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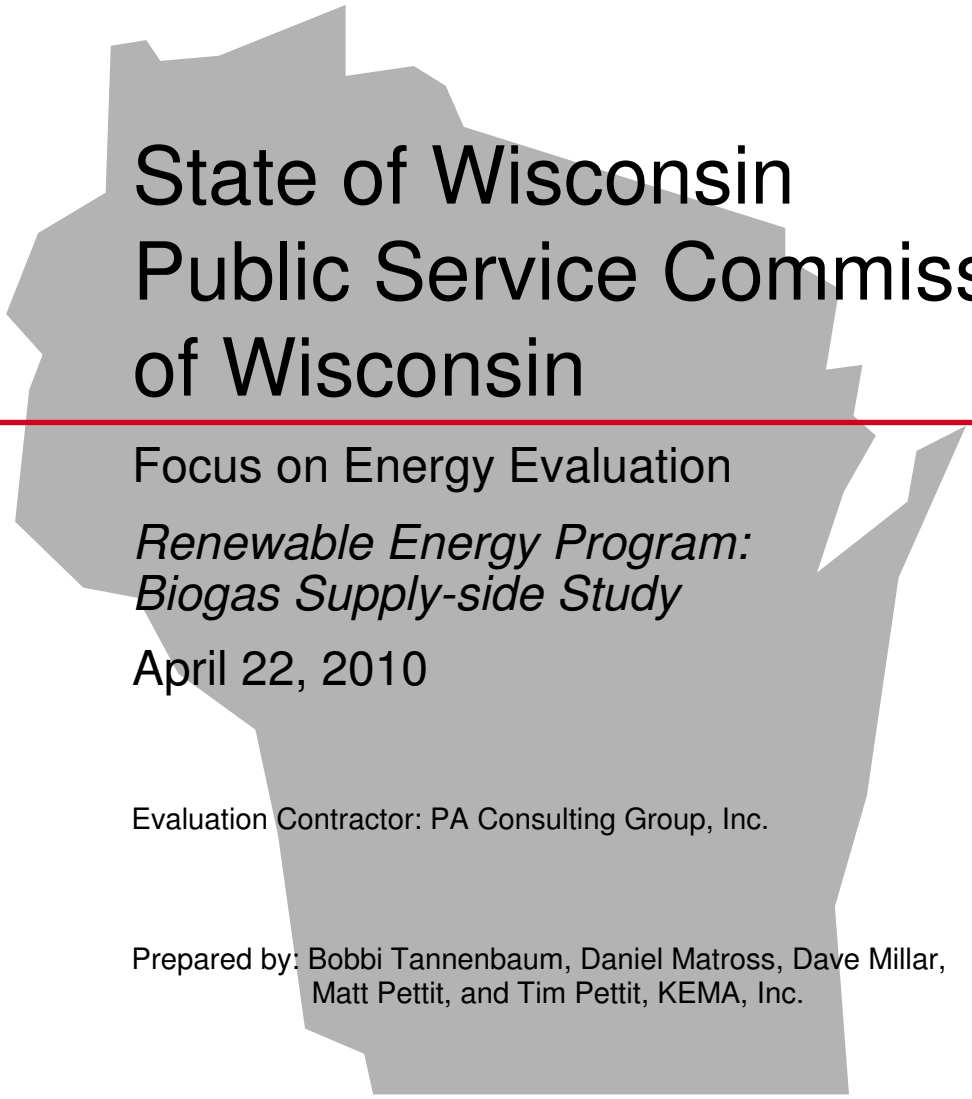

State of Wisconsin Public Service Commission of Wisconsin

Focus on Energy Evaluation

Renewable Energy Program: Biogas Supply-side Study

April 22, 2010

Evaluation Contractor: PA Consulting Group, Inc.

Prepared by: Bobbi Tannenbaum, Daniel Matross, Dave Millar, Matt Pettit, and Tim Pettit, KEMA, Inc.

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1. EXECUTIVE SUMMARY

The Focus on Energy Renewable program supports biogas project development in Wisconsin through financial incentives, networking, education, and informational resources to dairy farmers. Biogas energy and demand savings represent the single largest proportion of Focus on Energy renewable program kW and kWh savings. The Focus on Energy program posits that Wisconsin has more biogas activity than any other comparable state and that this is due to the program.

Historically, biogas systems have had low (consistently lower than 50 percent) self-reported attribution rates. The program may have had market effects not recognized by participants that a market-based research approach would identify. This study seeks to identify those program impacts that may have an effect on a farmer's adoption of biogas digesters, but that the farmers themselves may not recognize. We conducted the study in two phases:

- Phase 1: The evaluation team established metrics for measuring biogas activity to determine if Wisconsin has more biogas activity than other states. We also identified Minnesota and Pennsylvania as complementary states for comparative analysis of the factors, programmatic and otherwise, affecting biogas activity.
- Phase 2: The evaluation team conducted qualitative research to determine the factors that defined market activities in Wisconsin, Pennsylvania, and Minnesota and to assess whether it is reasonable to conclude that the Focus on Energy Renewable Program contributed to biogas activity in Wisconsin beyond what self-reports of direct impacts capture.

1.1 PHASE 1

In Phase 1, we established metrics that demonstrate Wisconsin has higher levels of biogas activity than other leading dairy states.

Among leading dairy states, Wisconsin has the highest number of biogas digesters installed. Wisconsin differs from some other top dairy states in that it has small farms. To draw accurate conclusions about overall biogas activity across the states we established evaluation metrics that adjust for differing herd (farm) sizes for comparison across the various dairy states.

Among other leading dairy states, Minnesota and Idaho have very little biogas activity. California contains large farms making relatively small investments in biogas. New York and Pennsylvania have similar farm sizes to Wisconsin, but less overall capacity and fewer installations than Wisconsin, respectively. Thus, using balanced accounting for both how many farms have digesters and installed capacity, we determined that Wisconsin has a higher level of biogas activity than other states.

Next, we identified Minnesota and Pennsylvania as comparison states for Phase 2 of this study. Both Minnesota and Pennsylvania have farm sizes comparable to Wisconsin. They do differ from Wisconsin (and each other) on key farm characteristics, program activity, and biogas adoption. The combination of the two states in comparison to Wisconsin provides a natural quasi-experimental qualitative comparison from which to draw conclusions about Focus program impacts in Wisconsin.

1.2 PHASE 2

KEMA conducted qualitative research in Phase 2 based on nineteen in-depth interviews with individuals from a wide-array of viewpoints and expertise. Interview topics focused on drivers for digester implementation, risks and barriers of implementation, and the effects of different utility policies, and state programs on biogas adoption. KEMA designed the questions to provide a complete picture of the biogas market in Wisconsin and the two comparison states. We also completed additional secondary research to determine the status of interconnection standards, buy-back rates, and other factors that may increase or hinder the adoption of on-farm biogas systems. The responses provided the evaluation team with a basis on which to determine whether Focus on Energy was contributing to biogas adoption in the state of Wisconsin.

We identified financial and non-financial drivers for the adoption of on farm biogas systems. In general, these drivers varied little across regions or states. Among financial drivers, producing electricity allows farmers to receive ancillary revenue and electricity sales provide a cash flow stream that can be important for cash strapped farms. That revenue stream is dependent on buy-back rates. Digesters also output digested solids that farmers use for cow bedding, which can reduce bedding costs or provide revenue when sold off farm. Farmers need the marginal revenue from electricity and digester bedding to make the investment financially viable.

A large majority of respondents identified odor control as a top motivator. Farmers increasingly recognize digesters as a tool to mitigate community pressure and improve relations with neighbors. Manure management is a secondary driver to odor control.

Financial and non-financial barriers also affect the decision to install digesters. Digester systems are capital intensive. Respondents generally cited construction costs of between $1 and $5 million. Gaining access to capital for an expenditure of this magnitude is difficult in private capital markets, especially since lending agencies may view digesters as an uncertain investment. Many respondents point to public financing of biogas digester systems as helping to reduce the front-end costs and providing legitimacy to the project, which in turn provides access to private financing. Without funding, capital requirements are often too high and buy-back rates too low to pay back the investment in a suitable amount of time, generally seven to ten years.

Connecting an anaerobic digester system to the grid involves a number of challenges, including utilities that charge high fees for interconnection or offer unfavorable buy-back rates. Some respondents identify low buy-back rates as one of the most important barriers to digester implementation. Lower interconnection costs reduce the upfront burden, while buy-back rates improve cash flow.

Myriad non-financial barriers also drive project decisions. These include steep learning curves to learn sophisticated operating techniques, technical challenges, maintenance, and market confusion.

1.3 CONCLUSIONS

The Focus on Energy program differs from the programs in the two comparison states in two key ways. First, Focus on Energy is a consistently funded program that has continuously provided incentives and services for a decade. This consistency increases awareness, knowledge, and acceptance of biogas digesters as a viable on-farm option. The consistency

of grants to farmers provides certainty in the marketplace. Minnesota, with its inconsistent program, provides a contrast.

The program's expansiveness—going beyond financial incentives to offer technical assistance, market development, outreach, and case studies appear to be important to the development of the biogas market in Wisconsin. Through this outreach, Focus leveraged federal grant money to make a number of digester projects economically viable. Focus assisted some farmers in completing USDA applications. Focus' grants, providing incentives for feasibility studies, as well as providing technical information on digester engineering, operation, and maintenance, helped mature the marketplace.

The education, outreach, and market development activities are likely program impacts on participants not recognized by respondents when self-reporting attribution. Information about dairy biogas digesters is ubiquitous in Wisconsin at forums for farmers. Wisconsin farmers may take this for granted and not give Focus credit for it in their responses to survey questions.

Favorable buy-back rates are also key to the adoption of biogas systems. They have a long-term impact on the economic viability of the project. Standard interconnection agreements regularize the process and provide farmers the certainty needed for the large capital expense of the digester. Wisconsin has both reasonable buy-back rates and standard interconnection rules and costs. Focus on Energy promoted these efforts. We have not identified a link between their activities and changes in Wisconsin buyback rates or interconnection standards.

The Focus on Energy biogas program has received some attribution based on participant and vendor self-reports that address the direct effect on participants. However, we conclude that Focus on Energy has likely had impacts on the Wisconsin biogas market not reflected in participant self-reports of program attribution. This qualitative study does not provide sufficient data with which to make a quantitative based assessment of these effects. We recommended that the PSCW provide some additional credit for these market effects.

At a minimum:

- Focus education and outreach (including case studies) have increased the awareness, knowledge, and comfort with biogas technology in Wisconsin. Each of the individual activities may appear non-consequential to a program participant, but the ubiquitousness of biogas information for Wisconsin farmers is likely to increase the adoption of biogas digesters on Wisconsin farms.
- Focus incentives have legitimized the projects that received Focus-only funding[1] and likely increased the probability or the speed with which farmers received financing.

These market effects are unlikely to be recognized by participants (or vendor) self-reports of attribution, but indirectly affect a participant's decision to install a biogas digester.

[1] The direct impact of the incentive on the participant's decision to install is reflected in the self-reported attribution. Vendor surveys capture the market development activities.

2. INTRODUCTION

2.1 PURPOSE OF THIS REPORT

The Focus on Energy Renewable Energy program supports biogas project development in Wisconsin through financial incentives, networking, education, and informational resources to dairy farmers. The Focus on Energy program posits that Wisconsin has more biogas activity than any other comparable state and that this is due to the program.

Biogas energy and demand savings represent the single largest proportion of Focus on Energy renewable program kW and kWh savings. Historically, these systems have had low (consistently lower than 50 percent) self-reported attribution rates. If the program has had market effects that are not recognized by participants, then identifying them through market-based approaches would indicate higher net program impacts than those revealed through self-reports.

Acknowledging that net-to-gross ratios based on self-attribution are low, this study seeks to determine program impacts that may have an effect on a farmer's adoption of biogas digesters, but that the farmers themselves may not recognize. We conducted the study in two phases:

- Phase 1: The evaluation team established metrics to measure biogas activity to determine if Wisconsin has more biogas activity than other states, and identified Minnesota and Pennsylvania as two highly complementary market cases for comparison analysis of the factors, programmatic and otherwise, impacting biogas activity.
- Phase 2: The evaluation team conducted qualitative research to determine the factors that defined market activities in Wisconsin, Pennsylvania, and Minnesota and assess whether it is reasonable to conclude that the Focus on Renewable Energy Program contributed to biogas activity in Wisconsin beyond what is captured in self-reports.

This report presents the combined findings for Phase 1 and Phase 2 of the study.

2.1.1 Project structure

The project incorporated the following activities to address the questions presented by the project

A. PHASE 1

- Establish consistent metrics to measure biogas activity across states that normalize for structural variations, such as herd size and number of farms. This project uses the number of digesters on dairy farms and generation capacity as the core metrics for comparison with Wisconsin.
- Compare normalized biogas activity in Wisconsin with other leading dairy states to determine if there is more activity in Wisconsin than in other states.
- Specify two leading dairy states for direct, in-depth comparison with Wisconsin, choosing the most complementary profile of characteristics to help address the

impact of the Focus program on biogas activity. KEMA selected Minnesota and Pennsylvania for in-depth comparison in Phase 2[2].

The results of Phase 1 are discussed in Chapters 3 and 4 of this report.

B. PHASE 2

- Establish a methodology to create a qualitative description of the major drivers and barriers of biogas adoption in each of the target states. KEMA relied primarily on personal interviews with a broad cross-section of experts and implementers with state, regional, and national perspectives on Wisconsin, Pennsylvania, and Minnesota.
- Synthesize interview responses to eliminate personal and situational biases across a broad spectrum of interviewees.
- Determine major drivers of and barriers to anaerobic digester installation on farms, based on consistent themes discussed by multiple interview respondents.
- Analyze digester activities in each of the comparison states in relation to the barriers and drivers.
- Determine if and how the Focus program in Wisconsin enhances drivers or reduces barriers, relative to the comparison states.

The results of Phase 2 are discussed in Chapters 5 through 7 of this report.

2.2 OVERVIEW OF THE WISCONSIN BIOGAS MARKET

Wisconsin is the second largest dairy producing state and home to 30 anaerobic digesters on dairy farms installed since 2002, with an additional two non-dairy farm anaerobic digesters, 14 landfill methane systems[3] installed since 2002, and some number of other commercial/industrial anaerobic digesters.

Wisconsin's Focus on Energy program is longstanding and highly regarded. Ratepayer fees from customers of participating utilities fund Focus on Energy. To receive Focus on Energy funds, a system had to be in the service territory of a participating utility, be a ratepayer, and offset electricity or natural gas.

In addition to Focus on Energy, the US Department of Agriculture (USDA) has funded biogas systems on dairy farms in Wisconsin under the Rural Energy Assistance Program (REAP)

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[2] KEMA initially selected three states for comparison. We reduced the number to two with PSCW approval, to allow for deeper understanding of digester activity and program activity in the selected states.

[3] US Environmental Protection Agency. Landfill Methane Outreach Program. List of LFG energy projects, sorted by state and landfill name. File: http://www.epa.gov/landfill/documents/xls/opprjslmopdata.xls. Documentation: http://www.epa.gov/landfill/projects-candidates/operational.html. Accessed April 12, 2010. KEMA adjusted the list to exclude projects that are expansions of existing landfill digesters only and counted only projects with a start date between 2002 and 2010.

program. Between 2002 and 2010, (the time period of the Focus program) only three digesters went into operation without funding from either Focus or USDA. Microgy, Inc., a third party digester operator owned and operated two of the three; they were not installed by farmers themselves. The breakdown of digesters receiving incentives during the Focus implementation period is shown in Table 2-1. A full listing of installations in Wisconsin can be found in Appendix A.

Table 2-1. Biogas Digesters Funded on Dairy Farms in Wisconsin, 2002–2010

Location	Source of Incentives	Number of Digesters
Focus Territory	Focus only	7
	USDA and Focus	16
Non-Focus Territory	USDA only	4
	Neither	3
Total		**30**

Source: USDA REAP Award List; Focus Award List.

The first generation of Focus on Energy biogas funding, from 2001–2007, provided small buy-down grants to eligible biogas recovery systems with a maximum funding of $45,000. In 2007, Focus on Energy increased its incentive levels to a maximum amount over $250,000 or 25 percent of the system cost, whichever is smaller. Focus also added a planning incentive with a maximum award of $50,000 designed to aid in feasibility studies and other pre-installation activities. Eligibility requirements did not change. Systems must be greater than 20 kW, with a simple payback horizon greater than two years and customers can only use $500,000 in total grants per year.

The regulatory burden for farmers in Wisconsin is moderate. Wisconsin does not impose more rigorous statewide nutrient loading requirements than those required by the US EPA. Wisconsin livestock siting laws regulate odor control. The expansion or establishment of a new CAFO farm requires the development of an odor score based on animal type, structures on-farm, proximity to residential areas, and manure storage technology. Operations with high odor scores are required to identify odor management techniques and mitigation technologies. The state lists anaerobic digesters as one of the more effective options for odor regulation.

Wisconsin has net metering structures for systems up to 20 kW that compensates customers with small renewable energy generators. The 20 kW size limit precludes biogas systems, which are uneconomical at this size. Biogas generators must enter into power purchase agreements with their utility. Investor owned utilities have or continue to offer biogas generators buy-back rates higher than the avoided cost rate. Both We Energies and Alliant Energy have offered consistent buy-back rates as part of negotiated settlements with the PSCW. Rural electric coops have not historically offered higher buy-back rates for biogas generation.

3. METRICS OF BIOGAS ACTIVITY FOR LEADING DAIRY STATES

This section reviews key dairy industry data for major dairy producing states and establishes metrics for leading dairy states. There is non-dairy digester activity in Wisconsin independent of Focus programs[4]. However, we believe that dairy farm operations represent a much better indicator of the target market for farm-based biogas and program activity in Wisconsin than the cattle industry as a whole—which might include beef cattle and relatively more free ranging herds. Free ranging herds limit the opportunities for manure collection necessary for biogas production.

3.1 DEFINITION OF LEADING DAIRY STATES

The top 15 dairy states account for the vast majority of US dairy production and Wisconsin has ten times the milk production of Vermont, the state ranked 15th by USDA for dairy production. The level of dairy activity in each state, ranked by number of milk cows, is shown in Table 3-1.

Table 3-1. Dairy Activity Statistics for Top 15 Dairy States

State	USDA Dairy Rank	Number of Dairy Farms (NAICS 11212)	Number of Milk Cows (1,000 Head)	Average Cows per Farm	Milk Production (10^6 Lbs. per anum)
California	1	1,839	1,813	986	40,683
Wisconsin	2	13,081	1,247	95	24,080
New York	3	5,237	627	120	12,103
Pennsylvania	4	7,434	550	74	10,682
Idaho	5	677	513	758	11,549
Minnesota	6	4,385	460	105	8,656
Michigan	7	1,971	335	170	7,625
New Mexico	8	196	332	1694	7,290
Texas	9	1,027	389	379	7,384
Washington	10	626	238	380	5,531
Ohio	11	2,955	275	93	4,980
Iowa	12	1,686	213	126	4,278
Arizona	13	146	181	1240	4,210
Indiana	14	1,462	166	114	3,371
Vermont	15	1,141	140	123	2,531

Source: USDA Agricultural Census 2007.

For the purposes of this study, KEMA further defines the top six states—California, Wisconsin, New York, Pennsylvania, Idaho, and Minnesota—as leading dairy states, those with large, mature, historical dairy production. California, New York, and Pennsylvania also have substantial biogas incentive programs and correspondingly high levels of biogas activity.

[4] For instance, by the time Focus was just beginning, 85 municipal wastewater treatment plants were already using digesters, but only a fraction produced electricity (Vik, 2003).

Idaho and Minnesota lack substantial programs and have low levels of biogas activity, presenting the beginnings of a natural comparison.

Earlier supply-side research completed by KEMA indicated that biogas vendors are likely to concentrate marketing on larger markets[5].

3.2 DIGESTER INSTALLATIONS AND CAPACITY

Table 3-2 shows digester and capacity values for the group of leading dairy states, focusing only on dairy farms with digesters installed between 2002 and 2010 and excluding swine, poultry, beef, and community food waste operations. Wisconsin, Minnesota, and Pennsylvania values (shaded green) are based on KEMA research incorporating the AgSTAR database, REAP award lists, casebooks, press releases, and personal interviews. New York, California, and Idaho values (shaded blue) are based only on AgSTAR database. Installed capacity values are a slight underestimate because KEMA could not determine a reliable capacity value for roughly five percent of the digesters included in the table.

The starting point for determining the number of digester installations and capacity is the AgSTAR database. This provides a reasonable, consistent estimate of installations in a given state. However, KEMA's analysis of Wisconsin, Pennsylvania, and Minnesota shows that AgSTAR slightly underreports the number of installed digesters in a state.

KEMA performed an in-depth accounting of all Wisconsin's on-farm biogas digesters to determine the quality of the information from AgSTAR. A revised list was built using the USDA's REAP awardees listings, the Focus on Energy funded systems database, the 2008 Wisconsin Agricultural Biogas Casebook (Energy Center of Wisconsin), and the 2004 and 2002 Agricultural Biogas Casebooks (Resource Strategies). All digesters were verified through primary interviews or multiple secondary sources (e.g., farm websites and press releases). For the core comparison states of Minnesota and Pennsylvania, KEMA did a similar exercise. However, in Wisconsin KEMA can also rely on records of the systems installed through Focus on Energy obtained as part of KEMA's evaluation activities.

KEMA concluded there were 30 digesters installed on dairy farms during the Focus primary program period (2002–present) in Wisconsin. AgSTAR reports installation by farm. When adjusted for farms with multiple digester installations, the AgSTAR reports 29. In Pennsylvania, KEMA finds 12 digesters and AgSTAR reports 10. KEMA's findings in Minnesota match the AgSTAR list. To summarize, AgSTAR can be expected to underestimate digester installations by one to two installations per state.

For California, Idaho, and New York, we chose to use the AgSTAR database numbers for consistency and transparency, accepting that these may be prone to slight underestimate. For Idaho only, KEMA was able confirm the AgSTAR database with a source personally involved. Because the goal of this study is attribution, KEMA focused resources on a deeper survey of the core comparison states, which proved to be more informative than painstakingly accounting for the AgSTAR underestimate in all states.

[5] Bobbi Tannenbaum, KEMA. *BioGas Panel Baseline Study Results.* May 5, 2006.

Table 3-2. Biogas Activity in Six Leading Dairy States, 2002–2010

	Number of Digesters	Installed Capacity (kW)	Average Herd Size Feeding Digester	Average Capacity (kW)[b]
Wisconsin	30	10,685	1,622	356
Minnesota [a]	4	307	4,300	154
Pennsylvania	12	2,345	1,170	160
New York	15	3,500	1,518	269
California	15	3,375	1,980	260
Idaho	2	3,750	7,350	1,875

[a] Note: Minnesota capacity values were only available for only 2 of the 4 digesters in the state. Therefore, the installed capacity is a severe underestimate and should be used judiciously. Average capacity is based on farms with smaller herds (see Appendix 1), and is also likely an underestimate
[b] Average Capacity is based only on systems with known capacity.
Green shading: based on KEMA research incorporating the AgSTAR database, REAP award lists, casebooks, press releases, and personal interviews.
Blue shading: based only on AgSTAR database

One feature of farms with digesters is that they tend to have larger herds than average, sometimes by a substantial margin (see Table 3-3). This is true in each of the leading dairy states and indicates that scale is an important consideration when examining trends in biogas adoption. Some of the barriers discussed later in this report are especially acute for small farms. Therefore, activity in states with a heavy proportion of small farms, like Wisconsin, is more remarkable than activity in states tending towards larger operations.

Table 3-3. Herd Size for Farms with Digesters vs. Average Herd Size, by State

	Average Herd Size for Dairy Farms with Digester	Average Herd Size per Dairy Farm
Wisconsin	1,622	95
Minnesota	4,300	105
Pennsylvania	1,170	74
New York	1,518	120
California	1,980	986
Idaho	7,350	758

Sources: AgSTAR database, USDA Agricultural Census

3.3 NORMALIZED BIOGAS ACTIVITY METRICS

To account for differing levels of dairy activity and differences in farm profiles, we normalized the digester installations and capacity by number of cows and number of farms. To understand the biogas activity metrics, it is critical to know herd size (cows per farm) because it differs between states.

Table 3-4. Normalized Biogas Activity Metrics

	Average Dairy Cows per Farm	Digesters per Thousand Dairy Farms	Digesters per Million Dairy Cows	Capacity per Dairy Farm (kW/farm)	Capacity per Million Dairy Cows (MW/million cows)
Wisconsin	95	2.29	24.1	0.82	8.57
Minnesota	105	0.91	8.7	0.07	0.67
Pennsylvania	74	1.61	21.8	0.24	3.19
New York	120	2.86	23.9	0.67	5.58
California	986	8.16	8.3	1.84	1.86
Idaho	758	2.95	3.9	5.54	7.31

Taking normalized metrics of digester installations and capacity together, we conclude that Wisconsin has a higher level of biogas activity than comparable states. Minnesota and Idaho clearly have lower levels of biogas activity. Minnesota scores relatively low in all normalized metrics, and it is clear that biogas activity in the state is lowest among the leading dairy states. The scale of operations in Idaho is huge, with two very large installations on two exceptionally large farms and the number of farms is small (677 compared to over 13,000 in Wisconsin, see Table 3-1). Two digesters is not a robust statistical sample to infer trends in the state. Nevertheless, with only two digesters, neither of which may currently be operating, biogas activity is not widespread in the state.

California has a comparable number of digester installations to New York and Pennsylvania, but because the California dairy industry is so much more concentrated as indicated by the highest average herd size, it scores highly on the per farm metrics. Thus, the farm participation rate (digesters per thousand dairy farms) is high in California, but this is structural because farms are so much larger than those typical of Wisconsin, Minnesota, and Pennsylvania. However, the farm size effect is removed when normalizing only by cows, and on a per cow basis, California comes in relatively low in activity. Thus, California dairy farmers have comparatively large farms making comparatively small investments in biogas.

Farm sizes in Minnesota and Pennsylvania are comparable to Wisconsin. Pennsylvania scores well below Wisconsin on digesters per farm basis and on a capacity per million dairy cows basis, indicating that the installation rate and investments in biogas are larger in Wisconsin. New York has participation rates similar to Wisconsin, but lower capacity. Their capacity is comparable to Pennsylvania. Overall, this indicates that farmers in New York and Pennsylvania are putting in smaller systems and making smaller investments in biogas than farmers in Wisconsin. Excluding Idaho, Wisconsin has substantially higher (40 percent or more in each case) capacity per million dairy cows, characterizing a relatively large number of small farms with substantial systems. Thus, considering both participation and capacity together, Wisconsin has the highest level of dairy farm-based biogas activity for the period 2002 to 2010. In conclusion, dairy biogas activity is higher in Wisconsin than in other leading dairy states.

4. SELECTION OF COMPARISON STATES

Based on information gathered above and research on market drivers, program activities, and regulatory obligations, KEMA identified Minnesota and Pennsylvania as states for comparison to Wisconsin. They provide the most complementary profile to help elucidate the impacts of the Focus programs. In addition to Wisconsin, KEMA performed in-depth interviews to determine market conditions and assess factors driving biogas adoption in Minnesota and Pennsylvania. For each of the three states individually and across the three states, KEMA sought multiple perspectives on the factors that influence the adoption of biogas in general and the factors that lead to individual decisions to install biogas systems. As discussed in Chapter 5 ("Methodology"), KEMA relied on interviews with members of the biogas industry, government and other staff involved in biogas programs or policy, and implementers.

The goal of selecting the comparison states was to select the states most complementary to each other and to Wisconsin. The ideal states for comparison would be ones with a substantial number of similarly sized dairy farms where a biogas program does not exist. Unfortunately, no single state fits this profile exactly. Instead, KEMA characterized each of the leading dairy states relative to Wisconsin according to a preliminary list of drivers, barriers, program profiles, farm characteristics, geography, utility programs, and market activity. A "perfect" comparison state did not exist. KEMA then sought to use a pair of states, which, through their combined profiles, could analytically substitute for the non-existent perfect comparison. We defined the most complementary profile as the profile in which the most variables (e.g., odor regulations, urban/rural geography, program presence) are similar to Wisconsin in one state and different from Wisconsin in one state. Table 4-1 at the end of this section summarizes the profiles.

4.1 MINNESOTA

Minnesota has four digesters installed on dairy farms and six landfill gas operations installed after 2002. Appendix A lists digester installations in Minnesota.

The Minnesota biogas incentive program has been inconsistent, without grants for much of the 2002–2010 timeframe. Recent efforts have sought more consistent, more substantial funding and are modeled on the Focus program. The first generation of incentives included production incentives and zero interest loans. The production incentive of $0.015/kWh produced was available for a maximum of ten years. Systems eligible for this incentive had to be smaller than 250 MW, installed on a farm, and operated by a Minnesota resident or in-state tribal council member. In addition to the production incentive, a ten-year zero interest loan was made available for a maximum of $250,000. Two early anaerobic digesters were built during the first generation of incentives. Both of these systems remain operational.

Minnesota's second generation of on-farm biogas incentives began in 2007 and is a one-time buy-down grant program for new systems and smaller optimization grant for existing systems. It is modeled on the Focus program. The installation grant is capped at $250,000 and the optimization grant is capped at $50,000. The grants are funded partially from state funds and from fees paid by nuclear energy production facilities (Legislative Bill MN Statutes 2007: 216C.41). As a state program, electrical co-op customers are eligible. To receive the grant, the system must be installed on a farm in Minnesota, have a simple payback horizon of greater than two years, and have 6,000 or fewer cattle. The funding is expected to be renewed annually, lending consistency to the incentive previously not present.

The state of Minnesota has no additional requirements beyond the EPA's nutrient loading regulations for farm wastes. It has established one of the most enforceable odor management regulations among our potential comparison states. Minnesota requires that farm owners submit an odor management system outlining what daily actions the farm will take to limit offensive odors and how the farm will respond to complaints or violations. Minnesota has established limits on hydrogen sulfide, ammonia, and particulate concentrations at the farm property line to determine whether a farm is out of compliance with odor regulations.

Minnesota has a statewide net metering agreement that is very similar to Wisconsin. Enacted in 1981, Minnesota's net metering bill limits system size to less than 40 kW. Monthly net overage is purchased by the utility at the retail rate. Only one of Minnesota's on-farm anaerobic digesters falls under the net metering agreement. Systems larger than 40 kW must enter into power production agreements (PPAs) with their local utilities and rates are negotiated on a case-by-case basis.

4.2 PENNSYLVANIA

As listed in Appendix A, twelve dairy farm biogas installations have occurred since 2002. Combined, a similar number of digesters are installed on poultry, beef, and swine farms. Pennsylvania also has had 27 landfill gas digesters installed since 2002. Additionally, KEMA research found twelve more dairy farm installations under construction.

The state of Pennsylvania has two grant programs that may apply to biogas projects. The Energy Harvest grant is most likely to assist with on-farm biogas systems. The grants typically range from $100,000 to $500,000 in start-up funding for Pennsylvania-based non-profit managed or farm-owned energy production projects that improve water and air quality. Energy Harvest has provided funds to 20 separate on-farm systems, one commercial/industrial system, and one wastewater treatment facility.

The Pennsylvania Energy Development Authority (PEDA) grant targets alternative fuel and energy projects. PEDA funding is not restricted to renewable energy sources and may fund alternative fossil fuel projects (e.g., "waste" gas projects, coal gasification, woody biomass, heat recovery, and energy efficiency projects that contain a research component). Typical grants range from $250,000 to one million dollars with a $1.5 million maximum award. The PEDA budget is typically in the range of $10 million funded by both federal and state funds. While the Energy Harvest grant targets non-profit and farm based systems, the PEDA grants are directed towards larger, privately owned systems. PEDA has not been responsible for funding many biogas projects, but has provided assistance to two landfill gas projects and one large commercial/industrial system.

Pennsylvania has not increased the rigor of nutrient loading regulation beyond the EPA's standards on a statewide basis. However, counties within the Chesapeake Bay watershed (much of southeastern Pennsylvania) have increased regulations ensuring over-surface flow of nutrients is severely restricted. The USDA's Census of Agriculture shows that livestock farms are concentrated in this area of the state. The state of Pennsylvania requires that new CAFO farms and expansions of existing farms file an odor management plan complete with an odor site index (OSI). Sites with OSI's exceeding the regulations are required to take preemptive abatement actions that may include physical barriers, alternative manure storage technologies, and anaerobic digestion.

Among the states considered in this analysis, Pennsylvania allows the largest nonresidential systems to participate in net metering agreements. Nonresidential systems as large as 5 MW may enroll in net metering agreements so long as they are part of “microgrids” or are available for emergency use. Microgrids are independently operable subsets of the larger electricity grid and an “emergency use” facility can power-up quickly to provide power during an emergency. Nonresidential systems that are not available for emergency use or part of microgrids are limited to three MW. Net generation overages are retained on a month-to-month basis and at the completion of the 12-month period, the producer is compensated at wholesale electric rates.

4.3 CALIFORNIA

California has 15 dairy farm digester systems according to the AgSTAR database. California. In addition to these smaller systems, the EPA Landfill Methane Outreach Program (LMOP) reports 31 landfill gas projects installed in California after 2002.

California’s Dairy Power Production Program (DPPP) incorporates two types of incentives specifically geared to on-farm dairy anaerobic digesters. The first portion of the DPPP is a $2,000/kW buy-down grant intended to reduce the upfront system cost by up to 50 percent. The other option available through the DPPP is a production incentive of up to $0.057/kWh for a maximum of five years. The maximum payout for this option is also capped at 50 percent of the total system cost. The DPPP is funded primarily through CEC-utility ratepayer fees. Systems receiving funds from the DPPP must be in California, pay CEC ratepayer fees, and produce electricity with the biogas. The DPPP existed from 2001 through 2006. During this time, the DPPP provided funds for ten on-farm digester systems.

California’s Self-generation Incentive Program (SGIP) is a set of incentives designed to encourage the installation of new distributed generation projects to meet part of a utility customer’s electric needs. Funding through this program is available to on-farm anaerobic digesters, wastewater treatment facilities, and industrial/commercial biogas systems. This program provides a start up grant for eligible renewable generation and advanced storage facilities greater than 30 kW and smaller than three MW. Incentive amounts vary on a case-by-case basis. The SGIP has existed since 2002 and has provided funding for two on-farm anaerobic digesters at a rate of $2.44/W for a beef operation and $4.53/W for a dairy operation. The SGIP has provided funds for 12 wastewater treatment facilities with incentive levels ranging from $2.81/W to $12.58/W. Funding from the SGIP is available to customers who wish to use landfill methane to generate electricity, but due to size restrictions, many landfills are not eligible for SGIP funds.

As is true in many states, California’s utility commission-sourced incentive programs do not affect farms that buy electricity from co-ops.

The state of California leaves odor and farm wastes regulation to the US EPA. California neither requires that farms file odor management plans, nor are there any specific laws regarding excessive odor from farm wastes. Odor complaints are dealt with using local nuisance laws with little consistency in penalizations from place to place.

The state of California has established net metering and renewable tariffs that apply to the state’s largest investor-owned utilities. Utilities limit the net metering agreements with anaerobic digester systems to a statewide limit of 50 MW, each system cannot be larger than one MW. This size restriction makes most non-landfill gas systems eligible for net metering

agreements. Publicly owned utilities may incorporate "'time of use" price adjustments to production credits. Net monthly system generation is retained by the producer until the end of the year. Net production at the end of the year is granted to the utility and the producer is not compensated for this overage. Systems involved in net metering agreements are exempt from interconnection application fees as well as initial and supplemental interconnection review fees. In addition to net metering agreements, systems less than 1.5 MW may enter into 10-, 15-, or 20-year feed-in tariffs with utilities and receive time-differentiated payments based on production.

4.4 IDAHO

Idaho has few digesters. The AgSTAR database lists two systems, which our research confirmed but suggests neither is currently operating. A Idaho-based source cited high interconnection costs in Idaho as severely limiting the long-term financial viability of the shuttered digesters.

Idaho's dairy industry is relatively young and did not begin developing in earnest until 2001. Early outreach efforts made in Idaho's nascent dairy industry to encourage early adoption of anaerobic digester technology were met with trepidation from dairy farmers and resistance from the state's largest utilities. Early attempts to build an anaerobic digester on a dairy operation resulted in extremely low savings and significant operational difficulties. This, combined with restrictively high interconnection costs and limited net metering agreements, resulted in the administration cancelling biogas outreach and killing the potential for developing incentive programs in Idaho. Furthermore, odor and nutrient regulations default to EPA base standards and are difficult to enforce.

4.5 NEW YORK

New York has 15 digesters on dairy farms. New York is also home to approximately 52 wastewater treatment facilities that use collected biogas for thermal or electrical energy[6]. The New York State Energy Research and Development Authority (NYSERDA) reports show that the majority of systems in New York (two commercial/industrial and 93 wastewater facilities) either flare or do not record what is done with collected biogas. LMOP indicates that New York hosts 25 landfill gas systems installed after 2002.

NYSERDA has offered a single incentive program for anaerobic digester biogas since 2000. NYSERDA's Anaerobic Digester Gas-to-Electric Program (ADGEP) provides a maximum grant of one million dollars for a 400 kW system. Although the incentive peaks for a 400 kW system, the program accepts systems up to 700 kW. Eligible systems must be installed in New York, be subject to NYSERDA ratepayer fees, generate electricity, and use manure, agricultural wastes, organic commercial/industrial wastes, or wastewater as feedstock for the anaerobic digester. The incentive, much like California's DPPP, consists of a buy-down grant and a production credit. The buy-down grant is based on a $500/kW of nameplate capacity with a maximum amount of $350,000. With the production credit designed to deliver the remainder of the award over the first three years of system operation. This program has

[6] Malcolm Pirnie, Inc. *Anaerobic digester gas-to-electricity for the municipal wastewater sector in New York.* Prepared for New York State Energy Research and Development Authority. Report Number MC-08-02, November 2007.

funded all of New York's fifteen on-farm biogas facilities, six wastewater treatment facilities, and one commercial/industrial anaerobic digester.

New York uses basic EPA nutrient loading regulation. New York neither requires odor management plans nor has it established specific laws regarding excessive odor from farm wastes. Odor complaints are typically handled using local nuisance laws.

Net metering in New York is available to solar, wind, and on-farm biogas systems. Anaerobic digester systems must be 500 kW or smaller (400 kW or smaller between 2002 and 2008) and are credited for net generation monthly. At the completion of a 12-month period, any net generation is compensated at the avoided-cost rate. This net metering agreement means that all currently installed on-farm systems are eligible for net metering agreements.

4.6 MOST COMPLEMENTARY COMPARISON PROFILE FOR ANALYSIS

We selected Minnesota and Pennsylvania as the most complementary states for comparative analysis. These states had comparable farms sizes, and differed on key variables, as shown below.

We quickly excluded California and Idaho as comparison states. We excluded California due to its larger farm sizes and different program structure. The dairy industry in Idaho operates somewhat differently than the dairy industry in Wisconsin and biogas activity is minimal. There appeared to be multiple factors leading to low adoption rates in Idaho, making it difficult to tease out any individual contributors. New York and Pennsylvania were both reasonable options, but Pennsylvania had two advantages. Penn State University had completed case studies on the bio digesters, which were a good source of information. Second, Pennsylvania had stricter nutrient loading regulations, which allowed us to see if these factored into the biogas adoption in that state.

Minnesota proved to be a natural comparison because it has similar characteristics to Wisconsin and has lacked a consistent biogas incentive program. For the majority of 2002–2010 Minnesota lacked a consistent program and had considerably lower levels of outreach and education than Wisconsin, providing a ready analysis point to explore program impacts. Moreover, Minnesota modeled its second generation of incentives after the Focus program and there are new projects in the pipeline, which over time should help characterize program impacts. However, it is hard to infer any conclusions at this time because the number of projects currently online and in the pipeline is still quite low and the second-generation incentives are recent, relative to the lag between when a farmer decides to install a digester and when it comes online.

As shown in Table 4-1, Minnesota and Pennsylvania make good comparison states to Wisconsin. They both are similar to Wisconsin in farm size and climate. For key issues we determined are important to the adoption of on-farm biogas systems one or the other differs from Wisconsin. For example, Pennsylvania has more stringent nutrient loading regulations than Wisconsin, but Minnesota does not. The reverse is true for odor regulation.

Table 4-1. Comparison of Five Leading Dairy States to Wisconsin

	Wisconsin	Minnesota	Penn.	New York	California	Idaho
Farm size	Small farms	Small farms	Small farms	Small farms	Larger farms	Larger farms
Incentive program	On-going since 2001	Not consistently funded	Present; recently increased	Comparable to Wisconsin	Comparable to Wisconsin	None
Education, outreach and other in program	Yes	No	No	Not researched	Not researched	Not researched
Odor regs.	EPA plus siting regs.	More Stringent	Similar: EPA plus siting regs	Similar: EPA plus siting regs	Similar: EPA plus siting regs	Similar: EPA plus siting regs
Nutrient loading regs	EPA	EPA	More stringent in major dairy areas	EPA	EPA	EPA
Net metering	≤ 20 kW	≤ 40 kW	More aggressive, 3–5 MW limit	≤ 500 kW	Sophisticated, 3 MW limit	Varies by IOU. ≤100kW
Buy-back rates for biogas (feed-in tariff)	Voluntary, vary by IOU	None	None	None	≤ 3 MW, rate based on CPUC market price referent	None
Non-farm biogas activity	Activity	Less activity	Activity level similar to Wisconsin	More activity	More activity	Less activity
Utility rates[a]	$0.07–0.09 per kWh	$0.06–0.08 per kWh	$0.09 per kWh	$0.13–0.18 per kWh	$0.10–0.12 per kWh	$0.04–0.06 per kWh
Interconnect. standards	IOUs have standard requirements and fees.	Case-by-case. Difficult and costly	Standardized IOU process in 2006	Not researched	Net metering parts exempt from fees	High costs
Climate	Seasonal Variation	Seasonal variation	Seasonal variation	Seasonal variation	Substantially warmer and drier	Substantially drier
Notes	Incentives increased July 1, 2007	Second generation program in 2007	Aggressive expansion of incentives and net metering programs		Many ongoing programs	

Yellow highlights indicate differences between the selected comparison states and Wisconsin. Gray shading indicates Wisconsin conditions and the items for which the selected comparison states are similar to Wisconsin.

[a]Based on Energy Information Administration average commercial prices 2002–2008 http://www.eia.doe.gov/cneaf/electricity/epa/average_price_state.xls. Wisconsin and Minnesota rates are generally lower than the national average. Pennsylvania's rates were higher at the beginning of the time period and are now lower than the national average.

5. PHASE 2: COMPARATIVE STUDY OF BIOGAS MARKETS

In Phase 1 of the Biogas Supply Side Study, KEMA established metrics to measure biogas activity, assessed the level of biogas activity in Wisconsin relative to other states, and identified two states for comparison analysis. KEMA concluded that Wisconsin has more biogas activity than the other major dairy producing states. The goal of Phase 2 of the Biogas Supply-side Study was to determine the factors that led to different anaerobic digester adoption rates and assess whether Focus on Energy has increased the adoption beyond what is reflected in self-reports.

KEMA conducted qualitative research in Phase 2 based on nineteen in-depth interviews with individuals from a wide-array of viewpoints and expertise. Interview topics focused on drivers for digester implementation, risks and barriers of implementation, the effects of different utility policies, and state program effects. The following sections detail the results of the Phase 2 study.

5.1 METHODOLOGY

KEMA sought to understand the Wisconsin biogas market by comparing Wisconsin with the two other states strategically chosen in Phase 1. As described in section 4.3, the states chosen for the analysis were Minnesota and Pennsylvania.

Following the selection of the comparison states, KEMA identified persons knowledgeable in anaerobic digesters from a variety of perspectives. We identified individuals who were:

- Rural renewable energy program implementers (“implementers”)
- Firms that design and install digester projects (“designers”)
- Academic faculty who study digesters and work with farmers on implementation (“researchers”)
- Utilities that work with farmers to bring biogas power onto the grid (“utilities”)
- Farm organizations (“farm organizations”).

KEMA devised a protocol to guide the in-depth interviews. The full protocol is included as Appendix B, but interviews focused primarily on the following questions:

- What are the drivers for farmers to install anaerobic digesters?
- What are the risks and barriers to installing anaerobic digesters?
- How does the state promote the adoption of anaerobic digesters and bio-energy?
- How do utility rules and energy buy-back rates affect the decision to install an anaerobic digester?

KEMA designed the questions to provide a complete picture of the biogas market in Wisconsin and the two comparison states. Responses give an indication of whether the drivers for biogas digesters were compelling enough to stimulate adoption without public assistance or whether structural barriers exist that require public financing and/or non-financial support to move the biogas market towards maturity. Non-financial support includes

education, information, assistance with grant applications, networking, and legitimacy in the eyes of private sector financiers. KEMA also asked respondents questions designed to provide insight on how state programs are addressing market barriers and what types of utility policies help or hinder the adoption of biogas. The responses provided the evaluation team a basis on which to determine whether Focus on Energy was contributing to biogas adoption in the state of Wisconsin.

KEMA conducted the interviews between Monday February 22, 2010, and Friday March 12, 2010. Nineteen out of twenty-four individuals contacted granted our request for an interview.

KEMA analyzed the results first by comparing responses in light of differences between states shown in Table 4-1, then to determine other factors that drive the decision to install digesters.

5.2 DRIVERS FOR ANAEROBIC DIGESTER ADOPTION

Although the drivers for biogas digester adoption are varied, a number of common drivers emerged during the course of our interviews. Broadly speaking, we categorize these drivers as non-financial and financial. The major reasons cited for installing digesters varied little across states and regions, especially among non-financial drivers, however where they do it is specifically noted in the following sections.

5.2.1 Non-financial drivers

Respondents cited a number of non-financial drivers during our interviews. Non-financial drivers are reasons to install digesters that cannot be quantified easily in terms of dollars generated or saved. They are compelling co-benefits that farmers desire, provided that the costs are financially manageable over time. These non-quantifiable benefits include the following:

Odor control. A large majority of respondents stated that odor control was a top motivator. This was true for Wisconsin and the comparison states, but especially true for respondents from Pennsylvania, where increased urban sprawl has put residents within close proximity to working dairy farms.

Digesters greatly reduce the odor associated with land spreading of manure solids. Farmers increasingly recognize digesters as a tool to mitigate community pressure and improve relations with neighbors. A respondent from Pennsylvania stated, “Farmers quickly tell you odor control” is an important driver. One national biogas implementer cited odor control as a top reason, saying that digesters mitigate the risk of bad community relations and help you “stay out of court with the neighbors.”

Some respondents noted that occasionally local relations favor implementation of digester systems to control odor. Another said that a digester can help mitigate public opposition to expanding herd size or becoming a concentrated animal feedlot operation. A farmer representing a Wisconsin farm organization said that a digester is an important investment when farmers want to put more cows in one place. He noted that his farm smells better with a digester than it did when it was one-quarter its current size. Since scaling up is an important component of being profitable, odor control has significant value not easily quantified in an economic cost benefit analysis.

Although odor regulations are more stringent in Minnesota than Wisconsin, respondents did not cite the regulatory burden as motivating odor control. Farmers in Pennsylvania, where odor control regulations are similar to Wisconsin, seemed most motivated by odor control. Instead of the regulatory burden, respondents cited urban sprawl as a major driver. Farmers needed to control odor to prevent conflict with suburban neighbors.

Manure management. Manure management is a secondary driver to odor control. Larger farms produce more manure, requiring more management, for which digesters are useful tools. As farms grow in size to become more economical, manure management becomes an increasingly burdensome challenge. Our analysis cannot attribute causality, because many large farms operate manure lagoons in lieu of digesters, but respondents cited manure management as a general theme that strengthens the case for digester installation. Farm sizes were similarly small across Wisconsin and the comparison states, but as shown in Table 3-3, average herd size on farms with digesters are larger than the corresponding state average.

According to a Wisconsin researcher, “manure is a big challenge because there is lots of it.” An EPA representative told us that digesters stabilize manure in a consistent and orderly process. The digesters contain the waste and minimize the chance of accidental discharge into lakes and streams. Another respondent said that for larger farmers, digesters provide regulatory certainty through minimization of manure spill risk.

Nutrient loading regulations are a factor in manure management, but the more stringent nutrient loading requirements of Pennsylvania were not cited anymore than the less stringent regulations in Minnesota and Wisconsin. Nutrient loading was not often mentioned. Respondents indicated that digesters do not reduce the amount of nutrients in the waste.

Energy independence and environmental stewardship. Respondents indicated that energy independence was a co-benefit of biogas installation if the project is financially viable. Some cited growing public awareness that digesters are an environmentally friendly way to manage waste and that renewable energy is an important step towards making the US energy independent. A Minnesota respondent said that many farmers are interested in being environmental leaders. A Pennsylvania farm organization representative said that the market is demanding products from companies that demonstrate environmental responsibility. Food processors can include stories on their websites about the farms that provide their milk products. The story of a digester installation makes a compelling case for that products’ environmental performance.

5.2.2 Financial drivers

Most of respondents said farmers would invest in anaerobic digesters only if they believe they will benefit financially. When asked about drivers for digesters, one designer who has worked on over 80 digesters all over the globe simply stated, “Money. Farmers only do it to improve the bottom line.” A farm organization representative stated that digesters provide farmers with a competitive advantage. The following discussion addresses the ways in which digesters can improve a farm’s bottom line.

The financial motivators are the same across the comparison states because all dairy farmers generally have the same needs. Producing electricity allows farmers to receive ancillary revenue that can be important for cash strapped farms. That revenue stream is highly dependent on buy-back rates. Digesters also output digested solids that can be used for cow

bedding, which reduces bedding costs or, when sold, provides a revenue stream. The marginal revenue (or cost reduction) from electricity and digester bedding is needed to make the investment financially viable. The following financial drivers for digester construction and discussed in detail below:

Reducing electricity purchases or selling electricity. Few if any farmers simply flare biogas from the digester. Rather, farmers typically enter into agreements with their local utilities to generate power and receive a new revenue stream. That revenue stream is critical to payback the initial capital investment. Farmers can either use electricity on site and sell the excess or simply sell all generated power. Additional revenue streams are also important to farmers due to the volatile nature of milk prices. For example, when milk prices are down, farms lose money and incur significant debt, which threatens the long-term viability of the business. Having a consistent revenue stream helps farms generate much needed cash flow. According to one researcher, "Farmers are delighted to get a check from the power company."

In general, buy-back rates for biogas digester energy are higher in Pennsylvania than in Wisconsin and Minnesota. Buy-back rates were higher in eastern Pennsylvania than in western Pennsylvania, where coal based electric energy production holds down the cost of electricity. In Wisconsin, four of the five[7] IOUs currently or have previously offered higher than market rate voluntary tariffs for biogas energy.

Digested solids. An often-cited benefit for digester owners is the use of digested separated solids for cow bedding and off-farms sales. After the digestion process, manure can be separated into methane, nutrient rich liquids, and digested solids. The solids have a greatly reduced somatic cell count, a 99.9 percent reduction according to one designer, thereby making it available as a soft clean product for cow bedding. One respondent stated that a digester can save a farmer $1,200 to $1,500 a month on bedding costs. Farmers also use the digested solids as nutrient rich soil amendments on farm for crop production. Many farms also bag and sell excess solids to other farms or nurseries. The 2009 Wisconsin Agricultural Biogas Casebook found that average price of digested solids was $20/ton.

Fertilizer. A number of respondents said that digested and separated liquids retain highly available nutrients such as phosphorous and nitrogen. The liquids can make a viable substitute for purchased chemical fertilizers, leading to savings. A Pennsylvania program implementer said that Pennsylvania farmers who normally rely on rainfall can mitigate drought risk by storing digested liquids for irrigation purposes. A designer said that farmers are now starting to be able to monetize the value of the liquids as a replacement for chemical fertilizers. Also, a representative from a Wisconsin farm organization said that he and others use the separated liquids to irrigate crops.

Reducing demand for fuels. Many farmers include waste heat recovery from the biogas engine, known as combined heat and power (CHP), for on-farm uses such as barn and digester heating. This is particularly useful in cold climates, where under normal circumstances farms need to run diesel or natural gas powered boilers for heating or process uses. Fuel savings is a factor taken into account in the economic calculus of digester installation.

[7] The fifth IOU, Madison Gas and Electric, is unlikely to have bio-digesters in its service territory.

Multiple sources stated that farmers must be able to pay back digester costs in no more than seven to ten years to find them economically attractive. According to one program implementer, the confluence of multiple revenue streams must come together to pay off the initial investment in a time horizon acceptable to the business. The most important revenue streams are electricity sales and savings, or sales of bedding materials. Other income streams may include carbon offset credits and tipping fees for co-digestion of other local waste products. The capital requirements of digester installation are so large that even with public funding farmers need favorable buy-back rates from their utility in order to make the project economically viable.

5.3 BARRIERS TO ANAEROBIC DIGESTER ADOPTION

While there are compelling reasons to install anaerobic digesters, there are also significant barriers hindering wide-scale adoption. Like the drivers, there are financial barriers and non-financial barriers. Digester systems are highly capital intensive and buy-back rates are often too low to motivate their adoption without assistance from public grants. Digesters systems also require a high level of sophistication to choose the correct technology and to operate the system correctly. The following sections describe the key barriers to digester adoption.

5.3.1 Financial barriers

Financial barriers include the factors involved in determining the return on investment. Fundamentally, this involves the two sides of the finance equation: how much capital is required to build a project and the cash flow and payback implications of the resultant revenue stream. Respondents most often identified high capital costs, interconnection fees, and low buy-back rates, as the primary financial barriers.

High capital costs. Anaerobic digester systems are a major expense for any dairy farm. Respondents generally cited costs of between $2 million and $5 million.[8] Gaining access to capital for an expenditure of that magnitude is difficult in private capital markets, especially since local lending agencies may view digesters as an uncertain investment. A Pennsylvania farm organization representative told us that local lenders are often hesitant to lend to farmers for digester projects because they do not know if it will be a profitable venture due to the technological uncertainty and lack of farmer experience.

According to a representative of a Wisconsin farm organization, “capital requirements are too high. The front end costs are a need that the business community isn’t providing.” A program implementer said, “I’ve never experienced one that didn’t need a grant. Maybe 6,000–8,000 head dairy would be large enough to show a positive benefit cost without subsidies.[9]” On the other hand, some sources[10] indicate as few 300 head may make a digester viable, although we found few farms with herds that small in any of the states we analyzed. Another farm

[8] Wisconsin projects tend to be on the low side of these estimates because the farms are relatively small.

[9] There are at least four on-farm digesters in Wisconsin that did not receive grants from Focus on Energy or the USDA. This respondent may be unaware of these bio-digesters.

[10] http://www.cleanenergyresourceteams.org/technology/biogas-digesters#4.

organization representative said that current research and development is focusing on scaling down digester and generator technology to serve smaller farms.

According to some respondents, low milk prices play an important factor in digestion adoption. A Wisconsin policy advocate stated that consistently high commodity prices are required. With low milk prices, you lose money. High milk prices generate cash that allows farmers to pay off debt and finance new projects such as digesters. A University economist said that milk prices have been low, which has been pressuring capital budgets. A national digester implementer said that farmers have been losing money for the past 14 months due to low milk prices. This discourages farmers from taking on new debt for digester installation.

Interconnection fees. Connecting an anaerobic digester system to the grid involves a number of challenges. Many of the respondents in all three states claimed that utilities have in the past or continue to charge punitive fees for interconnection in order to discourage biogas projects. This was especially true for rural electric cooperatives (RECs), which state public utility commissions do not regulate. One of the designers said, “If a utility doesn’t want you, they can put barriers in your way such as fees.” The reason many gave for utility resistance was that they have no incentive to enter into power purchase agreements from small, decentralized sources.

In Wisconsin, the degree of difficulty with interconnection depends on the type of utility that serves the farm. IOUs account for the majority of the Focus on Energy service territory. A Wisconsin respondent indicated that it is much easier to work with investor owned utilities regulated by the Public Service Commission of Wisconsin because they are required to use standard interconnection agreements. Before this requirement, there was a patchwork of requirements based on the 118 energy providers in the state. Since the passage of PSC 119 into state code, effective in 2004, all biogas interconnection agreements in PSCW regulated territory have standard technical requirements, insurance requirements, and fees. This has generally reduced the level of difficulty with interconnection.

In Minnesota, a farm organization representative described the interconnection process as, “difficult, costly, and long.” Utilities negotiate interconnection agreements on a case-by-case basis, stating that, “Utilities claim connection costs that may be just arbitrary. The interconnection fee is substantial. And it can take a year plus to negotiate a contract”. A program implementer said that while, “there are standard interconnection agreements in Minnesota, they don’t regulate the prices they charge. If the utility doesn’t want to put energy on the grid, they will charge the maximum they can get away with. There is no incentive for them to put small providers on the grid.”

Pennsylvania had experienced some of the same issues with interconnection fees as Wisconsin and Minnesota. At first, electric delivery companies put up fees as barriers that could make it impossible to make a digester project successful. A Pennsylvania program implementer gave an example where a farmer who installed a digester was still paying 60 percent of his pre-digester electric bill due to interconnection fees. In 2006, the State of Pennsylvania Public Utility Commission made it illegal to charge punitive interconnection fees and standardized the interconnection process for regulated utilities. Still, according to one designer, rural electric cooperatives still make it difficult to connect biogas power to the grid.

KEMA attempted to contact utilities in all three states to address the interconnection issue. The evaluation team was only able to reach one Wisconsin utility for an interview. We spoke with an agricultural rep who has worked with farmers on interconnecting biogas systems. He

said that utilities face real technical issues connecting biogas to the grid, including making sure the energy is safe and synchronized. The utility does not need the electricity, but it is still required to build and maintain the infrastructure to handle a significant power generator usually located at the end of the transmission and distribution system. At the same time, he also said that load balancing was not much of an issue with biogas, since in terms of energy, "it is a drop in the ocean."

Low buy-back rates. Interview respondents often cited unfavorable buy-back rates, the price paid to farmers for electricity put onto the grid, as the most important barrier to digester implementation. Across the board, respondents from all states said the rates that farmers receive for their digester energy are too low to make the projects viable without public grant money and other income streams such as bedding sales. Low rates make it uneconomical to install digesters on small farms less than 1,000 head. According to the Wisconsin Agricultural Casebook, only four farms with digesters have less than 1,000 head herd size, and none are below 800 head. Therefore, due to low rates, herd size is also a barrier for small-scale operations interested in digesters.

In Wisconsin, there is no state mandated buy-back rate for biogas energy. For investor owned utilities, rates are either pre-established in the annual rate cases or negotiated through a power purchase agreement (PPA) process on a case-by-case basis. According to a farm organization representative in Wisconsin, some utilities have offered higher biogas buy-back rates until they reached a certain system limit of biogas energy, after which they reverted to the PPA process. Many utilities, including all non-regulated rural electric coops, only offer the avoided cost rate of $0.045/kWh.

By 2005 a number of farms were approved for digester implementation grants from Focus on Energy and USDA, but were not able to go forward due to unfavorable buy-back rates. RENEW Wisconsin worked with We Energies and Alliant Energy to establish higher biogas rates as part of their rate case filings. In 2008, Alliant offered $0.093/kWh for up to 10 MW of capacity. We Energies has now started offering a $0.09/kWh buy-back rate and raised the maximum system size from one to two MW. Xcel Energy offers $0.073/kWh, but has not had any digester installations at that rate.

Our Wisconsin respondents stated clearly that the voluntary buy-back rates, while helpful, are not a high enough incentive to cause widespread adoption of the technology. Since buy-back rates are low, farmers have to rely on public grants and other revenue streams such as bedding sales to make the digester economically viable.

Similar to Wisconsin, respondents from Minnesota also emphasized that buy-back rates in their state were too low to provide sufficient incentive for the widespread adoption of biogas digesters. There is no biogas specific buy-back rate, and net metering is limited to systems less than 40 kW, therefore each bio-digester is required to negotiate a PPA. According to one program implementer, buy-back rates range from $0.045 to $0.08/kWh, which he said was too low to pay off digester projects without the assistance of public grants.

Until 2006, Pennsylvania had a situation similar to Wisconsin and Minnesota. However in 2005, the state passed energy legislation that raised the cap on the net metering law to three MW. Net metering allows a farmer to bank energy credits when the digester exceeds farm electricity needs (usually in the winter) and use credits when the farm needs more energy than generated (summer). At the end of the year, the utility pays back to the farmer

any unused credits at wholesale rates, which are specific to each utility. The utility aggregates any meter under a farmer's name within two miles of each other to make this determination.

For farmers on the east side of the state, this is a very good deal for digesters. Wholesale rates are higher, due to greater reliance on nuclear energy in that region. Western Pennsylvania is more coal dependent, therefore wholesale rates are quite low. The vast majority of digesters reside on the east side of the state for that reason. Farmers located in Renewable Electric Cooperative (REC) territories do not benefit from the net metering agreements, therefore it is difficult to install an economically viable digester in those territories.

5.4 NON-FINANCIAL BARRIERS

Nearly all of our respondents commented on the myriad barriers such as steep learning curves, technical challenges, maintenance, market confusion, and other issues not strictly related to financing and payback.

Installing a digester requires a significant commitment from the farmer to become educated on proper management. One respondent called it "akin to adopting another enterprise. The farmer needs to become a waste treatment company and a power provider." Dairy farmers' core expertise is raising cows for milk production; therefore, farmers must take great care to educate themselves on the skills needed for successful digester adoption. This is another reason why digesters are only appropriate for larger farms where resources and dedicated staff can be assigned to the digester project.

The market for biogas digesters is still in the early stages of development in this country. Respondents characterized the digester market as containing numerous vendors selling unfamiliar technologies to buyers with little or no experience with their products. Respondents reported a great deal of market confusion and technical uncertainty. Since each farm is different, what might work for one farmer would be disastrous for another. A Pennsylvania farm organization representative stated that while there is some private sector technical expertise out there, it is very limited. He said farmers need digester firms to provide ongoing support in the operation of the digesters. At this point, that demand is not being well served by the private market.

A few respondents characterized the market as suffering from unscrupulous vendors who sell farmers inappropriate systems. One designer said that Wisconsin is a hot bed of competition for digester business. Because of that, companies will, "say anything to get business." Choosing the wrong technology and, "getting screwed by your vendor" are major risks farmers run. While great diligence is required, many respondents said farmers in general lack the knowledge to make informed decisions regarding digester technology.

Equipment failure is common and maintenance requirements are often more than expected. One respondent, an agricultural representative from a Wisconsin utility, said that maintenance on the engine can cost $0.015/kWh alone. Temperature and pH often need to be adjusted and sand can build up in the digester causing costly total shutdowns. Hydrogen sulfide is a

toxic[11] byproduct of digesters that must be scrubbed from the gas. This adds another layer of complexity few farmers are trained to manage. One designer said many digesters do not last more than a year due to an inability to operate it proficiently.

Many farmers found USDA's terms and conditions to be unfavorable due to regulatory burden and federal requirements such as prevailing wage. Some farmers were reported to have returned federal and state money because they found the federal requirements too burdensome to comply with.

5.5 STATE PROGRAMS

Wisconsin, Pennsylvania, and Minnesota provide illuminating case studies on ways state policy affects the biogas market. Wisconsin's Focus on Energy provides grants and supports the biogas market through outreach, education, and support. Pennsylvania's Energy Harvest program provides grants to farmers as well, but leaves the outreach and education to the university system. Minnesota does not have a dedicated bio-energy program. The following describes each state program's contribution to the biogas market.

Wisconsin. Focus on Energy started in 1998 as a pilot program of Wisconsin Public Service to promote energy efficiency, conservation, and renewable energy. In 2002, the Focus on Energy program was expanded to incorporate the majority of the state. Since the program started with a limited budget, it focused on markets in which they believed they could make the most impact, namely residential photovoltaics, wind, and biomass including agricultural biogas. Focus designed the program to provide grant funding and technical support for farmers interested in installing digesters.

Grant funding started at $45,000 per digester for electricity plus $30,000 for heat cogeneration, for a total of $75,000 per system. Since this is a small percentage of digester capital requirements, few farms installed digesters at that funding level, even with matching federal funding from USDA. In 2007, Focus increased the incentive level to $250,000 per digester. According to Focus on Energy staff, the $250,000 grants yielded many more installations. Our analysis shows eight Focus-funded installations became operational after 2007, compared with fifteen from 2002-2007, but the average capacity of the later installations has doubled. Focus also works closely with the USDA to leverage Focus money with federal money available through the USDA Farm Bill 9006 program (now known as the REAP program) and AgSTAR.

In addition to grant funding, Focus on Energy also provides technical services, education and outreach, and market coordination. Focus was described by a designer as a "one stop shop" for technical information and grant funding. Focus staff provide a resource for farmers on technology, energy prices and negotiation, lenders, and information on developing sound feasibility studies.

[11] According to the Materials Safety Data Sheet, hydrogen sulfide gas is toxic and inhalation of sufficient quantities can result in unconsciousness, coma, and death, while olfactory fatigue to the characteristic "rotten eggs" smell makes human response an unreliable indicator of hazard. See http://avogadro.chem.iastate.edu/MSDS/hydrogen_sulfide.pdf, accessed April 12, 2010.

Focus also plays an educational and outreach role. Focus organizes an annual bio-digester conference to share information on digesters with farmers. They also hold monthly stakeholder meetings and maintain the only biogas technical working group in the country. When federal funding becomes available, Focus on Energy, the Wisconsin Department of Agriculture, and USDA would, "go on a road show" to get the information to farmers in the state. This allowed Focus to interact with farmers and share experiences about the installations. Focus also provides information on vendors and works with companies to help bring them to the Wisconsin market. According to a program implementer, four new companies are now working in Wisconsin on digester implementation due to Focus on Energy's help. Focus also funds a casebook to document the experiences of Wisconsin farmer's digester installation and operation.

Respondents also said that Focus on Energy provided behind the scenes policy and regulatory support. Focus provides USDA with technical support on an on-call basis. A USDA representative said that Focus and USDA are, "in constant contact." Focus has worked with the US EPA's AgSTAR program to develop a biogas specific monitoring and verification program. They also reported working with utilities to establish a standard interconnection agreement to streamline and simplify the process and with IOUs on their voluntary buy-back rates for biogas energy. However, since July 1, 2007, Focus has not received funding for and is not allowed to directly engage in advocating for policies.

Pennsylvania. Pennsylvania started their Energy Harvest program in 2006. The program also coincided with the net metering law change. Energy Harvest grants totaled $500,000 per digester. Energy Harvest also coordinated with USDA to help farmers leverage both state and federal grant money. According to a Pennsylvania program implementer, 19 dairies have been funded through Energy Harvest, and about half of those dairies also received matching federal funds. We could not corroborate the count of installations and our empirical analysis and the AgSTAR database indicate fewer installations, but this may be the result of KEMA using a narrower definition of digester installations. Given the recent development of the program, many of the funded digesters are likely not online yet.

The Energy Harvest program depleted its funds; however, recently the American Recovery and Reinvestment Act and the Pennsylvania Energy Development Fund funded digesters on a few farms. Energy Harvest does not provide technical support services aside from providing links to other resources and vendors. Penn State University has largely filled that role of working directly with farmers to provide education and technical support.

The combination of net metering regulations and the grants have yielded significant gains in digester implementation. Before 2006, Pennsylvania had only four or five digesters, according to the program implementer. Since 2006, 16 digesters have been installed and 12 more are reported to be in construction phase.

Minnesota. Minnesota does technically have a dedicated biogas program; however, it has suffered from lack of funding. Funding was provided only once in 2007. According to a Minnesota program implementer, the state funded six digester projects in that funding cycle at $250,000 each. Two were never built because they could not secure private sector financing. Two of the farms that did build digesters did not have matching federal funds, but were only able to do so because of their large size (6,000–8,000 head) made it economical.

Other farms have tried to build digesters on federal money, but according to Minnesota farm organization representative, some farms in Minnesota who received federal grants for a

digester were forced to give the money back because of a lack of state match and poor payback from low electricity rates.

Minnesota does not actively promote biogas digesters and does not provide a clearinghouse of digester information for farmers. The state does however provide links to internet resources on digester on its website.

6. DISCUSSION AND CONCLUSIONS

6.1 DISCUSSION

Based on our Phase 1 research, program knowledge, and in-depth interviews with a range of respondents, we present the following discussion and conclusions. The discussion focuses on the factors important in the adoption of on-farm bio-digesters. The conclusions look at the extent to which Focus on Energy likely increased biogas adoption in Wisconsin beyond that reflected in self-reports.

What are the most important drivers for digester adoption? Farmers are interested in installing digesters to control odor. Controlling odor is important for meeting odor regulations, especially when expanding or locating a farm. It is also important for maintaining good relationships with neighbors and mitigating risk of litigation. The importance of odor control has increased over the past ten years and will continue to increase with more farm consolidation and residential encroachment on farmland.

Financial benefits are key drivers. While odor control is an important non-quantifiable benefit, our respondents indicated that farmers are interested in digesters because they can ultimately improve the bottom line. Selling electricity can be an important source of cash flow, as can reducing bedding purchases or selling bedding. Once the capital investment is fully depreciated, long-term power purchase agreements can provide an important source of income for the lifetime of the equipment. While many farmers believe they will make money on the investment, not all are able to achieve profitability due to the difficulty involved in digester operation.

Manure management and using digested solids for bedding are also important motivators to farmers for the installation of biogas systems. These benefits were noted by many respondents to our interviews for this study. Several Focus program participants have also identified them as key motivators. Using biogas liquids as fertilizer, collecting tipping fees for co-digestion and selling carbon offsets, are also co-benefits realized by some farmers. These, however, are not the primary drivers.

How important is selling electricity? Selling electricity is critical for the economic viability of the investment. Electricity revenue is marginal revenue and therefore affects decision making. We heard from nearly all respondents that buy-back rates make or break the investment. In general, respondents said that current buy-back rates are too low for farmers to make the capital investment in a digester without public up-front funding.

How important are public funding programs for digester implementation? At present, respondents report that public funding is an important component for the economic viability of biogas projects. Without funding, capital requirements are often too high and buy-back rates too low to pay back the investment in a suitable amount of time, generally seven to ten years. Cost sharing for the large capital investment is also important because farms are typically cash strapped and rely on the price of milk to make or break their balance sheets.

Funding is also important for demonstrating the viability of digesters to private lenders. There was a general sentiment that farmers use state or federal funding to leverage much higher levels of private financing and that a small amount of money can go a long way. State or federal review and funding demonstrates to private sector lenders that the project is

technically sound and thus a less risky investment. This type of certainty may be more important today when credit is more difficult to secure.

Minnesota is an instructive comparison on program effects, because the Minnesota program was inconsistently funded until recently. In 2007, it was redesigned to mirror the Wisconsin program (in funding type and level) with the promise of on-going state funding. Subsequent to this program modification, farmers installed three of the four Minnesota on-farm bio-digesters. Minnesota's dairy industry (farm size), climate, buy-back rates, and drivers are similar to Wisconsin. The primary differences are that:

- Wisconsin has a *consistent* biogas program offering grants
- The Wisconsin program provides technical, educational and outreach services
- Some Wisconsin utilities have offered higher rates voluntarily for biogas.

The difference in the prevalence of on-farm biogas digesters is stark; Wisconsin has 31 on-farm bio-digesters compared to four in Minnesota.

Pennsylvania also demonstrates a commitment to biogas digester energy. In 2006, the state instituted one of the most favorable net metering laws in the nation and subsidized digester construction with $500,000 grants. Pennsylvania went from four or five digesters to add another sixteen with an additional twelve in construction phase.[12] This also supports the argument that digester construction with today's technology requires both favorable rates and construction subsidization.

Did Focus increase biogas digester adoption in Wisconsin beyond what is captured in participant self-reports? Participant self-reports capture the participant (or vendors) assessment of the role of the program on the installation of a renewable energy system. These are *direct* impacts on the participant or the vendor. Participants may indicate that the project was completed (or timing accelerated) because of the program (e.g., grants or technical assistance) and vendors may attribute their activities to Focus on Energy. The Focus attribution surveys capture these *direct* effects. This supply-side study assesses the presence and likelihood of *indirect* program impacts on the biogas market not reflected in self-reports.

Our research indicates that Focus on Energy likely contributed to increased on-farm bio digester adoption in Wisconsin

Table 6-1 below summarizes the factors that influence decisions to install on-farm dairy bio-digesters. The first three columns show the conditions in Wisconsin and the comparison states. The final two columns discuss the affect these have on the adoption of biogas digesters and then summarize what impact these factors have in Wisconsin.

[12] This includes on farm digesters for non-dairy farms.

Table 6-1. Key Factors Affecting Installations of Dairy Bio-digesters

	Wisconsin	Comparison to Wisconsin		Affect on Adoption of Dairy Bio-digesters	General Impact in Wisconsin
		Minnesota	Pennsylvania		
Farm size	Small Farms	Similar	Similar	More cost effective for larger farms.	Negative effect
Non-farm biogas activity	Activity	Less activity	Similar	Unknown	Unknown
Incentive program	On-going since 2001	Not consistently funded	Present; recently increased	Incentives: • Increase economic viability. • Give legitimacy to systems • Increases ability to obtain financing.	Some impact
Program provides education, outreach, and technical assistance.	Yes	No	No	Increases awareness, knowledge and comfort with technology, which increases adoption	Some impact
Odor regs. or odor control	EPA plus siting regs.	More stringent	Similar	Odor control (rather than regulations) to maintain positive relations with neighbors is driver, especially when near residences.	Some impact
Nutrient loading regs	EPA	EPA	More stringent	Driver for installing biogas system.	No impact
Net metering	20 kW limit	40 kW limit	More aggressive, 3–5 MW limit	Higher rates increase economic viability.	No impact
IOU buyback rates for biogas	Special voluntary rates for IOUs. Capped enrollment. Vary by utility.	PPAs. Low avoided cost rates.	PPAs when no net metering. Rates higher in east PA.	Higher rates increase economic viability. Only IOUs offer higher rates up to program limit.	Some impact
Utility rates[a]	$0.07–0.09 per kWh	$0.06–0.08 per kWh	$0.09 per kWh	Higher rates increase economic viability. Wisconsin and MN rates generally lower than national. PA rates were lower and are now higher than the national average.	Negative impact
Interconnect. standards and fees	IOUs have standard requirements and fees	Case by case difficult and costly	Standardized IOU process in 2006	Lack of interconnection standards and variable fees creates uncertainty, increasing risk to farmers.	Some impact

[a]Based on Energy Information Administration average prices 2002–2008 http://www.eia.doe.gov/cneaf/electricity/epa/average_price_state.xls, 2002–2008, commercial rates.

Consistency and expansiveness of the program. The Focus on Energy program differs from the programs in the two comparison states in two key ways. First, it is a consistently funded program that has continuously provided incentives and services for a decade. This consistency increases awareness, knowledge, and acceptance of biogas digesters as a

viable on-farm option. The consistency of grants to farmers provides certainty in the marketplace. Minnesota, with its inconsistent program, provides a contrast.

Financial incentives. Respondents indicate that government financial incentives are important for both legitimizing the projects to access private financing, and to reduce the payback for digester systems. The direct impact of Focus on Energy incentives, however, may be somewhat limited and is reflected in the self-reported attribution.

- Sixteen of the 23 Focus funded digesters also received USDA REAP funding.
- Six of the eight[13] Focus-only funded projects were installed when Focus provided small grant levels. Excluding one early grant for a genset upgrade[14], these grants accounted for between two and twelve percent of the total project costs, with all six projects having an overall average of 3.5 percent of project costs. It is unlikely that the grant substantially changed the project economics; although grants may have helped farmers secure private financing. These projects received varying amounts of project attribution, with respondents who attributed their projects to Focus acknowledging technical assistance or the grant as making a difference.
- Two of the eight Focus-only funded projects were installed during the increased grant period for Focus on Energy. These systems received a total $418,000 in Focus incentive dollars, which was approximately 20 percent of project costs.

The fact that Focus funding was combined with USDA grants for the majority of projects explains and supports the somewhat low self-reported attribution.

Education, outreach, and technical assistance. The program's expansiveness—going beyond financial incentives to offer technical assistance, market development, outreach, and case studies appear to be important to the development of the biogas market in Wisconsin.

Numerous respondents, from state employees to digester implementers and university faculty members, warned that the digester market place contains vendors who are not qualified or are unscrupulous in their business practices. Also, since digesters are still a pioneering technology, most farmers are not well educated on the topic and unsure which technology will work. Therefore, farmers need a trusted source of information to make informed decision on technology. Focus on Energy, as a neutral and state sanctioned information source, provides this value.

Focus did an excellent job of alerting farmers to federal funding opportunities. Through this outreach, Focus leveraged federal grant money to make a number of digester projects economically viable. Focus assisted some farmers in completing USDA applications. Several respondents also credited a system designer who took an early lead in the market to leverage Focus on Energy and USDA funds for their clients. Earlier research by the evaluation team indicated that while farmers found this helpful, the market providers indicated that they would

[13] One system was replaced by a larger system. Both received focus grants.

[14] A relatively small project.

have provided this service in the absence of Focus on Energy.[15] The recent interviews indicated that this has been the case. The effect of program assistance to farmers completing USDA grants is uncertain. Respondents stated that Focus on Energy publicized USDA funding opportunities and provided technical assistance, such as performing feasibility studies, which are required for federal funding.

Focus' grants, providing incentives for feasibility studies, as well as providing technical information on digester engineering, operation, and maintenance, helped mature the marketplace. Many respondents specifically cited Focus as instrumental in bringing digester adoption to the market, and cited education and market coordination (e.g., bringing in good designers) as major accomplishments These market development activities likely contribute to digester adoption because they help farmers reach a confidence level critical for an investment decision. In at least one case where Focus provided substantial technical assistance to a farmer, the farmer addressed this in his response to the evaluation attribution survey and provided the program with full attribution. At a minimum, some of the effects of technical assistance are reflected in the current self-reported attribution.

The education, outreach, and market development activities may be program impacts on participants not recognized by respondents when they are self-reporting attribution. Information about dairy biogas digesters is ubiquitous in Wisconsin at forums for farmers. Wisconsin farmers may take this for granted and not give Focus credit for it in their responses to survey questions.

Odor and nutrient loading regulations and concerns. Odor and other manure management concerns are key drivers for the adoption of on-farm biogas systems. Respondents were less likely to cite regulations and more likely to discuss the encroachment of residences into farm areas or increasing farm size as the reason for installing bio-digesters. Odor and manure management are of increasing concern in Wisconsin because as farms consolidate; they are subject to increasing scrutiny by neighbors and regulators.

Wisconsin has odor regulations somewhat more stringent than the EPA requirements, which would likely lead to increased adoption of biogas digesters. Minnesota, however, has even more stringent regulations than Wisconsin, but has only recently seen an uptake in bio-digesters with the new program modeled after Wisconsin. In Pennsylvania, substantial farm/resident interface and stringent nutrient loading regulations motivate digester installations.

Manure management issues motivate farmers to consider biogas, but the economics must appear favorable for them to proceed. The Minnesota comparison supports this argument—despite stringent odor regulations, Minnesota farmers had very low adoption of dairy biogas digesters until the grant program was available.

Buy-back rates. Favorable buy-back rates are key to the adoption of biogas systems because they have a long-term impact on the economic viability of the project. Wisconsin currently has a myriad of buy-back rates that vary by utility. Investor owned utilities have offered or currently offer special biogas rates through advanced renewable tariffs. Focus on Energy was involved in efforts to develop and promote these tariffs. PSCW staff report,

[15] Bobbi Tannenbaum, KEMA. *BioGas Panel Baseline Study Results.* May 5, 2006.

however, that it was other pressures that prompted them to pursue these tariffs. PSCW pressure resulted in *voluntary* biogas rates. Since they are voluntary, and the programs cap participation levels, many farms still go with individual power purchase agreements.

Interconnection standards and fees. Standard interconnection agreements regularize the process and provide farmers the certainty needed for the large capital expense of the digester. Respondents identified challenges associated with interconnection (connecting biogas systems to the electric utility system) when standard agreements are not in place, detailing stories of capricious interconnection fees causing insurmountable barriers.

Wisconsin has had interconnection standards and fees since February 2004. Pennsylvania standardized its process in 2006. Both of these states have substantial biogas activity, compared to Minnesota. Minnesota does not have standards and thus interconnections are negotiated case-by-case basis. Respondents report that interconnections are difficult and costly, and appear to be another barrier to biogas adoption in Minnesota.

Focus on Energy representatives report working with the PSCW to establish the standard interconnection agreement that has regularized the process. Consistent with buy-back rates, PSCW staff credit other factors for the adoption of interconnection standards.

6.2 CONCLUSIONS

The Focus on Energy biogas program has received some attribution based on self-reports that address the direct effect on participants. Based on the findings discussed above, we believe that Focus on Energy has likely had impacts on the Wisconsin biogas market not reflected in participant self-reports of program attribution. This qualitative study does not provide sufficient data with which to make a quantitative based assessment of these effects. We recommend that the PSCW provide some additional credit for these market effects.

At a minimum:

- Focus education and outreach (including case studies) have increased the awareness, knowledge, and comfort with biogas technology in Wisconsin. Each of the individual activities may appear non-consequential to a program participant, but the ubiquitousness of biogas information for Wisconsin farmers is likely to increase the adoption of biogas digesters on Wisconsin farms.
- Focus incentives have legitimized the projects that received Focus-only funding[16] and likely increased the probability or the speed with which farmers received financing.

These market effects are unlikely to be recognized by participants (or vendor) self-reports of attribution, but indirectly affect a participant's decision to install a biogas digester. We recommend that the PSCW give Focus on Energy some additional credit for these impacts.

[16] The direct impact of the incentive on the participant's decision to install are reflected in the self-reported attribution. Vendor surveys capture the market development activities.

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APPENDIX A: STATE-BY-STATE LISTS OF DIGESTERS

Tables listing individual digesters in Wisconsin, Pennsylvania, and Minnesota are included here. These tables form the basis of analysis to determine levels of biogas activity in each of these states.

A.1 MINNESOTA

Farm Type	Facility	Operational Date	Population Feeding	kW	Notes	Used in Analysis?	Exclusion Justification
Dairy	Riverview Dairy of MN, LLP	2008	7,400		Installed and operational	Yes	Included
Dairy	Diamond K Feeds, LLP		950		Permitting process still underway as of Jan 2010	No	Not operational yet
Dairy	West River Dairy, LLP	2008	6,600		Installed and operational	Yes	Included
Dairy	Jer-Lindy Farms	2008	200	37	Installed and operational	Yes	Included
Dairy	Northern Plains Dairy	2003	3,000	270	Installed and operational	Yes	Included
Dairy	Haubenschild	1999	750	130	(1) Supported using financing from AgStar (technical advice) and MN state (87500 grant and 150000 loan - farm spend 77500 directly) - from casestudy 2) According to a 2007 Mn Dept of Ag slide show Haubenschild farm has excess methane production and had a gas cleaner and fuel cell installed - fuel cell capacity/cost/output is unknown (slideshow: http://www.mda.state.mn.us/en/sitecore/content/Global/MDADocs/renewable/waste/manuredigestion.aspx#256,1,Recent Progress in Manure Digestion)	No	Prior to 2002

Sources:

Haubenschild Farm Case Study http://www.mnproject.org/pdf/Haubyrptupdated.pdf.

Jer-Lindy Farms Case Study: http://www.mnproject.org/e-Jer-LindyFarm.html.

AgSTAR database http://www.epa.gov/agstar/accomplish.html.

Minnesota Office of Energy Security on-farm digester grant awardee list.

A.2 PENNSYLVANIA

Farm Type	Facility	Year Operational	Population Feeding	kW	Notes	Use in Dairy Farm Analysis	Exclusion Justification
Dairy	Mason Dixon Farm	1978	2,985	600		Yes	Prior to 2002
Poultry	Brendle	1984	72,000	65		No	Non-dairy
Swine	Rocky Knoll	1985	1,000	130		No	Non-dairy
Dairy	Oregon Dairy Farm LLC	1986	385	65	No purchase agreement with utility (unit is paralleled with grid)	No	Unit parallel to grid
Swine	High, David	1998	1,200	22		No	Non-dairy
Swine	Pine Hurst	2004	4,400	47		No	Non-dairy
Dairy	Brookside Dairy	2006	425	85		Yes	Included
Dairy	Dovan	2006	400	100		Yes	Included
Dairy	Four Winds Farm	2006	500	130		Yes	Included
Dairy	Hillcrest Saylors Dairy	2006	750	100		Yes	Included
Dairy	Main Dairy	2006	500	90		Yes	Included
Dairy	Penn England Farms	2006	800	130		Yes	Included
Dairy	Schrack Farms	2006	600	200		Yes	Included
Dairy	Brubaker	2007	900	160		Yes	Included
Dairy	Pride -n- joy	2007	400	130		Yes	Included
Beef	Zimmerman	2007	121,000	175	Both chicken (120,000) and beef cattle (1,000) contribute to the system	No	Non-dairy
Dairy	Reinford Farm	2008	470	130		No	Included
Swine	Beaver Ridge Farm Inc.				Removed, not yet built	No	Non-dairy
Dairy	Bortnick Dairy	2009	1,800	500	Augmented with dog food residue from nearby plant	Yes	Included
Cheese	Fairview				Removed, not yet built	No	Cheese waste
	Graywood				No evidence of operation	No	No farm type
Swine	Hogs Galore				No evidence of operation	No	Non-dairy
Dairy	John Koller & Son, Inc.			120	Same as Fairview above	No	Duplicate
	Lackawanna River Basin Sewer Authority			130	Microturbine	No	Non-dairy
Swine	Mathis				Removed, not yet built	No	Non-dairy
Dairy	Pleasant View Farms	2007	6,500			Yes	Included
	Cove Area Regional Digester				Not yet operational	No	Non-dairy

Farm Type	Facility	Year Operational	Population Feeding	kW	Notes	Use in Dairy Farm Analysis	Exclusion Justification
Swine	Red Knob Dairy				Cancelled, farm shut down	No	Non-dairy
Swine	Southern Alleghenies Conservancy Inc.				Removed, co-signer for Pleasant View Farms on grant	No	Non-dairy
Cheese	Sun-Re Cheese Corp	2007		200	Cheese wastes	No	Cheese waste
Beef	Terczak veal farm				No information available	No	Non-dairy

Sources:

On Farm Anaerobic Digestion Biogas Production in Pennsylvania – 30 years, Penn State University

Penn State University Biogas and Anaerobic Digestion Group Case Studies http://www.biogas.psu.edu/casestudies.html

AgSTAR Database http://www.epa.gov/agstar/accomplish.html

Pennsylvania Department of Environmental Protection press releases

A.3 WISCONSIN

Farm Type	Facility	Year Online	Number of Cattle/Feeder Animals	Capacity (kW)	Focus Funded	In Focus Territory	USDA Reap recipient	General notes	Used in Analysis	Exclusion Justification
Dairy	Bach Digester LLC	2010	1,200	300	1	1	1	Not listed in casebooks. Recent press release: http://www.wisconsinagconnection.com/story-state.php?Id=35&yr=2010	Yes	Included
Dairy	Green Valley Dairy LLC	2009	1,200	500	0	1	0	Added a third digester, Focus feasibility study	Yes	Included
Dairy	Grotegut	2009	1,800	710	1	1	1	declined participation in 2009 casebook study - details are avail from Focus database	Yes	Included
Dairy	Statz Brothers, Inc	2009	2,560	600	1	1	1		Yes	Included
Dairy	Volm	2009	825	225	1	1	1		Yes	Included
Dairy	Central Sands Dairy, LLC	2008	3,800	720	0	0	1	Sells to Dairyland Power	Yes	Included
Dairy	Clear Horizons LLC (aka Crave brothers)	2008	1,900	633	1	1	0	Replaced generator with larger one	Yes	Included
Dairy	Norm-E-Lane, Inc. (NEL)	2008	2,500	600	0	0	1		Yes	Included
Dairy	Pagels Ponderosa Dairy LLC	2008	2,300	400	1	1	1	Two digesters, one genset	Yes	Included
Dairy	Pagels Ponderosa Dairy LLC	2008	2,300	400	1	1	1	Two digesters, one genset	Yes	Included
Dairy	Clover Hill Dairy	2007	1,400	225	1	1	1	Expansion (add thermal) in 2008	Yes	Included

Farm Type	Facility	Year Online	Number of Cattle/Feeder Animals	Capacity (kW)	Focus Funded	In Focus Territory	USDA Reap recipient	General notes	Used in Analysis	Exclusion Justification
Dairy	Holsum Dairy (Elm Rd)	2007	4,200	200	1	1	1	Newer project for Holsum	Yes	Included
Dairy	Baldwin	2006	1,200	200	0	0	1	St. Croix Electric Coop.	Yes	Included
Dairy	Green Valley Dairy LLC	2006	1,133	250	1	1	0	One rebate for two digesters	Yes	Included
Dairy	Green Valley Dairy LLC	2006	1,133	250	1	1	0	One rebate for two digesters	Yes	Included
Dairy	Lake Breeze Dairy Llc	2006	1,500	300	1	1	1		Yes	Included
Dairy	Lake Breeze Dairy Llc	2006	1,500	300	1	1	1		Yes	Included
Dairy	Norswiss Farms	2006	1,240	848	0	0	1	Sells to Dairyland Power, digester operated by microgy	Yes	Included
Dairy	Suring Digester, LLC	2006	1,075	250	1	1	1		Yes	Included
	Buckeye Ridge Renewable Power	2005	currently no information		0	0	1	Not listed in Casebooks. Confirmed as existing by Brenda Heinen. Only other evidence of this systems existence so far is a mention in the minutes from a Webster town meeting (item 13 at: http://tn.webster.wi.gov/meetings.php?p=t&id=358)	No	No farm type
Dairy	Emerald Dairy Waste Processing Inc	2005	1,600	-22	1	1	1	A later stage of this project was funded by focus (in 2008) to offset gas (electricity goes to St. Croix Electric Coop.)	Yes	Included
Dairy	Five Star Dairy Farm	2005	975	775	0	0	0	Sells to Dairyland Power, digester operated by microgy	Yes	Included
Dairy	Quantum Dairy, LLC	2005	2,100	200	1	1	1		Yes	Included
Dairy	Wild Rose Dairy	2005	880	750	0	0	0	Sells to Dairyland Power, digester operated by microgy	Yes	Included

Farm Type	Facility	Year Online	Number of Cattle/Feeder Animals	Capacity (kW)	Focus Funded	In Focus Territory	USDA Reap recipient	General notes	Used in Analysis	Exclusion Justification
Dairy	Vir-Clar Farms	2004	700	175	1	1	0	One rebate for two digesters	Yes	Included
Dairy	Vir-Clar Farms	2004	700	175	1	1	0	One rebate for two digesters	Yes	Included
Dairy	Holsum Dairy (Irish Rd)	2003	1,925	400	1	1	1	initial project installed 2 digesters, focus funded a 2005 expansion (increase generation capacity)	Yes	Included
Dairy	Holsum Dairy (Irish Rd)	2003	1,925	400	1	1	1	initial project installed 2 digesters, focus funded a 2005 expansion (increase generation capacity)	Yes	Included
Dairy	Double S Dairy	2002	1,100	120	1	1	0	Received Focus funding for a generator upgrade, original system was not eligible at time of installation	Yes	Included
Dairy	Gordondale Farms (aka Deere Ridge)	2002	850	140	1	1	1	Part Funded by Focus Pilot program (re: Don Wichert) aka Deere Ridge Dairy	Yes	Included
Dairy	Stencil Farm	2002	1,200	120	0	1	0	Built during Focus pilot period, retired	Yes	Included
Dairy	Tinedale Farms	2001	2,400	375	0	1	0	Built during Focus pilot period, retired, casestudy: www.mrec.org/pubs/212-1.pdf	No	Prior to 2002
Non-Dairy	Maple Leaf	1988	50,000	200	0	1	0	Farm shut down, no longer operating	No	Non-dairy

Sources:

Voell, 2009

Kramer, 2002.

Kramer, 2009.

AgSTAR database http://www.epa.gov/agstar/accomplish.html

Wisconsin Ag Connection. 1/11/2010. "Another Farm Anaerobic Digester Goes Online" Accessed 3/1/10. From: http://www.wisconsinagconnection.com/story-state.php?Id=35&yr=2010

KEMA records of Focus program work

USDA REAP recipient list

APPENDIX B:INTERVIEW PROTOCOL

Focus on Energy Evaluation

Renewable Energy Program: Biogas Supply-side Study, Phase 2

Interview Framework

Interviewee name:

Interview date and time:

Interviewee state:

Perspective: (state level, regional/national)

1. Can you tell me about what your organization does in regards to on-farm (dairy) bio-digesters?
2. Can you tell me about what you do professionally specifically in relation to bio-digesters?

    a. What percent of your job is related to digesters?

    b. How long have you been working on bio-digesters?

3. What do you see as the main reasons that dairy farmers install bio-digesters? (any others) intv. Instructions – get at the relative importance and frequency of the reasons.)

    (Probe these topics more specifically, if appropriate)

    a. Odor control

    b. Meeting air quality regulations

    c. Water quality & nutrient loading regulations

    d. Reducing electric bill or selling electricity

    e. Concern for the environment

    f. Energy independence

    g. What about fertilizer (selling, use on property)

    h. Bedding (selling, use on property)

    i. Tax incentives

    j. Proximity to suburban neighborhoods (related to odor)

    k. Increased farm productivity (how does it increase productivity?).

4. Are there other benefits to installation of a digester that I'm missing?

5. Why are farmers generating electricity rather than flaring the gas?

6. How has the relative importance of these factors changed over time? If so, how? (and in what time frame)

7. Do these reasons to install biogas digesters vary by region? If so, how and why? (get specifics on the states of interest)

8. What are the risks associated with implementing anaerobic digestion and biogas power?

9. What do you see as the main barriers to dairy farmers for implementing anaerobic digesters?

   (probe these topics more specifically, if appropriate) (get at relative importance and frequency)

   a. Access to capital

   b. Availability of information & technical expertise

   c. Technological uncertainty

   d. Buy-back rates (are they too low?)

   e. Regulatory barriers such as permitting?

   f. Operational costs .

10. Are there issues with connecting a biogas system to the grid? Are there interconnection standards that help mitigate this problem?

11. Do these barriers differ in different regions? If so, how and why?

12. Are there any other barriers that we haven't touched on?

13. To what extent if any does the development of biogas in other sectors such as wastewater treatment affect the development of dairy biogas?

14. How do State biogas programs encourage the market for biogas? Can you talk specifically about what the different programs in WI, PA, and MN are doing?

15. What aspects of these programs do you think are most important for increasing the adoption of on-farm biogas systems? Please explain why you think these reasons are

<u>STATE PROGRAM QUESTIONS</u>

16. Why did your state start a biogas program?

17. Can you tell me how and why your State's biogas program promotes dairy farm biogas?

a. Probes, only as needed.

i. Financial – grants, incentives, etc.

ii. Non-financial – education (how and to whom?), work on buy-back rates, feed-in tariffs, interconnection standards, assistance getting other funding, technical expertise, etc.

18. What major changes (new activities, changes in incentive levels, etc.) have you made to your program and why?

19. What aspects of your program do you think are most important for increasing the adoption of on-farm biogas systems? In what ways?

20. How does the Federal government encourage biodigesters in these states?

21. Is there anything else we should know about how the State program influences the biogas market?