Capitalizing on Energy Opportunities on New York Dairy Farms

Participant Briefing Paper: Opportunity Analysis

Dairy Power New York Summit: Creating a Greener, Cleaner Future October 29-30, 2009

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FORWARD

Thank you for participating in the Dairy Power New York Summit: *Creating a Greener, Cleaner Future*. The summit will be held Oct. 29-30 at the Holiday Inn in Liverpool, N.Y. This meeting offers an unprecedented opportunity to affirm our shared commitment to creating economically viable digester operations on New York dairy farms. As an expert in your field, your experience and unique perspective will be crucial to our collective success.

The focus for the Dairy Power Summit will be to identify breakthrough approaches to widespread adoption of anaerobic digester technology in New York by designing business strategies that build economic, social and environmental value for all parties involved with and impacted by digesters.

In preparation, we have created this briefing paper for your review.

How to Use the Briefing Paper

This paper is divided into two sections: an Opportunity Analysis and a Reference Document. The Opportunity Analysis assumes some familiarity with digesters and digester economics. The Reference Document provides a resource for basic digester information as well as more in-depth learning about the intricacies of various digester and renewable energy issues. We hope you find this information useful in your preparation for participating in the summit.

The Opportunity Analysis includes important information and current data on anaerobic digestion in New York, as well as some ideas to inspire innovative thinking. The opportunity areas discussed in this document represent the contributions of dozens of industry experts (see Acknowledgments) and have been developed to provide context and to prompt thought relating to the possibilities for project development. These opportunities are not meant to be exhaustive; there are other innovations that we hope to further develop in collaboration with you and the other participants at the summit.

As you read through this paper, please keep the following questions in mind:

- What additional opportunities come to mind to facilitate project development and generate business value?
- What role can you play in helping realize these opportunities both during and after the summit?
- How can these opportunities be more widely adopted?
- How can the opportunities be combined to create additional value?
- Who are the key stakeholders to champion these opportunities?
- What are the business models that will make these opportunities a viable reality and resounding success?
- What are the regulatory and financial barriers that need to be addressed?

ACKNOWLEDGMENTS

The Dairy Power New York Summit and this briefing paper would not have been possible without the contributions and input of the following people:

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INTRODUCTION

The Dairy Power New York Summit: *Creating a Greener, Cleaner Future* will be an action-oriented dialogue among leading dairy and renewable energy industry stakeholders to develop new solutions to facilitate the adoption of anaerobic digester technology in New York and accelerate adoption throughout the United States. To support this dialogue, this document provides an in-depth analysis of issues in New York, including the market opportunity for digesters, the conditions necessary for success, the opportunities available, and the financial implications of digesters. By investing the time to read this document prior to the summit, participants will arrive at the summit with a common foundation of knowledge and will be prepared to focus on action plans that advance anaerobic digesters in New York.

Who is Facilitating the Summit?

The summit will be facilitated by John Whalen, principal at Blu Skye Sustainability Consulting, and Molly McGuigan, organizational development consultant. John has facilitated many large summits in the past, and his facilitation strength lies in engaging stakeholders and experts, who don't usually work together, in conversations they've never had, creating a shared vision of a future they all want to see happen, and aligning around the actions that create real value for the industry and its stakeholders. He uses a variety of methods that break down barriers, challenge assumptions, open avenues for innovation and foster collaboration. Molly has more than 14 years of experience partnering with corporations, small businesses and non-profits to increase individual and organizational performance through learning and development. Her work focuses on creating high-impact executive education programs, designing strategic change initiatives and facilitating team development. The facilitation method that John and Molly will use at the Dairy Power Summit is called Appreciative Inquiry.

What is an Appreciative Inquiry Summit?

The summit will use a large-group facilitation technique known as Appreciative Inquiry.[1] To appreciate means to value — to understand those things worth valuing. To inquire means to study, to ask questions, to explore. Appreciative Inquiry is, therefore, a collaborative exploration to identify and understand a particular group's strengths, their greatest opportunities, and their aspirations and hopes for the future, and to build a shared plan of action that will help create that future.

An Appreciative Inquiry Summit is a whole-system working meeting that engages a cross-section of as many internal and external stakeholder groups as possible — groups that care about and have a stake in the future of the industry. This means more diversity and less hierarchy than is usual in a working meeting, and a chance for each person and stakeholder group to be heard and to be exposed to other perspectives on the challenges and opportunities facing the group. Each individual participant has been selected because of their ability to contribute as a decision-maker, influencer or activator to make the opportunities for anaerobic digestion viable.

This summit is *task focused*, not simply an educational event or a conference. Through a highly participative process you will build a shared vision, explore opportunity areas, and create a practical action plan. This plan will build on the historic strengths of the dairy industry in stewardship of the land and protection of the environment, and will engage the core decision-making components that affect the ability of anaerobic digester (AD) technology to flourish.

The outcome of the summit will be the development of action plans to move us toward our collective goals as well as a collective commitment to follow through on these actions.

[1] Go to http://appreciativeinquiry.case.edu/ for more information on Appreciative Inquiry.

DAIRY INDUSTRY OVERVIEW

The dairy industry has a unique value chain that reaches from farmers, associations and cooperatives to processors, manufacturers, retailers and consumers. The economic impact of the U.S. dairy industry is estimated at close to $100 billion and is responsible for hundreds of thousands of jobs nationwide.[2] The reach is felt abroad with exports having an annual value of more than $3 billion and represent 9%[3] of the total amount of dairy products sold.

Today there are approximately 59,000 total dairy farms in the United States and, on average, there are 155 cows per farm.[4] Each cow has an average production of 2,300 gallons of milk per year. In total there are 9.1 million cows that produce an annual output of more than 180 billion lbs. of fluid milk.[5] The multiplied economic impact of dairy farmers and the cooperatives they own is estimated at more than $172 billion.[6] This is almost 10% of the total agricultural farm sales within the United States.[7]

An estimated 100 dairy associations[8] have diverse objectives ranging from representing dairy farmers in regulatory/policy matters, providing educational programs, assisting with milk production and promoting dairy products for consumption. These associations exist on both a national and local level.

The approximately 200 dairy cooperatives account for roughly 11% of all agricultural sector markets of farm cash receipts. Dairy cooperatives market 86%[9] of all milk delivered to plants in the United States. By themselves, cooperatives total sales account for $38 billion.[10]

There are more than 1,000 processing plants nationwide. These locations account for nearly 182 billion lbs. of dairy products. Of this total output, 57 billion lbs. is for fluid milk alone.[11] The remaining output is spread across products such as cheese, yogurt, ice cream and powdered milk. With an impact to our economy of about $140 billion, processors contribute significantly to the dairy value chain.[12]

What is Driving Sustainability in the U.S. Dairy Industry?

Global climate change, accelerated by the build-up of greenhouse gases in the atmosphere, has captured the unprecedented attention of government, industry and the public at large — illuminating a host of new challenges. The dairy industry has not been exempt from the need to change, and in this dynamic environment, new challenges constantly appear on the horizon. Confronting and anticipating these challenges presents both opportunities to improve environmental performance *and* drive business value — ensuring a sustainable future for people and the planet. To harness the dairy industry's collective strengths in charting a bold path forward, it is important to understand some key drivers behind the movement commonly referred to as "sustainability." These drivers include:

- Food supply and demand
- Land resources
- Water scarcity
- Threatened ecological systems
- Societal/consumer demand
- Regulation
- Business investment and innovation

[2] NMPF Dairy Producer Highlights. (2007). National Milk Producers Federation.
[3] USDEC
[4] USDA February 2008 Milk Production Report
[5] 2007 IDFA Dairy Facts
[6] Rodger Cryan 2008 NMPF, Page 9
[7] USDA United States Fact Sheet
[8] 2008 Encyclopedia of Associations
[9] USDA: Cooperatives in the Dairy Industry
[10] Estimate of 2007 prices from USDA (2006) Farmer Cooperative Statistics
[11] IDFA 2007 Dairy Facts
[12] U.S. Dairy Markets & Outlook, Page 4

More detail on each of these drivers is included in the Reference Document.

The Greenhouse Gas Footprint for Fluid Milk

Scope and methodology

Greenhouse gases (GHGs) are gases that occur in the atmosphere both naturally and through human activities, including operating power plants and driving vehicles. Each GHG interacts differently in the atmosphere. The potency of a gas depends on its ability to trap heat in the atmosphere and the length of time it remains there before breaking down. Because of these different potentials, GHG are reported in the uniform metric of carbon dioxide equivalents (CO_2e). Other GHGs discussed in this paper include methane (CH_4: 23 times as potent as carbon dioxide); nitrous oxide (N_2O: 310 times as potent as carbon dioxide); and refrigerants (HFC/HCFC refrigerants that range from 400 to 12,000 times the potency of carbon dioxide).[13] A "carbon footprint" is a common term for a life cycle assessment (LCA) of GHG emissions; it is a measure of the amount of GHGs emitted by a given activity, measured in units of carbon dioxide.[14]

To understand where the GHG emissions occur in the fluid milk supply chain, a footprint analysis was conducted using *secondary* research. The intent of the "scan-level" footprint is to inform strategies to address the primary sources of GHG emissions across the value chain.

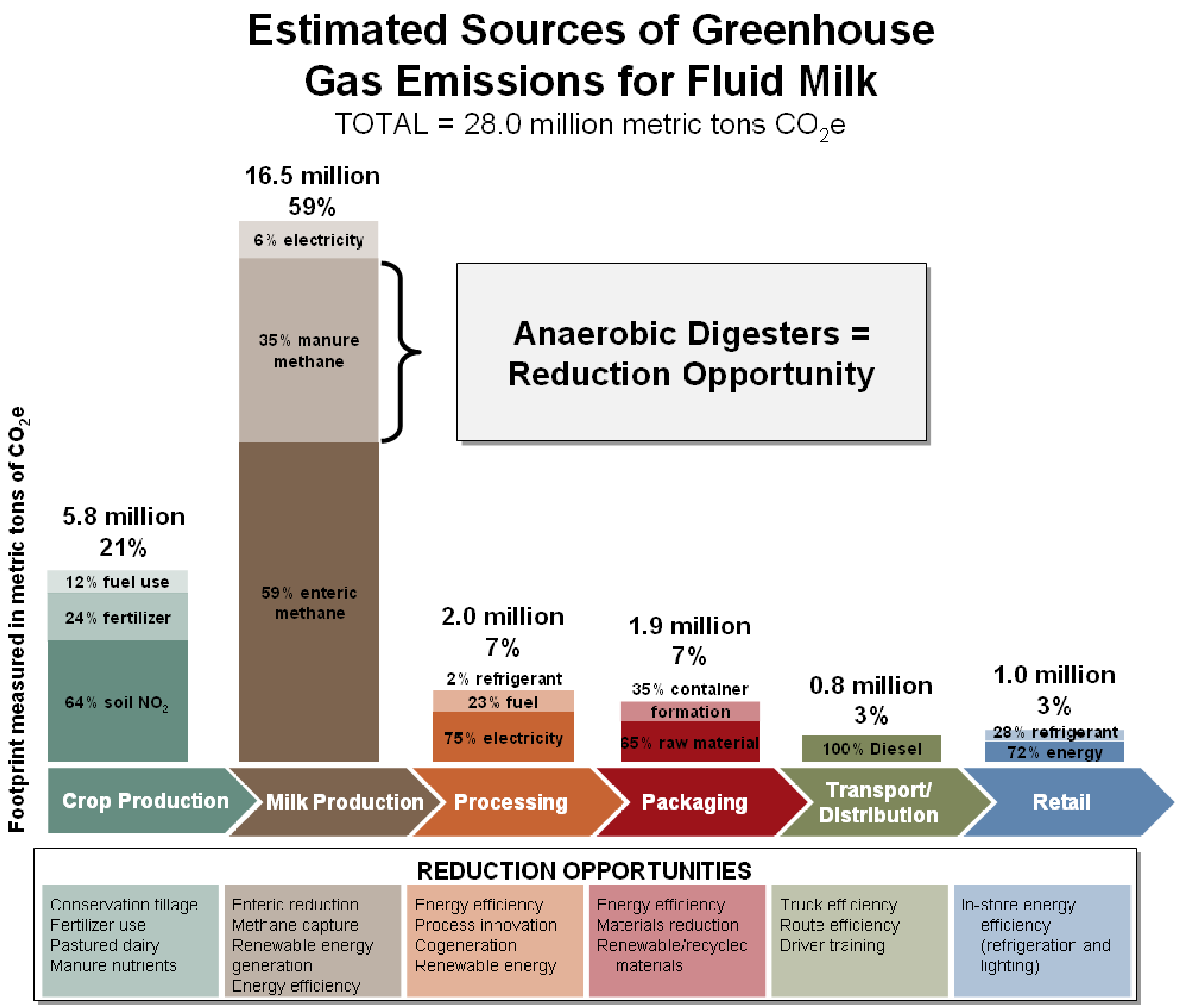
The scan-level footprint drew upon data from 36 secondary sources to calculate emissions from each stage in the fluid milk value chain. The University of Arkansas is in the process of conducting a comprehensive peer-reviewed life cycle assessment (LCA) for fluid milk. The LCA will provide a detailed review of emissions sources based on data gathered from industry participants across the fluid milk value chain. The study will be the first comprehensive survey of the GHG emissions for the U.S. fluid milk value chain and is expected to be complete by the end of 2009.

Footprint findings

The figure below shows the aggregated results of the scan-level footprint for fluid milk and the relative size of GHG emissions across the value chain. Crop and milk production make up the majority of emissions. This is typical of LCAs where the early steps in the value chain require extraction or use of natural resources and therefore have larger GHG emissions due to the large amounts of energy and/or high quantity of inputs required. While the steps further down the value chain (processing, packaging and transportation) may have smaller relative contributions, they are still significant portions of the footprint and represent an opportunity to add business value to all stages of the fluid milk value chain.

The *estimated* total aggregate GHG emissions for fluid milk per the scan-level footprint is 28 million metric tons of GHGs, which is equivalent to the emissions of 5.1 million passenger cars.[15]

[13] Intergovernmental Panel on Climate Change (IPCC)
[14] http://www.carbonfootprint.com Carbon Footprint LTD accessed Nov. 10, 2008
[15] U.S. EPA – Green Power Equivalency Calculator, www.epa.gov/grnpower/pubs/calcmeth.htm

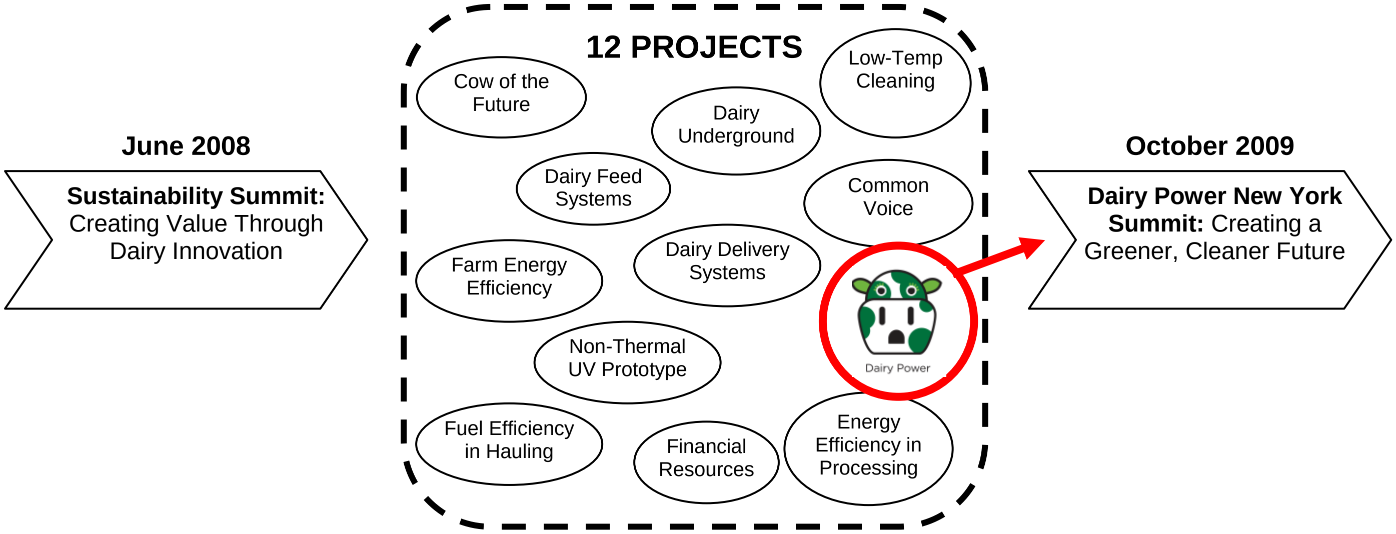


Summit Context

In June 2008, the dairy industry's first Sustainability Summit: *Creating Value Through Dairy Innovation* convened in Rogers, Ark., bringing together more than 250 participants representing 166 farms, businesses and organizations. The goal of this summit was to identify opportunities to reduce GHG emissions and build business value across the dairy value chain.

Twenty-seven projects emerged, and project teams worked together after the summit to assess the full potential of each. Dairy Power, along with 11 other projects, went through a rigorous review process to ensure that the assumptions are sound and the potential is viable. In January of 2009, the Innovation Center for U.S. Dairy, which represents approximately 80% of dairy in the United States, endorsed the portfolio of projects and committed to manage and advance these projects with the support of many stakeholders from around the country and the world.

The Dairy Power New York Summit plays a critical role in advancing this project by focusing specifically on the carbon reduction and business value opportunity presented by methane digesters.



2020 Goal for Dairy Industry Greenhouse Gas Reductions

Following the June 2008 Sustainability Summit, an industrywide leadership team — the Sustainability Council — worked with GHG reduction project teams to draft a set of GHG reduction goals for each stage of the value chain. Committing to significant industrywide goals serves several purposes:

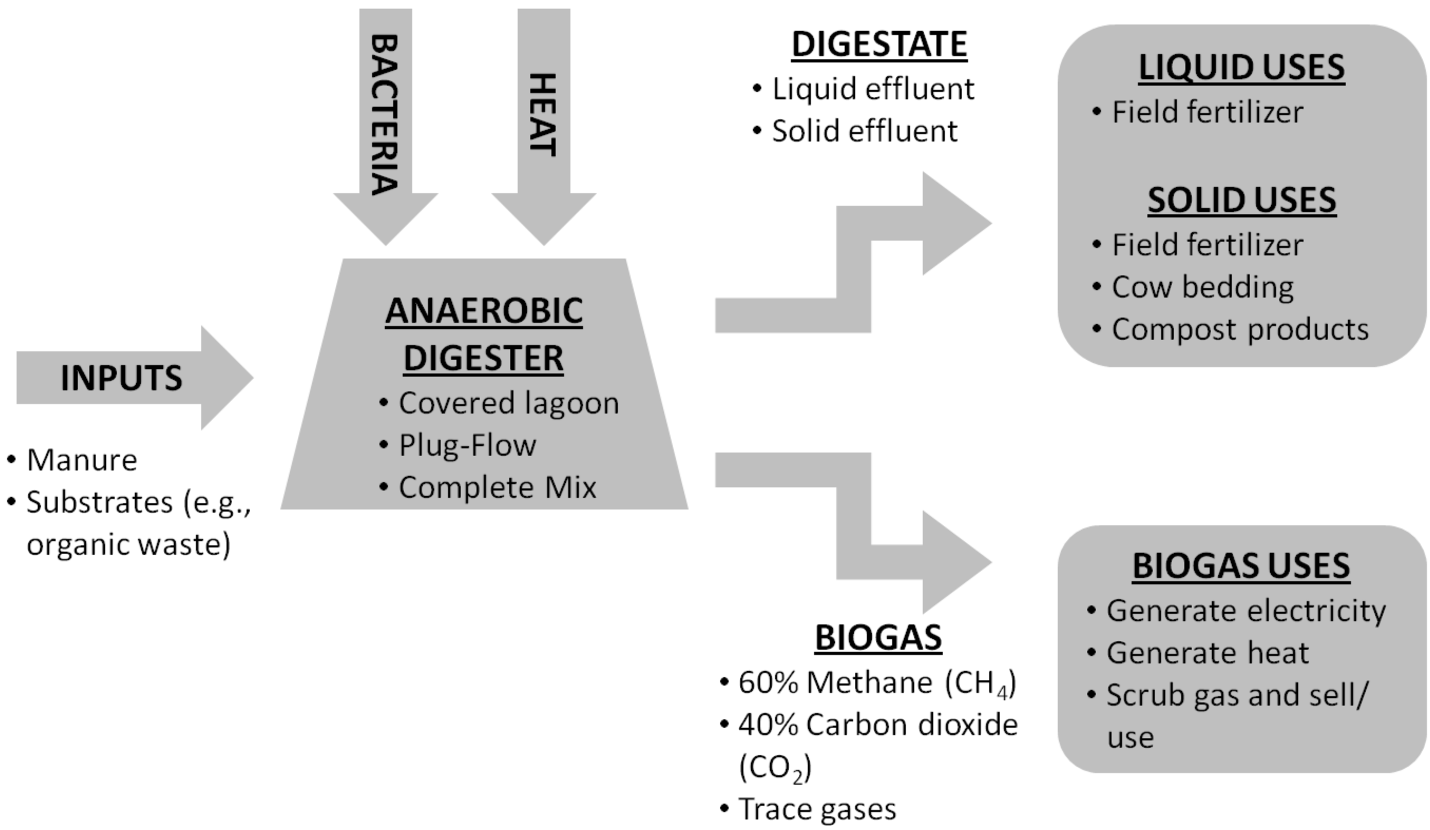
- Substantial goals signal the industry's commitment to leadership in reducing GHG emissions
- These goals empower people to challenge current thinking and help drive breakthrough innovation
- They provide a framework for tracking and measuring progress and enable an effective public relations strategy

The Sustainability Council used data from the scan-level footprint, research on best practices, and information gathered by the project teams to draft the GHG reduction goals, which were endorsed by the Innovation Center for U.S. Dairy in January 2009. In total, these "stretch" goals, achievable by 2020, represent a **25% reduction in total GHG emissions from a 2007/2008 baseline**.

2020 Goal:
25% Reduction in Total GHG Emissions
(from a 2007/2008 baseline)

Anaerobic Digester Overview

The following diagram shows a conceptual view of how anaerobic digesters work. A more detailed overview is provided in the Reference Document.



Potential Methane Digester Benefits

A critically important first step in reaching the dairy industry's GHG reduction goal is to develop best practices and models for implementing anaerobic methane digester use on U.S. dairy farms. Methane from manure from our nation's 9.1 million dairy cows accounts for approximately 21% of the total fluid milk carbon footprint — and it represents a largely untapped source of renewable energy.[16]

The following table represents *potential* benefits — tangible and intangible — by relevant stakeholder groups. This list is not comprehensive.

Stakeholders	**POTENTIAL BENEFITS**			
	Revenue Enhancement	**Cost-Reduction or Avoidance**	**Risk Mitigation**	**Other**
Dairy Producers	• Excess electricity • Scrubbed biogas • Cow bedding • Compost • Food waste tipping fees • Carbon credits • Education/consulting	• Reduced energy costs (electricity, natural gas and/or fossil fuels) • Reduced or avoided cow bedding costs • Reduced or avoided fertilizer costs • Pathogen reduction	• Pathogen reduction • Diversified revenue streams • Contracted price rates	• Odor control • Nutrient management • Expertise and knowledge-building • Innovation opportunity
Digester Industry	• Digester sales • Digester consulting/education • Digester service and support • Expansion opportunities into complementary markets (e.g., food processing, other organic waste, etc.)	• Reduced sales and marketing costs	• Broader client base	
Utilities	• Rate payer programs (e.g., "Cow Power" in Vermont through Central Vermont Public Service)	• Reduced or avoided capital investment • Reduced costs accessing new raw inputs (i.e., not having to explore for gas fields)	• Supporting clean energy development	
Substrate Providers	• Closed-loop process can increase sales	• Reduced or avoided food waste disposal and/or storage costs	• Supporting waste reduction	
Government	• Tax revenue from new businesses created		• GHG reduction	• Job creation • GHG reduction

16 U.S. Dairy Roadmap to Reduce Greenhouse Gas Emissions and Increase Business Value. December, 2008.

Market Potential

Market drivers

The factors driving the development of anaerobic digester systems include the following:

1) Increasing land-use pressures
   - Suburban sprawl is increasing the interaction between neighborhoods, agricultural processes and farms throughout the nation. Population and development pressures continue to grow and producers will find it even more important to be conscientious of the impact of their operations on their neighbors. In particular, odor is the number one reason that neighbors complain about nearby dairy farms.

2) Environmental quality issues
   - Increasing regulation of air and water quality is resulting in more oversight of the farm's management of residual waste streams, such as manure and flush waters
   - There are growing consumer demands for environmentally responsible products that have low carbon footprints and incorporate stewardship ethics into production practices
   - International and consumer pressures are leading to the creation of a regulatory mechanism (e.g., cap and trade) to measure and reduce greenhouse gas emissions. This will require better environmental management systems, and ADs can provide a number of management options as well as new revenue streams.

3) Consolidation of the U.S. dairy industry
   - A large number of farms are going out of business, and in some instances demand is being consolidated in larger-herd-size farms. Mid-size and large farms can have challenges managing their manure and some would benefit from proven, cost-effective manure treatment systems that meet their needs, while also providing a source of clean, renewable energy.

4) Demand for clean energy
   - Climate change concerns and the oil price spikes of 2008 have caused both consumers and businesses to rethink how the energy they use is generated. There is increased pressure on governments and utilities to provide options for power from sources that do not deplete natural resources and also do not expose consumers and businesses to severe price spikes.

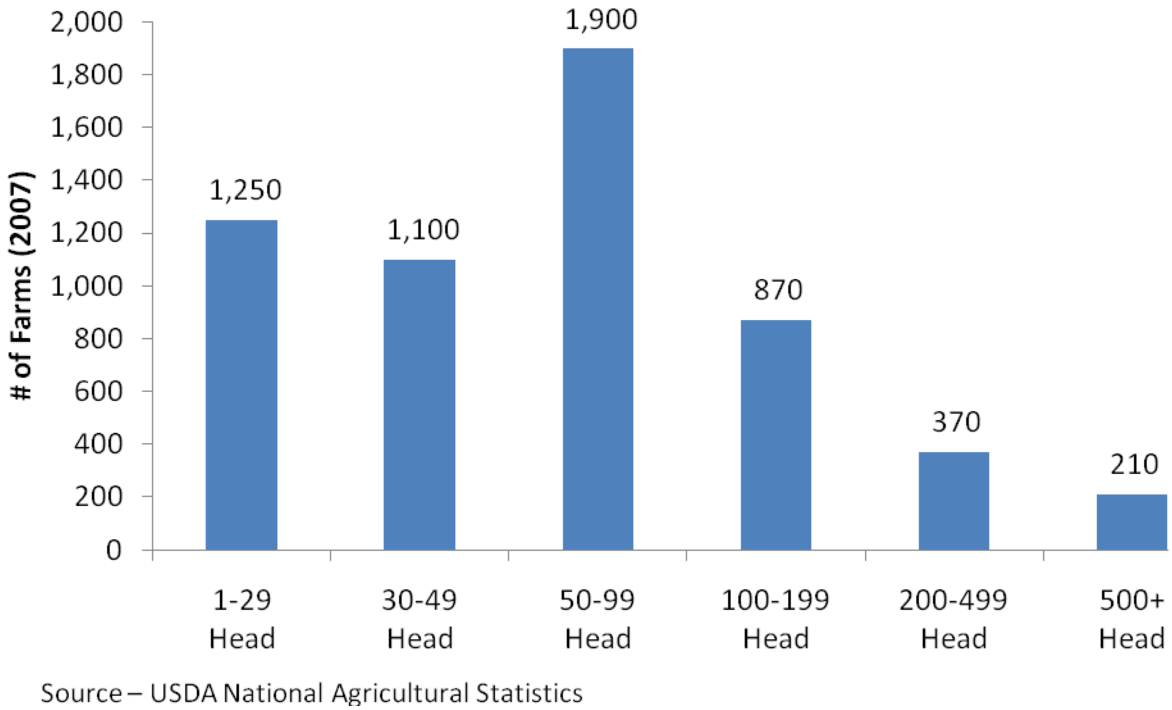
Opportunity for anaerobic digesters in New York

Dairy statistics show that there are 626,000 cows on more than 6,000 dairy farms in NY that are responsible for producing 12,432 million lbs. of manure in 2008.[17] As of August 2009, AD in NY included approximately 14,000 cows and an in-place generation capacity of 2.5 megawatts (MW). Considering projects that are both in the planned and under-construction phase, digested manure from an additional 23,000 dairy cows in NY will add 8 MW to the electricity generating capacity of digesters currently in operation in NY.

The average herd size of a NY dairy farm is about 110 cows; however, for the purposes of AD planning and opportunity analysis, it is important to note that this average can be deceiving as the distribution of herd sizes across farms varies significantly.

[17] *Hoard's Dairyman*, 2009

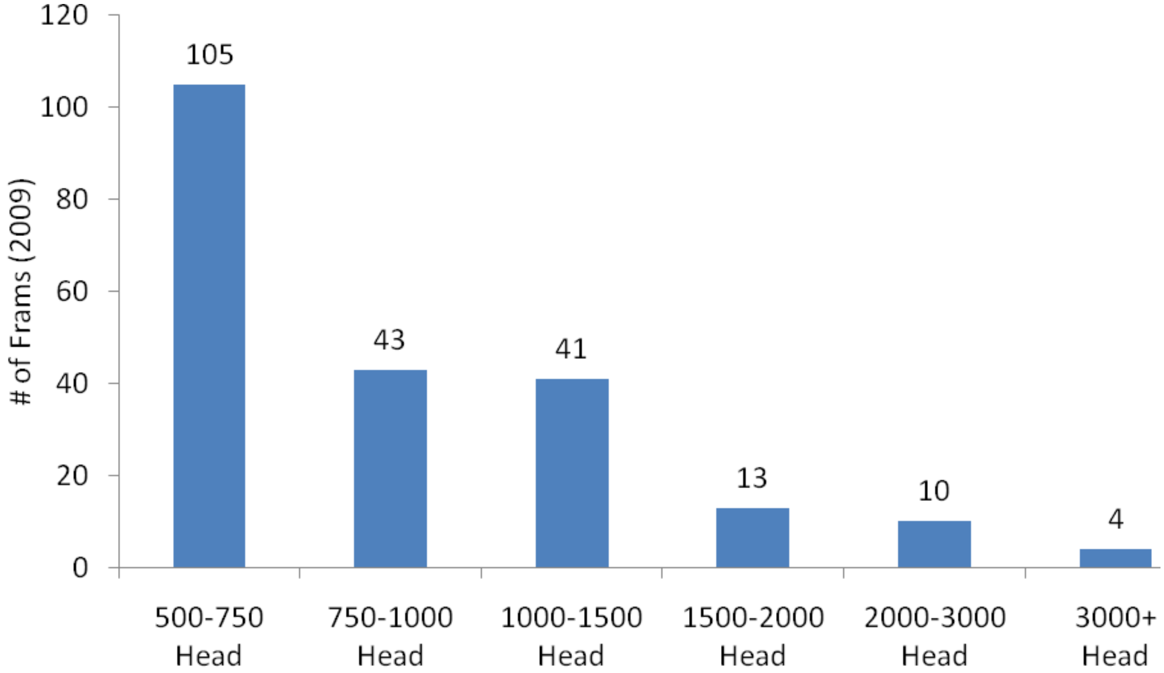
Figure 1: Distribution of NY Dairy Farms, by Herd Size (2007)



Under a typical digester business model that assumes no substrates are added, practitioners use a rule of thumb as an initial screen for assessing potential digester feasibility. This screen is that the farm should have anywhere from at least 500 to 1,000 head of cows or greater. The logic is that for farms with more than 500 to 1,000 cows, the volume of manure produces enough gas to help offset the large capital investment costs.

As of August 2009 there are 13 digesters in operation in NY, 12 of which are at farms with more than 500 head. NY DEC CAFO data from June 2009 indicates that NY has 216 dairy farms with 500 head or more, so digesters have approximately 6% penetration. (Note: This does not include 65 CAFO farms for which DEC received erroneous data showing 0 cows). The following chart illustrates the opportunity available at large-scale dairy operations in NY.

Figure 2: Distribution of 500+ Head NY Dairy Farms, by Herd Size (2009)



Source: New York Department of Environment and Conservation, CAFO Registry

NY also has approximately 5,500 farms that are below 500 head, and the Dairy Power Summit will be exploring viable options for these small- and medium-size farms as well. A viable, profitable solution for these farms would only serve to increase the opportunity for ADs in New York.

Opportunity for biogas production, energy production and GHG reduction

The potential production of biogas from New York dairy farm digesters depends on many assumptions, including: whether substrates are added, quality and type of those substrates, digester design and management, and the type of bedding material used on the farm. Therefore, it is difficult to calculate precisely the potential; nevertheless, there have been several studies conducted on the potential in NY, notably from EPA AgStar and Cornell University. Following is a summary of the findings:

Table 1: Comparison of Studies of Biogas Potential for NY Dairy Farms

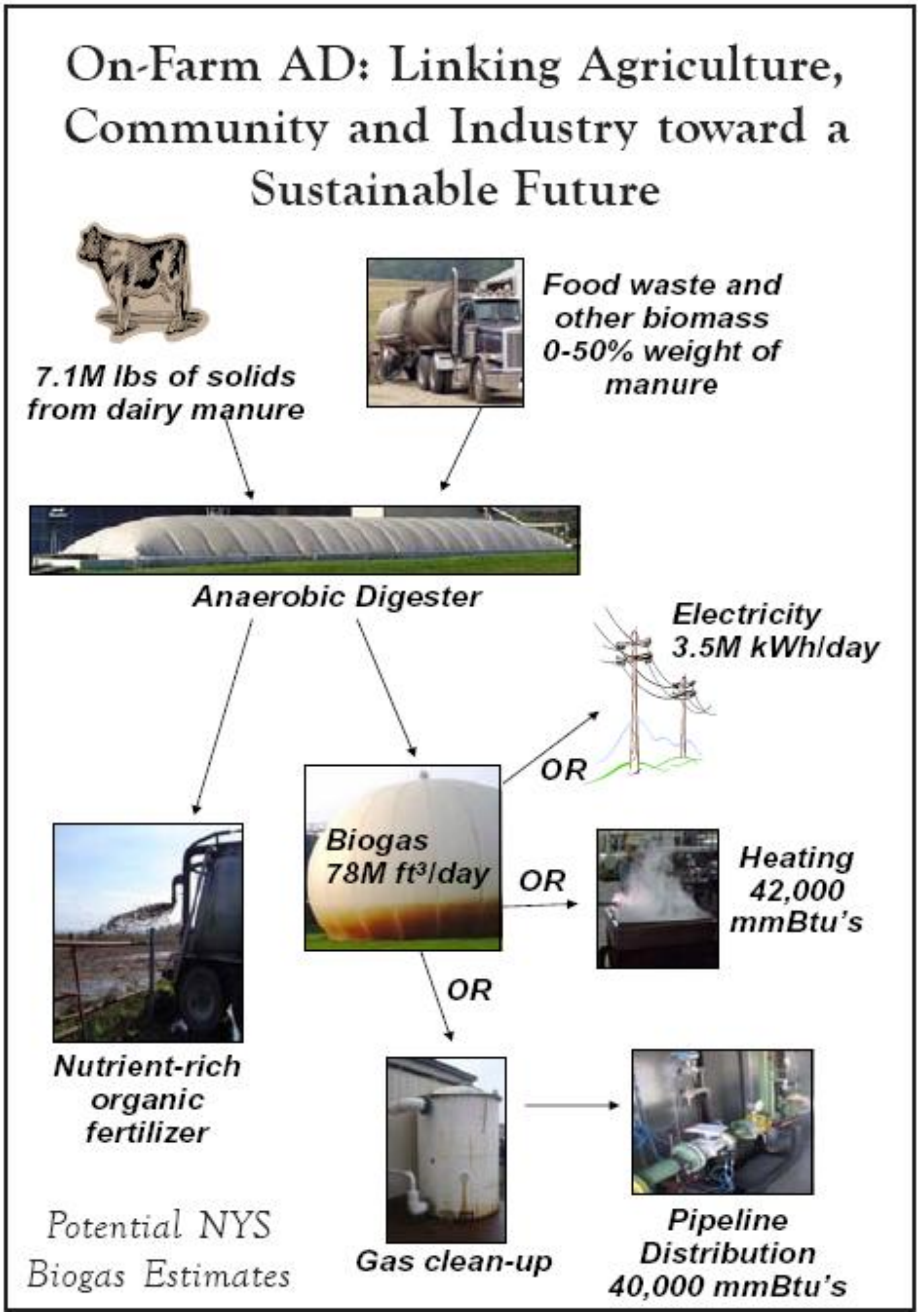
	AgStar	Cornell
Year of data	2002	-
NY dairy farms	7,388	-
NY dairy farms amenable to digesters	157	-
Number of mature dairy cows at amenable farms	141,000	-
Substrates added	None	Yes
Methane production potential (billion ft^3/year)	2.0	28.5
Electricity generation potential (000 MWh/year)	132	1,278
CO_2e reductions from methane destruction (000 tons/year)	6.0	-

Sources: EPA AgStar, Cornell University PRO-DAIRY

(Note: The AgStar study intentionally excludes dairy farms with fewer than 500 head; however, a feasible opportunity for small and medium farms would significantly increase the estimated market potential.)

Biogas production estimates for NY from the Cornell study are shown in the figure below. The analysis calculates the available mass of dairy manure and organic food waste available for co-digestion, and shows that through anaerobic digestion, these materials can be transformed into several useable outputs. Digester effluent is recycled to the land base as organic fertilizer; biogas is used to generate electricity, used as a heating source, or scrubbed and injected to a gas pipeline for distribution.

The analysis is based on the state's long-term potential for developing manure-based renewable energy from an estimated 80% of the large (> 700 cows) and medium (200 to 699 cows) CAFOs with added substrates that increase the biogas production by a factor of three.[18]



[18] Curt Gooch, Cornell University. 2009

Conditions for Success for Significant Adoption of Digesters in New York

There are a number of different conditions that interact with one another to create scenarios for success for digesters in NY. Some conditions are required in all instances and others are dependent upon the different operational scenarios of the various projects developed (e.g., community digesters, substrate acceptors, 100% wheeling operations). Listed below are the main conditions that would facilitate widespread adoption of AD technology. These conditions have been identified through extensive research into the issues in NY and nationally. For more specific information on the issues, please refer to the applicable section of the accompanying reference document.

Regulatory/policy

- Policies that provide biogas incentives
  - Strong, renewable portfolio standard (RPS) with a "carve-out" for biogas; and/or
  - A feed-in tariff that guarantees biogas generators a viable and appropriate market return on investment
- Favorable net metering laws, for example:
  - Net metering rates above current avoided cost
  - Net metering applies to multiple meters
  - Net metering without a limitation on the size of the engine generator set
  - Net metering that allows the sale of extra energy through wheeling to another full-cost customer
- Clear delineation as to who owns the renewable energy credits (RECs)
- Development of a national biogas association to organize and advocate to speed industry development and promote the benefits of biogas production
- Policies that encourage and facilitate diverting food and food processing waste streams for energy production

Infrastructure/support

- Utility distribution and transmission grids that are capable of accepting digester-generated power
- Well-communicated, streamlined interconnection process that details the necessary process steps and timing, as well as specifies who is responsible for various upgrade costs
- A strong technical service industry with trained personnel able to provide reliable service for the complete digester energy generation system (i.e., including the generator set and electrical connections)
- A centralized resource for producers interested in a digester — providing clarity on the necessary steps and decision points, including the business case, funding, construction specifics, operational requirements and permitting requirements prior to construction

Economic profitability/financing

- Power prices received by producers that cover costs and generate a positive return
- Available financing from lenders and investors who understand the process, risks and rewards
- Lenders who are willing to ease the up-front cost burden to producers
- Clearly understood and reliable cost estimates for projects from consultants and developers
- Multiple viable options for biogas, including: electricity generation, pipeline injection, compressed natural gas (CNG) used for vehicles, and energy use by other on-farm ancillary businesses
- Digester technologies that are profitable for small, medium and large farms
- A proven, well-documented track record of success with digesters, giving confidence to dairy producers and investors
- A comprehensive, uniform method of calculating GHG emission reductions in order to reliably quantify the benefit from carbon credits

Resources for producers

- Ability for dairy to outsource digester financing, operation and/or energy generation to a third party

- Clear AD residual management plans and residual fractionation capabilities that allow farmers to manage their farms in a closed-loop fashion
- A process of comparing system designers in a way that provides "apples-to-apples" standards to help evaluate the pros and cons of different systems and companies
- An industry-accepted financial model with reliable cost and revenue estimates and assumptions

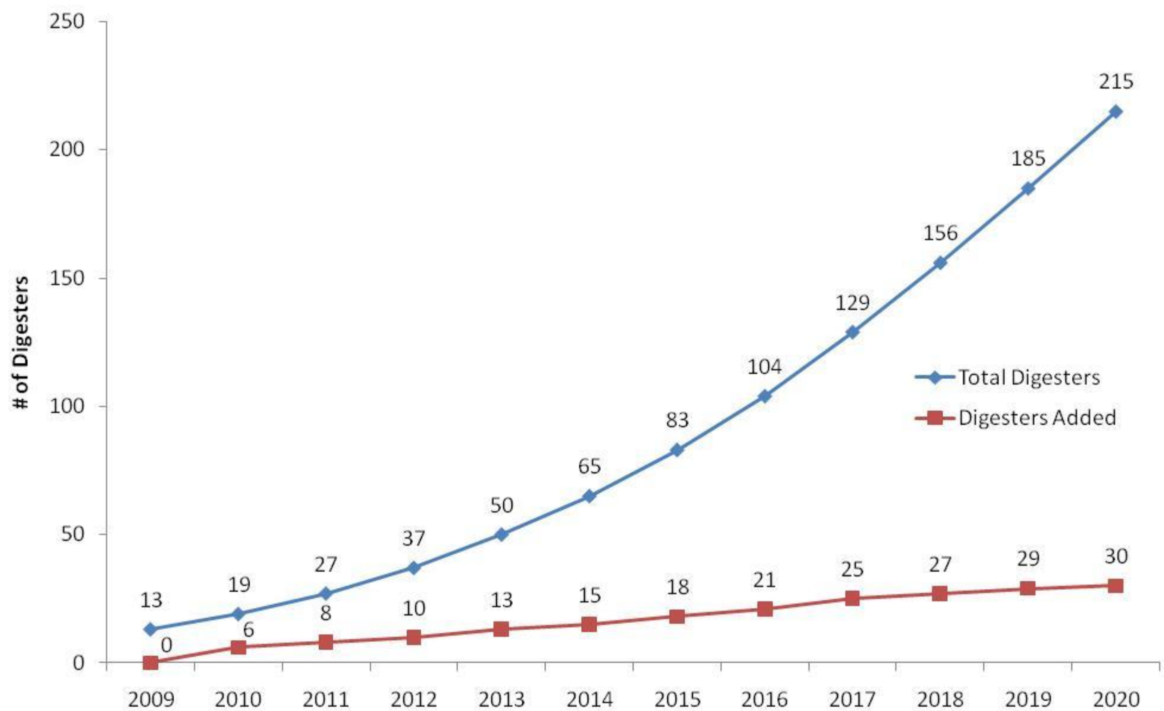
Digester design

- Digesters designed as a complete system of integrated components and serviced as such
- Designs that incorporate the potential expansion or change in substrate materials and the resulting change in gas output
- Vetting of digester developers and/or the inclusion of a warranty
- Turnkey designs for installation — a complete engine-generator set and biogas handling skid, appropriately sized and assembled in a factory, that streamlines design and installation

Preliminary Digester Growth Goals

The summit is designed to collaborate on the projects that will help capture the significant opportunity for digesters in NY highlighted in a previous section. Following are preliminary targets for digester adoption in NY; these are only to serve as a starting point for discussion at the summit, as goals will be refined and finalized during the summit by the summit participants themselves.

DRAFT Goals for Digester Adoption in NY – 2010-2020



Analysis of Opportunities to Advance Digesters

In order to facilitate capturing the market opportunity in NY, the Dairy Power project conducted numerous outreach interviews. These include both stakeholders in NY as well as national stakeholders who have an interest in digesters. Based on these interviews, opportunities were identified that summit participants could develop into action plans for digester installations and for initiatives that support greater installation of digester systems.

We identified four types of opportunities:

- Quick-win – these opportunities can be acted on at the summit and immediately after and should result in "shovels in the ground" within six to nine months
- Medium-term – these opportunities require additional thoughtful collaboration and coordination, and it may be one to two years before the vision for the project is achieved
- Longer-term – these opportunities require significant, "game-changing" innovations in technology, business model or both. The thought is that it may be two to five years before these projects are completed
- Enabling – these opportunities are foundational, and provide the support to allow the quick win, medium-term and longer-term projects to succeed

We have categorized each opportunity into one or more areas:

- Existing digester operators – opportunities that apply to dairy producers who are already operating a digester or are well into the planning process
- On-the-ground digester project – opportunities that involve projects that would build new digesters in NY
- Business model – opportunities that involve a fundamental change to the existing practice of generating electricity from an AD, using some energy to offset farm use, and then selling the remainder under a net metering arrangement
- Energy options – opportunities that involve a different approach to utilizing the energy contained in biogas
- Policy – opportunities that involve changes at the legislative and/or regulatory level
- Supporting tools – opportunities that play a supportive role to other projects, including On-the-Ground opportunities
- Technology innovation – opportunities that involve advances in digester technology
- Dairy Power project support – opportunities that support the Dairy Power project itself and its mission and goals in NY

The following tables indicate the categories to which each opportunity applies:

Quick-win Opportunities

#	Opportunity	Description	Existing Digester Operators	On-the-Ground Digester Project	Business Model	Energy Options	Policy	Supporting Tools	Technology Innovation	Dairy Power Project Support
1	Farms with easy interconnection — joint RFP for a group of digesters	For farms over 500 head that have been identified by NYSEG and National Grid as having low interconnection costs (e.g., <20% capacity)		X						
2	Incorporate other food waste (processing, retail) into current projects	Addition of nearby food waste — processing, retail — to increase biogas output	X		X					
3	Manure storage covers — joint RFP for covers and offsets	Farms <500 head that store manure have an opportunity to cover their storage units, prevent GHG from being emitted, and gain revenue from carbon credits		X						

Medium-term Opportunities

#	Opportunity	Description	Existing Digester Operators	On-the-Ground Digester Project	Business Model	Energy Options	Policy	Supporting Tools	Technology Innovation	Dairy Power Project Support
4	Large energy buyer commits to energy purchase and substrate delivery	A large energy buyer and substrate provider (Walmart, Birdseye, Heinz, Price Chopper, Wegmans, prisons, universities, state institutions) can help close the loop and drive digester adoption — potential to have bilateral agreement and wheel power through utility	X	X	X					
5	Co-op led project aggregating producers and a single third party digester operator	Co-op agrees to leverage buying power and contract with a third party to install and operate digesters on behalf of a group of its producers		X	X					
6	Innovative use of digested effluent	Digested effluent processed to generate extra revenue for the farm (e.g., cow pots, Moo Doo, compost, cow paper, cellulosic conversion)	X		X					

#	Opportunity	Description	Existing Digester Operators	On-the-Ground Digester Project	Business Model	Energy Options	Policy	Supporting Tools	Technology Innovation	Dairy Power Project Support
7	Community digester (may be located at farm or at landfill or at retailer/energy user)	Small/medium farms and/or landfills and/or substrate providers that are located within a five mile radius of each other share a central digester and truck manure or organic materials to the digester		X	X					
8	Wheel power to VT or MA	Power is transmitted to VT or MA, generating a higher power price or renewable energy credit for the producer	X			X				
9	Innovative use of energy in ancillary on-farm businesses	For example, greenhouses, tilapia farms, leasing to third party businesses	X		X	X				
10	Nutrient recover innovation	Technological advances on separating (or fractioning) nutrients at the “back-end” of the digesters and marketing the pieces separately	X						X	
11	Partnership with organic waste disposal site where they provide substrates	Municipal solid waste facility (e.g. Waste Management) provides organic waste to digester — digester potentially located on-site at Waste Management and manure hauled to WM. Policy change would help encourage people to separate organics	X		X		X			
12	Optimization of feedstock mix to maximize biogas production	Research conducted and standards developed for the optimal mix of feedstocks to use in the digester to produce as much biogas as possible	X						X	

Longer-term Opportunities

#	Opportunity	Description	Existing Digester Operators	On-the-Ground Digester Project	Business Model	Energy Options	Policy	Supporting Tools	Technology Innovation	Dairy Power Project Support
13	Gas pipeline cluster	Network of digesters connected via underground gas pipeline — gas is scrubbed/cleaned then injected into the natural gas network or otherwise used		X	X	X				
14	Compressed natural gas (CNG)	Gas is scrubbed/cleaned and then compressed and used as fuel in tractors and/or milk trucks that have been converted to run on natural gas	X			X				
15	Small digester prize	Large $ prize offered for innovative, cost-effective solution for small-farm energy generation							X	

Enabling Opportunities

#	Opportunity	Description	Existing Digester Operators	On-the-Ground Digester Project	Business Model	Energy Options	Policy	Supporting Tools	Technology Innovation	Dairy Power Project Support
16	Cow Power rate-payer program (e.g., Vermont)	Consumers and businesses voluntarily pay a premium price for dairy power; premium used to fund digester projects and cover utility costs			X		X			
17	Financing of digester projects	Develop a financial consortium focused on finding and being sources of capital (or a clearinghouse for capital) for digesters, carbon credits, and RECs			X			X		
18	Policy actions	- Clarify REC ownership - Improve ways to cover interconnection costs - Improve net metering - Enhance RPS incentives for digesters; carve-out for digesters - Develop an industry biogas coalition - Facilitate aggregation of farm power, carbon credits, and RECs	X				X			
19	Grant/stimulus opportunities for grid upgrades	Joint proposal for stimulus, energy, rural development or other federal and state funding (producers, utilities, developers)					X			

#	Opportunity	Description	Existing Digester Operators	On-the-Ground Digester Project	Business Model	Energy Options	Policy	Supporting Tools	Technology Innovation	Dairy Power Project Support
20	Clearly defined vision and goals for digesters in NY	Goals for 2010, 2015 and 2020 for the number of digesters in NY								X
21	Standard contracts with developers and with utilities	- Standard performance and service contract - Interconnection process, costs, standard PPA						X		
22	Joint RFP/turnkey solution	A group of digester projects coordinates a joint RFP for all digesters and encourages creation of a turnkey or full-service solution						X		
23	Milk cooperative digester services	1-800-DIGESTER centralized support, collective bargaining, RFP, REC support	X					X		
24	Vendor evaluations	Have a Web site where people can review/give feedback on vendors — also, a standard comparison would be available						X		
25	Standard feasibility/ economic models	Development of a standard tool — AgStar owned — have an advisory group (farm credit union) then someone who can do the work						X		
26	Governance/ Management for projects coming out of summit	How often the governance team will meet; what is the accountability								X
27	Communication	Coordinated, timely communication of summit outcomes and progress to stakeholders and the general public								X

FINANCIAL ANALYSIS OF EXISTING AND ALTERNATIVE DIGESTER BUSINESS MODELS

This section provides an overview of the financial and economic prospects of digesters in NY. The following scenarios have been developed from baseline data from case studies by the Cornell Manure Management program. The goal of these selected scenarios is to show the potential of digesters given certain assumptions and costs from real data.

The analyses presented assume energy produced is used on the farm and any excess power is sent to the grid and is reimbursed on an avoided cost basis (what the utility would pay if it had to build new generation facilities). This can significantly impact the economic returns to the dairy producer compared with situations where wheeling the full quantity of power generated to another party can result in additional revenues in excess of the $0.08 kWh the dairy pays to the utility. These scenarios vary due to wheeling charges and the retail sale rate the power buyer is currently paying (or is willing to pay). An example of this scenario is provided below and has been generated using real-world costs and investment numbers.

The assumptions and all pertinent information is included below for a 1,000-cow farm that is wheeling 100% of the electricity generated from a 250 kW genset to a buyer who is currently paying $0.144 kWh in NY:

Components to model
-1,000-cow dairy
-250 kW generator set

Financing (no substrates/food waste vs. substrates/food waste)

1) Capital cost = $1.5 million (no substrates), $1.75 million (with substrates)
2) Two funding incentives
    a. Renewable portfolio standard for renewable energy attributes
        i. NYSERDA capacity incentive — $125,000
        ii. NYSERDA performance incentive — $175,150 per year in years 1, 2 and 3
    b. Investment tax credit or Treasury grant
        i. Projects for which construction starts in 2010 — ~$337,500[19]
3) Total loan amount = $850,000
4) Loan terms = 10 years, 7% interest
    a. Annual loan payment = $118,431
    b. Annual loan payment w/ substrates = $153,264

Biogas production

1) Energy is bought from utility company
2) Electricity is sold directly to third party user at rate of $0.144/kWh
3) Wheeling charge — $0.024/kWh
4) Operational costs — $0.04/kWh
5) Profit margin — $0.08/kWh[20]

Other potential revenue sources NOT INCLUDED:

1) Sale of bedding
2) Carbon credit sale
3) Tipping fees generated from waste producer
4) Tilapia farms
5) Greenhouse

[19] The Treasury grant is 30% of eligible costs, which is the remaining capital cost after deduction of the cost of buildings and deduction of the value grants or capacity incentives that reduce the cost basis. Starting with costs of $1,500,000, subtract the NY RPS capacity incentive of $125,000, and estimate $250,000 for building and any other ineligible costs, and the base is now $1,125,000. The grant of 30% of this amount is $337,500.

[20] Estimate based on input from operating digesters

One important factor that should be noted is that the farm buys all of its energy used on the farm from a utility company. The rate per kilowatt hour ($0.08/kWh) is less than can be received from selling to a third-party buyer (including a wheeling cost of $0.024/kWh). With this information in place, an annual income statement was compiled solely for the electricity production on the farm:

NO SUBSTRATES/FOOD WASTE	**INCOME**	**EXPENSES**
Income statement		
Revenues:		
Electrical generation	$262,800	
Expenses:		
Operational costs		$86,724
Loan payment		$118,431
Total expenses		$205,155
Profit before taxes	$57,645	
Tax credit[21]	$44,000	
Earnings before income taxes	$101,645	

SUBSTRATES/FOOD WASTE	**INCOME**	**EXPENSES**
Income statement		
Revenues:		
Electrical generation	$525,600	
Expenses:		
Operational costs		173,448
Loan payment		$153,264
Total expenses		$326,712
Profit before taxes	$198,888	
Tax credit[22]	$88,000	
Earnings before income taxes	$286,888	

It should be noted that this scenario provides a win-win situation for the parties involved. The power buyer is paying the same amount for their power supply but is purchasing renewable power from a local source, a benefit to the company's public image. The utility has not lost the dairy revenue from power purchase and has actually increased revenues as a result of wheeling power for the dairy (approximately $50,000 per annum without substrates), and the dairy producer has a new revenue stream from electricity sales. The dairy can potentially reduce costs further by using digested solids for animal bedding or sell the solids off-farm as a soil amendment.

More traditionally utilized economic case studies have also been included for review. Four different case studies were chosen using various herd sizes: 250, 500, 750 and 1,000 head. In some cases, the size used may not exactly match these targeted numbers. The data were adjusted for inflation in the scenarios in which digesters were built and in operation prior to 2009.

[21] If the farm takes the investment tax credit or Treasury 30% grant, it would not get a production tax credit as well.
[22] ibid

Case Study Analysis

The following financial information is derived from data provided by NY on-farm anaerobic digester case studies posted on the Cornell Manure Management Web site. These numbers are intended to be a point of comparison between farms that have commissioned digesters and those considering investing in an AD. Data was added as inputs through a model, developed by Dr. Brent Gloy at Cornell University. The assumptions were intended to take a conservative approach to create a baseline, which can then be improved by the addition of other factors. Important assumptions were as follows:

- No tipping fees were included with this assessment for scenarios when imported substrate is co-digested with manure
- Thirteen cubic feet of biogas per volatile solid converted
- 550 BTU per cubic foot of biogas
- The farm pays $0.12/kWh for electricity. It will sell all excess electricity back to the grid at the **avoided cost** for the utility at $0.06/kWh.
- No upgrades to the grid were required as part of the capital investment
- Carbon credit revenues were considered a constant at $2 per credit net of any aggregation or exchange costs
- Financing terms were a seven year loan at 8% and 65% of the total capital costs
- Ten-year terminal value

The adjusted capital cost of each farm taken from the case studies is shown in Table 1:

Table 1. Adjusted capital costs of each farm used as input into the Gloy model.

Farm #	1	2	3	4	5	6
Capital cost ($)	$330,207	$322,134	$405,510	$713,947	$1,021,948	$1,655,519
Per cow basis ($/cow)	$3,302.07	$1,288.54	$811.02	$1,427.89	$1,362.60	$1,655.52

Farm #	7	8	9	10
Capital cost ($)	$1,729,252	$1,245,823	$2,200,000	$4,500,000
Per cow basis ($/cow)	$1,441.04	$830.55	$1,100	$1,071.43

Each farm is listed below with the number of cows and the type of digester installed on the farm:

Table 2. Hypothetical Farm No. and No. of cows and farm data source.

Hypothetical Farm #	# of cows	Source case study Farm name, adjusted amounts	Digester type
1	100	JJ Farber case study	Fixed-film
		100 head farm	
2	250	Freund Dairy case study	Plug-flow
		250 head farm	
3	500	AA Dairy case study	Plug-flow
		600 head scaled down to 500	
4	500	Ridgeline Dairy case study	Complete Mix
		525 head scaled down to 500	
5	750	New Hope case study	Plug-flow
		850 head dairy scaled down to 750	
6	1,000	Patterson dairy farm 1,000 head farm	Complete Mix
7	1,200	Roach Dairy farm	Complete Mix
		1,200 head farm	
8	1,500	Sunny Knolls Dairy case study	Plug-flow
		1,400 head scaled up to 1500	
9	2,000	Aurora Ridge Dairy case study	Plug-flow
		2,000 head dairy	
10	4,200	Sunny Side Dairy	Modified Plug-flow
		4,200 head dairy	

With the above data in mind, below are two tables that show the Net Present Value (NPV) and Internal Rate of Return (IRR) corresponding to each farm installing an AD. The NPV is a calculation that is used to analyze the viability of a project in terms of its profitability. By discounting all future cash flows from the investment at a certain interest rate, a present value can be found. Generally, if a project has a positive NPV, the investment should be undertaken. The IRR is a measure of the rate of return of the project over the life of the investment.

There are two types of NYSERDA grants that apply for methane digesters in New York. The Capacity Incentive provides funding for $500 per kilowatt of electric generator capacity. Important to note is that the maximum amount of funds to be given out to a single project may not exceed the lesser of either $350,000 or 50% of the total purchase, engineering service and installation costs. The Performance Incentive related to new ADs provides a 10 cent per kilowatt generated payment for no more than a three year period. For more information on these grant programs, please refer to the NYSERDA website at http://www.nyserda.org/funding/1146summary.pdf. The first table shows the results if both the NYSERDA Capacity and Performance Grants are applied to the project. The second table shows the results if the Capacity and Performance Grants are removed.

Table 3. NPV for each hypothetical farm applying both the NYSERDA Capacity and the NYSERDA Performance Incentives to the financial analysis.

Farm #	1	2	3	4	5	6
Number of cows[23]	**100**	**250**	**500**	**500**	**750**	**1,000**
NPV zero terminal value	-$353,669	-$198,469	-$67,754	-$245,167	-$627,113	-$1,114,268
NPV with terminal value	-$365,412	-$150,244	$62,741	-$117,859	-$502,935	-$946,035
IRR capital zero terminal value	N/A	-10%	5%	-2%	-12%	-14%
IRR with terminal value	N/A	0%	13%	-6%	-2%	-5%

Farm #	7	8	9	10
Number of cows[23]	**1,200**	**1,500**	**2,000**	**4,200**
NPV zero terminal value	-$994,679	-$170,324	-$746,155	-$1,377,058
NPV with terminal value	-$748,147	$222,424	-$216,931	-$244,869
IRR capital zero terminal value	-10%	6%	-1%	0%
IRR with terminal value	0%	14%	8%	9%

Table 4. NPV for each hypothetical farm applying neither the NYSERDA Capacity nor the NYSERA Performance Incentives to the financial analysis.

Farm #	1	2	3	4	5	6
Number of cows[23]	**100**	**250**	**500**	**500**	**750**	**1,000**
NPV zero terminal value	-$381,003	-$266,737	-$204,425	-$560,025	-$832,051	-$1,387,609
NPV with terminal value	-$392,746	-$218,512	-$73,929	-$456,163	-$707,874	-$1,219,376
IRR capital zero terminal value	N/A	-14%	-3%	-14%	N/A	N/A
IRR with terminal value	N/A	-4%	7%	-3%	-5%	-7%

Farm #	7	8	9	10
Number of cows[23]	**1,200**	**1,500**	**2,000**	**4,200**
NPV zero terminal value	-$1,322,688	-$580,335	-$1,292,837	-$2,525,090
NPV with terminal value	-$1,076,157	-$187,587	-$763,613	-$1,392,901
IRR capital zero terminal value	-14%	-2%	-6%	-6%
IRR with terminal value	-3%	7%	4%	4%

It is important to note that these numbers come from conservative estimates and assumptions. A common pattern that can be observed is that as cow sizes increase, the investment is more attractive. This isn't exactly true throughout because each farm in the case studies faced a variety of challenges which may have increased capital costs relative to the other farms in the study.

[23] Representing 85% lactating cows and 15% dry of the total