterization and Biochemical Methane Potential Tests Conducted on Wastes from Aurora Organic Dairy,* Presented to ActNeutral, Inc. October 2008.

[16] Keske *supra* note 4 at 9-36.

[17] Keske *supra* note 13.

[18] John H. Martin, *An Assessment of the Performance of the Colorado Pork, LLC. Anaerobic Digestion and Biogas Utilization System.* Report submitted to Kurt Roos,

environmental quality aspects can help to improve neighbor relations and mitigate nuisance lawsuits on agricultural operations. However, when faced with high anaerobic digestion capital investment costs, it can be difficult to determine whether the large investment justifies potential future legal expenses.

While legal costs are frequently calculated in the cost of doing business, the risk associated with an odor-related nuisance lawsuit can be difficult to estimate. The majority of cases are settled outside of court and insurance companies typically subsidize the settlements. Furthermore, when nuisance verdicts are handed down by courts, documentation of the damage awards (which include punitive damages) can be challenging to find. Not all verdicts and settlements are reported. Also, opinions from appellate judges don't routinely mention awards.

A summary of recent nuisance lawsuit awards and settlements can be found in Figure 4.0. The cases are ordered by year. Also listed are the states where the lawsuit was filed, case or plaintiff as available, and type of operation. The settlement and damage values (which include punitive damages) have not been corrected for inflation. The type of agricultural operation is listed on the right hand column.

U.S. Environmental Protection Agency AgSTAR Program. EPA Contract #68-W7-0068 March 18, 2003. Dr. Martin's technical report also included an economic analysis, which noted an *annual loss* in farm income at $931/year or $0.19 per unit of sow capacity per year. The rate of return with internal financing, which was the method of financing the CP system, was slightly less than seven percent. The start-up project capital expenses were heavily subsidized by federal funding.

Figure 4.0 Summary of Financial Awards from Agricultural Nuisance Suits Involving Odor

Claims Awarded in Nuisance Suits				
Year	**State**	**Award**	**Plaintiff/Case**	**Operation**
1991	NE	$375,600	Kopecky v. National Farms, Inc.	Swine
1996	KS	$12,100	Settlement—plaintiff/respondent both undisclosed in news article.	Swine
1998	KS	> $15,000	Twietmeyer v. Blocker	Beef feedlot
1999	MO	$5,200,000	Vernon Hanes et al. v. Continental Grain Company	Swine
2001	OH	$19,182,483	Seelke et al. v. Buckeye Egg Farm, LLC and Pohlman	Egg/Poultry
2002	IA	$33,065,000	Blass, McKnight, Henrickson, and Langbein v. Iowa Select Farms	Swine
2004	OH	$50,000,000	Bear et al. v. Buckeye Egg Farm, Anton Pohlman and Croton Farms, LLC	Egg/Poultry
2006	AL	$100,000	Sierra Club, Jones, and Ivey v. Whitaker and Sons LLC	Swine
2006	MO	$4,500,000	Turner v. Premium Standard Farms Inc.; Contigroup Co., Inc.	Swine
2007	IL	$27,000	State of Illinois (Plaintiff). Respondent undisclosed.	Swine

The awards listed in Figure 4.0 ranged from $12,100-$50,000,000. Seven of the ten reported cases involved swine operations. Two cases involving large awards were against the same owner of two Ohio egg production facilities. There was one example of a settlement to a Kansas cattle feedlot. Six of the documented cases occurred west of the Mississippi.

Blass et al. v. Iowa Select Farms presents the most unusual case, because a high punitive damage award ($32,065,000) was distributed to only four neighboring farm couples. Most large awards of that magnitude involve class action lawsuits. In this case, couples reported having been subject to noxious gases, offensive odors and excessive amounts of flies. The couples sued Iowa Select Farms complaining that improperly-disposed-of swine carcasses and unsanitary conditions created health risks. The couples also alleged that Iowa Select willfully and recklessly located the 30,000-hog facility on the 640-acre farm without regard to its impact on neighbors. An expert at trial testified that the farm produced as much excrement as 90,000 to 150,000 people.[19]

In addition to information gathered from legal databases, personal interviews with western agricultural producers yielded similar results. Mr. Doug Derouchey of Wyoming Premium Farms in Wheatland, Wyoming reported that his operation spent approximately $200,000 in legal fees fighting two lawsuits, in which plaintiffs were seeking approximately $2,000,000 in punitive damages. [20]

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[19] Jean Hays, *Jury Punishes Feedlot Owner for Making Neighbors' Lives Miserable.* The Wichita Eagle. May 27, 1998. See also Mark Harrison, *Hog Farmers Settle Lawsuit.* The Fort Payne, Alabama Times-Journal. June 23, 2006.

[20] In personal communication with Mr. Doug Derouchey, he reports that the farm's single most important consideration for purchasing an AD unit mitigation of nuisance lawsuits. He estimates that earlier this decade, Wyoming Premium Farms paid roughly $200,000 in legal costs to fight two nuisance lawsuits, where the plaintiffs were seeking a total of approximately $2 million in punitive damages. The digesters were built as part of this negotiated settlement agreement. Personal interview and site visit July 22, 2009.

Evidence of large legal awards provides context for the enterprise budget shown in Figure 3.0. An imminent lawsuit that could result in more than $5.9 million in damages (including punitive damages) or fines in one year would overcome a 20% decrease in revenues and an increase in costs, from the expected conditions presented in the enterprise budget. In other words, preventing legal conflict can justify the net losses from an AD project.

Furthermore, many of the nuisance claims on record involve swine operations. Cases with high punitive damage awards also involve swine operations. Not all of the nuisance suits have occurred in regions with high population pressures, including the Wyoming Premium Farms operation in Wheatland Wyoming. The Wyoming Premium Farms case illustrates two interesting rural western issues. One is that agricultural operations are susceptible to legal action, even in areas that are not experiencing rapid population growth, like Wheatland, Wyoming. Second, the topography of high elevation land results in cross-winds, and odor problems may be more difficult to predict than the mere presence of a "downwind" housing development. Therefore, trend of nuisance suits could persuade agricultural operations to consider adoption of AD units as a management practice, even when the operation is not located in an urban-rural interface.

V. The Potential for Nuisance Suits to Ignite a New Energy Market.

While it is has established that anaerobic digestion has the potential to generate natural gas and electricity, at this writing the technology does not typically to pay for itself in the western United States unless there is a nuisance lawsuit. However, the use of anaerobic digestion technology at these few sites, including the site at Wheatland, Wyoming, has led to innovative technological research that might reduce anaerobic digestion operating costs. Reduced operating costs in a few parameters, such as water costs, could be enough make anaerobic digestion economically feasible, which would open the door to a market.

For example, high solids content waste is a major barrier that has been identified as unique to the arid western United States. Technology providers have consistently noted that research dollars spent to study methods for overcoming high solids content waste may provide considerable payback for future implementation of AD technology in these arid regions of the country.[21] At the moment, private funding for high solids content research may not yield economic returns for industry, but research conducted at sites that have already implemented anaerobic digestion to prevent lawsuits appear to be sparking engineering innovations that could reduce costs.

One example of this advance is a two-stage digester, presented in Figure 5.0. Here, hydrolysis takes place in one reactor and methane generation takes place in a second reactor. A small amount of water is percolated over a bed containing low moisture manure and other waste organics. Organics present in the waste leach into the liquid phase and are hydrolyzed by microbial activity. The hydrolyzed organic liquid waste can then be processed through a high rate anaerobic digester, such as a fixed film digester, to generate methane. Preliminary work

[21] Keske *supra* note 3.

conducted by university engineering researchers has shown promise for this technology.[22] Researchers have demonstrated that this process can yield up to 125% and 293% methane compared to that of a conventional process. Water can be re-circulated through the hydrolysis reactor until maximum possible organic content is leached into the liquid. Onsite wastewaters would be a sufficient water supply. One problem encountered with the leachate bed is porosity of the waste material and inefficient water flow and distribution throughout the system. However, in this recent research, researchers have been able to improve process efficiency by the addition of pistachio hulls, hay, corn stalks, and straw.

Using only a small amount of water will likely reduce digester malfunction because microbial activity will be better balanced[23], and operational costs will be reduced due to the lower water requirements.[24]

Likewise, increases in methane potential by two-stage dry anaerobic digestion—and therefore increased energy production potential—could yield enough energy production to make electricity generation more financially rewarding.

In summary, while conducting engineering research might impose large costs upon private firms, it might very well be cost effective to conduct this technical research at locations

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[22] Sybil Sharvelle and Luke Loetscher, Final Report: Bench Scale Demonstration and Pilot Plant Design of a Multiple Stage Anaerobic Digestion System. Report to Colorado Governor's Energy Office. August 17, 2009.

[23] Sharvelle and Loetscher *supra* 22.

[24] Keske *supra* 3 at 48-50.

that have already implemented anaerobic digestion to mitigate lawsuits. Under such conditions, nuisance lawsuits in the agricultural sector might have ignited a market for energy produced by anaerobic digestion.

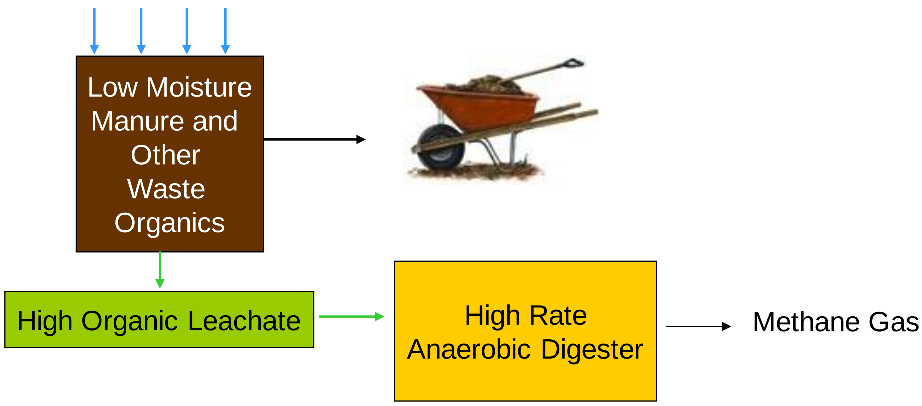

Figure 5.0 Two-Stage Anaerobic Digestion Process

Appendix A

Gross Revenue. Gross revenue can be further explained as follows:

Gross Revenue = Energy and VOM Payment + Capacity Repayment + Carbon Credit

(1) *Energy +VOM Payment* = Energy Produced *.064 (expected price per kWh)

(2) *Capacity Repayment* = Capacity Rate (assumed at 9.55) * Billing Capacity

Billing Capacity=Energy Produced/Hours of operation per month (average of 744)

(3) *Carbon Credit*=Methane produced*5.5 (carbon price per ton)*21 (gas conversion rate)

Methane produced=

[Energy produced per month/ Sum of energy produced] *

[Annual methane produced in metric tonnes]

Feedstock conversion to energy. Feedstock is converted to "energy produced". This is determined as follows:

(1) Volume of slurry (lbs./day) converts to lbs of solids: % solids in feedstock=8%.

(2) Conversion to methane produced: 5.6 $ft.^3$/lbs. of solids.

This is the estimated conversion rate of feedstock from lbs. of solids to gas

(3) Biogas produced=methane produced/molecular ratio (.7) of methane to biogas

(4) Energy produced in BTUs =biogas produced*Heat content (65) BTU/$ft.^3$

Models are based upon technical assumptions for co-digestion, as a consistent level of diverse feedstock is required to ensure engine efficiency.

Appendix B

Case Example of Wyoming Premium Farms, LLC

Wyoming Premium Farms is a 6,000 acre swine operation located in Wheatland, Wyoming. The operation is primarily owned by Japanese investors. Mr. Doug Derouchey, the operations manager, is the minority business owner. There are approximately 5,000 sows and 18,000 other swine in various stages of development, ranging from nursery to finishing. The operation owns two complete mix AD units that service four separately located barns. Approximately 20,000 gallons of waste are generated from the four collective barns. The AD units run 24 hours per day, seven days per week. AD #1, installed in 2003 at the sow barn for $1 million, presents 80kW capacity. AD#2, with 160kW capacity, was installed in 2004 to accommodate the other swine. The operation has a methane gas line tap, but the infrastructure is not feasible to support a gas line. Unused gas is flared.

In contrast to most projects, the Wyoming Premium Farms digesters were purchased in cash and received no government financial support. This is an important principle for Mr. Derouchey, who suggested the installation of the digesters to the majority owners. Mr. Derouchey believes that, "These are probably the only two digesters in the nation that were built with not one government dollar." Derouchey is forthright that the main purpose for the installation of the AD units was to mitigate costs stemming from nuisance lawsuits, and that the projects would otherwise not be economically viable. He attributes the poor economic returns to periods of long shut down, high maintenance costs due to the corrosiveness of the biogas, and low supply prices for selling electricity to the grid.

Mr. Derouchey was interviewed during two telephone calls and a July 22, 2009 site visit. He is accustomed to providing tours to visitors who have an interest in learning more about the digesters. Mr. Derouchey allowed photos to be taken of one of the digester units and he was willing to share some financial information, which has been integrated into the sensitivity analysis. Photographs of the operation are presented below, and electronic copies of the photos are available upon request.

Cost Information:

A. *Peak demand charges*: Mr. Derouchey reports that at least one time/month, the generator is forced to shut down during peak demand. Even when it is down for as short as 15 minutes during peak demand, Derouchey estimates that the operation is forced to pay $1,500-$3,000 in monthly charges to Wheatland Rural Electric.

B. *Annual maintenance costs:* Mr. Derouchey estimates that he pays approximately $20,000 per year for maintenance. Included in these estimates are:

- Replacement generator parts from RCM International.
- Routine oil maintenance (which takes places approximately once every 10 days).
- Engine maintenance and repair specialists (e.g. $60/hr. for a specialized engine operator trained in tractor maintenance and repair from Caterpillar). At one time, Wyoming Premium Farms needed to contract with AD repair specialists from Missouri for digester maintenance and repair, but this need has been reduced since local labor have accumulated more experience in this specialized work.

C. *Major engine repairs:* In addition to annual maintenance fees, Derouchey states that he has "overhauled" and conducted major repairs to both engines on two separate occasions during the past five years. This involved replacement of valves, pistons, etc. Direct costs were estimated at approximately $20,000 (approximately $5,000 per incident, with two incidents observed for each digester). In addition to this expense, the operation was forced to purchase electricity during the times of generator shut down.

D. *On-farm labor for routine maintenance:* Mr. Derouchey currently employs the equivalency of one full-time laborer to maintain the AD units. Although AD review is required seven days per week, the estimated time of dedicated labor necessary to run the digesters is approximately 40 hours a week. The farm pays workers $8.76/hr. as part of a government sponsored agricultural work program. Housing, included in the worker's compensation, is not calculated in this expense. Thus, costs for routine labor are $350 each week and $18,221 every year.

Revenue and Cost Offsets for Wyoming Premium Farms:

A. Lawsuit mitigation: Summarized in article.

B. Cost offset of irrigation system: The company is able to offset electricity and water costs by using electricity and effluent water to power a 125 horse power motor irrigation system. The irrigation system pumps 200/gallons per minute of effluent water onto irrigated silage corn (used to feed the swine and beef cattle). Additional irrigation water is also used and pumped at a rate of 600 gallons from a well. Based upon operational costs from four irrigation units, Derouchey estimates that he saves roughly $4,500/month for the 4 months of irrigation season ($18,000 annually). The other four irrigators are not located close enough to the generator infrastructure to utilize the energy.

C. Cost offset for lighting/fans: Mr. Derouchey reports saving approximately $2,000-$3000 each year from using on-farm electricity for lighting and fans.

D. Net Metered Electricity: Mr. Derouchey supplies excess electricity to Tri-State at a rate of $0.02/kWh. He is unsure of the average volume that he sells to Tri-State each month.

E. *Fertilizer:* The solids separators enable Mr. Derouchey to uses the remaining solids as fertilizer for silage corn, which is used to offset feeding costs for the 900 head cow-calf operation. Corn is also occasionally fed to the swine during the finishing process. Derouchey estimates that the operation produces 750 acres of corn each year and that he saves $150/acre in fertilizer costs for an annual savings of $112,500.

F. Carbon credits: Mr. Derouchey reports that he has sold carbon credits through 2007, although has not reported the volume sold or the revenues collected. He believes that the operation was able to sell the credits at a price of roughly $5/tonne, close to the market peak of $7/tonne.