WISCONSIN
BIOENERGY
INITIATIVE

THE BIOGAS OPPORTUNITY IN WISCONSIN

2011 STRATEGIC PLAN

Building a renewable energy landscape in Wisconsin and beyond

Our Mission

Created in 2007 by the University of Wisconsin-Madison College of Agricultural and Life Sciences, the Wisconsin Bioenergy Initiative seeks to cultivate bioenergy expertise among UW-Madison, UW-System and Wisconsin stakeholders to anchor the innovative research that is being conducted within our great state. We are a university-based coalition that helps the talent across Wisconsin create, commercialize and promote bio-based solutions.

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This report is dedicated to the late Wisconsin Secretary of Agriculture Rod Nilsestuen and his family for their lifelong commitment to the Wisconsin energy opportunity.

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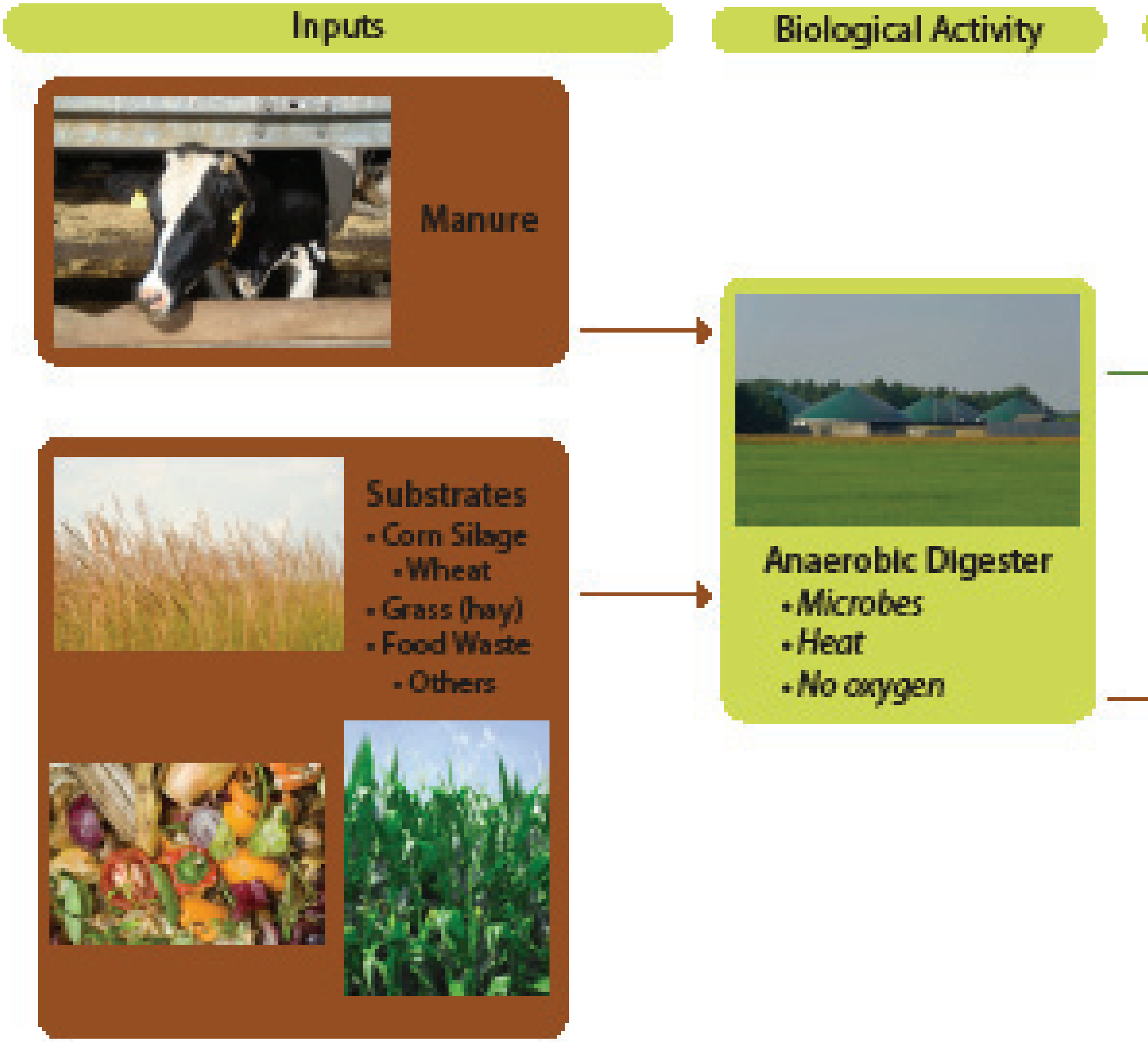
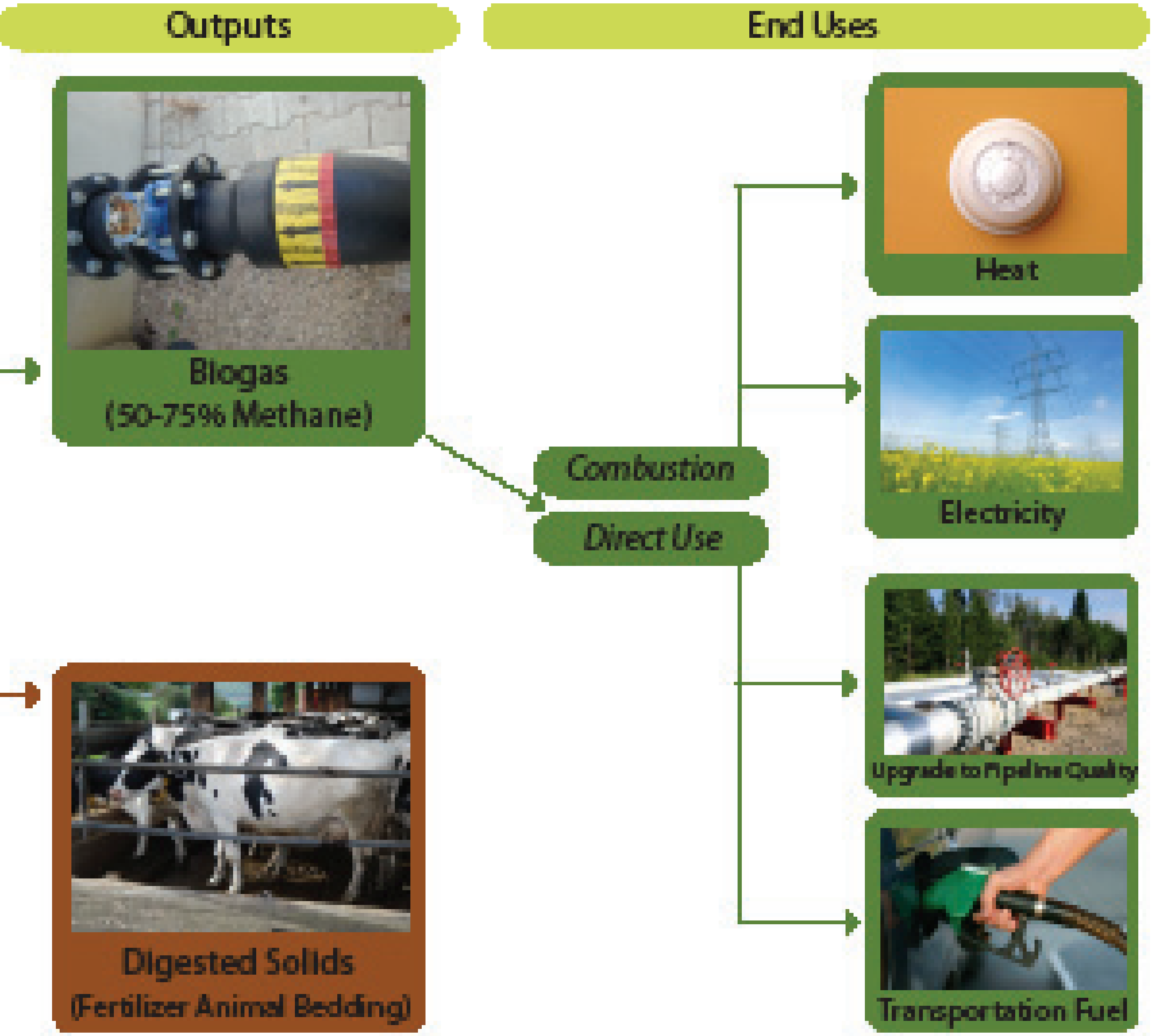
THE BASICS OF BIOGAS

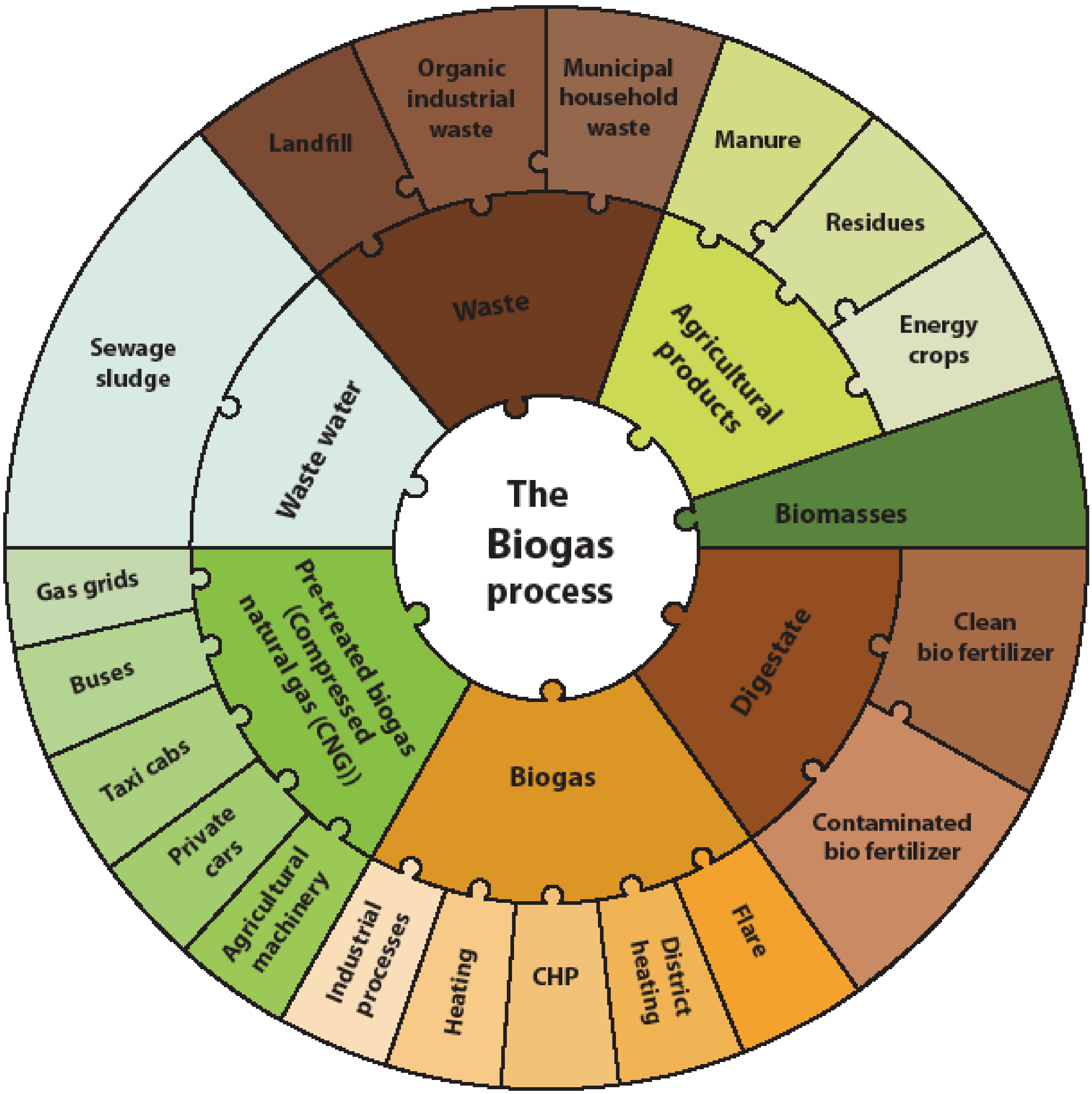


Biogas is produced by the decomposition of organic matter in the absence of oxygen. For typical biogas systems, this organic matter can include manure or plant substrates like crops or food waste. These inputs are fed into an anaerobic digester where microbes in the presence of heat and absence of oxygen break down the organic matter and produce biogas (composed of methane and other gases). In addition to biogas, the solids that have been digested are also a product of anaerobic digestion.



The biogas produced from this process can be combusted for electricity and heat, or can be used directly by upgrading the gas to pipeline quality or further upgrading to a transportation fuel. Thus, biogas is a versatile energy source. The digested solids can also be utilized as an organic fertilizer or as animal bedding.

Graphic adapted from work done by Team Biogas.



Graphic adapted for U.S. biogas market from a similar graphic from the report: "On the Road with CNG and Biomethane" Intelligent Energy Europe

EXECUTIVE SUMMARY

Wisconsin can create wealth and jobs by building a new energy economy. Now is the time to transition the old energy economy, built on coal and petroleum, to homegrown energy sources like biogas and biomass to create power, heat and alternative fuels to drive a new energy economy. This Wisconsin Biogas Strategic Plan is a tool to allow business leaders and policymakers to discuss how to make it happen.

Anaerobic digestion is the process by which microorganisms break down organic materials in a closed vessel, in the absence of oxygen. Anaerobic digestion is used as a renewable energy source because the process produces a methane and carbon dioxide-rich biogas that produces energy and can help replace fossil fuels. The nutrient-rich digestate produced during anaerobic digestion can also be used as fertilizer.

Wealth Retention and Wealth Growth

Increasing the use of biogas energy systems in Wisconsin can maintain and potentially expand the state's global and domestic economic position of the dairy and food processing sectors, also known as the Wisconsin food system.

Making the Biogas Economic Value Change Work

The Wisconsin financial community can be a leader with investments in biogas-to-energy systems but needs policy that improves the transparency, longevity and clarity (TLC) of renewable energy investments. The key to success is recognizing that every member of the biogas economic value chain needs to make a profit. The farmer or food processing manufacturer needs to cash flow their investment in a biogas system, the developer of the anaerobic digester must sell enough systems to stay in business, the banker needs to have long-term investment security and the utility sector and other energy end users must make profit.

Innovative Partnerships to Catalyze Biogas Plants

Because there are so many potential societal benefits from biogas energy systems, it makes sense to align public policy goals with business opportunity. For example, there are anaerobic digester ownership hybrid variations, publicly owned models, and community-owned models. There are joint or co-ownership models that could be done with Wisconsin utilities managing the biogas conversion plant for pipeline quality gas or a local government converting gas to a fuel quality to run waste collection vehicles. Many other creative ownership and collaborative possibilities exist in the Wisconsin biogas-to-energy opportunity.

Homegrown Energy Increases Wisconsin Energy Security

Currently, an estimated $16-18 billion leaves Wisconsin each year for energy to run businesses, power and heat homes, and fuel vehicles. An estimated $853 million alone is spent for coal energy imports. Any time we can use a homegrown energy source such as biogas and biomass, it helps retain and build wealth in our state.

Value of Biogas Co-Benefits Can Be Monetized

An on-farm biogas system can reduce odor emissions and potent methane greenhouse gas emissions, create opportunities for combined heat and power which is a much more efficient energy production technique, be used as a part of a nutrient management strategy to reduce runoff into waterways, and make valuable co-products or a high quality organic bedding or fertilizer. Monetization of the co-benefits can be a factor in making these biogas plant systems economically viable.

Rewarding Rural Energy Development Entrepreneurs

Creating a rural economic renaissance through greater homegrown energy innovation takes supportive public policy. The Standard Offer Contract system can be created to target rural energy growth and provide the financial community greater certainty when loaning money for projects. The creation of something similar to the Wisconsin Cow Power Program targeting the growth of biogas energy plants around the state will keep Wisconsin a sector leader and help the state's dairy businesses remain a dominant economic force.

Wisconsin is well positioned to be a U.S. leader in the creation of biogas energy plants. The state would see multiple benefits if it catalyzed the biogas energy sector. The benefits can be particularly strong as a part of a rural economic development strategy because waste streams and energy crops from agriculture facilities are used for energy purposes and create value-added income streams. Rural businesses and communities might be able to use heat from the biogas energy plants if projects are strategically co-located, and Wisconsin should consider targeting large data centers to locate in the state by offering anaerobic digesters as a green energy source. Large municipalities can also derive benefits from biogas-to-energy use at landfills and by diverting food waste to a digester for energy. There is little question that many private sector businesses in Wisconsin could profit from biogas-to-energy growth in the burgeoning green technology sector.

The Midwest region, and specifically Wisconsin, have abundant biogas feedstock materials including organic feedstocks such as manure and crop residues, a variety of waste from food processing (particularly milk and cheese plants), wastewater treatment, biomass processing byproducts (especially ethanol stillage), fats and greases. State policy and programs need to better reflect that processing through wastewater treatment plants or burying waste materials in landfills is too costly to society when some of the waste stream could go to productive use for energy. A wiser investment is to promote diverting waste away from landfills and to reduce pressure on wastewater treatment plants by recycling and reusing waste in digesters.

Farms and rural communities can become the centerpiece for new energy solutions and strategies to improve the environment with biogas plants. The German Biogas Association predicts that the number of Germany's installed biogas plants will exceed 5,000 by the end of 2010, with more than 3,000 on-farm systems. By comparison, at the start of 2010 the U.S. had 151 on-farm anaerobic digesters (small biogas plants). Wisconsin has the most of any state, with 22 on-farm and 31 total systems. There is a clear opportunity for biogas expansion in Wisconsin and the Midwestern states through methane (anaerobic) digesters. Yet, despite the great potential, project development seems to have reached a plateau recently. It will likely take public policy to expand the opportunity in Wisconsin and the region.

Promoting biogas plants in Wisconsin and the Midwest allows multiple energy generation options. Unlike intermittent sources such as wind and solar, biogas plants can continuously generate reliable forms of renewable electricity, further maximize efficiency through combined heat and power, be cleaned into a pipeline quality gas or further processed into a vehicle fuel.

The public is increasingly concerned with issues including public health, water quality, air quality, soil quality and land use conflicts from animal agriculture operations in Wisconsin. There is also growing public interest in increasing renewable energy uses and reducing greenhouse gases in the state. Wisconsin's showcase dairy sector is facing many challenges with what some call manure management. More cows means more manure, not enough land for spreading, and regions where spreading is problematic, such as a Karst geography region where groundwater contamination is more likely to occur. Community conflict can occur when dairy operations want to expand. The viability of agriculture is a critical component to Wisconsin's economic stability and growth. Rural and urban areas are dependent upon each other for the food and fiber system value chain, but face multiple societal conflicts meeting the needs of its citizenry. Anaerobic digestion systems offer a partial solution to some of the conflicts, but this single technology can be expensive for some. Furthermore, current economic challenges make public and private partnerships more saleable to the citizens of the state for solving societal issues.

A significant barrier holding back the growth of Wisconsin's biogas sector is that anaerobic digesters are not currently economical investments for most farmers. All of the factors combined in this equation result in an overall cost that is not always an attractive investment for farmers or agricultural production processes. The costs to be considered include manure management, capital investment of the digester, opportunity cost of a digester, the availability of substitutes for the byproducts, odor, bacteria and parasites, the availability of pipelines nearby, retrofitting transportation to use the methane gas and the price of electricity.

Many existing digesters sell the electric output to electric utilities, but utilities and farmers are not in full agreement on a price that is beneficial for both sides. To get an adequate price from the farmer's perspective is to pay more for power generation than what the utility pays for some other energy sources. There may be variations in public policy that can address the financial costs of societal problems through the technology and agriculture practices. Several business models exist within the biogas opportunity. These include the own and operate model where the digester sponsor takes all the investment risk and potentially derives all the benefits. The design and build by a third party operator who may own and operate the digester and sponsor provides the substrate materials. There are hybrid variations, publicly owned models and community-owned models as well. This strategic plan aims to align policy with business opportunity and beneficial society needs.


STAKEHOLDERS
© iStockphoto

FRAMING THE STAKEHOLDER PROCESS

Wisconsin has much to be proud of with our success in promoting and developing biogas-to-energy use in our state. This strategic planning process is designed to build on Wisconsin's existing biogas success, maintain momentum and push us to the next level. One key to success is recognizing the diversity of professional backgrounds of stakeholders and multiple businesses that can benefit from biogas development. At a stakeholder meeting on Oct. 15, 2010, more than 75 leaders from the financial community, agriculture, food processing, state and local government, engineers and biogas system developers, utilities, university researchers and more came together to frame ideas contained in this strategic plan. This collaboration around our common goals can include job growth, new investments and business expansions, innovation and leadership in renewable energy, and new wealth accumulation for Wisconsin. The group discussed policy, research and commercialization needs for the state strategic planning document.

Participants considered these questions:

What existing opportunities in the biogas sector need a complementary public policy, require some additional research or could benefit from a new collaboration? How can we start to make that happen today?

What new opportunities come to mind to stimulate new projects and increase existing business value?

How can these opportunities be more widely adopted in Wisconsin and the Midwest?

Who are key stakeholders to champion these opportunities (here today) and that we need to reach out to partner with us going forward?

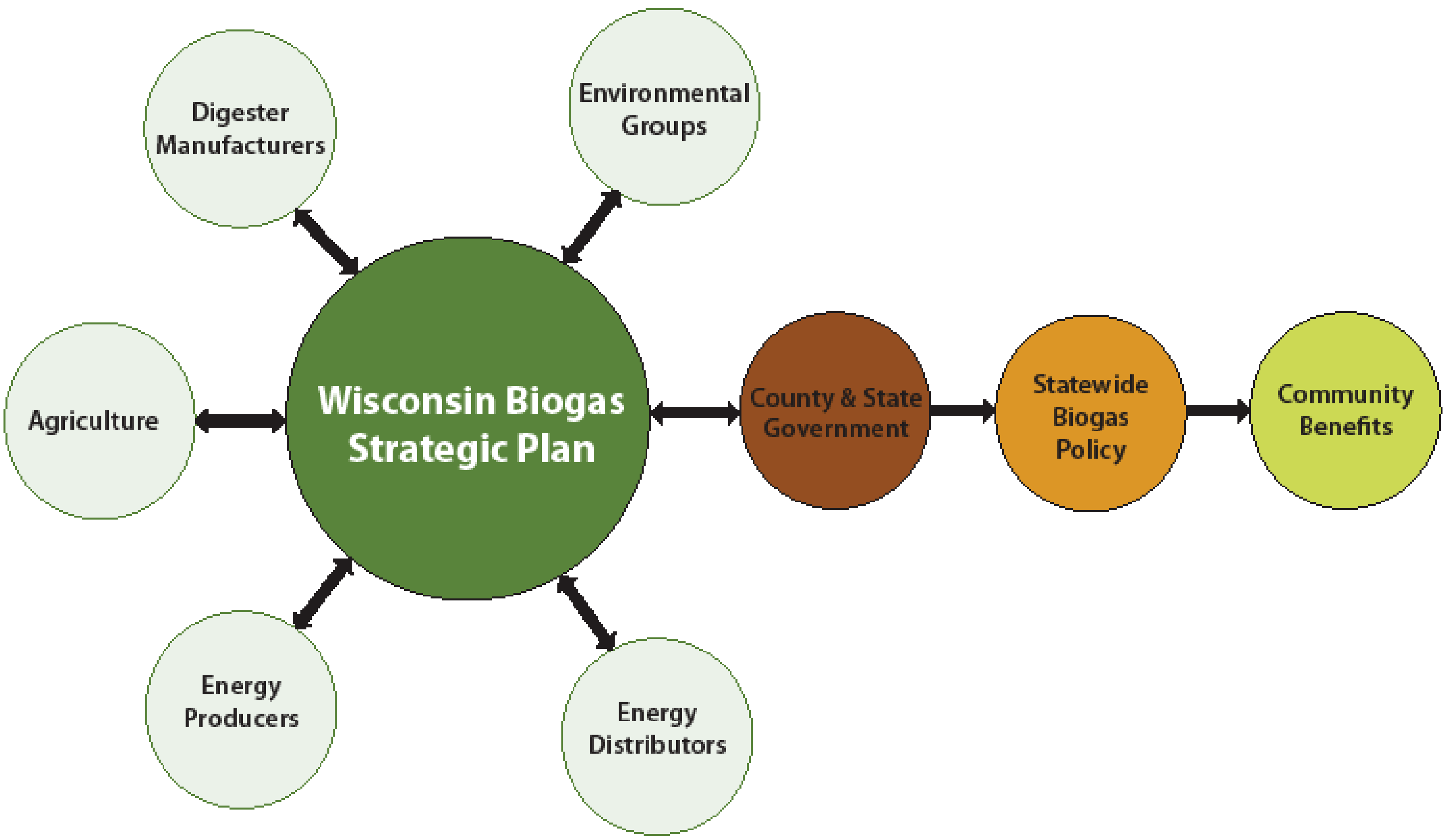
What sectors can collaborate more to achieve common goals of greater use of biogas to energy in our state and region?

What are some existing and new business models that will make these opportunities a success?

What are regulatory and financial barriers that need to be addressed? How can we collaborate to address all challenges and make them into opportunities realized?

What role can you play in helping to realize these opportunities during and after this meeting?

WISCONSIN BIOGAS STAKEHOLDER COMMUNITIES



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THE BIOGAS OPPORTUNITY

MAKING THE CASE FOR BIOGAS IN WISCONSIN

Wisconsin has no oil, coal, natural gas or uranium. Thus, it is much more dependent on importating fossil fuels than most states. Wisconsin is also more dependent on coal than most states, obtaining 69 percent of its electric energy generation from coal-fired generators. Overall, closer to 82 percent of Wisconsin's energy comes from out-of-state sources. Therefore, homegrown renewable energy from biomass, wind, solar and waste products to biogas will continue to rise in importance in the coming years. Wind and solar will produce large amounts of renewable energy, but because generation can be intermittent it makes biomass and biogas attractive. The increased use of biogas plants can create stable, controllable energy and is easier to integrate into the existing electrical infrastructure. The bonus with anaerobic digesters as a biogas plant is their generation of heat. The rate structure in Germany actually rewards, through a higher power purchase price, the development of combined heat and power plants. These combined heat and power (CHP) facilities are much more energy efficient. Additional opportunities are emerging to take biogas from an anaerobic digester and clean the gas to pipeline quality. Biomethane meets the specifications for the natural gas pipeline and its existing over 2 million miles of infrastructure.[1] While natural gas prices are low today, that may not be true for the longer term. Starting to build a local biomethane production system could place Wisconsin at a long-term competitive advantage. Renewable natural gas has storage capability and creates a potential partnership with utilities to operate systems for pipeline quality clean up, connection to the grid and storage. The creation of these systems for renewable natural gas is starting to become more common in the U.S., with 22 biogas projects injecting into the pipeline in 2008. Europe is leading the way with biogas-to-renewable natural gas on their "net," or pipeline grid. The U.S. can move to greater energy independence by moving in this direction.

Greater Biogas in Wisconsin Can:

- Produce homegrown clean energy
- Take waste products to make energy and maximize the value of feedstock
- Reduce methane, a potent greenhouse gas
- Provide new income streams for farmers and food processing sector
- Help Wisconsin agriculture and food processing become known internationally as a green business sector
- Reduce capacity pressure on wastewater treatment facilities and landfills by diverting and reducing waste to create energy
- Save local governments money and create rural regional wealth.

Electricity Generation

In 2009 Wisconsin on-farm biogas systems had an electricity generation capacity of 11.6 megawatts, enough energy to power approximately 10,000 homes. Wisconsin digesters average approximately 70 tons per week of digested solids and 130,000 cubic feet per day of biogas. Between January 2007 and June 2008:

- Farms with herd sizes under 2,000 produced an average of 150,000 kilowatt-hours (kWh) of electricity.
- Farms with herd sizes between 2,000 and 4,500 produced an average of 440,000 kWh of electricity.

While on-farm anaerobic digesters may never produce the majority of energy for the state, these systems will serve as a complement to other intermittent renewable energy options like wind and solar, which are dependent on weather patterns. By comparison the energy generation for anaerobic digestion would have to increase by a scale of tenfold to equal state wind generation.[2]

Interest in biogas continues to grow throughout the U.S. The Environmental Protection Agency (EPA) has a partnership with the U.S. Department of Agriculture to promote growth in this area through the AgSTAR program. Currently, the U.S. has about 151 on-farm anaerobic digesters systems; AgSTAR projects the U.S. potential at 8,000 systems. There is a targeted program to increase the use of anaerobic digestion to at least 1,300 farms by 2020. The reason state and federal policy want to promote the use of on-farm anaerobic digestion goes beyond greater energy independence for our nation and there are many farm operational benefits of these systems.[3]

Non-Energy Benefits

Anaerobic digestion provides many benefits as a part of a manure management solution. Digesters decrease the volume of manure while maintaining the useful nutrients, and can reduce or eliminate some types of bacteria and parasites. In conjunction with other practices, digestion can control odors of livestock operations. Anaerobic digesters produce methane gas that can be directly injected into a natural gas pipeline after filtering and cleaning. Methane can also be used as fuel for transportation or electricity. Finally, the digestion process results in a byproduct that can be used for bedding or fill dirt.

Today, the major economic driver for a dairy digester is the bedding it provides owner-operators. The reduction of material for spreading is a key secondary economic driver. The energy product of gas and electricity is probably the third economic driver in the investment at a farm-scale. For larger industrial scale operations, the cost avoidance of a wastewater treatment charge is probably the primary economic driver. For this business sector the processed gas for boilers helps in dealing with energy cost volatility and risk management of fuel prices.

For the dairy digester there are some economies of scale issues today. Some analysts believe a minimum of 800 to 1,000 head operation is needed to make a stand-alone digester project work. Further research indicates mid-size dairy (500 to 800 head) operations could be financially feasible with the right business plan and partnerships. One federal study indicates 300 to 499 head dairy operations could work with a centralized manure processing anaerobic digester. The dairy operator today does not have a lot of business experience in electricity generation or gas generation and may be frustrated by having to hire dedicated employees for equipment operation. Other business services are likely needed, including liability insurance, contracting, and aggregation of materials and energy. In Europe, one of the primary motivations for digester use is bio-security or pathogen control. In the U.S., a motivation is public pressure for nutrient management and prevention of ground and surface water contamination.

It is critical for Wisconsin farmers to have a nutrient management plan that is implemented to address environmental concerns and prevent major runoff events that result in impairment to waterways. Especially for larger animal operations, the anaerobic digester used in conjunction with the nutrient management plan can result in reducing environmental threats and allows for a farm good neighbor policy with nearby non-farm residents. While anaerobic digesters reduce odors and make manure easier to apply to the land, the overall volume of manure and nutrients do not change appreciably due to anaerobic digestion. Still, these non-energy benefits of anaerobic digester use have a great monetary value to the farmer and society as a whole. The question today is how to monetize these benefits.

A group of UW-Madison graduate students from the Nelson Institute CHANGE-IGERT program did some analysis and modeling of anaerobic digestion benefits in the areas of odor reduction, greenhouse gas reduction, energy generation, waste and nutrient management and found that they can be quantified (although more detailed analysis was suggested in their final paper).[4] A group of Canadian researchers also did a thorough literature review and concluded some of co-benefits can be quantified.[5]

NON-ENERGY BENEFITS AS PRIME MOTIVATORS FOR AGRICULTURE PRODUCERS*:

Reduced Odors: Biogas systems reduce offensive odors from overloaded or improperly managed stored facilities. These odors impair air quality and may be a nuisance to nearby communities. The odor-causing volatile organic acids are consumed by biogas-producing bacteria.

High Quality Fertilizer: During anaerobic digestion, the organic nitrogen in the manure is largely converted to ammonium. Ammonium is the primary constituent of commercial fertilizer, which is readily available and utilized by plants.

Reduced Surface and Ground Water Contamination: Digester effluent is a more uniform and predictable product than untreated manure. The higher ammonium content allows better crop utilization and the physical properties allow easier land application. Properly applied, digester effluent reduces the likelihood of surface or ground water pollution.

Pathogen Reduction: Heated anaerobic digesters reduce pathogen populations dramatically in a few days. Lagoon digesters isolate pathogens and allow pathogen kill and die-off prior to entering storage for land application.

**From AgSTAR website*

During the anaerobic digestion process, microbes can convert volatile acids in livestock manure into biogas consisting of methane, carbon dioxide, small amounts of water and other compounds. Likewise, during the anaerobic digestion process a liquid effluent, called digestate, is produced. The digestate contains the water, all the minerals and approximately half of the carbon from the incoming materials. The majority of the nutrients remain in the liquid and manure solids are stabilized through anaerobic digestion. The opportunity to dry and transport digester solids is greatly improved over raw manure. The solids can be recycled and used for bedding or as a soil amendment on the farm. Alternatively under proper conditions, composting the digested solids can result in a product that can be sold to homeowners or the landscape industry. Depending on the system design, biogas can be combusted to run a generator producing electricity and heat, called a co-generation system, burned as a fuel in a boiler or furnace, or cleaned and used as a natural gas replacement.

Food and Dairy Processing Plants

Wisconsin has a robust food processing sector and is especially dominant in dairy processing plants. The Wisconsin Department of Commerce markets the state's more than 1,000 food-processing facilities in its economic growth strategy noting the large number of breweries, cheese producers, and processors of meat, fruit, vegetables and grains. Because these facilities generate a large amount of solid and liquid waste, they are prime candidates to utilize anaerobic digesters, and the majority of these plants have them. There should be a synergy in targeting locations of the facilities with a business that could use the energy, especially a combined heat and power type of plant, (see innovative partnership section). Food scraps represent about ten percent of Wisconsin's municipal solid waste and slightly more than half of that waste comes from business settings.[6]

Dry digester technology presents greater opportunity for managing food waste and yard waste. In early 2011 the University of Wisconsin-Oshkosh began producing electricity and heat for the campus from about 8,000 tons of organic waste generated each year from campus cafeterias. The Oshkosh project is the first commercial-scale system of its kind in the U.S., according to its developer BIOFerm Energy Systems of Madison. It is a technology that is common in Germany where 1,000 similar systems operate. This type of digester can also handle yard waste like grass clippings, and food processing waste. The city of Toronto is collecting and treating about 40,000 tons per year of organic waste from a curbside bin program. These materials are all diverted from costly landfill storage. The systems can also provide the other co-benefits including odor control.

The Wisconsin dairy sector has been a leader in using digesters to manage waste, but there is still a lot of room for expanding usage. The Energy Center of Wisconsin (ECW) analyzed the 20 Wisconsin counties that have 25,000 or more head of dairy cows. Their analysis focused on the top 17 Wisconsin counties with larger dairy operations (licensed as Concentrated Animal Feeding Operations or CAFOs) and found that 112 CAFOs in those counties could generate 45 MW of energy with onsite anaerobic digestion.[7]

How much biogas energy could be generated from Wisconsin dairy farms with more favorable policies? How much more energy would be generated if you added other feedstock or substrates to those digesters? You could, for example, set a meta framework for the state and break it down into the maximum theoretical energy generation, potential generation (a stretch goal) and projected growth under status quo or a slightly better scenario. The maximum theoretical energy generation may not be relevant because not all dairy farms will have digesters even under the most favorable policy environment.

BIOGAS PRODUCTION COULD PROSPER AT:

- Wastewater Treatment Facilities
- Landfills
- Food Processing Facilities
- Dairy Processing Plants

Graduate students assisting with this project calculated that if all the 23 million tons of manure generated by Wisconsin dairy cattle were run through digesters and converted to natural gas, it could produce nearly 4.4 percent of the state's natural gas needs. This represents a $185 million under-utilized opportunity. (See Got Gas? Analysis of Wisconsin's Biogas Opportunity paper).[8] A potential generation stretch goal for the longer-term of 1000 digesters in Wisconsin could produce about 250 MW of energy, especially if other feedstocks are added to prime the pump. Under a status quo scenario, Wisconsin would only add about three to nine digesters a year or with higher utility buy-back rates of about ten cents per kWh (or more) could add 20 to 30 dairy digesters per year, according to developer testimony in Public Service Commission rate cases. More detailed modeling would be needed to get a more exact growth projection, but these projections provide a snapshot of potentials. Energy generation is a significant factor in encouraging more anaerobic digesters in Wisconsin, but other co-benefits and externalities are the key to reaching our full potential in the state.

The uniquely adaptable energy opportunities for biogas also include taking compressed natural gas (CNG) and making it into a clean burning vehicle fuel. Biogas can be used to fuel a CNG vehicle directly. This system could be particularly adaptive for vehicle fleets. Local governments with landfills and wastewater treatment plants and fleet vehicles might find this an attractive energy alternative. The California Air Resources Board (CARB) found landfill and dairy biogas to CNG vehicle fuel to have the lowest carbon footprint of all the fuels analyzed for California law. These CNG fuels are more common in Europe, especially for mass transit systems in urban settings.[9]

Finally, the flexibility of biogas-to-energy lends itself to innovative uses in rural settings, especially as the knowledge increases of substrates and using other crops with a digester. Renewable energy strategies for biomass and biogas in partnership need further consideration. Little attention has been given to understand how landscape-based solutions for agriculture combining biomass and biogas renewable energy strategies might be developed.

Biogas and Biomass Synergy as a Landscape-based Systems Scale Solution in Rural Areas

The rural landscape, with agriculture and forest biomass for energy, along with waste-to-energy biogas, offers opportunities in many areas. Setting some principles and guidelines for managing the development of biomass for energy is critical. Priority areas include replacing annual crops or pasture, utilizing greater minimum or no-till practices, reducing chemical applications below current annual crop levels, building habitat nesting timing into a harvesting strategy and using perennial crops as buffers between annual crops and waterways.

Working lands are where the landowners have already established crops for food and fiber, and woodlands for paper and pulp production. With the biomass-to-energy economic opportunity, working lands will have energy sheds along with food sheds. The critical question is can growing biomass crops also maximize the ecosystem benefits of these working lands especially for nearby sensitive watersheds? The key is to determine how to make these sustainable systems by optimizing socioeconomic and ecological benefits.

We need to look at options that provide a greater local benefit and ensure that the energy generated could be used locally or regionally. We want a system where the creation of new rural businesses occurs or that an existing farmer cooperative can grow or expand, and that there is an opportunity for rural landowners and businesses to move up the energy economic value chain. One way to nullify this agriculture sector economic conundrum is to diversify sources of farm income by again turning manure into a valuable resource. Manure can be a source of bioenergy through digestion and co-generation. However, that might possibly be too narrow a solution. A system-wide solution calls for a big, bold, audacious ideas. The answer may come from stringing together a series of ideas.

Why not, for example, plant riparian vulnerable areas (conservation payments) to grasses that can be harvested as a source of renewable energy feedstocks? These feedstocks would be mixed with solids that are an end product of manure digesters and part of the power from the digester would be used to run a pelleting plant or a greenhouse. Selling pellets to these plants, either individually or as a cooperative, is a new source of income. Another income source that is starting to look viable is to scrub the methane and use it as a substitute gas, or use it as a fuel source (e.g., compressed liquid propane gas). The liquids from the digester would either be shunted to ponds (heated with heat from the digester that is currently vented off to the atmosphere) where algae would be grown to produce biodiesel. Some of the solids and liquids could also be used in greenhouses (again, heated in the winter from excess digester energy) where cooperative arrangements could be developed with community supported agriculture (CSA), community gardens, or even grocery chains. Other technologies are looking at creating byproducts such as chars or fertilizers.

Matching up growing energy crops creates another income stream for the farmer or landowner. The key is to create as many diversified income streams to farms as possible to keep the land in agriculture, and most importantly, make manure too valuable to allow it to escape into the larger environment. While today the current digester technology scales best with larger dairy or animal operations, the mid-sized operations are worth further development. If we do not create more public policy and programs to promote small-scale distributive energy systems, the rural benefit could be missed. The tipping point is today.

CHALLENGES CAN EQUAL OPPORTUNITIES

We cannot think about the Wisconsin biogas energy opportunity outside of the following global, national and statewide societal challenges.

- **Maintaining a global and domestically competitive dairy sector**
- **Maintaining a global and domestically competitive food processing sector**
- **Remaining competitive in a time of scarcity of resources**
- **Addressing impaired waters in our state**

- **Navigating land use conflicts and maintaining sustainability of soil quality**
- **Dealing with the reduction in farms and farmers**
- **Preparing for emerging concerns over agriculture nutrient management, greenhouse gases and air quality, and public health**
- **Trying to control the high societal costs of waste managed through landfills and wastewater treatment plants**
- **Reversing the trend of dwindling traditional energy resources**

Our proud Wisconsin heritage is linked with a robust dairy sector, agriculture in general, and the more than 1,000 food processing facilities in our state. It is commonly called the food system. If we want a sustainable economy built around the food system, keeping our competitive edge must be tied to long-term energy security, a healthy environment with clean water, air and soils, and reducing costs around waste management. A biogas development strategy can be a part of keeping the Wisconsin food system with a competitive edge.

Investments made today are cheaper than those deferred until tomorrow. Wisconsin and the U.S. need to be better positioned for a changing world by starting to invest in energy independence, including homegrown energy resources. Global competition for energy and scarce natural resources increase with emerging nations, including China and India, able to competitively buy from countries with access to resources. Now is not the time to focus on legacy fossil fuel infrastructure or status quo energy policy. The transition from an economy that was built around coal and petroleum will take time and strategic thinking to avoid economic disruption. Prudent investment in clean energy technology is needed.

The public is increasingly concerned with the issues of public health, water quality, air quality, soil quality and land use conflicts from animal agriculture operations in Wisconsin. There is also growing public interest in increasing renewable energy uses and reducing greenhouse gases in the state. Wisconsin's showcase dairy sector is facing many challenges with what some call manure management. More cows means more manure, not enough land for spreading, and regions where spreading is problematic (e.g., Karst geography), and community conflict can occur when dairy operations want to expand. The viability of agriculture is a critical component of Wisconsin's economic stability and growth. Rural and urban areas are dependent upon each other for the food and fiber system value chain, but face multiple societal conflicts meeting the needs of its citizenry. Anaerobic digestion systems offer a partial solution to some of the conflicts, but this single technology can be expensive for some farms and businesses depending on how society values and monetizes all of the system benefits.

Substantial Economic and Environmental Benefits to Dairy Farms

The combination of substantial environmental and economic benefits to Wisconsin dairy operations makes utilization of an anaerobic digester valuable under an optimal management strategy. The research done by UW-Madison graduate students, in conjunction with the strategic planning process, shows that the state dairy sector does realize environmental and economic benefits from odor reduction, increasing nutrient management flexibility, reducing greenhouse gas emissions, combined with revenues from energy generation sales, potential sales of by-products such as animal bedding, and the potential for environmental credits. As stated elsewhere in this strategic plan paper, the use of innovative partnerships could be critically helpful with generating pipeline quality gas or the ability to clean compressed natural gas (CNG) for fleet and vehicle fuels.

Size and Scale of Dairy Farms Should Not Be a Barrier

Research on the Wisconsin biogas energy opportunity has demonstrated that anaerobic digestion is a proven technology that can be deployed in a wide variety of business settings. Far too often it is stated that only the largest dairy farm operations can have anaerobic digesters and be economically successful. Using manure alone as a feedstock, a study done for the state of Oregon dairy industry, found that more cows and more manure did not equal more electricity generated. This is due largely to the limited energy intensity of manure alone as a feedstock. The research further demonstrated that using a co-digestion strategy, (e.g., adding other feedstock such as rye grass straw commonly found in Oregon) increased electrical generation by five times compared to using manure alone. Using a complete mix technology with other co-digested feedstock when evaluated through a regression analysis found that size and scale of the dairy farm were not statistically key factors in the economic success of an anaerobic digester. Much more significant, according to the study, was the power purchase agreement (PPA) with the energy end user.[10] In similar research, the EPA AgSTAR program found that dairy farms with 300 head of cattle can be cost effective using a centralized approach (processing waste from multiple farms at one location) somewhat similar the dairy digester project starting in Dane County.[11]

Capital Expenditures Should Not Be a Barrier

Today, some Wisconsin dairy operations may face limited access to capital for investment in anaerobic digesters due to the last two years of economic downturn and depressed profits from the revenue shortfall of low milk prices. Hopefully with a domestic and international economic recovery beginning, the trends limiting capital can be reversed. Close work with the financial lending community to improve transparency, longevity and clarity (TLC) of power purchase agreements will open the door to new capital investment in biogas plants. But the analysis from the Oregon dairy digester study shows that "capital expenditures are a one-time factor that account for less than 10 percent of a biogas plant's long-term viability."[12]

Current Power Purchase Agreements and Tax Credits May Not Benefit Farmers and Call for Greater Collaboration Among the Value Chain

The concept of making the biogas value chain work is a key to success. Without a better power purchase agreement (PPA), the return on investment (ROI) of a dairy farm anaerobic digester may not pencil out for some farmer operations. One part of the problem is that even with existing government incentive programs such as the Wisconsin Focus on Energy and federal Rural Energy for America Program (REAP) grants and loans, the on-farm anaerobic digester can have high overall operational costs compared to current revenue streams. The issue seems to focus on the "financial sweet spot" between the utilities' avoided cost and the farmer's heat and energy needs avoided costs. Utility policy experts at the Wisconsin biogas stakeholder

CONVERTING BARRIERS TO OPPORTUNITIES:

Dairy Farm Sector: Wisconsin has 78 farms with a 1,000 or more head, 194 farms with 500 to 999 head and 798 farms with 200 to 499 head.

Hog Farm Sector: Wisconsin has 99 swine farms with more than 1,000 head.

Food Processing Sector: Wisconsin has over 1,000 food processing facilities.

Ethanol Plant Sector: All of Wisconsin's existing ethanol plants should consider having an anaerobic digester.

Landfill and Wastewater Treatment Plant Sector: Some use digesters now, more could in the future.

Commercial Food Waste Sector: Businesses, universities and other facilities that generate large volumes of food food could source separately, use an onsite digester, or parter with a community or nearby farm.

The state has about 30 operating digesters with 22 on farm digesters already operating. Wisconsin has learned a lot from success and failure to lead us into future growth and development.

Wisconsin has a Renewable Portfolio Standard. Although most utilities have met or are close to meeting the requirements in current law, policies could be modified to target biogas growth.

meeting effectively argued that the energy buy-back rate system (the PPA) should not subsidize anaerobic digester co-benefits to society, and to some degree the co-benefits realized by the farm operation. While the debate will continue over who pays for all of the societal benefits, a closer look at Wisconsin tax policy and the renewable energy credit systems might be an avenue for policy consensus or a politically negotiated compromise with the biogas value chain.

The discussions with agriculture stakeholders, lenders, and biogas system developers in this process indicate current federal and state tax incentives do not adequately work for the farmer purchasing anaerobic digester renewable energy technology. Analyses completed for the state of Oregon dairy sector, and by a national study done by Meister Consulting Group and Heinrich Boll Institute validates this observation.[13] The federal production tax credit (PTC) and federal investment tax credit (ITC) have worked fairly well for wind generation renewable energy, in part, because of partnerships formed by investors who can use the credits versus the farmers. "Farmers are generally unable to monetize the value of the federal tax credits and so they must frequently enter into different forms of partnerships with tax equity investors," according to the authors of "Beyond Biofuels: Renewable Energy Opportunities for U.S. Farmers."[14] In a similar fashion the Oregon dairy digester study modeled investment scenarios and found that "in most cases tax driven attributes do not typically empower a dairy."[15]

It is interesting to consider the model scenarios from the Oregon dairy digester study in detail. The authors looked at a utility-avoided costs scenario (an on-peak rate of $0.057/kWh and off-peak rate of $0.046/kWh), a negotiated power purchase agreement scenario (a net PPA of $0.09/kWh after wheeling costs) and an advanced renewable tariff or feed-in tariff scenario ($0.12/kWh for biogas generated electricity). The impact of each scenario is best expressed in terms of a pre-tax ROI length of time. The utility-avoided costs scenario showed a likely return on investment of around 20 years and no probability of less than ten years. The negotiated PPA scenario improved the financial viability in a statistically significant way with a high probability of return on investment in less than 15 years. Finally, the advanced renewable tariff scenario dramatically improved the financial viability in a statistically significant way with a high probability of return on investment in less than ten years and several data runs showing five years or less. These scenarios were not run with a tax credit benefit, depreciation allowance and some other "below the line" benefits. The study authors conclude that, "all parties interested in promoting dairy-based biogas development should play a role in improving power purchase rates, controlling feedstock acquisition expense and establishing co-product markets." Stated another way it is making the biogas value chain work and points to further consideration of innovative partnerships to take advantage of any tax credit benefit.[16]

Combined heat and power (CHP) accounts for about nine percent of current U.S. electricity generation (about six percent natural gas and three percent other renewable energy sources). Clearly partnership with anaerobic digesters on farms, food processing facilities and other waste generators should explore CHP opportunities with a business needing energy. It has been discussed that computer data centers are interested in energy from anaerobic digesters. Hospitals, institutions, universities and state buildings might also be candidates for CHP partnerships. The other linkage to consider is business partners who could take advantage of the tax credits, federal ITC and PTC, and whether a state tax credit targeting CHP and anaerobic digesters is a policy for Wisconsin to consider. In Germany, the formation of farm energy cooperatives had many advantages and big economic development ramifications. German wind cooperatives create up to 3.1 times for overall economic benefits and 2.6 times more jobs. German renewable energy growth has created around 300,000 jobs in less than a decade.[17]

INNOVATIVE PARTNERSHIPS

Several business models exist with the biogas opportunity. These include the own and operate model where the digester sponsor takes all the investment risk and potentially derives all the benefits. The design and build by a third party operator who may own and operate the digester and the sponsor provides the substrate materials (e.g., Crave Brothers Farm and Pieper Electric Business/Clear Horizons). There are hybrid variations, public-owned models and community-owned models as well. Because there are so many potential societal benefits from biogas energy systems it makes sense to align public policy goals with business opportunity. What are some innovative partnerships that are already occurring and what new ones might be considered? Existing innovative partnerships in Wisconsin now include:

Community Digesters

Community digester projects present an opportunity for Wisconsin with several benefits including combining feedstock collection at several farms or industrial sites and sharing financial investment in a methane digester biogas plant. The community digester could include a cooperative business model, a public-private partnership or traditional small business partnership. Likewise, these types of projects may be easier to leverage public investment or subsidy by maximizing public benefits such as removing waste from landfill or wastewater treatment systems. As small to mid-size biogas plants looks to infrastructure investments such as piping to bring manure to a processing site or at the end use stage of cleaning methane from a digester to connect to a gas pipeline, the community digester model might maximize the ability to use third-party investors for equipment and infrastructure. Most importantly, small to mid-size dairy farms likely cannot afford a methane digester due to construction costs; the community digester just might make this biogas energy opportunity possible.

Dane County is pursuing the first community digester project in Wisconsin under a public and private partnership. Clear Horizons plans to privately finance a digester project in Waunakee along with a $3.3 million state earmark to support it. This project establishes a clear public benefit by using advanced separation technology to remove much of the phosphorus from manure. Dane County is extremely concerned about algae pollution in nearby lakes, and phosphorus from manure is a contributor to green algae in the lakes. Dane County is a rapidly urbanizing area, but remains a state leader in agriculture products. The county has around 400 dairy farms and 50,000 dairy cows resulting in a $700 million dollar local industry.

The Clear Horizons regional digester located in Waunakee is expected to generate $2 million worth of electricity every year. The company also expects to sell post digestion fiber materials. Dane County is planning another community digester project near Middleton, and other states are exploring the model and testing out the potential variations of business models.

Ethanol Plants

First generation biofuels through corn-to-ethanol production have paved the way in starting a new energy economy. The development of corn-to-ethanol was a logical first step in clean energy fuels using a technology advanced in 1980s with limited success, but experiencing resurgence to a current production level of 13 billon gallons in the U.S. and about half a million gallons in Wisconsin. Recently, corn-to-ethanol fuel production has faced challenges with the blend wall, production as a ten percent blend to gasoline peaks. Current corn-to-ethanol systems also faced challenges with policy such as a Low Carbon Fuel Standard including calculations of indirect land use. Indirect land use is the concept of diverting some lands with corn-to-energy causes more food crops in other parts of the world displacing carbon capturing rain forests. Existing corn-to-ethanol plants require large amounts of electricity and heat. The production process also produces waste material. Anaerobic digesters can produce energy from wastes and make a

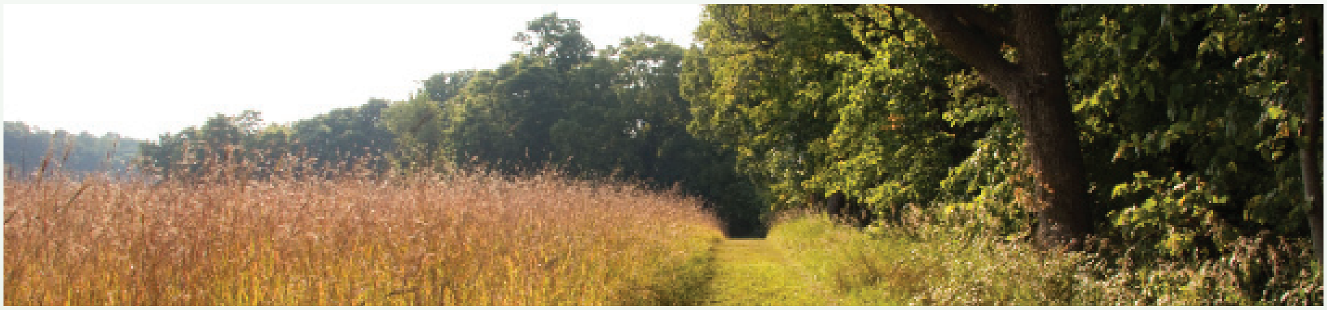


Photo by Falicia Hines

powerful match to ethanol plant energy needs. Using anaerobic digesters has the effect of lowering the overall greenhouse gas emission footprint of a plant and helps these facilities to better comply with a Low Carbon Fuel Standard policy. The United Ethanol of Wisconsin plant just received a $2 million grant to work with Eisenman Corporation on a $7 million digester installation at their facility in Milton. It makes sense that all ethanol plants should have digester technology since feedstock is already shipped to these facilities every day, and a waste product comes from making the fuel. It is worth noting that Poet Energy included a digester in the design of its Iowa project to produce next generation cellulosic ethanol from corn stover and corncobs. The digester is a critical component to the profitability of the new plant.

Other Partnership Models for Wisconsin to Consider

Utility Quality Gas to the Pipeline and Anaerobic Digesters

One example of converting to pipeline quality gas is at the Binder Biogas Plant near Freiburg, Germany. The plant is only one of approximately a dozen out of Germany's 5,000 biogas plants that are using part of the biogas to produce renewable natural gas or biomethane. The project produces 1 MW of electricity, but also injects 500 cubic meters of renewable natural gas into the pipeline every hour. Since the feed-in tariff policy offers very generous electric buy-back rates, very few biogas projects in Germany are using all or part of the biogas to produce renewable natural gas. Raw biogas must be upgraded from roughly 50 percent methane to 95 percent methane in order to be injected into the natural gas distribution system. The German feed-in tariff policy has been amended to provide a payment bonus for upgrading raw biogas to biomethane. The business model employed at this site is the farmer produces the biogas and sells it to the utility. Haase Company (a utility subsidiary) assumes all financial responsibility to upgrade the gas to pipeline quality standards and inject it into the pipeline (called the net in Germany).

Innovative Demonstration Project

Wisconsin should create green pricing for a gas demonstration project or pilot effort in the state. The city of Madison, which is currently doing a small-scale pilot to separate organics from its waste stream going to the landfill, could partner with its energy utility, Madison Gas & Electric (MG&E) on a green gas pricing demonstration project. The city would have to take the diverted organic waste and run it through a digester to produce energy. The utility could petition the Public Service Commission (PSC) to allow a price for therms of gas generated under this system from a dry digester business partnering with the city of Madison. Under a voluntary green energy purchase system, the utility would be allowed to sell this energy to the residents or businesses in their Madison service territory at a slightly higher price Getting the utility to price out pipeline-quality gas under this type of program builds a body of

Photo by Ted Petith

knowledge about green pricing of gas and allows the community the opportunity to pilot waste diversion for energy. Something similar could be set up at UW-System campuses interested in diverting organics out of the landfill waste stream to produce a clean and green technology energy. The campus could get even more innovative and link it with a CHP plant, which would fit with UW-System campus sustainability initiatives.

Public/Private Partnership

Wisconsin should consider having a Wisconsin utility or a holding company build or finance a digester project at a public institution. Under this arrangement, a state or local government facility could finance a digester project in partnership with the utility. Dairyland Cooperative has used a program to work with farmers to finance digesters. This type of arrangement has financed the manure digesters at Five Star Dairy in Elk Mound, Wild Rose Dairy in LaFarge, and Norswiss Farms in Rice Lake. These three digester projects are 0.775 MW each and generate 6,000 MWh each annually, according to Dairyland Cooperative. Bach Digesters LLC in Dorchester and Norm-E-Lane Dairy in Chili. also used this Dairyland Power program. Another variation on this could potentially be developed using Property-Assessed Clean Energy (PACE) Programs.[18]

BIOGAS INNOVATIVE PROJECT COMPRESSED NATURAL GAS (CNG)

The flexibility of using existing technology of digesters to convert methane to energy is further demonstrated by an innovative project lead by Cornerstone Environmental Group and Unison Solutions along with the Dane County Landfill to make compressed natural gas (CNG) for use as a vehicle fuel. The first full-scale demonstration project was launched in December 2010. The patent pending process can use biogas from landfills, wastewater treatment plants and agriculture and food waste digester. The system is flexible enough to be used for small or larger fleet vehicles. The biogas from the digester is pumped into the system and cleaned. Then it could be routed to a CNG fueling station for use in CNG vehicles. Also, the conditioned biogas can be mixed with natural gas to produce a blended vehicle fuel similar to biodiesel or ethanol/gasoline blends.

Partnership Model Like Those Used in Germany

Create a joint venture with utility and a farmer or food processing business for a gas pipeline injection joint ownership like Germany. PSC regulates pipeline safety so they do care about this dimension of projects. The joint ownership model would let the utility do the injection. The farmer or food processing company could own the digester. Perhaps some type of holding company could allow for this business arrangement.

Rural Economic Development Partnership Model

Wisconsin could use a rural economic development strategy with the Agriculture Enterprise Zone (AEZ) program run by the Department of Agriculture, Trade and Consumer Protection (DATCP). Maybe this model could be done in conjunction with a small rural industrial park, or Tax Incremental Financing District (TIF) to extend or fund the extension pipeline costs. Local governments have broad bonding authority, and then a business end user with an energy need could partner with the community and local land owners for crop substrates to run through the digester.

Related Ideas:

Data Center Businesses to Wisconsin

The average data center uses the energy equivalent of 25,000 homes, and as a business sector has been a leader in seeking renewable energy options to meet power needs. A team of Hewlett-Packard researchers has already written a blueprint for using a dairy digester to power the massive computer center needs of a data center business. Combining one of these innovative partnership models could attract jobs to rural areas by luring a data center business with a promise to make it a green business using digester technology for their energy source.

Local government fleet running on digester gas cleaned for biogas fuels

A business with a car or truck fleet could be targeted for digester gas that is cleaned to a fuel level. Dane County has been working on a demonstration of a mobile unit to covert biogas to vehicle fuel in the form of compressed natural gas (CNG). This innovative public and private partnership can produce biogas CNG from a small portion of the biogas at existing biogas to energy systems to supply the energy equivalent of approximately 100 gallons of diesel per day. The Cornerstone Environmental Group working with Dane County has already developed biogas vehicle fueling projects in California and Ohio.

MAKING THE VALUE CHAIN WORK

Financial lenders have many choices on where to direct loans to private business. In the current conservative lending climate, some financial institutions have become increasingly cautious about lending to new technologies. In order to increase lender confidence, Bruce Kahn, director and senior investment analyst at Deutsche Bank Group, outlined to biogas stakeholders the key issues for financing projects. He noted that investors look to public policy for three key drivers he called TLC:

- Transparency – Easily understood and open to all
- Longevity – Matching investment tenor and staying the course
- Certainty and Consistency – Incentives need to be financeable

The concept of a predictable and transparent support framework to attract investors is highlighted in a study done by Deutsche Bank Group, "Paying for Renewable Energy: TLC at the Right Price: Achieving Scale through Efficient Policy Design." This study gives extremely high marks to Advanced Renewable Tariffs (ARTs) for meeting the criteria established for investor confidence: transparency, longevity and certainty. Accomplishing these factors allows investors to better predict the returns of renewable energy projects. A more rapid development of renewable energy options is likely to occur under ARTs, according the study authors. "Using (ARTs) to support renewable energy accelerates the process of technology development. It enables these clean, low-carbon technologies to reach grid parity and provides a part of the solution to climate change mitigation."[19] This policy has supported an estimated 75 percent of global photovoltaic (PV) capacity and 45 percent of the global wind capacity through 2008 with some form of (ARTs) in more than 28 developing countries.

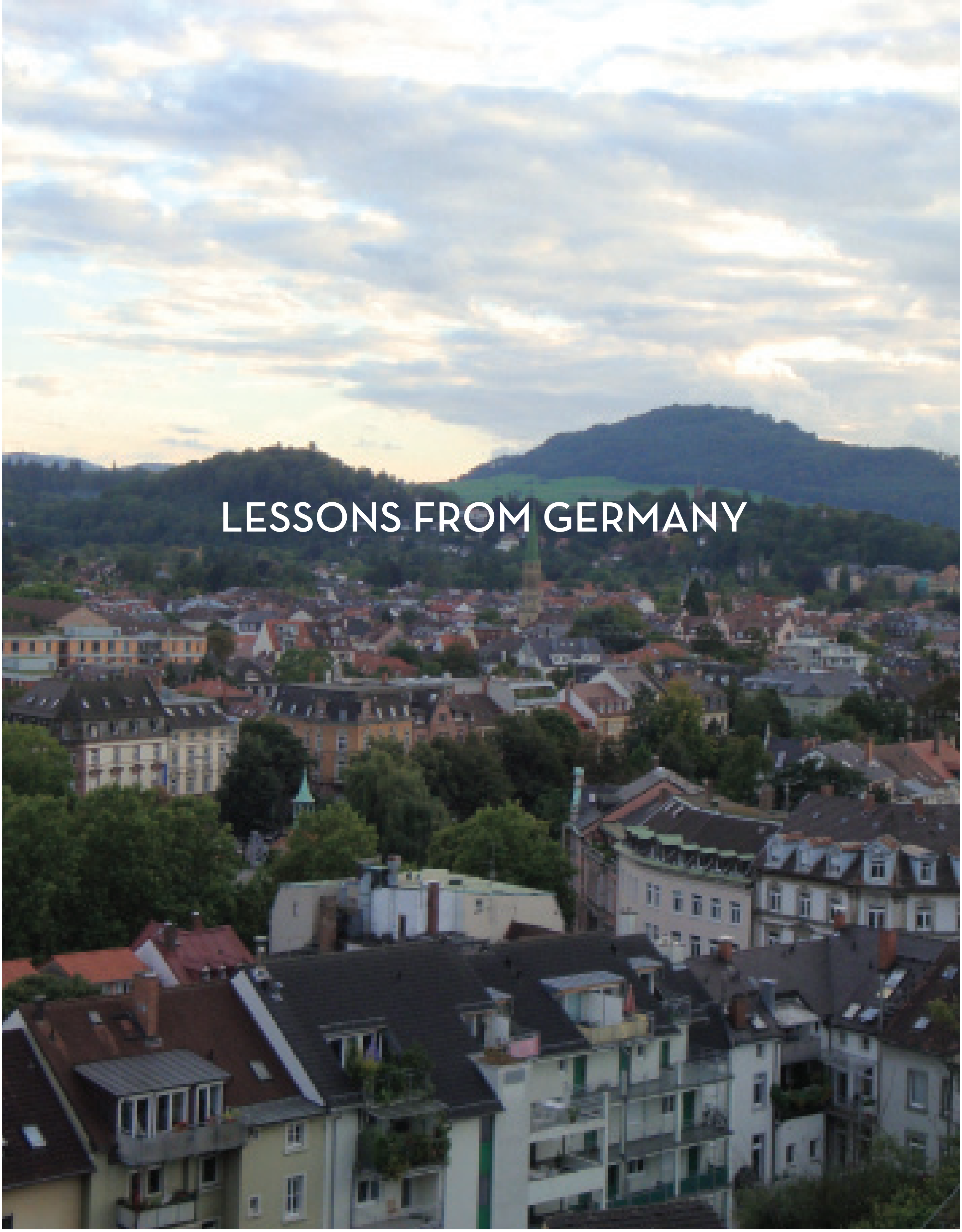
Job Creation Occurs with the Correct Renewable Energy Policy

The report scores the policies of nations around the globe and gives the U.S. mixed marks on the TLC criteria. Kahn noted that investors want transparency, longevity and clarity to deploy capital in scale and minimize risk. He added that the "right price" for renewable energy purchase can be achieved by policy that strikes a fair balance between public and private sector interests, creating a new benefit to society as a whole. The policy of ARTs works throughout the globe because it can:

- Achieve scale against a target – macro or micro
- Reduce the cost of capital due to increased certainty
- Bring in Independent Power Producers (IPPs) and expanding the market
- Easy to understand through a standard offer

Using Germany as a case study can be illustrative of how TLC draws the investment community into funding renewable energy projects. Germany created its Feed-In Tariff Law, also known as Advanced Renewable Tariffs, in 1990 and made modifications in 2000, 2004 and 2009. From 2000 to 2008 the cumulative investment in renewable energy increased 93 percent because of the policy. For the biogas industry sector Germany set the target of getting 30 percent of total electricity production from renewables by 2020. The target then was matched by an incentive of a higher utility buy-back rate that better reflected the cost to purchase equipment such as anaerobic digesters on farms. Further, other policy incentives were added such as sustainable biomass harvesting practices and matching biogas plants (anaerobic digesters) with CHP to increase the buy-back rate. The basic energy buy-back for biogas rate was 11.6 EUR cents for systems less than 150 kW, 9.1 EUR cents for less than 500 kW and 8.2 EUR cents for less than 5 MW systems. The added bonus incentives could result in almost doubling those buy-back rates.[20]

Once a critical mass of biogas plants were built in Germany, the growth curve was exponential. From 2005 to 2010 the number of biogas plants doubled from 2,600 to 5,300. The renewable energy growth in Germany was a robust job creator, with an estimated 500 people working in the biogas energy sector in 2005 to about 12,000 people working in the biogas sector by 2010. According to the German government, more than 280,000 jobs were created in renewable energy sectors by 2009. Germany leads in biogas production, with enough energy to power 3.8 million households. The farm economy saw a significant income boost with about 3,000 on farm biogas energy plants. Overall the renewable energy sector generation increased from 4.3 percent in 1997 to 15.1 percent in 2008. The impact on energy security was significant with less dependence on energy imports saving 2.2 million Euros, the equivalent of more than $2.8 billion, and avoided costs from the most expensive fossil fuel plants of 9.4 billion Euros. Biogas represents about ten percent of renewable energy generation in Germany today. For this dramatic increase in renewable energy generation the German ratepayer has seen only a 12 Euros to 25 Euros per household per year increase, or $15.70 to $32.70 a year per household.[21] This means a monthly increase of about $1.30 to $2.70, which is less than cost of a cup or two of good coffee each month.[22]


LESSONS FROM GERMANY

As a part of this project, a delegation of UW-Madison graduate students and policy experts traveled to Germany in September to study its policies, programs and business models around biogas-to-energy development. The National Science Foundation (NSF), the Nelson Institute for Environmental Education and the WBI funded the project.

Because Germany is the world leader in biogas-to-energy and both UW-Madison and the WBI recognize that education and outreach go beyond the borders of the state, region and nation, we wanted to look closer at why Germany is leading in renewable energy development. Furthermore, for the stakeholder meeting, others who have researched the German policy and commercialization systems were invited to make presentations. The goal was to share a portion of what the group learned in Germany and identify lessons for Wisconsin, the Midwest and the U.S. to consider.

Key lessons from Germany:

- Farmers in Germany have seen amazing wealth accumulation from biogas-to-energy generating 60 to 80 percent of their income from energy sales. This has insulated them from the food commodity price roll coaster.
- Renewable energy job growth in Germany is impressive, with around 300,000 people employed in solar, biomass, biogas and wind sectors.
- Utility ratepayers have seen relatively small increases in their monthly bill due to increased use of renewable energy and the higher power purchase price. Because the costs are split among all utility ratepayers in the country the cost was about 4 Euro per month or $5.17 per month, as of last year.
- Germany's more than 15 years of growing its biogas-to-energy sector can demonstrate important business models for Wisconsin to consider including biogas plant co-ownership; innovative partnerships with utilities particularly in cleaning biogas to pipeline quality; the value of using waste heat and shipping to nearby community or businesses; and partnering with universities.
- Scale can matter, but does not have to be a barrier to wider biogas-to-energy development, particularly on smaller farms. Germany has some innovative system designs for large and small systems.

Left: Photo by Ted Petith

- Germany has used new innovations with the inputs into an anaerobic digester and the end uses of productions coming out of a digester. We will further research opportunities with substrates and additives to digesters during the input phase. A broader policy discussion is needed on the range of end uses of biogas plants including electricity, heat, pipeline gas, fuels and end products.

- Policy is important. The social, economic and cultural differences between Germany and the U.S., specifically Wisconsin, may be a significant factor to achieve long-term change to a new energy economy.

Placing a higher value on the multiple co-benefits of using anaerobic digester biogas-to-energy systems would distinguish Wisconsin from Germany and other states in the U.S. These co-benefits include, but are not limited to, on-farm cost savings in manure management and use, nutrient conversion, manure odor and pathogen reduction, and broader societal benefits of reduced greenhouse gases, potential to improve water quality and rural economic growth.

While the U.S. is still slowly coming out of the biogas opportunity starting gate, Germany and other parts of the world are rapidly utilizing anaerobic digesters to create a distributive network of biogas electrical energy, heat, pipeline quality gas and even vehicle fuels. Germany has 30 times as many digesters as the U.S., and is not alone in promoting biogas renewable energy in Europe. Denmark and Sweden also use biogas for direct use or to generate electricity. Denmark typically uses a combination of animal manure and agriculture waste to generate community-based power shipped by pipelines. In contrast, Sweden uses manure, agriculture and food waste to create biogas that is then cleaned into fuel for vehicles. Germany utilizes a diverse feedstock for digesters that includes manure (the power purchase agreements pays more for at least 30 percent manure use in Germany), corn silage or chopped corn stover, Sudan grass, and other crops. Germany deploys many different technologies with variations for small and large farms, and other operations. Most common digesters in Germany use a continually stirred tank reactor.

The EPA AgSTAR Program projects that the U.S. could have upwards of 8,000 anaerobic digesters producing biogas on farms across the land. The total generating capacity would be around 1500 MW, or around 2 percent of all electricity. If policy and economics can align, Wisconsin and the U.S. could have even more biogas-to-energy facilities than the agency projection. The problem is that biogas remains a relatively untapped resource in the U.S. due to concerns with economic viability and a lack of agreement on deployment strategies or the policies to make that happen quickly. Globally, 75 percent of biogas potential lies in anaerobic digestion of agricultural crops, byproducts and manure. Seventeen percent is in municipal and industrial organic waste and eight percent in sewage and wastewater treatment. One bottleneck is the cost to upgrade technologies needed to boost biogas to the same quality as natural gas and the current low price of natural gas.

The delegation that went to Germany saw several types of creative business partnerships and innovation at the biogas facilities. One of the amazing things about homegrown energy biogas plants is the flexibility to create energy for the electrical grid, reuse the heat on site or send it somewhere nearby for use, clean the methane gas for pipeline transport, and convert the gas to a vehicle fuel. The German feed-in tariff model might not be a precise fit for U.S. development, but it speaks to the importance of public policy as a key industry driver. In addition to the Renewable Energy Sources Act, the German government has made commitments for 30 percent of the country's electricity and 14 percent of its heat to be supplied by renewable sources by 2020. These targets, coupled with a generous tariff rate for power purchases, make a winning combination for biogas project development in Germany.

Why is this important to Wisconsin? On the local level food processing and dairy agriculture are two of Wisconsin's signature industries generating billions in state revenues and providing key jobs. Food processing and dairy farms are prime locations for anaerobic digesters. In the U.S. some 30 percent of food is thrown out and taken to costly landfill operations. Food waste can prime the pump for anaerobic digesters to produce more biogas energy. Taking a waste product and making homegrown renewable energy in Wisconsin and the U.S. just makes sense.

BIOGAS RESEARCH: UW-PLATTEVILLE BIOPLASTICS PROJECT

Tim Zauche, a UW-Platteville chemistry professor, is heading up an interesting research project looking at bioplastic degradation and anaerobic digestion. The project that began in the fall of 2010 has several objectives including testing whether bioplastic will degrade anaerobically with manure and mixed waste streams, whether the bioplastic can increase methane production and is the digestate appropriate for growing media—soil amendment.

The research is being done on a pilot scale digester, a modified 4-stage digester that was built by Hanusa Renewable Energy for the pilot project. The research is looking at the impact of organic wastes on anaerobic digesters as well as the biobased plastics. The work is being done at the Pioneer Farm, near the city of Platteville. The Pioneer Farm is a part of a collaborative venture, called the Wisconsin Agricultural Stewardship Initiative, between agriculture producers, state government and the University of Wisconsin System.

For more than 20 years, Germany had several preeminent cultural and political factors driving energy independence including a strong populist opposition to nuclear power, a general desire to not depend on Russia for natural gas and overall greater desire for greenhouse gas reduction. The German political coalition of agriculture groups, particularly its 250 agricultural machinery cooperatives, and rural financial institutions combined to push many of the policies that resulted in the feed-in tariff law.

The WBI will continue to investigate German policy and how to effectively apply these lessons to Wisconsin policy and procedure.

POLICY

POLICY RECOMMENDATIONS FROM STAKEHOLDERS

During the Wisconsin stakeholder meeting, the group brainstormed on creating a policy menu to share with policymakers in 2011. The participants respected a diversity of views, and the policy menu was not expected to be a consensus document. No individual participant or organization has to endorse any or all of the menu's policies. This planning document is designed to serve as a resource, and organizations will choose on whether they will formally advocate for specific policy. The WBI facilitated the discussion to ensure research supports policy discourse. Later, small subcommittees selected a small subset of shorter-term, achievable ideas and policies categorized as essential goals and a second set of bolder steps that might take time to achieve. The subset of ideas is listed below, followed by a more extensive menu of policy options.

Essential goals: short-term and achievable

Promotional or education and outreach campaign: Find a high profile spokesperson to promote homegrown biogas renewable energy. A Green Bay Packer or Milwaukee Brewer could talk about homegrown energy. Seek possible funding from dairy business promotion groups such as the Milk Marketing Board, the Dairy Business Association or Professional Dairy Producers of Wisconsin.

Action Item: Work with business groups to discuss an education and outreach campaign.

Explore usage of the Clean Water Fund for digesters: Currently this Department of Natural Resources administered program funds Wastewater Treatment system upgrades and replacements using a mixture of federal funds and state revenue bonding funds. This is a very competitive fund for local government wastewater treatment needs, but has been utilized for anaerobic digesters in conjunction with other local government wastewater treatment capital expenditures.

Action Item: Work with state officials and policymakers to explore expanded use of the Clean Water Fund program.

Do a pro-forma comparison on costs of six types of projects: There is limited publicly available detailed budget and cost pro-forma analysis of a variety of anaerobic digester technologies.

Action Item: Work with biogas developers, the agriculture and food processing sector and utilities to develop a Wisconsin-based set of pro-forma business comparisons.

Biogas Ombudsmen or technical assistance expertise: Many anaerobic digester owner-operators could benefit from ongoing technical expertise about system operations and other business related opportunities.

Action Item: Work with University of Wisconsin Extension, the Wisconsin Technical College System, the biogas developers and others to determine the best way to create permanent technical assistance expertise.

Left: Photo by Ted Petith

Locate digesters at state facilities or high profile locations: Site locations ranges from state building facilities such as the Waupun prison, UW-System campuses, a publicly high-profile site like Miller Park or Lambeau Field.

Action Item: Work with state officials to determine feasibility of state projects and have private sector outreach on other high profile projects for public demonstrations.

Put together a list of all potential funding sources: A variety of state and federal programs could be funding sources for anaerobic digesters and biogas plants.

Action Item: Some sites exist already such as Renew Wisconsin and Focus on Energy. Work to make sure lists are available on a public access site.

Tradable ITC and PTC: Under federal law there are both a Renewable Energy Investment tax credit and Renewable Energy Production tax credit. Could federal or state tax law be modified to create a trading mechanism?

Action Item: Discuss with federal and state policymakers options for tradable tax credits.

Another voluntary tariff: Some Wisconsin utilities offer voluntary advanced renewable tariffs for power purchase agreements of renewable energy generation. What steps are needed to expand these tariffs?

Action Item: Discuss with utility sector, the Public Service Commission and policymakers options on tariff system.

Property tax reduction for biogas plant: The turnkey type of anaerobic digester operations would particularly benefit if the equipment of the biogas plant was exempt from the property tax on land where it is located.

Action Item: Discuss options to create a property tax credit or reduction for biogas plants with policymakers. Consider additional benefits for combined heat and power partnerships with businesses needing energy.

Photo by Falicia Hines

Pilot a gas utility green pricing program: Limited knowledge is available on a pricing structure for anaerobic digesters to pipeline quality gas conversions under a green pricing system.

Action Item: Work with utility sector, Public Service Commission and others on a pilot program design.

Greater outreach and training for farmers: More farmer-to-farmer discussion and training could occur about the benefits of anaerobic digesters and creating biogas plants.

Action Item: See biogas ombudsmen recommendation.

Biogas credits on a BTU basis:

Action Item: Work with policymakers and Public Service Commission and utility sectors on ideas.

More grants programs for biogas installations:

Action Item: Discussion with policymakers on options.

Establish a biogas cooperative network: Germany was very successful in working with their farm machinery cooperatives in advancing biogas-to-energy and the policy to support it. Could similar models be created in the U.S.

Action Item: Discuss with University of Wisconsin Center for Cooperatives and the private Cooperative Network organizations possible options.

Facilitate more collaboration between farm digesters and food waste sources:

Action Item: Work with leaders in both agriculture and food processing sector and food waste generators such as universities or hospitals on possible partnerships.

Potential steps in Biogas Strategic Plan: bolder and long-term

Statewide nutrient trading program: Discussions about a nutrient-trading program have taken place between the Wisconsin Department of Natural Resources and Dane County. If Dane County moves ahead with a nutrient-trading program it could be a model for the state.

Statewide Advanced Renewable Tariff (ARTs), Feed-In Tariff (FiTs) or Standard Offer Contract: A long-term agreement with utility on a higher buy-back rate for biogas. Contracts would be in the 15-year or 20-year length with regulated utilities required to make connections and pay a buy-back rate better reflecting installation costs.

Decoupling of rates with Advanced Renewable Tariffs: Similar to policy option above, policymakers could look to decoupling with an ART.

Tradable greenhouse gas reduction system: Policy options could include a model built off a federal Cap and Trade Program or state model along the lines of the Eastern U.S. system.

Low Carbon Fuel Standard: The state of California has a Low Carbon Fuel Standard law. The Midwestern Governors Association has a policy and research paper that analyzed issues surrounding a Low Carbon Fuel Standard policy in the region or in individual states.

Renewable thermal standards for gas utilities: Work with the American Biogas Council and other organizations include state utilities on what is necessary for these standards.

Aggressive but equitable Renewable Portfolio Standard for state: The state of Wisconsin currently has a Renewable Portfolio Standard (RPS) for regulated utilities to use 10 percent renewable energy generation by 2015.

Comprehensive federal climate change policy: Congress has considered comprehensive climate change policy with the pass of a bill last session in the U.S. House of Representatives. Federal bills will likely be introduced again this session.

Ban organics from landfills: A statewide ban of organic materials from landfills would require action by the Wisconsin legislature. Local governments might have some latitude to pull organics from its waste stream collection for use in anaerobic digesters.

Greater development of small scale systems and alternative uses for biogas: Work has already begun in Wisconsin on small-scale systems, but could clearly be more robust.

The WBI will work with biogas stakeholders after the release of this strategic plan report to implement robust public discussions around the Wisconsin biogas opportunity and approach policymakers about ideas in the policy menu.

POLICY MENU

Co-authors: Amanda Bilek, Peter Taglia and Gary Radloff

Renewable Portfolio Standards

The policy instrument historically used to increase renewable electricity generation has been a Renewable Portfolio Standard (RPS) or a Renewable Electricity Standard (RES). An RPS sets a percentage of electricity generation in an electric utility's portfolio to come from renewable energy resources by a certain date. An RES generally starts out small in the near-term and steadily increases the percentage of required renewable electricity into the portfolio over time. Energy sources that can be used to meet the RPS in Wisconsin include tidal and wave action, fuel cells using renewable fuels, solar thermal electric and photovoltaics (PV), wind, geothermal, hydropower less than 60 MW, and biomass including landfill gas and biogas. Wisconsin's current RPS has a statewide target of 10 percent by 2015, with statutory requirements varying by utility. Specific requirements are as follows:

- Each year from 2006 to 2009, a utility cannot decrease its renewable energy percentage below the average renewable energy percentage for 2001, 2002 and 2003.
- In 2010, each utility must increase its renewable energy percentage by at least two points above the average percentage for 2001, 2002 and 2003.
- Each year from 2011 to 2014, a utility cannot decrease its renewable energy percentage below the average renewable energy percentage for 2010.
- In 2015, each utility must increase its renewable energy percentage by at least six points above the average percentage for 2001, 2002 and 2003.
- For each year after 2015, a utility cannot decrease its renewable energy percentage below the percentage for 2015.[23]

The Wisconsin Public Service commission must determine by June 1, 2016 if the state met the renewable energy goal of 10 percent by Dec. 31, 2015. If the PSC determines that Wisconsin did not meet the state goal, it must determine how the goal can be achieved with additional actions.

Renewable Energy Carve Outs or Set Asides

Within an RPS policy, states can choose to carve out or set aside a specific percentage of renewable energy generation to be derived from a specific renewable technology. Very few examples of resource carve outs or set asides exist in current RPS policies, but the examples that do exist are for solar and wind or allow electric utilities to use a small percentage of energy efficiency to meet renewable energy requirements. An RPS allows electric utilities to select from a large menu of renewable energy options to meet the requirement, which can help to bolster development of large renewable generation projects, which benefit from economies of scale. However, biogas projects, which are mostly distributed and often smaller generation, can have a more difficult time securing power-purchase agreements when competing with larger generation projects. A carve out or set aside would require that a small percentage of an RPS be met with renewable electricity derived from biogas projects. A carve out or a set aside is more difficult to amend to an existing RPS. Still, if the state of Wisconsin considers increasing the RPS requirement, a biogas carve out could be a part of the discussion.

Enhanced Renewable Portfolio Standard (eRPS)

During the last legislation session, as part of the Clean Energy Jobs package, an eRPS was considered. The policy would have allowed electric utilities to generate credits for renewable natural gas injected into the pipeline, thermal energy from combined heat and power, or co-generation projects and use the credits to meet the state RPS. The Clean Energy Jobs package proposed to increase Wisconsin's RPS to 25 percent by 2025. If this policy would have passed, a regulatory process would have determined a conversion factor for thermal energy and renewable natural gas. The conversation factor would translate into a Renewable Resource Credit (RRC), a credit used in Wisconsin to track renewable energy generation and determine compliance with the policy. Supporters felt the policy would add flexibility for electric utilities and would build a market incentive for upgraded biogas to renewable natural projects, which currently does not exist. Electric utilities use peaking plants to provide electricity when electric needs reach a peak. These plants can be started and shut down rather quickly. Conventional natural gas is the fuel source for some of these peaking plants and an eRPS that would allow renewable natural gas upgraded from biogas projects to meet the requirement could offset all or part of the conventional natural gas use when a peaking plant is brought online.

Compliance and Credit Tracking

In order to determine utility compliance with an RPS policy, states use some form of credit calculation and tracking. Most states call these credits renewable energy certificates or renewable energy credits (RECs). In Wisconsin these credits are referred to as Renewable Resource Credits (RRCs). Although the names are slightly different, both are used to demonstrate RPS compliance and track voluntary renewable electricity purchases to ensure the same credit is not used in both the compliance and voluntary market. RRCs enable utilities in Wisconsin to buy and sell credits among utilities with excess renewable generation to utilities needing additional generation to demonstrate policy compliance. Wisconsin is also a member of the Midwest Renewable Energy Tracking System (M-RETS) which tracks renewable energy generation and assists in verifying compliance in Illinois, Iowa, Manitoba, Minnesota, Montana, North Dakota, Ohio, South Dakota and Wisconsin. Credits contain information about the environmental and non-power attributes of renewable electricity generation including type of renewable energy resource, date when energy generation began, date when the renewable energy generation was built, generator's location, eligibility for certification, and greenhouse gas emissions associated with the generation.[24] Credits can monetize the value of renewable electricity by allowing renewable generators to sell credit attributes into the compliance or voluntary market. However, there is price volatility associated with the sale of renewable energy credits, which presents some risk to the holder of the credit.

Voluntary Markets for Renewable Electricity

Prior to the passage of renewable portfolio standards in individual states, voluntary efforts helped drive the development of renewable electricity generation. Individual private interests can purchase RECs to offset conventional electricity use at a facility or through an activity. REC purchases by large corporations and public institutions to offset conventional electricity use in buildings have contributed to steady growth in the voluntary market for renewable electricity. Growth can also be attributed to individual utility green pricing programs for renewable electricity.

Utility Green Pricing Programs

Green pricing programs for different forms of renewable electricity make up a large share of the voluntary market for renewable electricity. A utility green pricing program offers an option to utility rate payers to purchase renewable energy above standard electricity rates. Voluntary purchases by customers require electric utilities to supply enough renewable electricity to meet customer demand. Tracking systems, such as M-RETS verify compliance and voluntary market transactions. M-RETS assists participating states to follow the REC's path through a voluntary or compliance market and retire the credit once it has been used to avoid counting the credit again in the future.[25] In Wisconsin, the law allows utilities to count green pricing sales towards the RPS, but utilities do not double count these credits as a best practice.

Wisconsin Green Pricing Programs

The city of Madison and some state government departments have committed to purchase a set percentage of renewable electricity. Beginning in 1999, Madison's Metro Maintenance and Administration Facility began targeting to purchase 25 percent of its electricity use through the Madison Gas and Electric wind power program. In 2007, the City of Madison Common Council adopted a resolution to purchase ten percent of its electricity from renewable sources in 2007 and 20 percent by 2011.[26] Voluntary renewable electricity purchases like these help drive additional renewable electricity generation in addition to any state level statutory requirements. Corporations or government agencies could tailor voluntary renewable electricity purchases towards biogas projects in order to drive additional development.

Green Pricing for Biogas Projects

Few models exist in the U.S. for utility green pricing programs focused on electricity generated from biogas projects. Central Vermont Public Service (CVPS) operates one of the most successful green pricing programs for biogas electricity in the country. CVPS serves approximately 18,000 retail customers across the state of Vermont and created a program known as "CVPS Cow Power™." The program was the first manure-based, farm-to-consumer green power-purchasing program in the U.S. CVPS customers who sign up to participate receive all, half or a quarter of their energy through the program, which supports renewable energy development and Vermont dairy farms. Utility customers who opt into the program pay a four-cent premium per kWh. One hundred percent is paid to cow power-producing farms. The program currently has six participating farms that receive a premium price for their electricity.

Voluntary and compliance markets are both important to driving renewable electricity development and could become even more important with tailored programs for biogas-to-electricity voluntary purchases or statutory requirements such as carve-out or set-aside within an RPS policy or adopted of an enhanced renewable energy portfolio.

Advanced Renewable Tariffs

The policy tool known as Advanced Renewable Tariffs (ARTs), or sometimes called Feed-In Tariffs (FITs), has proven, across the globe, to expedite the development of renewable energy generation. Germany has realized the most success with this policy tool and has utilized it for the longest period of time. Between 2000 and 2008, Germany's national share of renewable electricity generation more than doubled from 6.3 to 15.1 percent with the ARTs being a critical driver. ARTs offer a long-term, fixed payment to renewable energy generators. In comparison, the RPS seeks to create price competition between renewable generators to meet defined targets at least-cost, and typically defines maximum cost through a price cap instrument.

How ARTs function

These tariffs allow a renewable energy generator to feed the power of their solar panel, wind turbine, methane digesters, biomass fueled boiler, or other renewable generation into the larger energy system power grid and receive a prescribed (by a regulator or unit of government), price/unit generated (typically, $/kWh). This prescribed price is typically referred to as a buy-back or off-take rate.

Tariff and Policy Design Variations

The laws can differ, but essential principles include that the utility company must provide access to the grid to anyone or any group producing renewable energy. The buy-back rate is established for a set amount of time (say 15 to 20 years). This guaranteed long-term payment reduces the financial riskiness of the project. The stable buy-back rate is why banks and other financial lenders have more willingness to finance renewable energy projects.

Pricing Flexibility

Prices can vary according to the type of technology, the size of the system and its location. Any potential increased costs to the utilities are paid for by adjustments to all customers' bills. The utility gains increased energy generation capacity without having to invest in the cost of new generation under the ARTs.

Adjustable Over Time

A system can be established to adjust policy or rates as needed. Some countries phase down the rate a little each year over time, under what is sometimes called rate digression.

Difference with Renewable Portfolio Standard

Advanced Renewable Tariffs are often contrasted with RPS's. Wisconsin's RPS requires utilities to provide 10 percent of their energy from renewable sources by 2010, but does not specify that 10 percent of renewable energy be from a homegrown renewable energy source. Some utilities in Wisconsin already offer higher renewable energy buy-back programs, but these programs are often limited to the utility's voluntary green energy programs, and only in their service area. Also they are not uniform across the state. These programs often have limits on the type and eligible size of the generator and the total capacity of the program. The benefits typically go to the larger scale projects and often to out-of-state projects and investors. Small-scale distributive energy generators are often disadvantaged under the current RPS.

The issue of a predictable and transparent support framework to attract investors is the key factor highlighted in a study done by Deutsche Bank Group, "Paying for Renewable Energy: TLC at the Right Price: Achieving Scale through Efficient Policy Design." TLC stands for (Transparency, Longevity and Certainty), the critical factors that support investor confidence in renewable energy markets. This study gives extremely high markets to ARTs for meeting the criteria established for investor confidence: transparency, longevity and certainty. Accomplishing these factors allows investors to better predict the returns of renewable energy projects. A more rapid development of renewable energy options is likely to occur under ARTs, according the study authors. "Using (ARTs) to support renewable energy accelerates the process of technology development. It enables these clean, low-carbon technologies to reach grid parity and provides a part of the solution to climate change mitigation."

The Wisconsin PSC and others have raised concerns about how the federal law, PURPA, may prevent states from setting ART rates that are higher than the utility avoided cost. A January 2010 paper by the National Renewable Energy Laboratory (NREL) examined the issue in greater depth. Navigating around this issue may be tricky is one message from the paper, which provides several pathways to implement ARTs in the U.S. The principal author of the paper, Scott Hempling of the National Regulatory Research Institute, points to a pathway under PURPA for states to implement ARTs and an alternative pathway under the Federal Energy Regulatory Commission (FERC).

Under the PURPA pathway suggested by the NREL paper a state would have to create supplemental forms of payment for renewable energy (above the avoided cost) such as RECs, subsidies in the form of cash grants or utility tax credits equivalent to the amount of additional payment (now the practice in Washington state). Likewise, a voluntary payment program based on avoided costs can be structured. Under the FERC pathway, an ART could comply if the rates are cost-based or market-based and contracts would need to be reviewed by FERC. This route would likely be considered administratively burdensome. There are exemptions under PURPA for generators less than 20 MW. This option could offer a short-term solution until some clarification of the federal law occurs. U.S. Congressman Jay Inslee has legislation to fix PURPA and language was included in the Waxman-Markey climate change bill that has passed the House of Representatives (the U.S. Senate has not taken action on any energy or climate legislative package).

Net Metering

Net metering has been used as a policy instrument to encourage development of locally produced renewable electricity connected to the electric grid. Currently, 35 U.S. states have some form of a net metering policy. Under a net metering program, renewable electricity generated by a utility customer enables the customer to run the electric meter backward to offset electric use. Projects that produce excess generation and still remain under the designated capacity limit receive retail rates for the excess electricity fed to the grid.

Wisconsin Net Metering Policy

The current net metering policy in Wisconsin allows several different types of renewable energy technologies to receive a net metering contract if the renewable energy system has a capacity of 20 kW or less (We Energies customers have a 100 kW system capacity limit for wind projects).[27] The Wisconsin net metering policy applies to investor-owned and municipal utilities.

Wisconsin's net metering policy is on par with most other states in the Midwest, but Iowa has a 500 kW system capacity limit and Kansas has a 200 kW system capacity limit for non-residential customers. The Iowa and Kansas net metering policies only apply to investor-owned utilities. The Kansas policy also has an aggregate capacity limit of 1 percent of the utility's peak demand during the previous year.

Net Metering Outside of the Midwest

States outside of the Midwest have used net metering policies to specifically drive adoption of biogas systems. Vermont explicitly includes biogas from sewage-treatment plants and landfills, and anaerobic digestion of agricultural products, byproducts and wastes in the definition of renewable energy.[28] Renewable energy systems up to 250 kW can qualify for a net metering contract. The policy places an aggregate capacity limit of 2 percent of the electric utility's 1996 peak demand or peak demand during the most recent calendar year (whichever is greater) and applies to all electric utilities in Vermont.

In August 2010, New York changed their net metering law to drive adoption of biogas projects. The maximum system capacity for farm-based biogas systems was increased from 500 kW to 1 MW.[29] Since the statutory change is fairly recent, implementation of the policy will require tariff revisions, which have yet to be determined. The New York net metering policy applies to investor-owned utilities and there is an aggregate capacity limit of one percent of the utility's 2005 demand for solar, agricultural biogas, residential micro-CHP and fuels cells.

Changes to Wisconsin's Net Metering Policy

Wisconsin could consider changes to the existing net metering statute by raising the capacity limit for all types of renewable energy, or implementing specific language to drive biogas system development. An increase in the system capacity limit could be coupled with an aggregate capacity limit for an individual utility based on electric demand in a previous year. Increases in the net metering system capacity limit would be specific for biogas-to-electricity projects and would not address incentives for other utilizations of biogas. Increasing the system capacity limit of current net metering policies could drive development of additional biogas projects. Receiving retail rates for excess generation can help to improve the investment payback

Community Digesters

Community digester projects present an opportunity for Wisconsin with several benefits including combining feedstock collection at several farms or industrial sites and sharing financial investment in a methane digester biogas plant. The community digester could include a cooperative business model, a public-private partnership or traditional small business partnership. Likewise, these types of projects may find it is easier to leverage public investment or subsidy by maximizing public benefits like removing wastes from landfill or wastewater treatment systems. As small to mid-size biogas plants look to infrastructure investments such as piping to bring manure to a processing site or at the end use stage of cleaning methane from a digester to connect to a gas pipeline, the community digester model might maximize the ability to use third party investors for equipment and infrastructure. Most importantly, small to mid-size dairy farms likely cannot afford a methane digester due to construction costs. The community digester just might make this biogas energy opportunity possible.

Biogas Systems on Small and Medium Sized Farms

Wisconsin Dairy Farms

	Farms	Animals
1 to 49	5,836	362,472
50 to 199	7,252	1,214,867
200 to 499	798	417,835
500 to 999	194	218,915
1000 to 2499	71	170,401
2500 or more	7	30,020

Source: USDA National Agricultural Statistics Service (NASS), 2007 Census of Agriculture

Current biogas project development in Wisconsin has mostly taken place on dairy farms that have at least 800 cows. Project development has occurred on these operations due to an economy of scale issue; the investment in a digester will be roughly the same if an operation has 800 cows or 2000 cows. Project development in other parts of the country has trended towards dairy operations that have 1000 or more cows. There are a few project examples of biogas systems on farms other than dairy, however dairy is the dominant livestock sector utilizing anaerobic digestion in the Midwest and in the U.S. In the Midwest, there are a few biogas projects at swine, cattle, and poultry operations, but these projects tend to be on farms with a larger number of animals.

The table above compiles the number of Wisconsin dairy farms according to number of animals. The largest number of dairy farms in Wisconsin have between 50 and 199 dairy cows. Another large segment of farms have between 200 and 499. Previous and current biogas project development is missing the largest segment of the Wisconsin dairy sector and strategies must be developed to determine how small and medium-sized operation could take advantage of biogas technology.

Wisconsin Small Farm Pilot

In March 2010, the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) announced a $200,000 grant award to Tomah-based USEMCO to develop and demonstrate an anaerobic digester for small farms. USEMCO has been in the process of developing a more cost-effective digester for smaller farms. The company will design, manufacture, assemble and operate the anaerobic digester on a 150-cow organic dairy farm near Chaseburg. Dairyland Power Cooperative will purchase the electricity produced by the project. The major goal of the project is to develop an anaerobic digester that is cost effective for small farms but the project also hopes to reduce greenhouse gases, odor, and solids runoff. The Wisconsin small farm pilot project holds the potential to significantly increase the number of biogas projects in Wisconsin and further propel Wisconsin as a leader in biogas project development.

Minnesota Small Farm Pilot

The Jer-Lindy Farm in central Minnesota is working to prove that digesters can work on average-sized Minnesota dairy farms. Like Wisconsin, the overwhelming majority of dairy farms in Minnesota have fewer than 200 cows. The 240-acre dairy farm has 160 milking cows. The Jennissens, with the help of a grant from the Environment and Natural Resources Trust and other supporters, are testing anaerobic digestion technology. The goal of the project is to determine if it might be feasible—or profitable—for an average-sized Minnesota dairy farm to operate an anaerobic digester. The project was constructed in fall 2007 and began to produce electricity in May 2008. Manure from the Jennissen's free-stall barn is scraped twice daily into a mixing pit where recycled water is added in order to achieve 6 to 8 percent solids concentration of the slurry. The slurry is then pumped into the 33,000 gallon digester tank where it is held at 106 degrees for five days. Biogas from the digester is burned in an internal combustion 350-horsepower modified Chevrolet engine to power an electrical generator that produced approximately 40 kW of electricity. Excess electricity is sold to Stearns Electric Association.

When the project first began to operate, only digesting the manure from their cows was not enough to power the 40 kW engine. The Jennissens began to explore the possibility or adding organic substrates to their digester to increase gas production. They partnered with a local dairy processing plant to deliver waste cheese whey to add to the digester. The addition of 5 percent cheese whey tripled the gas production and excess gas is now being flared off.

Another stumbling block the project has encountered has been the reliability of the engine generator set. A 40 kW engine was used in order for the project to take advantage of Minnesota's net metering policy. The pilot site has gone through three engines because they have not found a small-scale engine to run on biogas long-term. The Jennissens have partnered with a local electrician to design an engine generator set capable of operating long-term and at the size needed for the project. The capacity of the engine will also be increased to produce electricity from the excess gas generated by the digester since the addition of the cheese whey. The Jennissen small farm digester pilot project holds many lessons for future projects in Wisconsin or other parts of the country.

Future of Small Farm Projects

Based on operational experience at the Jennissen dairy farm and other projects from around the globe, the addition of organic substrates has incredible potential to increase the biogas production at individual projects sites without a huge additional capital investment. Operational experience has also proven that small farms will need a combination of grants and economic incentives to be feasible or maybe even profitable.

Renewable Fuel Standards

RFS policies require a specified percentage of fuel sold in a state or the U.S. to come from defined renewable sources. Twelve states have RFS policies, such as Iowa's requirement that begins at ten percent renewable fuel by 2010 and increases to 23 percent by 2018. Most activities for RFS policies waned following the large expansion of the federal RFS program passed in the December 2007 (Energy Independence and Security Act) and recently promulgated by the EPA as the RFS2 program. This policy specifies a specific volume of renewable fuels that must be sold in the U.S., reaching a total volume of 36 billion gallons by 2022. The RFS2 program further divides the volumetric goal into subcategories for advanced biofuels and cellulosic biofuels, and fuels for each subcategory must meet greenhouse gas reduction targets and other definitions. A producer of biogas CNG must petition the EPA to generate credits under the RFS2 program and these credits are further limited to the advanced biofuels sub-category, the smallest portion of the RFS2 program. Thus, the RFS program may provide some incentives for biogas CNG, but it is more difficult for a biogas CNG producer to generate credits than producers of conventional liquid biofuels (e.g., ethanol or biodiesel).

Low Carbon Fuel Standards (LCFS)

An LCFS rates different types of transportation fuels by their energy content and carbon footprint and allows fuel providers to choose what mix of fuels will be used to meet the requirement. The flexibility of an LCFS is unique among fuel policies, allowing all transportation fuels, including ethanol, biodiesel, natural gas, electricity for electric cars, and biogas CNG, to compete with petroleum to meet the standard. By increasing the diversity of fuels in a market, an LCFS will also reduce fuel price volatility that comes from over-dependence on petroleum. LCFS policies have been enacted in California; proposed at the federal level; and proposed in 11 Northeast states, Washington, Oregon, British Columbia, and Europe. A stakeholder group formed by the Midwestern Governors Association is also developing design principles for a low carbon fuel policy.

LCFS policies have significant benefits for biogas CNG. Biogas producers that supply biogas CNG to vehicles, such as bus fleets, would generate credits that could be sold to petroleum suppliers that must meet the overall carbon footprint requirement of the policy. Since biogas CNG has been found to have the lowest carbon footprint of available fuels, credits generated by biogas CNG vehicle use are likely to have significant value to an LCFS credit market. Under California's LCFS policy, the carbon footprint for various biogas CNG sources has been established making it easier for producers to generate credits under this policy.


RESEARCH

SUBSTRATE USE IN BIOGAS OPERATIONS: AN UNDERUTILIZED OPPORTUNITY?

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Abstract

This review analyzes the use of different substrates to increase biogas production. Substrates can include, though not exclusively, corn, grass, and/or wheat silage. We discuss the role of substrates in the digestion process, and how to design the most efficient mix of substrates to maximize biogas production. The evaluation of biogas as an opportunity fuel for Wisconsin requires a technical evaluation while also providing a disposal mechanism for a variety of organic wastes. The current status of substrate use in Wisconsin is evaluated to stimulate discussion on future potential market-based substrate opportunities (e.g., integration with existing waste streams).

Why are substrates critical for biogas production?

The production of biogas from anaerobic digestion involves the conversion of complex organic matter, or substrates, to methane by specialized anaerobic bacterial communities. The rate and efficiency of this digestion depends upon both the chemical structure of the substrate and the stability of the bacterial community. Selecting a consistent mix of substrates with high energy content (like simple sugars and fats) that is readily available to the bacteria will maximize biogas production. Feeding the digester highly variable substrates with nutrients locked away in compounds that bacteria cannot break down (like lignin and cellulose) will lead to poor biogas production.1

What mix of substrates optimizes biogas production?

Manure is actually among the least efficient substrates for biogas production (Figure 1). In contrast, maize silage produces approximately nine times more methane as manure. Other sources such as industrial wastes (primarily food wastes) can yield even more biogas: food scraps (265 m3 biogas per ton), bakery wastes (714 m3 biogas per ton), and fats and grease (961 m3 biogas per ton).3 A mixture of "co-substrates" from agricultural, municipal, and industrial products can be combined to optimize biogas production.

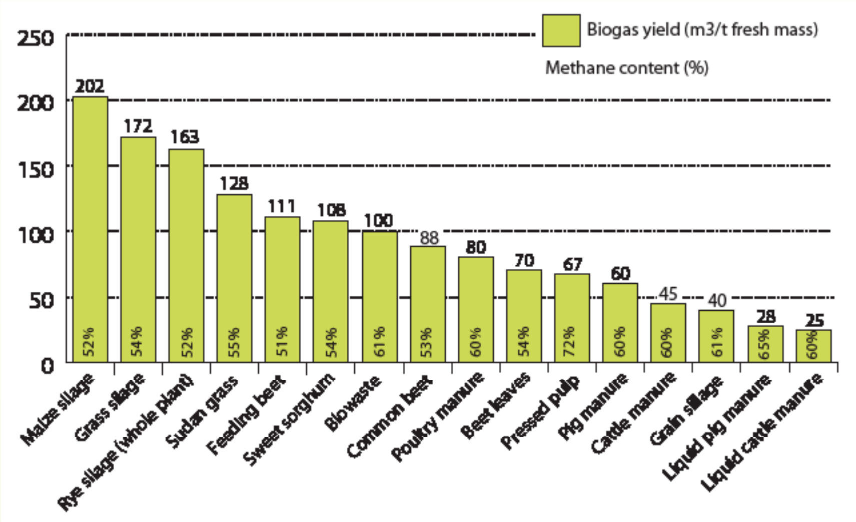

Figure 1: Biogas Yield and Methane Content of several agricultural products. Source: FNR (2009)

Left: Photo by Falicia Hines

How should producers select an appropriate mix of substrates?

Each digester should be individually designed and maintained to maximize biogas production based on the unique conditions of that site. There is not one "magic mix" that will work for all digesters, and each producer will have to analyze the trade-offs inherent in selecting an appropriate mix of substrates.

When selecting substrates, it is important to consider:
(1) How much energy is in the substrate?
How consistent is the substrate over time? And how reliable is the substrate source?
What is the cost of collecting and transporting the substrate to the digester site?

What is the current status of substrate utilization in Wisconsin?

According to the Wisconsin Agricultural Biogas Casebook, there are 21 on-farm anaerobic digesters operational. As shown in Figure 2, nine are adding substrates (in addition to manure). Of these nine, six are adding substrates associated with the food processing industry.

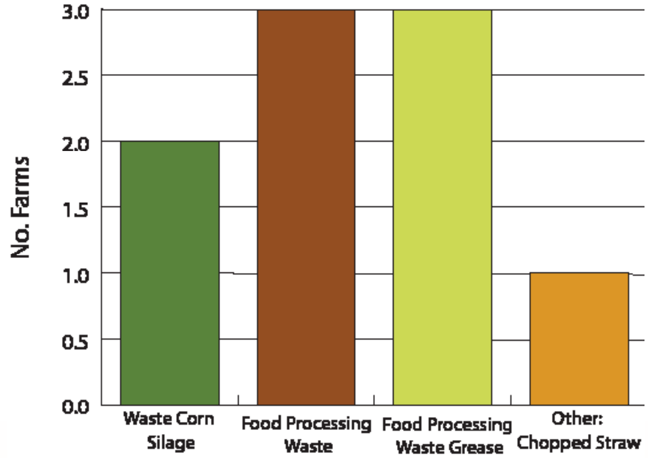

Figure 2: Categorization of substrates currently used in Wisconsin on-farm digesters. Source: Kramer (2009).

What is the current status of substrate use in Germany?

In Germany, many rural dairy producers use approximately 30 percent manure and 70 percent other substrates, mostly corn silage, but also wheat, grass, and other inputs. It is common to see co-digestion of two or three different feedstock. Producers suggested that they had learned that some manure was essential to maintain a good stability of bacterial communities in the digester, but that other substrates provided more energy and better biogas production. Producers using only crops as inputs did report some concern about bacterial stability. Additionally, specialized biotech companies provide laboratory services that will monitor the bacterial communities in digester systems and prescribe specific micronutrient additives that help maintain optimal digestion. Anecdotal reports suggest that these services have decreased the volatility of some systems and made manure-free digesters a real option. In addition to providing a steady source of stable bacterial communities, using manure substrates is also incentivized by the German government. The ethical debate about growing food products for energy generation in Germany led the government to increase the buy-back rate for producers who included a minimum of 30 percent manure in their systems.

Summary

Substrates and co-digestion should be evaluated in all current and future on-farm biogas projects in Wisconsin. The ability to integrate other waste streams and simultaneously increase the biogas yield should have a positive impact upon the future of this opportunity energy source in Wisconsin. As with all biologically mediated processes, consideration of all projects should consider the following:

Benefits:

- Increased biogas yield
- Integration of waste streams to produce energy
- Decrease waste streams currently sent to landfills and municipal treatment plants
- Increased opportunities for businesses (i.e. food processors) to integrate combined heat and power projects
- Decreased odors from current methods (i.e. composting)

Concerns:

- Requires consistent quality of the substrate (minimize shock loads and inhibitory concentrations)
- Availability and proximity of substrates to on-farm digesters

Potential Discussion Questions for Substrate Potential in Wisconsin

- Is the use of substrates to increase biogas production currently considered in planning on-farm digesters? Specifically, can the use of substrates make small-herd size (<200 head) on-farm digesters more economical?
- What is the potential to link substrate sources (i.e. food processing plants) with on-farm digesters in Wisconsin?
- What is the potential to adapt energy crops, such as grass, into on-farm digester projects?

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THE GREEN CHEESE PROJECT

The Green Cheese project is a group effort focused on identifying synergies that reduce greenhouse gas (GHG) emissions, reduce the use of fossil fuels, reduce other environmental impacts, and improve profitability of integrated dairy and bio-fuels production systems.

Members of the Green Cheese project are:
Douglas Reinemann, Louis Armentano, Victor Cabrera, John Norman, Horacio Aguirre-Villegas, Thais Passos-Fonseca, Josh Posner, Franco Milani, and Simone Kraatz

Objectives of the project

1) Investigate synergies and opportunities to reduce energy intensity and environmental impact of dairy and bio-fuels production.
2) Provide guidance to:
   a) Individual farms to
      i) choose technologies and management practices to reduce energy intensity and environmental burden of milk production;
      ii) prepare for carbon credits market
   b) Policymakers regarding implications of specific technologies on WI energy and GHG balance, aiming better resource allocation
3) Compare efficiency and environmental impact of dairy production systems in WI vs. other regions
4) Expand Life Cycle Assessment database of agricultural products

Summary of our first study

Our first study was compiled as "Net energy intensity and greenhouse gas emissions of integrated dairy and bio-fuels systems in Wisconsin", which results are summarized below.

Five different diets with and without dry distillers grains (DDGS) and associated ethanol production were analyzed using the Green Cheese system expansion model to estimate and compare the environmental footprint of each diet-based scenario, using two different manure management practices (with and without biogas generation).

The diets were basically the following:
- CADS: 29% of dry matter intake (DMI) from Corn silage, 29% of DMI from Alfalfa silage, and equal amounts of DDGS and Soybean meal (in DM basis);
- CSDG: 36% of DMI from Corn silage, 22% of DMI from Alfalfa silage, maximizing DDGS;
- CSSB: 36% of DMI from Corn silage, 22% of DMI from Alfalfa silage, maximizing Soybean meal;
- ASDG: 22% of DMI from Corn silage, 36% of DMI from Alfalfa silage, maximizing DDGS; and
- ASSB: 22% of DMI from Corn silage, 36% of DMI from Alfalfa silage, maximizing Soybean meal.

The net energy intensity and the greenhouse gas (GHG) emissions per kg of energy corrected milk (ECM) of each scenario were estimated.

We assumed that biogas would displace the production and combustion of natural gas, because it is the most similar primary fossil energy source. Most biogas is used to produce electricity at the point of production and our initial estimates were that in this use scenario the credits would be slightly smaller than those claimed for natural gas substitution.

The minimum greenhouse gas (GHG) emissions and net energy intensity per kg of ECM occurred in systems that used diets with dry distillers grains (accounting for the associated corn ethanol production) and anaerobic digestion on the farm to generate biogas.

GHG results

The average effect of including anaerobic digesters for on-farm biogas generation reduced GHG emissions from milk production by 0.24 kg CO_2-eq /kg ECM, CO_2-eq: Carbon dioxide equivalent (Figure 1).

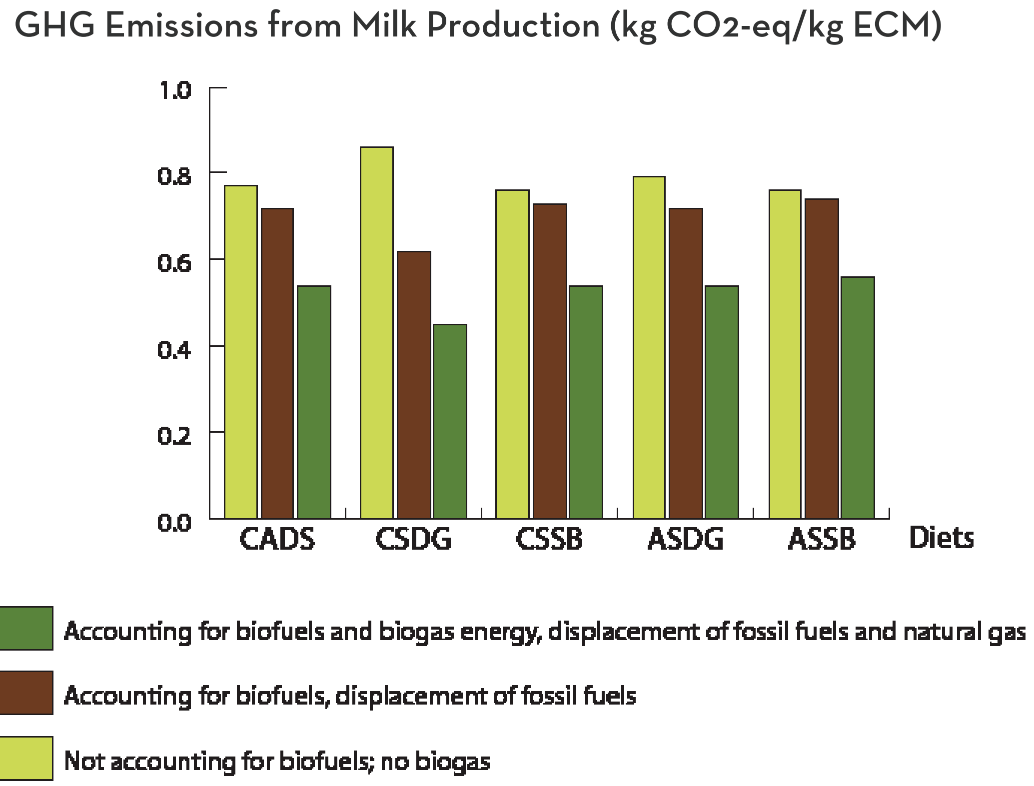


Figure 1. GHG emissions in different scenarios.

If the biogas was used to generate electricity the avoided emissions for electricity production would be smaller (0.12 kg CO_2-eq/kg ECM) than the avoided emissions for natural gas production and combustion.

Reduction in emissions was due mainly to the avoided natural gas production and combustion (0.19 kg CO_2-eq/kg ECM), and secondarily to avoided CH_4 emissions from manure storage. Production of CH_4 through anaerobic digestion decreased the amount of C left in manure, thus reduced CH_4 emissions from manure during storage post-digestion (0.05 kg CO_2-eq/kg ECM). It was assumed that the CO_2 emitted from the combustion of CH_4 in the biogas would have otherwise been emitted from the manure when it was exposed to the air.

Energy intensity results

On average, biogas produced 2.57 MJ/kg ECM. The inclusion of biogas generation made all of the scenarios net energy producers (Figure 2).

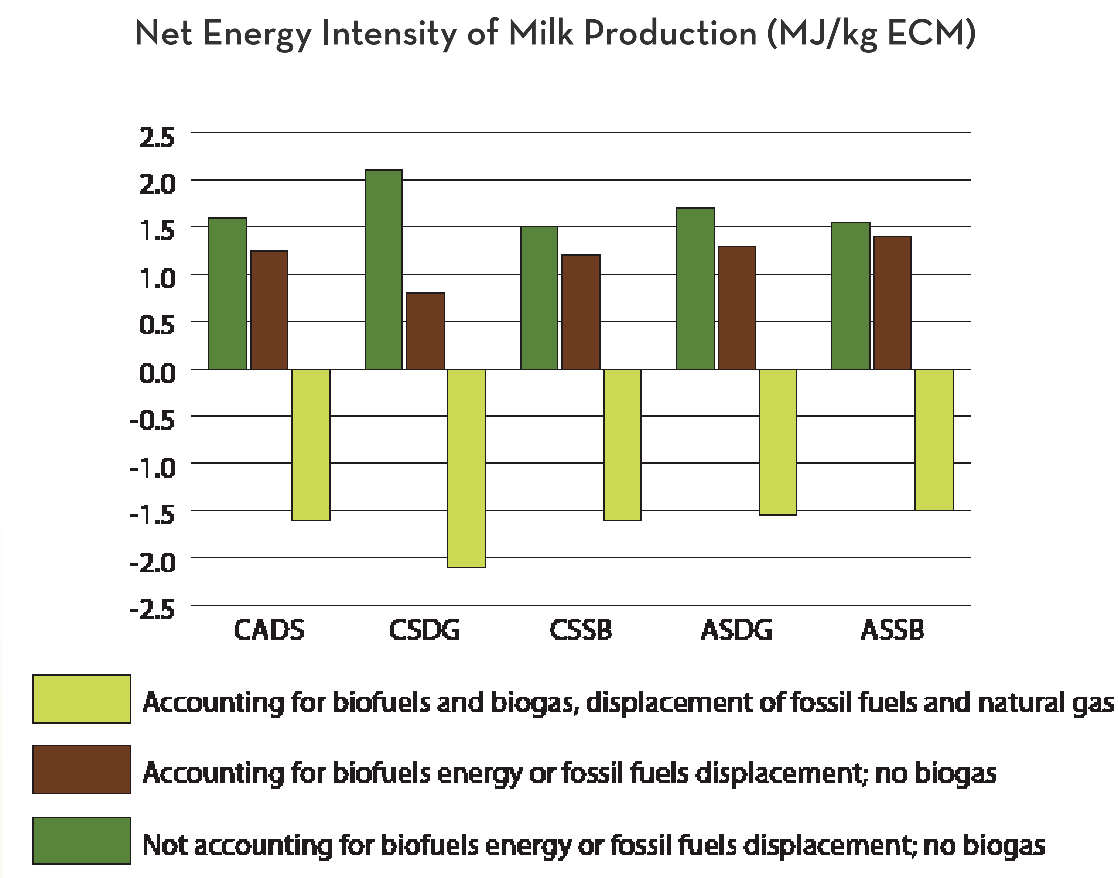


Figure 2. Energy intensity according to different scenarios.

If the biogas was used to generate electricity, a conversion efficiency factor (of 0.25-0.30) should be applied.

General conclusions

The significance of biogas in GHG emissions and net energy intensity in this study reflected in reductions of 30-35% in CO2-eq/kg ECM and 213-240% in MJ/kg ECM.

Note: we did not do a complete analysis of the treatment, transport, delivery, and end-use conditions of biogas. A more complete analysis would likely affect these estimates and this work is continuing.

Possible implications for the biogas-electricity industry

If all farms with more than 200 cows in Wisconsin (corresponding to around 40% of the state's milk production or 4.5 billion kg of milk/year (based on data from the USDA, NASS, WI FO, 2008)) would implement anaerobic digesters to process dairy manure into biogas that would displace natural gas utilization, the potential on-farm energy production (from biogas) would be 11.5 billion MJ/year, and the correspondent potential of savings on GHG emissions would be 1 billion kg CO2-eq/year.

Further research suggestion

Energy intensity and greenhouse gas emissions related to different ways of biomass utilization, such as:
a) combustion in boilers to generate steam (and thus heat and/or electricity);
b) feedstock in biorefineries to produce liquid bio-fuels; or
c) co-substrate in anaerobic digesters in conjunction with dairy manure to generate biogas.

GOT BIOGAS? AN ANALYSIS OF WISCONSIN'S BIOGAS OPPORTUNITY*

Aleia McCord,[1,2] Jeffrey A. Starke,[1,3] Mirna Santana,[1,4] Sarah Stefanos[1,2,5] and Steve Plachinski[1,2]
[1]University of Wisconsin-Madison [2]Nelson Institute for Environmental Studies [3]Department of Civil and Environmental Engineering [4]Department of Soil Sciences [5]Department of Sociology

**Full report has been published separately. See www.wbi.wisc.edu to download a copy.*

Research Conclusions

Anaerobic digestion has the potential to offer the state of Wisconsin a suite of economic, social, and environmental benefits beyond its obvious utility as a source of clean, renewable energy. Public and private decision makers should recognize and value these benefits when assessing whether biogas is an appropriate public or private investment.

Specifically, anaerobic digestion can help livestock producers and food processors with waste management. In some cases, this waste management with anaerobic digestion results in direct savings for private interests. For example, reduced odor emissions resulting from the implementation of anaerobic digestion in rural areas could increase rural property values by over $100 million dollars. Likewise, privately owned food processors could potentially save $500,000 in sewer charges each year. In other cases, the benefits of anaerobic digestion offer more indirect or secondary waste management benefits to the state. Reduced agricultural run-off means cleaner public drinking, recreational, and irrigation waters. These cleaner waters could translate into reduced healthcare costs from food-borne & waterborne illnesses as well as increased revenue for Wisconsin's state parks due to fewer beach closures. Employing on-site anaerobic digestion for food processing wastewater reduces the strain on Wisconsin's aging municipal wastewater treatment systems, conserving the state's limited resources by extending the life of these systems.

Anaerobic digestion also offers opportunities for promoting energy independence in Wisconsin. Currently, Wisconsin sends about $18.6 billion per year out of the state to meet its fossil fuel energy needs. Existing on-farm biogas systems already have the potential to offset $2.2 million of coal for electricity or, if upgraded to create pipeline quality natural gas, nearly $15 million in natural gas. If all the manure in Wisconsin was used to generate natural gas, Wisconsin could offset 4.4% of its annual natural gas usage. This suggests that rather than viewing the 23 million tons of manure generated each year in the state as a $48 million dollar management headache, Wisconsin could view its manure as a $185 million underutilized opportunity.

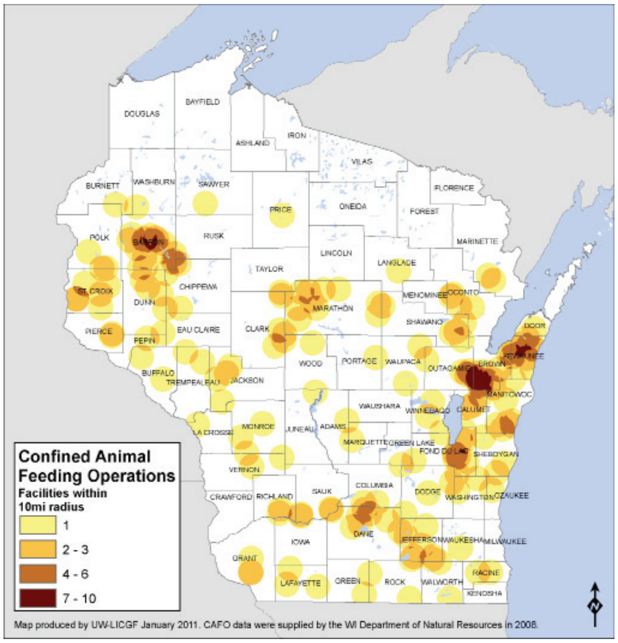
A host of other economic opportunities also accompany anaerobic digestion. Specifically, biogas could generate new green jobs and stimulate the growth of a new industry while offering a stable source of on-farm income not subject to commodity price fluctuations. In Germany, over 11,000 people are employed by the biogas industry. Dairy producers may also benefit from new revenue streams created by the co-products of biogas generation. Specifically, digestate may be used as bedding or fertilizer. These products can be used on-farm, creating a closed loop system, or sold off-farm as a value-added product. Finally, if regional or national carbon markets materialize, dairy producers stand to reap great benefits for methane reductions. At current EU carbon prices, a 100 head farm could qualify for as much as $10,000 each year.

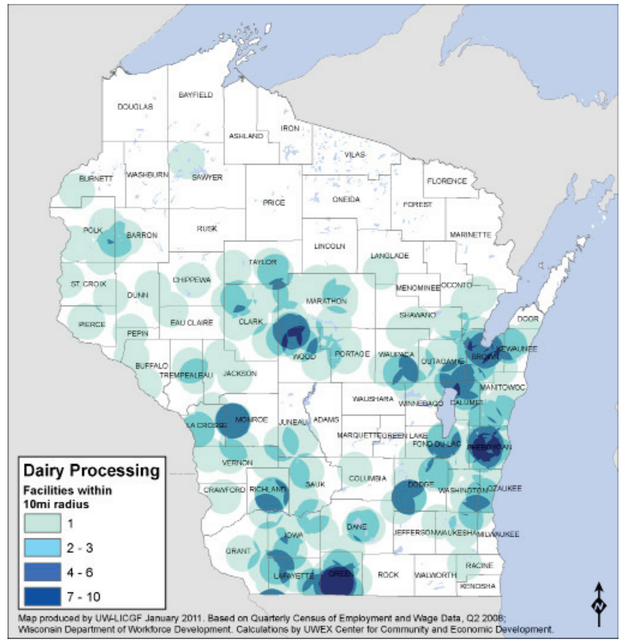
Greenhouse gas emission reductions are another under-appreciated benefit of biogas production in Wisconsin. Anaerobic digestion reduces greenhouse gas emissions in three ways: (1) reduces direct emissions of methane and nitrous oxide from manure, (2) offsets nitrous oxide emissions from synthetic fertilizers by utilizing digested manure as a fertilizer, and (3) offsets CO_2 emissions from carbon-intensive fossil fuel combustion through biogas energy production.

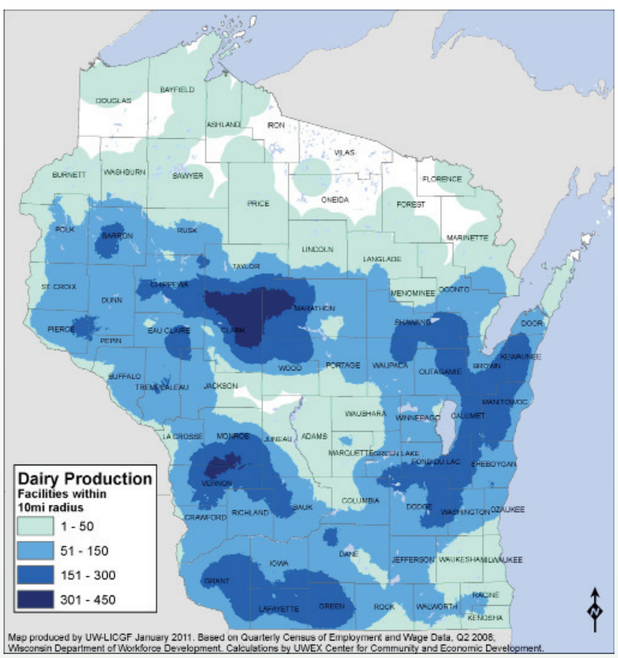
A full economic assessment of Wisconsin's biogas potential should build on the qualitative and quantitative analysis of the four categories of benefits presented here. Despite the demonstrated magnitude of these benefits, biogas production is not without its costs. Public and private decision-makers should carefully weigh the challenges to biogas production identified by the state's stakeholders. In addition, decision-makers should carefully consider the potential benefits and drawbacks of using non-waste substrates in digestion. Finally, although examples such as Germany demonstrate that anaerobic digestion can be profitable on small farms (<100 head), biogas production in Wisconsin does have the potential to incentivize industrial animal production at the expense of small farms. These challenges, while potentially significant, can be overcome if biogas is properly promoted and regulated.

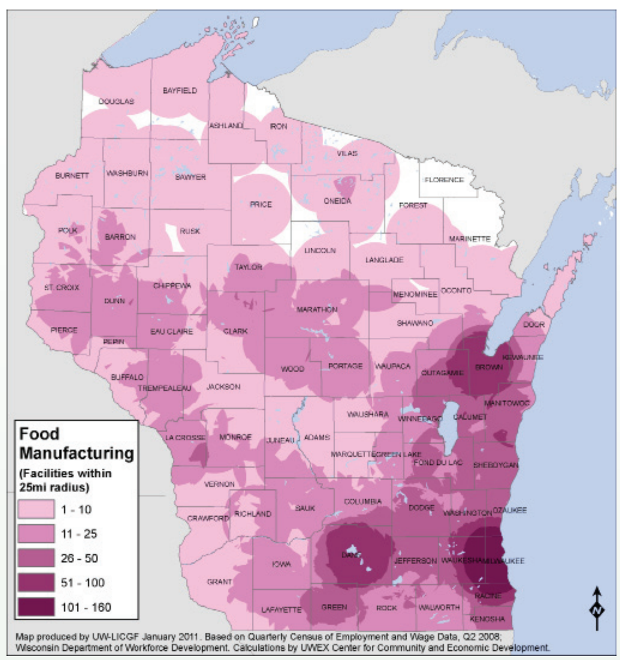
APPENDIX

OPPORTUNITIES FOR REGIONAL CLUSTERS

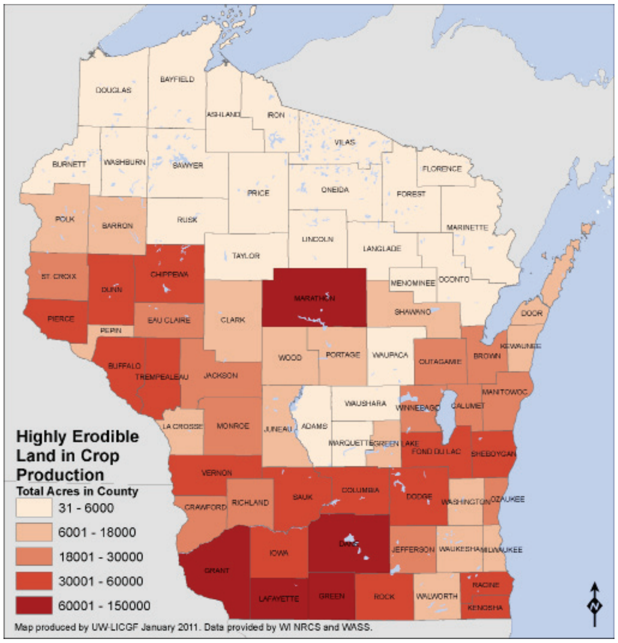


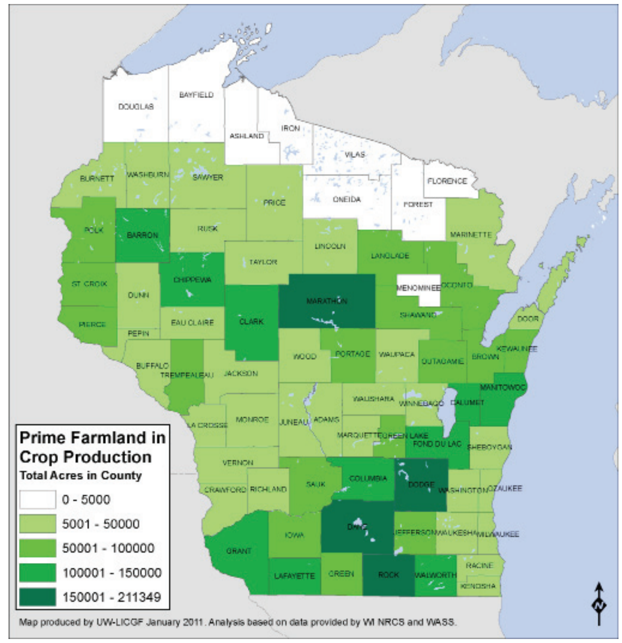






Left: Photo by Gregg Sanford





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Additional Resources:
Renew Wisconsin Web Site, Wisconsin Biogas Toolbox www.renewwisconsin.org/biogas/biogastoolbox.htm
Web site includes regulations related to biogas energy production, a variety of studies, and some information of funding resources.

Anaerobic Digesters: The Economic Situation
Source Don Wichert Wisconsin Energy Conservation Corps (WECC)

Possible Best Case Farm Biogas Economics Today: 1,000 Head Dairy
Installed cost: ~ $1,250 per head= $1.25 Million
–State or USDA grant: $250,000
–Tax on grant: $95,000
–30 % Federal Tax Credit/Grant: $375,000
–Depreciation: $400,000

•Final cost to customer: $320,000
•Supports 200 kW engine & 1.25 Million kWh/yr
•@$0.08/kWh revenue is: ~$100,000
•Payback of 2-3 years
•Other income streams: bedding, waste heat, environmental credits
Current Biogas Incentives: Grants
•Focus on Energy-WI
•USDA

Current Biogas Incentives: Grants
•Focus on Energy-WI
•USDA
•US Treasury
•Loan Guarantees: USDA
•Carbon or methane offsets
•Advanced tariffs

Current Wisconsin Focus on Energy Incentives
•Up to $250,000; 25% of system cost

•Grants based on expected renewable energy production
•Up to $500,000 in NE part of state

US Government Biogas Incentives:
30% of project cost
–US Treasury grant (through 2010)
–Tax credit •US Dept. of Agriculture
–Up to $500,000 or 25% of project costs
–Loan Guarantee up to $25 million

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