Agricultural Anaerobic Digestion Roadmap for Connecticut

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Prepared for the CT Farm Energy Program (CFEP) a program of Connecticut Resource Conservation & Development Area, Inc. (RC&D). Funding is being provided by the CT Department of Energy and Environmental Protection (CT DEEP) and the US Department of Energy (DOE).

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Disclaimer

Introduction

The agricultural Industrial sub-sector in Connecticut consumed 29 gigawatt hours of electric energy at 360 facilities, which makes it a relatively small (.01 percent) energy consumer overall.[1] Even though this figure does not include thousands of farms operating under a residential electric rate, agricultural energy consumption is still small compared to other industry sub-sectors. But the impact of Connecticut's agricultural sector on the economy is significant. A 2010 University of Connecticut study found that: agriculture's impact on the state's economy is approximately $3.5 billion; that every dollar in agricultural sales generates up to an additional dollar in the economy; and agriculture generates approximately 20,000 jobs statewide (most of which are local).[2] The value of Connecticut's farms to the quality of life we enjoy is well established. The preservation of our remaining farms is necessary "in order to maintain a readily available source of food and farm products close to the metropolitan areas of the state, to conserve the state's natural resources and to provide for the welfare and happiness of the inhabitants of the state," according to the State's General Statutes.[3]

Connecticut's dairy farms vary widely in size, but even the largest pales in comparison to the size of farms in the rest of the Country. There are approximately 19,000 milking cows[4] at 111 registered dairy farms in Connecticut ranging in size from five to 1,600 cows. Small Connecticut and New England farms struggle to compete in wider dairy markets that include Midwestern, Plains and Pacific states where one farm can accommodate half of Connecticut's whole herd. As a result, competitively producing milk is a challenge for Connecticut's dairy farmers and many other small dairy farms throughout the Northeast.

As part of this Roadmap, CFEP conducted a survey of dairy farms of varying size in Connecticut to gauge their interest in anaerobic digesters ("AD" or "digesters") on their farms.[5] Thirty-one farms responded. Of those, 11 said they were interested in a digester, primarily for manure management, electric energy and bedding material. Of those that were interested in a digester or may be interested in a digester, eleven respondents said it was cost prohibitive and 6 said that financing is a concern. In spite of being a proven manure management tool as well as a means to produce renewable energy and enhance the sustainability of Connecticut's dairy farms, only one digester project has made it past the conceptual planning stage in the State.

This Roadmap is intended to explore the costs, requirements and incentives available to dairy farms in Connecticut seeking to install anaerobic digester facilities to manage animal manure and produce renewable energy and other coproducts of value. Although the focus is on Connecticut's dairy operations, anaerobic digestion can be used to manage other livestock manure, such as pig and chicken manure, although the exact composition of organic materials used will impact

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[1] See Table 2: Annual delivered industrial electricity consumption in Connecticut, by sub-sector, 2011; Page 42 at http://www.ct.gov/deep/lib/deep/energy/cep/2013_ces_final.pdf

[2] UConn Department of Agricultural and Resource Economics and The Connecticut Center for Economic Analysis; *Economic Impacts of Connecticut's Agricultural Industry*; September, 2010; Page 3; See http://www.ct.gov/doag/lib/doag/boards_commissions_councils/governors_council/02_UConn_2010_Economic_Impacts_of_CT%27s_Agricultural_Industry.pdf

[3] CGS Section 12-107

[4] See USDA "Milk Cows and Production by State and Region," at http://www.ers.usda.gov/data-products/dairy-data.aspx

[5] See Appendix for complete survey questions and responses.

system design and biogas production amounts. This Roadmap further identifies areas where there may be opportunity for program enhancements and further discussion among policy makers, developers and farmers to advance agricultural AD projects in Connecticut as a means to achieve shared policy goals, including reduced carbon and other greenhouse gas emissions, local renewable energy development and the preservation of Connecticut's dairy farms.

Unlike other renewable energy technology development on farms, AD has the potential to reduce water pollution and increase the environmental quality and economic viability of the farming operation itself. Manure from livestock can cause a number of environmental issues when not managed properly and anaerobic digestion is a means for dealing with this pollution. Anaerobic digesters can help farms improve nutrient management practices and control odors from animal waste while producing renewable energy. In addition, farm digesters have the potential to be revenue generators, with renewable energy and value-added products being another product produced on the farm, while reducing the volume of waste that must be disposed of. But even when avoided costs from manure management are factored in, anaerobic digestion technology requires stable incoming revenue to be viable. It is highly improbable that the necessary capital to build a digester can be secured based on only avoided costs to the farmer and wholesale energy market revenues alone.

Anaerobic digestion systems can be used on dairy farms to achieve a number of benefits, including:

- Odor reduction from the spreading and decomposition of animal manure
- Locally produced renewable energy source (biogas)
- Greenhouse gas (GHG) emissions reductions (over land spreading and open air composting)
- Pathogen reduction to increase the safety, recycling and healthy nutrient reuse of the liquid and solid fractions of animal manure
- Reducing potential for phosphorus pollution to surface water bodies, through several pathways
- Value added products such as soil conditioners and growing media can be produced from manure solids

Adding pre-treatment technologies can reduce phosphorus concentrations in liquid manure and potentially result in less water pollution. A solid separator coupled with a decanter centrifuge may remove up to 40% of the phosphorus in liquid dairy manure. The synergy of technologies and the resulting value-added products make anaerobic digesters appealing for reducing phosphorus pollution to surface waters. Electricity from a digester complex can be used to power a separator, centrifuge, and other farm operations. The liquid manure fraction can be applied to soils at an agronomic rate for nitrogen without over applying phosphorus.

Biogas produced from the digestion of manure can be used for heat production, to power generators, fuel cells or micro-turbines to generate electricity, to create compressed natural gas for fleet vehicles or renewable natural gas that can be injected into the natural gas pipeline. The capital costs can vary widely depending on the end use of the energy, and the value of the energy output is important to the overall economics of an AD facility.

Renewed interest in AD is occurring in Connecticut as a result of state-sponsored energy-related Pilot programs and the market incentives introduced via the food waste diversion mandate enacted in 2011. Connecticut became the first state to mandate that food scraps generated by large-scale generators (producing an average of 2 tons or more of food waste per week) be separated out from other wastes and sent to a composting facility when it passed Public Act 11-217.[6] Large food waste generators, such as commercial wholesalers and distributors, industrial food manufacturers, supermarkets, resorts and conference centers, are affected by the mandate.[7] While most food waste generators are expected to be affected by the construction of facilities in the coming years, there is an exception provided if a permitted source-separated organic recycling facility is not located within 20 miles. This could provide an important opportunity for agricultural anaerobic digesters to appeal to generators in more agricultural areas who wish to recycle their organic materials though are not located near a major facility.

Connecticut accurately anticipated the importance of increasing opportunities for the management of source-separated organic materials when it catalyzed the market with the food waste diversion law in 2011. As financing conditions have improved and the first facilities have worked through new permitting processes, anaerobic digestion facilities are expected to increase in number and in the range of sizes to suit specific areas and needs. The Department of Energy and Environmental Protection's ("the Department" or "DEEP") has continued to prioritize increased capacity for managing source-separated organic materials in its latest recycling policy plan, the *Comprehensive Materials Management Strategy*, which identified expanding processing capacity at new and existing compost facilities, including new AD facilities, as a top growth priority.[8]

Given the new food waste market and policy commitment on behalf of the State, now is an optimal time to reexamine the economics of a farm digester to complement the State's renewable energy, materials management and sustainability goals.

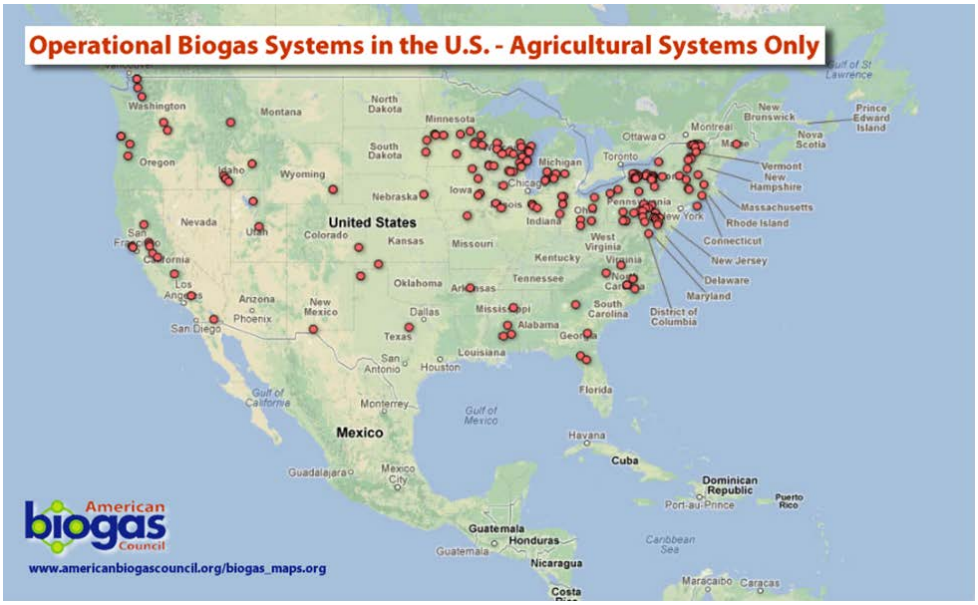
[6] See CGS Section 22a-226e. Recycling of source-separated organic materials. PA 11-217 was updated by Public Act 13-285.

[7] Targeted generators create the following average annual projected volumes of source-separated organic materials and are affected by the statutory implementation dates: ≥ 104 tons/year: January 1, 2014 and ≥ 52 tons/year: January 1, 2020.

[8] *Comprehensive Materials Management Strategy*, Page 20. See

Anaerobic Digestion on Farms

According to AgSTAR[9], there are approximately 260 anaerobic digester biogas systems in operation on farms in the United States.[10] The majority of those projects are dairy farm-based. Connecticut currently has one digester located on a farm.[11] Massachusetts has three, Vermont has 17, and Maine has one farm digester. All of the digesters on farms in New England and New York are in conjunction with dairy operations. The smallest dairy farm with an operating digester in the United States has approximately 200 cows and co-digests outside substrates, e.g. food waste. It runs a 60 kW generator and provides space and water heating. The largest farm with an operating digester has more than 9,000 dairy cows and produces about 1.4 MW of electricity on manure alone. The average operational dairy farm digester in the US has about 1,800 cows.



Source: American Biogas Council[12]

Farm digester projects are operating and do work, but they also have among the highest rates of failed projects, discontinued projects, or projects that do not emerge from the planning phase.

The Wisconsin Office of Energy Innovation Biogas Survey Report of AD plants in the State found the three main challenges to farm AD include:

1. Achieving economically sustainable operation;
2. Incorporating new systems into the existing on-farm framework of waste logistics and labor allocation; and
3. Ensuring farm personnel are equipped to operate and manage these complex biological and energy generation systems.[13]

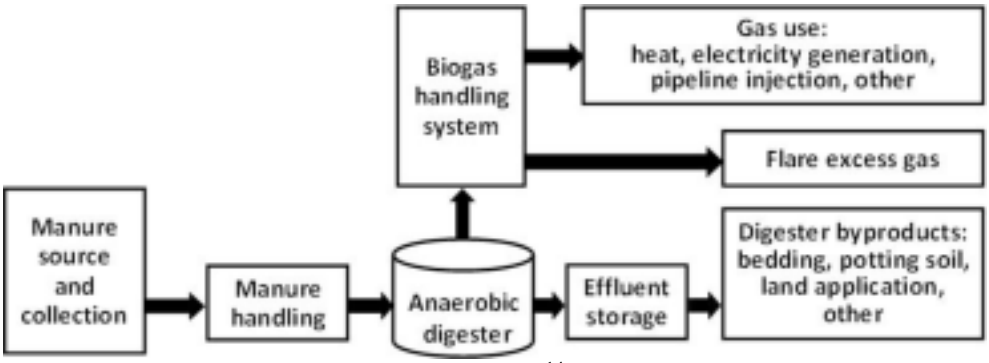
[9] AgSTAR is a program within the US Environmental Protection Agency that promotes the use of biogas recovery systems to reduce methane emissions from livestock waste.
[10] AgSTAR Livestock Anaerobic Digester Database, 2015 Update, see https://www.epa.gov/agstar/livestock-anaerobic-digester-database. Note this figure includes some small pilot and academic systems.
[11] Freund's Farm in East Canaan, CT.
[12] https://www.americanbiogascouncil.org/images/maps/agricultural.jpg
[13] Wisconsin Biogas Survey Report, P. 15; see http://www.stateenergyoffice.wi.gov/docview.asp?docid=27510&locid=160

How AD Works

Anaerobic digestion systems produce energy by capturing methane gas produced naturally in the decomposition process of organic material. This organic material can include food waste, fats oils and greases, waste processed in waste water treatment plants and, in the case of dairy farms, animal manure.

Anaerobic digesters consist of several key components, including:

- Manure collection systems
- Anaerobic digesters (tanks or covered lagoons)
- Biogas handling systems
- Gas use devices (engine, fuel cell, gas scrubbing equipment for CNG or RNG)
- Effluent storage



Source: National Association of Building Sciences[14]

A manure collection system is needed to gather manure and transport it to the digester. In cases where a digester is situated on a farm, existing manure management systems may be adapted to deliver manure to the digester. Such systems are optimal as transportation costs to get feedstock to the digester's doorstep can quickly and significantly impact the price of disposal.

Digesters are designed to stabilize manure and optimize the production of methane. As manure decomposes, it creates biogas, typically consisting of about 60% methane and 40% carbon dioxide. Trace amounts of nitrogen, oxygen, hydrogen sulfide and water vapor may also be present in biogas. The gas is collected in the biogas handling system, where it is treated and piped to the gas use device, usually an electric generator. Flares are also installed to destroy excess gas when the primary gas use device is being serviced or otherwise not in use.

[14] See Stages of Anaerobic Digestion Processes at https://www.wbdg.org/resources/biogas.php

Batch digesters and continuous digesters are the two basic types of anaerobic digesters. Batch-type digesters are the simplest to build. Organic material is loaded into the digester and allowed to digest. The retention time (time it takes to digest material) depends on temperature and other factors. The effluent is removed once digestion is complete and the process is repeated. However, in a continuous digester, organic material is regularly fed into the digester, which allows for biogas production without the interruption of loading material and unloading effluent required of batch-type digesters. Given that a farm digester is assumed to be producing maximum energy value in order to be economic, continuous digesters are explored further and batch type digesters are not.

Complete mix digester at Wild Rose Dairy in Webster Township, WI, uses manure from 880 cows and food waste as fuel to produce 775 kW of electricity.

Continuous, complete mix digesters are engineered tanks, above or below ground, that treat slurry manure with a solids concentration in the range of 3 to 10 percent. These structures require less land than lagoons, are heated and are compatible with combinations of scraped and flushed manure collection systems.[15]

Cost

According to AgSTAR, the economics of dairy farm AD begin to take shape at approximately 500 head, although food waste and other incoming organic materials can help support projects with less.[16] Dairy farms with 300-350 head have also built digesters successfully, although many of these projects incorporate food processing waste or other outside organics. A USDA/NRCS report in 2007 found that:

> Typically, the value of the energy alone produced by a manure anaerobic digestion system will not provide a positive cash-flow given current U.S. energy costs. The combination of multiple benefits including energy value, odor control, by-product sales, carbon credit value, and possible tipping fees for taking other materials (such a food waste) is the best approach to operating a manure digestion system with overall benefits that exceed system installation and operation costs.[17]

The same report found that mixed digesters averaged a total cost of less than $800,000,[18] but those costs are average and the figures are dated. The cost of an AD system is highly impacted by the inputs and desired outputs, so there can be wide variation in system cost. The low end of the spectrum is around $1.2 million and a project for a commercial digester in Southington, which will generate about 1 megawatt of electricity, includes organic separation equipment and

[15] AgSTAR Handbook "A Manual For Developing Biogas Systems at Commercial Farms in the US;" 1-3; February, 2004. See https://www.epa.gov/sites/production/files/2014-12/documents/agstar-handbook.pdf

[16] See AgSTAR's list of Livestock Anaerobic Digesters at https://www.epa.gov/agstar/livestock-anaerobic-digester-database

[17] An Analysis of Energy Production Costs from Anaerobic Digestion Systems on U.S. Livestock Production Facilities; October, 2007; p.16.

[18] Id. Page 3.

other high tech features, and is anticipated to cost more than $10 million to build. A small to mid-sized farm AD project will be closer to the middle range, but still filling a rather wide cost spectrum, from $1.5 million all the way to $7 million to complete.

Financing AD on CT Farms

Risk

The Department's *Comprehensive Materials Management Strategy* noted with regard to new AD facilities in Connecticut that: "[s]ecuring feedstock is a challenge…as is contamination of feedstock, siting, permitting, and overall economics and financing".[19] These challenges contribute to the overall business risk of an AD developer on farm or off.

Financing necessarily depends on an assessment of risk to the financially committed parties involved in the project. Anaerobic digesters are not generally "plug and play" systems, like solar, wind and other forms of renewables. They need regular care and monitoring. In 2013, NYSERDA and the Innovation Center for US Dairy published a study that identified the key business risks associated with anaerobic digesters on farms as follows:[20]

- Construction risk: risks associated with being on time and on budget.
- Technology risk: risks associated with the performance of the various technologies used in the system to process waste, engine generator set, anaerobic digester, processing of outputs, and other associated equipment.
- Interest rate risk: risks associated with variation in interest rates during the time period in which the project is financed could increase the overall cost of the project.
- Margin risk: risk on the value of inputs (tipping fees) and the value of outputs (electricity, RECs, digester fiber, nutrients, etc.).
- Management risk: the risk of having the expertise and ability to manage the digester system at its full potential, and any impacts on the management of the overall farming operation.
- Counterparty risk: risks associated with the numerous other parties to the transactions, such as lenders, financers, utilities, state entities, equipment providers, food waste providers, any contracted operation and maintenance, and buyers of outputs.

NYSERDA found that of these risks, "margin risk is perhaps the most critical for securing financing for digester projects because it has the closest and most direct tie to the ongoing profitability of the projects."[21] Addressing margin risk is where state-sponsored programs and policies can significantly improve the viability of farm digesters by helping to reduce risk through favorable energy purchase contracts for 10-20 year terms and/or low interest financing.

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[19] *Comprehensive Materials Management Strategy*, Page 20. See http://www.ct.gov/deep/lib/deep/waste_management_and_disposal/Solid_Waste_Management_Plan/CMMS-Final_Adopted_Comprehensive_Materials_Management_Strategy.pdf

[20] NYSERDA. 2013. "Portable Digester Systems for Small- to Mid-sized Dairy Farms in New York," NYSERDA Report Number 14-06.

[21] NYSERDA. 2014. "Anaerobic Digester Business Model and Financing Options for Dairy Farms in New York State," NYSERDA Report Number 14-30. Page 3.

Revenue

Digesters have three main products (jointly "co products") to generate sources of revenue:

1. Tipping fees for accepting waste
2. Energy revenue from heat/hot water, electricity or gas
3. Digestate end products, such as liquid fertilizer, animal bedding and mulch

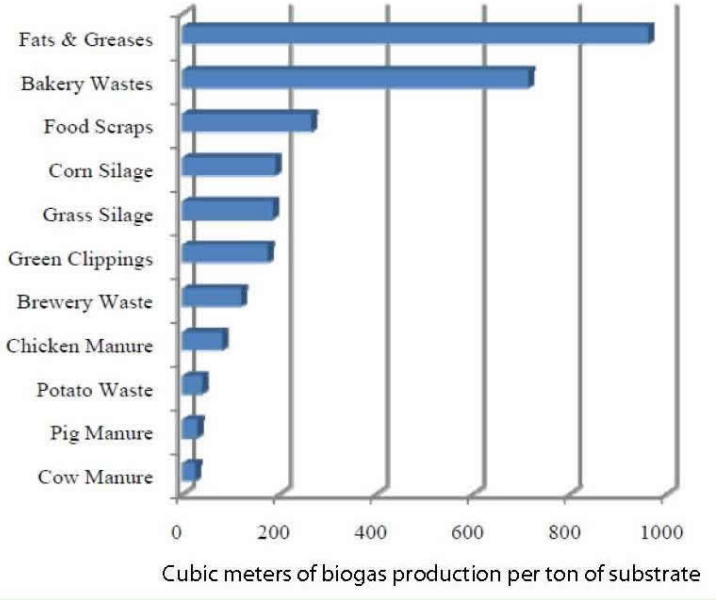
Various markets drive the value of products offered. Tipping fees and energy revenue markets are discussed below. However, for the purposes of this Roadmap, the digestate end products (3 above) are assumed to be revenue neutral and repurposed to farming operations for fertilizer and animal bedding. This assumption does require reevaluation based on the specific project plans and economic opportunities. Liquid and dry materials resulting from anaerobic digestion do have a value in end markets but these markets are not well established and are highly individualized.[22]

Tipping fees

Tipping fees vary for the source of organic waste being received, the availability of waste supply and distance the waste travels to get to the digester. Farms in Connecticut dispose of their manure in multiple ways, but there is no indication that dairy farms are incurring costs for manure disposal. However, hauling manure to eligible fields for spreading and manure storage costs can be significant. There is definitely value associated with improved manure management on dairy farms in Connecticut, including odor reduction, water pollution control and emissions reductions. But each of these benefits has a unique and highly individualized value to the particular farm and as such, monetizing this value is a challenge.

Co-Digestion & Food Waste

Co-digestion is when different organic wastes are used in the same digester. Combining organic waste from outside waste streams can help increase biogas production and project economics at farm digesters. Contracts for food waste that generate tipping fees help address margin risk and bring added confidence to lenders.



Cow manure is one of the lower biogas yielding wastes when put into a digester. Fats, oils and greases and food waste create the most biogas.[23] As a result, many dairy farms add food waste to the manure in their digesters to increase the

[22] In Connecticut, Freund's Farm currently has a digester and produces popular "Cow Pots" using digestate materials. Cow Pots are a great example of the revenue potential for digestate materials, but the associated capital and operational costs of the product are not examined here.

[23] Biogas production graphic from American Biogas Council; See https://www.americanbiogascouncil.org/images/biogasYields_differentFeedstocks.jpg

amount of biogas produced. Project economics are also improved by adding food waste. An economic analysis of AD on farms in New York State found that: "co-digestion is key to improving the economic viability of digesters, primarily through collected tipping fees, and in some cases through increased biogas production."[24]

In Connecticut, food waste may be combined with farm wastes in the digestion process. No specific animal manure to food waste ratio exists under Connecticut State Regulation. Different food wastes contain different levels of nutrients (e.g., nitrogen and phosphorous) that must be considered in terms of the farm overall nutrient profile when assessing the impact of co-digesting food waste on a farm. For this reason, the Department considers the ultimate use of the digestate when evaluating environmental permit applications.

Accepting source-separated food waste is a possible option for farm digesters to supplement both their biogas output and tipping fee revenues, but there are also risks that must be considered, including the cleanliness of the food waste in terms of harmful contaminants and the consistency of the waste deliveries from day-to-day. Planned commercial food waste digesters in Connecticut are equipped with front end sorting equipment that can detect and prevent contamination from incoming loads, but this equipment costs in the millions of dollars. Farm projects will quickly become uneconomic if this equipment is added to the overall capital cost and the cost is hard to justify, since the primary goal of the digester is farm nutrient management.

Connecticut farms seeking to accept food waste will need to identify potential waste providers and are encouraged to test multiple samples of materials to determine their load-to-load consistency and biogas production value prior to finalizing contracts between the parties. Contamination management is naturally a cause for concern and is more so on farm projects that are unlikely to have mechanical equipment to detect and remove contamination before it happens. This can increase labor costs and therefore must be factored in to the operational cost of the system. Farms can seek out food waste producers that pose less risk, such as food manufacturers and other sources of pre consumer waste, such as universities and banquet halls. Protocols for checking and testing loads as well as penalties for violations of contamination levels should be clearly spelled out in feedstock contracts to protect the farm against losses from contaminated loads.

Facilities taking waste wood and other organic waste in Connecticut have protocols established to manage contamination that work, as do small and large farm AD projects across the country and in Europe. Although project systems differ, best practices exist and may be identified and explored separately, especially if contamination concerns are prohibiting farm project viability. Food waste can generate per ton tipping fees in the range of $10 to $45 per ton or more up to the current MSW tipping fee rate, depending largely on the level of contamination associated with the waste and the needed infrastructure to reduce contamination to acceptable levels. Farm projects handling only manure do not require expensive front-end separation equipment to remove contaminants as food waste digesters typically do. Still, food waste is a potential revenue stream must be examined for farm AD projects, especially given the potential biogas production value increases from adding food waste to the mix.

[24] NYSERDA. 2013. "Portable Digester Systems for Small- to Mid-sized Dairy Farms in New York," NYSERDA Report Number 14-06

Energy

As noted above, there are several energy products that can come from AD. The most common is electricity because it employs a relatively simple and familiar technology. Electric generators have become standardized and many of the major engine manufacturers make "gensets" that run on biogas.

Integrating AD into existing or expanded state-sponsored renewable electricity programs that value the multiple benefits of AD via its electricity output, would make AD more viable generally.

As mentioned in the introduction, farms are not generally big energy consumers and this is certainly the case with regard to electricity. Most State-sponsored energy programs in Connecticut and in many other states have traditionally either disallowed or disadvantaged the participation of AD in favor of zero emission sources, such as solar and wind. Integrating AD into existing or expanded state-sponsored renewable electricity programs that value the multiple benefits of AD via its electricity output, would make AD more viable generally. In the case of farm AD, production will often exceed onsite electric use. Connecticut's electric distribution companies will credit farms for the excess energy through its net metering rate, which equals the average wholesale energy rate over the previous year. Although more stable than riding the hourly market or losing the electricity production altogether, net metering is not likely to improve project economics significantly.

The good news is that the Department clearly recognizes the need for renewable power contracts to incentivize AD development in Connecticut:

> *"The availability of attractive renewable power contracts could be essential for new AD facilities to be viable, especially given their relatively high capital costs. Subsidization of other Class I renewable energy generation sources such as solar has increased the disparity in capital costs between AD and solar."* [25]

Electricity

A few programs exist in Connecticut that offer energy revenue opportunities for electricity produced by anaerobic digesters. These programs have not yet worked to incentivize a farm digester in Connecticut, but at least one planned commercial food waste digester has been accepted into an energy program that pays for its electric output at a rate above wholesale. It is apparent that promise exists and incentives are priced within the ballpark of needed revenues. What follows is a list of Connecticut renewable electric incentive programs that are currently available to help generate revenue for farm digesters.

Class I RECs

Anaerobic digesters are Class I renewable resources in Connecticut. Class I resources earn credits for their renewable energy attributes whereby one megawatt equals one Renewable Energy Credit (REC). To illustrate the effect, a renewable energy facility that produces 1 Megawatt of power for 4,000 hours in the year, receiving a REC price of $30 per megawatt

[25] *Comprehensive Materials Management Strategy*, Page 20.

would earn an additional $120,000 in REC revenue in addition to the payment it receives for its power output. These credits can be sold in the marketplace ("REC Market") to utilities and suppliers, who have renewable energy supply requirements.

RECs are normally sold on the REC market or via bilateral contracts between buyers and sellers. RECs prices tend to be locked in for short durations, typically not exceeding three years. Capital lenders are more comfortable with longer term, predicable revenue streams. For this reason, Connecticut created the "ZREC" and "LREC" programs.

Connecticut's ZREC (zero emission renewable energy credit) and LREC[26] (low emission renewable energy credit) programs provided an opportunity for small Class I renewable resources to receive 15-year contracts for their RECs, thereby locking in a certain, predictable revenue stream, improving lending rates and project economics. Anaerobic digesters were indirectly excluded from participation in the ZREC and LREC programs because biogas engine technology simply cannot yet meet the stringent emissions limits required by the programs in an economic manner. This effect has further disadvantaged AD as an option for Connecticut dairy farms seeking to install renewable energy technologies.

At the time of this writing, the ZREC and LREC programs are winding down. Should new programs be enacted to incentivize Class I resources through utility purchase of their RECs, farm digesters should be reevaluated. A new or enhanced program employing an environmentally-focused formula that considers the whole facility's overall pollution reductions and environmental benefits, rather than simply relying on the technical requirements of the genset's air permit, would help incentivize AD. Such an approach would also more accurately represent the benefit to Connecticut electric ratepayers who fund the REC programs, from AD investments.

Virtual Net Metering

Virtual Net Metering (VNM) is a program offered in the Eversource and United Illuminating service territories to its State, Municipal and Agricultural customers to encourage the installation of Class I (and Class III) small generators.[27] VNM allows customers who operate behind-the-meter generation ("Customer Host") to assign surplus production from their generator to other metered accounts ("Beneficial Accounts") that are not physically connected to the Customer Host's generator to receive the benefit of the electric energy produced.

VNM is a helpful program to incentivize farm AD projects because it provides energy credits at retail, not lower wholesale, rates. Plus, the program allocates a portion of Transmission and Distribution (T&D) rates, resulting in a higher credit value that helps fund the additional cost of AD. A commercial food waste digester planned in Southington, Connecticut, will be using VNM to monetize its energy in partnership with the Town. The facility will create renewable energy and feed it to the Eversource distribution system. Eversource, in turn, will credit designated

[26] ZREC emissions are set at zero and apply to renewable technologies like wind and solar. LREC Emissions cannot exceed 0.07 pounds of NOx, 0.10 pounds of CO, and 0.02 pounds of VOCs per MWh of electricity produced. Generators that are 95% efficient with pre control and emissions control equipment can produce emissions that are 3 and 4 times the LREC emissions cap.

[27] See http://www.energizect.com/your-town/solutions-list/virtual-net-metering for more information on VNM.

Beneficial Accounts belonging to the Town of Southington at the current retail rate plus a percentage of T&D for every kilowatt hour of electricity produced by the digester. The Town will pay the digester for its output at a rate less than or equal to the Town's VNM credit.

While the VNM program is promising, it is also limited. VNM in Connecticut is capped at $10 million annually and the cap has been reached for the Municipal sector and the Agricultural cap is close to capacity. In addition, VNM limits participation by businesses, which could be a helpful tool for a farm digester to market and lock in supplemental food waste supply contracts if it chooses to do so. A food waste supplier, such as a grocery store or restaurant, may find it attractive to supply waste to the digester if it can also purchase energy generated in part from its own waste. This type of arrangement creates a partnership-like link between the food waste supplier and the farm that could result in a better running digester. New rules that allow for beneficial electric accounts to belong to large food waste generators could help incentivize both compliance with the food waste diversion mandate and renewable energy goals.

Shared Clean Energy Facility

Public Act 15-113 called for a two-year pilot program to support the development of shared clean energy facilities. A shared clean energy facility is a Class I renewable electric energy facility (i.e., AD) that is interconnected to the utility's distribution system. Like VNM, shared clean energy facilities allow for the renewable project to be located away from a third party "subscriber" that pays for the output of the energy to the project. DEEP has been rolling out the Shared Clean Energy Facility Pilot program and a draft Request for Proposals from private developers was released in May and updated on June 9, 2016.[28]

Shared clean energy facilities, like VNM, are a viable alternative to support farm AD. Unlike VNM, commercial customers may participate. However, this program is also a limited Pilot program, capped at a total generating capacity of up to two megawatts in United Illuminating's service area and four megawatts in Eversource's service area.

Renewable Energy RFP

A new renewable energy procurement was enacted in 2015 that authorized the Department to administer a solicitation for Class I renewable energy projects from 2-20 megawatts in size.[29] Project awards include contracts with the investor owned electric utilities (i.e., Eversource and United Illuminating) to purchase both the power output and the RECs from the project for up to 20 years.

The 2-20 megawatt procurement does allow for farm-based and other AD projects to bid into the solicitation. At the time of this writing, the Department is reviewing approximately 100 renewable project submissions under the 2016 procurement and AD is likely among the bidding projects. However, it should be noted that the procurement sought peak load reduction benefits and contained a two megawatts minimum project size requirement. AD is a baseload renewable

[28] DEEP's Revised Draft Request for Proposals from Private Developers for Shared Clean Energy Facilities; June 9, 2016 Revision; see http://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/7ce949985681845e85257fb9006981be/$FILE/2016.06.09_FINAL%20Updated%20Draft%2015-113%20RFP.pdf

[29] P.A. 15-107 *An Act Concerning Affordable and Reliable Energy*, Section 1(b)

source so it provides consistent energy output, but does not start up quickly or produce more during peak hours. The two megawatts requirement is large for a farm based AD project, which typically will produce one megawatt of power or less.

Compressed Natural Gas and Renewable Natural Gas

Existing incentives for renewable energy in Connecticut (and throughout the United States) are highly electricity-centric, incentivizing renewable electricity via state-sponsored procurements that award energy purchase agreements. However, biogas can be converted to biomethane gas as a replacement to Compressed Natural Gas (CNG) for trucks, fleet vehicles and farming equipment to replace diesel fuel or as a Renewable Natural Gas (RNG) for use as a replacement for pipeline-grade natural gas.

The main complicating issue with the creation of renewable gas is that the biomethane needs to be "cleaned" in order to be used, which requires expensive equipment that adds to the cost of projects. RNG projects will additionally require access to pipelines so that the gas can be injected into the system that add to the capital expense of the project. Yet the advancement in sustainable farming that can result from on-site CNG production and use to power farming equipment, trucks and heating could be significant and should be explored in Connecticut.

Connecticut will never have access to indigenous supplies of natural gas, which makes it wholly dependent on external factors like transportation pipeline cost and availability and volatile fossil fuel energy markets to supply its needs. Locally produced RNG could supplement environmentally risky gas from fracking and may provide significant price advantages, especially at times of peak use when transportation pipeline delivery costs skyrocket. The major benefits of RNG production are that it takes methane already naturally produced from animal manure and other waste and prevents it from going into the atmosphere as a potent greenhouse gas. Instead, the waste is converted into a carbon-neutral fuel. RNG also helps address energy security because it is a locally-produced and fuel is available in every community. Once cleaned and scrubbed, RNG from biogas can be safely injected into the existing natural gas pipeline.

Though estimates vary for how much renewable natural gas can be produced, there is a broad consensus that RNG can make a substantive and valuable contribution to global renewable energy production. A series of studies from government research agencies and industry in the last few years have found that anywhere from 5% to 20% of today's natural gas demand could be met with RNG.[30] National Grid, an electric and natural gas utility serving New York and Massachusetts customers among other Northeastern states, is pursuing a Renewable Natural Gas strategy after researching its potential in its service territories and factoring in environmental, cost, feasibility and reliability benefits.[31] The utility found that up to 17% of New York's natural gas demand and up to 10% of Massachusetts' demand could be met with biogas from various waste resources.[32]

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[30] Edward Dodge; How Much Renewable Natural Gas Can Be Produced; Breaking Energy; September 18, 2014; see http://breakingenergy.com/2014/12/18/how-much-renewable-natural-gas-can-be-produced/

[31] National Grid "Renewable Natural Gas – A Vision for a Sustainable Network," 2010; see https://www9.nationalgridus.com/non_html/NG_renewable_WP.pdf

[32] Id.

Vermont Gas is currently implementing an RNG option that will provide its gas customers the opportunity to replace all or some of their traditional, fossil-based natural gas with RNG. Customers who sign up for the program will be able to choose the amount of RNG they wish to purchase, from 10% to 100%, which can reduce, or potentially eliminate, their carbon footprint for natural gas usage.[33]

Renewable natural gas may not be an economically viable fuel for dairy farm AD production in Connecticut today since there is unlikely to be economic access to natural gas pipelines at rural farms. However, current expansions underway may create opportunities to shorten the distance new pipeline is needed to tie into dairy farms within an economic range.

RINs

CNG from biogas is an "advanced biofuel" under the EPA's Renewable Fuels Standard. Renewable Identification Numbers (RINs) are created when an advanced biofuel is sold as a vehicle fuel, much like the REC used to incentivize renewable energy in the electric markets. RINs have a market value because petroleum refineries must purchase RINs to meet their regulatory compliance obligations. The RIN market, however, tends to be a shorter-term market (contracts of less than one year) so the long-term prices of RINs and the ability of RIN sales to help finance a biogas to CNG project is limited. However, RINs do create an additional source of revenue for biogas from AD when used as a transportation fuel.

Operation Costs and Maintenance (O&M)

O&M costs include daily operator labor to perform routine maintenance and pump the manure, expenses for engine oil changes and minor repairs and larger maintenance issues such as engine overhauls and sludge removal. According to the National Institute for Building Sciences, O&M for small-to-medium-sized digesters with electrical generators, are estimated at 3% of the digester system turnkey cost.[34] The USDA and NRCS 2007 "Analysis of Energy Production Costs from Anaerobic Digestion Systems on U.S. Livestock Production Facilities," placed costs for O&M for complete mix digesters using dairy manure at 7% of total capital project costs.[35]

Maintaining and ensuring that the digester and all the associated equipment is operating properly (particularly pumps and agitators) will be daily tasks and additional time should be anticipated during initial startup when operators are learning the nuances of the system. Maintenance calls may also be necessary in restarting digesters and if an engine-generator is a part of the system, mechanical maintenance and equipment cleaning should be regularly scheduled to avoid long-term, expensive outages.[36]

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[33] See Vermont Gas webpage at https://vermontgas.com/innovation/renewable-natural-gas/ and RNG

[34] See https://www.epa.gov/sites/production/files/2014-12/documents/protocol_overview.pdf

[35] USDA/NRCS "Analysis of Energy Production Costs from Anaerobic Digestion Systems on U.S. Livestock Production Facilities" at http://www.agmrc.org/media/cms/manuredigesters_FC5C31F0F7B78.pdf; October, 2007; Page 4.

[36] Biogas is dirty and although biogas engines are readily available and working, regular cleaning is important to keep the engine running at its best. When the AD system is not producing energy, it will either need to run on a second engine or incur charges from the utility for feeding off of the grid, both of which are expensive propositions. Scheduling regular outages will help control costs and avoid expensive unplanned outages.

Funding Programs & Opportunities

A number of programs exist that will help support financing anaerobic digestion projects on farms in Connecticut, which are summarized below. Financing does require security, which can be an impediment to farms seeking to purchase and own the digester. Farmland in Connecticut is valued at its working value, rather than its market value under PA 490. While this helps alleviate property tax burdens, it can make it challenging for a farm owner to finance a capital intensive technology like AD using their land as security.

REAP

Title IX of the Agricultural Act of 2014, (2014 Farm Bill) reauthorized the Rural Energy for America Program (REAP),[37] which provides assistance in the form of grants and loan guarantees for projects that increase private sector supply of renewable energy and projects that decrease energy demand through energy efficiency improvements. Connecticut farms[38] and small businesses located in eligible rural areas[39] may apply for assistance through REAP to help pay for a digester project.

REAP provides loan guarantees on up to 75% of the total eligible project costs or grants for up to 25% of the total project cost. Applicants may apply for both grants and loan guarantees, but will be required to contribute the minimum 25% in funding toward the project. The minimum grant amount is $2,500 and the maximum is $500,000.

Loan guarantees on may be up to 75% of total eligible project costs, with a $5,000 minimum loan amount and $25 million maximum loan amount. Utilizing a loan guarantee alone, applicants may apply for up to 85% of the total project cost up to the maximum. Rates and terms are negotiated with the lender and subject to USDA approval. Other terms and conditions apply. [40]

REAP is a viable funding opportunity for an on-farm or qualifying small business digester. The CT Farm Energy Program offers educational information about the Program and assistance to Connecticut farms with REAP applications.

Environmental Quality Incentives Program (EQIP)

EQIP[41] provides financial and technical assistance to agricultural producers in order to address natural resource concerns and deliver environmental benefits such as improved water and air quality, conserved ground and surface water, reduced soil erosion and sedimentation or improved or created wildlife habitat. EQIP offers grants that are capped at $450,000. Farms seeking to install AD systems may qualify for EQIP funding for new or upgraded manure management

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[37] USDA REAP homepage at http://www.rd.usda.gov/programs-services/rural-energy-america-program-renewable-energy-systems-energy-efficiency

[38] Agricultural producers must earn ≥ 50% of their gross income from agricultural operations to be eligible

[39] "Rural Areas," defined as areas other than: (1) A city or town that has a population of greater than 50,000 inhabitants; and (2) The urbanized area contiguous and adjacent to such a city or town, as defined by the U.S. Bureau of the Census using the latest decennial census of the United States. Property address eligibility determinations are officially made by Rural Development upon submitting a completed application, however an online address look up reference map is available at http://eligibility.sc.egov.usda.gov/eligibility/welcomeAction.do?pageAction=rbs

[40] REAP Fact Sheet at http://www.rd.usda.gov/files/RD_FactSheet_RBS_REAP_RE_EE.pdf

[41] See EQIP Connecticut at http://www.nrcs.usda.gov/wps/portal/nrcs/main/ct/programs/financial/eqip/

systems or additional infrastructure in-line with the AD system. Examples may include scrape alleys, manure collection pits, pipelines, pumps, and storage. Farms must be Farm Bill eligible and must have a Comprehensive Nutrient Management Plan (CNMP). The CNMP should clearly show the farms plan for animals, nutrients and infrastructure to balance productivity and manure, soil, and water.

CT Department of Agriculture's Environmental Assistance Program (EAP)

The Connecticut Department of Agriculture administers the Environmental Assistance Program (EAP), which provides grant opportunities for capital improvements that help farms maintain compliance with DEEP-approved agricultural waste management plans.[42] Assuming the farm digester is driven by a farm's manure management needs, this program would provide an opportunity to apply for funds to recoup a portion of the capital expense. EAP grants are made subject to fund availability.

As of this writing, there are no funds available under EAP, however, the program still exists and can be funded in future State budgets.

AD PILOT Program

The CT Green Bank continues to be a national leader in leveraging public dollars to attract private investment for in-state clean energy projects. The CT Green Bank specifically offers a Pilot program[43] that provides capital investment for anaerobic digestion projects. The program requires that the biogas be used by a gas-fired combustion turbine, reciprocating engine, fuel cell or other commercially available prime mover to generate electricity and be no more than 3 megawatts in size.

The AD Pilot program provides for five project opportunities and currently four digester projects have been approved by the CT Green Bank Board to receive loans. Only one of the four approved projects has closed on its loan. There is one project opportunity still available under the program. The CT Green Bank has discussed potential farm-AD projects with farmers and developers, although none of the Board-approved projects are farm-based.

Section 319 Clean Water Act Funds

Water runoff from agricultural lands and waste from animals can generate bacteria and nutrients that are identified as "nonpoint sources of pollution" (NPS), meaning that that the pollution source is not from an outfall pipe otherwise regulated by the Department. According to the Department, the most common sources of excess nonpoint source nutrients in surface water are chemical fertilizers and manure from animal facilities.[44] The Department's Bureau of Water Protection and Land Reuse serves in a coordinating role for the various NPS programs and administers the state's Section 319 grant program, which uses a portion of federal program dollars for NPS implementation and planning projects. This program could provide technical and financial assistance for farms seeking to install AD as a means of managing manure.

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[42] See State Department of Agriculture's website at http://www.ct.gov/doag/cwp/view.asp?a=3260&q=398986

[43] See the Energize CT website at http://www.energizect.com/your-business/solutions-list/Anaerobic-Digester-Projects for more information on the AD Pilot Program.

[44] DEEP's CT 2014 NonPoint Source Management Plan, Page 63; see http://www.ct.gov/deep/lib/deep/water/nps/planupdate/ct_nps_plan_final.pdf

Investment Tax Credit

The Investment Tax Credit (ITC) is a federal corporate tax credit available to the commercial, industrial, utility and agricultural sectors for renewable energy facility construction.[45] The amount of the ITC is dependent on the type of facility built. AD facilities are eligible for a 30% tax credit for the cost of the facility, *provided construction of the project commences prior to 2017*.[46] The credit begins when the facility is placed in service and continues for 10 years from that date.

Although there has been a lot of discussion about reinstituting the ITC for various renewable energy projects, specific action by Congress is needed to prevent its expiration on December 31, 2016. This impending deadline places obvious time constraints on any farm AD project that relies on the ITC to be economic.

Property Tax Exemption

Property taxes in Connecticut must include a credit for renewable energy system if that system is producing energy for consumption on the real property the system is located.[47] Often times, farm digesters feed excess electricity to the distribution system because there is not enough on site load to use all of the electricity produced. Feeding excess electricity in any amount to the grid appears to render the project ineligible for the property tax exemption. However, AD projects that participate in the Virtual Net Metering program that use the aggregate of their Host and Beneficial Accounts are eligible for a property tax exemption.[48]

Farm buildings, machinery and equipment are eligible for mandatory and optional exemptions to property taxes under state law.[49] These exemptions may be worth exploring in cases where a farm owns the AD facility that is situated on the farm.

Regulatory Path

Anaerobic digesters must receive multiple permits to build and operate in Connecticut. These permit applications can be relatively easy or significant undertakings that require time and professional assistance to complete. The applicable permits and the associated costs are mainly driven by the size of the project, amount of incoming waste, ultimate use of the digestate and energy output. If the project is connected to utility infrastructure, utility approvals to interconnect to the grid will also be required.

Applicable permits are listed below. There can be a significant difference in permitting timeframes based on the type of permit being sought. Farmers proposing AD projects on their farm should seek DEEP approval of a CNMP developed by a qualified professional. The farm's CNMP is the starting point for environmental reviews. NRCS regional offices can provide

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[45] At http://programs.dsireusa.org/system/program/detail/658

[46] The Consolidated Appropriations Act, 2016 (H.R. 2029, Sec. 301) extended eligible facilities to claim the Investment Tax Credit through the end of 2016

[47] CGS Section 12-81(57)(D)

[48] CGS Section 12-81(57)(D)(III)

[49] See State Department of Agriculture's Agricultural Laws and Regulations page at http://www.ct.gov/doag/cwp/view.asp?a=1366&q=317762

assistance to farmers seeking to develop or revise a CNMP by referring them to qualified professionals and NRCS offers some financial assistance programs for planning purposes.[50]

Once project specifications are clear and an applicant is ready to prepare environmental permitting applications, the applicant is strongly advised to contact DEEP to schedule a pre-application meeting.[51] At this meeting, the Department will discuss the project as a whole with the applicant, including how it fits within the individual farm's CNMP, what specific environmental permits are needed to operate, permit compliance requirements, as well as a more definitive permit review timeline. A meeting with DEEP early on can avoid unnecessary costs due to time lost.

Once project specifications are clear and the applicant is ready to prepare environmental permits, the applicant is strongly advised to contact DEEP to schedule a pre application meeting

Finally, if construction will be undertaken on preserved agricultural lands, written notification to the Connecticut Commissioner of Agriculture is required.[52] The Department of Agriculture will review the proposed location, dimensions and use of the facility and the Commissioner's approval is required in order for the project to proceed.[53]

Permits

Local Zoning

Connecticut's 169 cities and towns have individual zoning rules with regard to siting various facilities on farmland and in commercial areas. The farmer or land owner should meet with their town officials early in the process to find out if any building constraints exist relative to the property on which the digester will be situated.

Organic Materials

Permitting requirements for receiving organics are driven by the amount and type of material received. Only "source-separated" organics, meaning organic materials that were never mixed with other wastes, may be accepted. If no more than 5,000 cubic yards of organic waste originates from off-farm per year, then the AD facility will require a DEEP General Permit for the Discharge of Stormwater from Industrial Activity. The Stormwater General Permit process can often be completed by the applicant with the assistance of DEEP and requires a fee of $500.

If more than 5,000 cubic yards of organic waste originating off farm come to the facility, the digester will need to obtain a Volume Reduction Facility (VRF) Solid Waste Permit from

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[50] See USDA and NRCS informational handout on CNMPs, including CT NRCS contact information at http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1166381.pdf

[51] See DEEP's users' guide to environmental permits at http://www.ct.gov/deep/cwp/view.asp?a=2709&q=324232&deepNav=GID=1643

[52] CGS Chapter 422a

[53] See CT Department of Agriculture's Farmland Preservation Program webpage at http://www.ct.gov/doag/cwp/view.asp?a=3260&q=399016 and the Program's Do's and Don'ts informational brochure at file:///C:/Users/Julie/Downloads/FPP%20Do's%20&%20Don'ts%20Brochure.pdf

DEEP.[54] The application fees are specific to the permitted activity. If the digester is processing 100 tons per day or less of source-separated organics, the General Permit application fee is $7,750. For facilities taking more than 100 tons per day, the application fee is $10,000.[55] The VRF Permit requires a technical review of the project including incoming materials, technology used, end uses of materials and other factors that will present environmental impacts. DEEP VRF reviews are rigorous and will likely take more than 180 days to complete and an applicant must consider and plan for the costs from environmental engineers and consultants. These professionals are often needed to conduct tests and provide other specific required information to the Department.

Water Discharge

The general permit for miscellaneous discharges may only apply to farms discharging digester wastewaters to sewers or hauling wastewaters collected in a holding tank to a wastewater treatment plant (POTW). If taking in food waste for the digester, it must be demonstrated that the AD project is an integral part of the farming operation, critical for manure and nutrient management. Food waste volumes will be limited to quantities developed in the nutrient management plan based on agronomic land application rates of available cropland and markets for value added products produced.

Air Permit

The emissions released into the air from stationary internal combustion engines such as diesels and turbines used to generate electricity are regulated by the Department's Engineering and Enforcement Division of the Bureau of Air Management. A New Source Review (NSR) permit may be required for the engine.[56] There is an initial application fee of $940 for the NSR, however the ultimate permit fees will be based on an inventory of emissions at the premises, which are calculated subject to State Regulations[57] and billed when the Department completes its review. If it is determined that no permit is required, then the applicant will get written confirmation of this and half of the application fee refunded. The draft permit will be subject to public notice and a hearing may be required if objections are filed or questions raised by the public or the Department. Review time for completed applications are estimated at about 180 days.

Siting an Energy Facility

If the AD facility is producing electricity it will require Siting Council approval before construction commences. If the project is below 1 megawatt in capacity, the project will generally be exempt from Siting Council review, although communications with the Siting Council are necessary. If the farm digester is over 1 megawatt in capacity, the project must file to petition the Council to approve the location and construction of the facility by declaratory

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[54] See DEEP Fact Sheet at http://www.ct.gov/deep/lib/deep/Permits_and_Licenses/Factsheets_Waste/commercialgp_fs.pdf

[55] Application fees are spelled out in RCSA Section 22a-208a-1

[56] See DEEP's NSR Environmental Permitting Fact Sheet at http://www.ct.gov/deep/cwp/view.asp?a=2709&q=324214&deepNav_GID=1643#NSR

[57] See RCSA Section 22a-174-26, and CGS Section 22a-174(g) for detailed fee information.

ruling.[58] If a Petition for Declaratory Ruling is required, initial response time from the Council is within 60 days and the filing fee is $625.[59] If a site inspection is needed, and an additional fee of up to $500 may be incurred by the applicant.

Interconnecting to the Grid

If producing excess electricity for sale to the grid, the project will have to apply to interconnect to the distribution system of the electric utility company. Interconnection will not be denied as a rule, but it could be costly to do if the existing distribution system equipment cannot accommodate the additional electricity generated by the project. Generally speaking, if system upgrades are required, the applicant must pay those costs, which can be significant and quickly drive down project economics. Interconnection is an additional, separate process from permitting that requires the services of an electrical engineer to complete. Applicants should allocate several months' review time by the utility, although the process is often quicker.[60] Farms seeking to interconnect are encouraged to contact their utility for the specific rules, application guidelines and fees.[61]

What Programs Work to Support Farm AD

Agricultural Anaerobic Digestion Ombudsman

Both New York and Vermont have employed ombudsmen to help guide farms seeking to install anaerobic digestion systems through the myriad of permits, processes and programs to make the systems viable. In Vermont, the position was funded through the Renewable Development Fund, which is a charge collected by the utility and is also funded by donations. New York is considered a leader in AD development with over 30 projects up and running, including farm AD. The New York Ombudsman program, offered through the New York State Energy Research Development Authority (NYSERDA), is credited with helping 20 of those facilities come to fruition.[62]

Massachusetts Organics to Energy Program

Massachusetts Clean Energy Center offers competitive grants for programs that turn organic waste into renewable energy. Organics-to-energy technologies may produce electricity, heat or CNG. The maximum grant award is $400,000. The Massachusetts CEC and the Organics-to-Energy Program are funded from the Renewable Energy Trust Fund, which is the equivalent of the Combined Public Benefits Charge paid by electric utility customers in Connecticut.

NYSERDA Gas-to-Electricity Program

New York State electric utility customers are eligible to apply for funds to install on-site anaerobic digester gas-to-electricity systems with a power generation capacity of 50 kW or

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[58] CGS Section 16-50i(a)(3) for siting exemptions for qualifying small power production facilities for the producer's own use and a generating capacity of 1 megawatt of electricity or less.

[59] See http://www.ct.gov/csc/lib/csc/guides/2016guides/renewable_energy_facility_petition_guide_0216.pdf#55850

[60] The electric utilities keep a queue of applicants that have submitted completed applications. That queue is impacted by the volume of requests and may have longer wait times following State-sponsored RFPs, for example.

[61] See Eversource Interconnections and United Illuminating Interconnections

[62] See AGStar Case Study: Overcoming Barriers in New York at https://www.epa.gov/sites/production/files/2016-02/documents/ny_ombudsman_case_study_12_30.pdf

greater in New York State. Approximately $20.4 million is available to install on-site, anaerobic digester gas-to-electricity (ADG) systems. These systems must ultimately be connected to the electric utility's distribution system. Funding is capped at $2 million per project and is in the form of both performance- and capacity-based electricity production incentives.

NYSERDA's project is unique because it also offers free technical assistance for facilities considering an AD project, including technical evaluation, project planning, electrical grid interconnection assistance, sourcing of biomass feedstocks, and other aspects of project development.

Vermont Cow Power

In Vermont, an electric utility, Green Mountain Power (GMP), worked with farms to establish "Cow Power," a program that adds a voluntary .4/kWh to electric consumers' bills to help pay for the program. For every kilowatt-hour requested by customers and provided by a Vermont farm, GMP pays the farmer for the energy at the current utility generation rate, plus the Cow Power charge of four cents for the environmental benefits of the generation.

If there aren't enough kilowatt-hours available from participating GMP farms, GMP will try to acquire and retire Renewable Energy Certificates from other regional renewable generation sources, issued by the regional system operator, to support renewable generation in a broader sense. If there are no certificates available in the regional market for four cents per kilowatt-hour or less, the company will deposit Cow Power payments into the GMP Renewable Development Fund (RDF). Overseen by an independent board, the RDF will provide incentives to farmers to become involved in or increase electricity output into the Cow Power program.

Recommendations

1. Reevaluate CT's Electric Energy Program Incentives as Applied to AD

The most important change that can be made to incentivize farm AD in Connecticut is to realign the existing programs so that they apply to AD technology. Given the multiple environmental benefits, including greenhouse gas reductions, AD is not being properly valued under the renewable energy credit programs for solar and fuel cells. The LREC, for example, uses engine emissions as a guide for eligibility rather than the environmental impact of the project as a whole toward reducing harmful emissions. This change could have helped dairy farm AD projects get past the critical financing stage by allowing it to secure a long term contract for its environmental attributes.

Current renewable energy programs are largely limited pilot programs that require AD to compete for very limited opportunities versus technologies like solar, wind and fuel cells that have had a head start in the renewable market. However, many of these programs are expiring and future proposals will be discussed and considered both during the Department's 2016 *Comprehensive Energy Strategy* planning process and at the Legislature in the 2017 Regular Legislative Session. Slight changes to existing programs and new programs that call for a long term REC for AD and/or solicitations for the purchase of power from renewable technologies that also advance the water quality and waste diversion goals of the state should be enacted.

2. Consider State Incentives for CNG and RNG production

Connecticut does not have an equivalent to the RPS for natural gas. Currently, natural gas prices are low, so from a market perspective, it is an optimal time to investigate enacting a renewable source mandate for natural gas that will help diversify the state's natural gas supply in a way that benefits the environment overall. Incentives to support bringing critical natural gas infrastructure to a few large dairy farms in Connecticut should also be investigated as part of the gas utility expansion plans underway. If economic, the utility could theoretically benefit from even a small supply of local, readily available gas capacity as well as the extension of gas lines to more customers on the path to the farm.

Similarly, CNG production and use for trucks and even farm equipment is a viable alternative to electric production from farm digesters. Either CNG or RNG do increase capital costs to digesters, but other renewable technologies faced these hurdles in the past. Solar has become accessible to businesses and residents because incentives were put in place that associate a dollar value with the environmental benefit these systems provide. AD provides carbon reduction, improved water quality, waste management and renewable energy benefits that, if monetized, would help develop a market for AD products and projects in Connecticut.

3. Consider Creating a CT AD Ombudsman Position

Vermont and New York have AD Ombudsman programs that help farmers seeking to develop AD projects through the myriad of permitting and energy offtake processes required to bring a plant to fruition. As discussed herein, Connecticut's processes are also complicated and overlapping, making them difficult to navigate without costly consulting assistance. The ombudsman positions in Vermont and New York are part time and funded through the use of grants and donations.

4. Reinstate Funding for the Environmental Assistance Program

Connecticut state government has been pulling back on or cancelling funding for various worthy programs in light of the current economic realities the State faces. Funding for EAP through the State Department of Agriculture could be a critical piece of an overall plan to fund a dairy farm digester in the state, as well as to help offset the costs of other manure management investments. The program allows the Commissioner to reimburse a farmer for some costs associated with the digester. As such, EAP should continue to be a priority area of investment when funds are available.

5. Develop Food Waste Best Practices

The combination of food waste and farm waste can help boost gas production and revenue opportunities for a digester project on a farm. However, farms planning on using food waste to supplement manure for feedstock need to have in place protocols that will help them identify contamination before it enters the digester as well as to generally control the quality of the materials that come from off the farm. Future research to help define best practices for managing in-coming food waste to farm digesters should be explored in cooperation with the Departments of Energy and Environmental Protection

and Agriculture. When a farm digester is built in Connecticut, it will likely be with some financial assistance. Best practices for managing what is essentially the project's fuel would help protect the investment made in the digester to ensure its viability over the long term.

Other Resources

AgSTAR Handbook "A Manual For Developing Biogas Systems at Commercial Farms in the US;" February, 2004 at https://www.epa.gov/sites/production/files/2014-12/documents/agstar-handbook.pdf

Massachusetts Executive Office of Energy and Environmental Affairs "Financial & Technical Assistance for Anaerobic Digestion Projects," see http://www.mass.gov/eea/agencies/massdep/climate-energy/energy/anaerobic-digestion/anaerobic-digestion-financing-and-technical.html

Massachusetts Clean Energy Center's Small Scale Organics Vendor Directory, see http://www.masscec.com/small-scale-organics-energy-vendor-directory

New York State Department of Environmental Conservation, AD webpage, see http://www.dec.ny.gov/chemical/97612.html

Vermont CowPower Program information is available at http://www.greenmountainpower.com/innovative/cow/how-it-works/

Cornell University Small Farms Program information is available at http://smallfarms.cornell.edu/2013/06/11/anaerobic-digesters/

US EPA Renewable Fuel Standard information is available at https://www.epa.gov/renewable-fuel-standard-program/program-overview-renewable-fuel-standard-program

Appendix A Survey Form and Results

CONNECTICUT FARM ENERGY PROGRAM

May 16, 2016

Dear Dairy Producer,

The Connecticut Resource Conservation & Development Area, Inc. (CT RC&D) a non-profit organization is conducting a survey through its Connecticut Farm Energy Program (CFEP) of Connecticut dairy farms with regards to anaerobic digesters. Additionally, CFEP is working in conjunction with JPC Consulting (a sub-contractor) to develop an anaerobic digester "Road Map" along with hosting stakeholder meetings. The results of this project will be used to improve policy along with laying out needed steps in order to implement an anaerobic digester on a Connecticut farm. We appreciate your time and participation in taking this brief survey. Your cooperation will enable us to advocate for anaerobic digesters on behalf of the Connecticut dairy community in the future. For your convenience we have included a postage paid envelope to return your survey **by June 1, 2016. If you prefer to take the survey electronically or by phone please contact us at 860-345-3977 CTFarmEnergy@aol.com and we'd be happy to assist you.**

Connecticut Anaerobic Digester Survey

Farm Name:

_____

Address:

_____

Phone number:

_____

Email:

_____

Contact Person:

_____

Years in Operation:

_____

Number of milking cows: **Range in answers from 6 - 1,400 milking cows**

Number of total cows on the farm: **Range in answers from 15- 2,800 total cows on the farm**

Is excess manure an issue for your farm? Y or N

Yes	4
No	27

Where does your excess manure get used, ex. On your farm, off farm, etc.?

On farm	13
Off farm	2
On farm/off farm	6
No excess	10

Is lack of manure for fertilizing an issue for your farm? Y or N

Yes	9
No	22

Do you have interest in an anaerobic digester? Y or N

Yes	11
No	17
Maybe	3

If yes, why (please check all): (11 farms responded)

Manure management	10
Electric energy generation	9
Heat generation	7
Bedding Material	10
Compost product to sell off farm	8
Tipping fee income	4
Other – recycling, odor reduction, sale of gas, carbon footprint, income	4

Have you investigated anaerobic digesters for your farm? Y or N If yes, how long ago?

Yes	4
No	24
Maybe	1
N/R	2

If you are interested in a digester, what prevented you from implementing one on your farm? (Please check all)

Cost (yes and maybe)	1
Financing (yes and maybe)	3
Not sure how to implement an anaerobic digester (yes and maybe)	1
Maintenance (yes and maybe)	2
Other lack of prime farm land to cover PDR base, choose one that fits our needs, return on investment, still thinking.	12

What type of manure system do you have on your farm? Solid or Liquid

Solid	4
Liquid	9
Both	7
N/R	2

Do you have a manure storage system on your farm? Y or N

Yes	22
No	8
N/R	1

If yes, what type? Above ground tank, in ground pit, open stack, walled stack, or other?

In vessel composter	1
Compost facility	1
Above ground tank	5
Open Stack	2
Don't know	1
Walled stack	4
Underneath barn	1
Piles	1
Bins	1
Bedded pack composting	1
Pit stack pile pad	1
Concrete pit	1
N/R	1

Do you currently have any type of manure separation equipment on the farm? Y or N

Yes	3
No	26
Maybe	1
N/R	1

What type of bedding do you currently use in your operation?
(Some farms responded with more than one type of bedding)

Ground Pellets	1
Hay	3
Leaves	1
Manure Solids	2
Sand	12
Shavings	5
Sawdust	10
Woodchips	1
N/R	1

Are you interested in learning more about anaerobic digestion for your farm? Y or N

Yes	13
No	16
Maybe	1
N/R	1

Would you be interested in a stand-alone digester unit? Y or N

Yes	8
No	16
Maybe	9
N/R	1

Would you be interested in a cooperative digester unit? Y or N

Yes	4
No	16
Maybe	9
N/R	2

Other comments you would like to make:

- Labor intensive and we spread manure on the farm every day.
- A little more information would have made it easier to answer the "are you interested in" questions. For example, knowing if there is a minimum number of cows needed to operate an anaerobic digester, what types of bedding work/won't work, must manure be liquid, and similar facts would make it easier to decide if the technology is adaptable to my farm.
- We are currently using a composting/bedded pack system. Working NMP with NRCS.
- Would need to have control of what is added from tipping.
- Digesters are a win win.
- I do not know much about digesters but manure management and storage is an issue for me.
- Co-op digester seems a solution especially if the town could participate with school food waste.

Appendix B Comments

Comments were solicited on the Draft Roadmap document from interested stakeholders, particularly Connecticut State Agency staff. Additional clarifying information provided by stakeholders has been included and integrated into the final Roadmap, with final comments integrated on August 10, 2016. Special thanks to the stakeholders that took the time to provide input, including:

- Charles Lee, Nonpoint Source Program Supervisor, Bureau of Water Protection and Land Reuse
- Christopher Malik, Watershed and NPS Management Planning and Standards Division, Bureau of Water Protection and Land Reuse, Connecticut Department of Energy and Environmental Protection
- Joseph Wettemann, Senior Sanitary Engineer, Subsurface Disposal & Agriculture, Water Permitting & Enforcement, Connecticut Department of Energy and Environmental Protection
- Diane Duva, Director, Office of Energy Demand, Bureau of Energy and Technology Policy, Connecticut Department of Energy and Environmental Protection
- Rick M. Ross, Associate Director, Statutory and Infrastructure Programs, Connecticut Green Bank
- Stephen Anderson, Office of the Commissioner, Connecticut Department of Agriculture
- James Hyde, State Agronomist, USDA NRCS
- James Muir, RCM Digesters