Towns of Yates and Somerset
Anaerobic Digester Pre-Feasibility Study
Final Report

Town of Yates
8 South Main Street
PO Box 484
Lyndonville, NY 14098

By
Philip D. Lusk
1330 Lawrence Street, Apartment #1
Port Townsend, WA 98368
605.224.4334
plusk@pipeline.com

and

Angela McEliece
510.853.4767
angelamceliece@gmail.com

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Summary

In 2021, the Towns of Yates and Somerset (Yates/Somerset) commissioned a high-level scoping study about using **anaerobic digestion (AD)** to produce renewable energy and other co-products from dairy manure. The study concluded there is "Significant Technical Potential" for an AD project, given the estimated farm number and herd size of the dairy farms found in the general area.

Yates/Somerset subsequently commissioned this pre-feasibility study to better evaluate how AD produces renewable energy and other valuable co-products. The analysis goals include:

- Identify waste stream quantities and qualities.
- Evaluate farm manure management practices.
- Estimate biogas energy quantities and uses along with a system description.
- Develop a +/- 20% total project cost estimate.
- Conduct an economic cost-benefit analysis.
- Discuss other issues and areas of concern, including state and federal incentives and other related project requirements.

This study has identified a potential AD system site that shows excellent technical and financial potential. What happens next will require all interested parties to better define the desired outcomes and pathways to ensure success.

The evaluation brings one major conclusion. Having a full range of revenue-producing co-products that increase profit makes a significant difference to a financial analysis. Quite simply, it is difficult to justify an AD system based only on the revenue received from electricity sales. A project becomes a profitable biorefinery when it produces energy, fuels, and chemicals having a high value and low-carbon footprint.

Introduction

Yates/Somerset are in western New York State, northeast of Buffalo and west of Rochester. Located on the southern shore of Lake Ontario, the Town of Yates (Orleans County) is known for competitive sports fishing and agricultural production. The Town of Somerset (Niagara County) is known for tourism. Agriculture is a key industry here as well, as the county's flatland is used to grow grapes, apples, peaches, and other fruits.

In 2021, Yates/Somerset commissioned a high-level scoping study for the potential use of AD for odor control, to produce renewable energy, and for other co-products at four dairy farms. These farms are all within a five-mile radius of the Towns of Yates and Somerset, and are in relative proximity to one another.



The scoping study raised a key factor, which is the use of sand as a freestall bedding material. Without first separating the sand from the potential feedstock, sand bedding is incompatible with an AD system. Inevitably, sand will fall out of the feedstock solution and begin filling the digester's reactor. The accumulated sand will eventually reduce tank volume and inhibit the AD system's ability to produce biogas.

Any sand-laden digester will eventually fail. Sand can be recycled for use as bedding using a **sand-manure separation (SMS)** system, making the feedstock more amenable to treatment by an AD system. Regardless of SMS process efficiency, any AD system must be designed for an easy clean-out of the solid materials that eventually will accumulate in the tank. The presence of sand and ease of digester clean-outs is a key consideration for a successful AD project. Operational longevity in areas such as solids removal needs to be

discussed and brought to the attention of any potential project developer or engineering firm, prior to doing business with them.

The scoping study concluded there is "Significant Technical Potential" for an AD project, given the number and size of dairy farms within the general area of Yates/Somerset. In the ideal world, no significant barriers to the project's success were found. Given the study's error margin and assumptions, the paper-based project exceeded the financial threshold needed for more consideration.

However, the level of uncertainty of the estimated capital investment and operating costs were highly dependent on the accuracy of the model's input parameters. Quite simply, most specific farm-level details were not available, and the underlying method was hoped to produce results accurate to within +/-30% of real-world results.

Following the study's completion, Yates/Somerset worked diligently with the four potential dairy farm partners, as well as with the surrounding community, to build support for an AD project. These four farms supplied initial manure and operating parameter surveys, and now are possible participants in an AD project.

By obtaining more specific farm-level information on key factors such as individual farm manure management practices, the type of cows in production (e.g., Holstein), average daily milk production, and other factors reduce the error margins.

This pre-feasibility study estimates AD system costs and benefits for four dairy farms located in the two counties. Based on representative farm dairy herd sizes, the estimates include installed capital costs and annual operation and maintenance (O&M) expenses. The co-products produced by the AD process include methane-rich biogas, fiber, mineralized nutrients, and odor control.

The analysis done using the Techno-Economic Analysis Model (TEAM©), a decision-support tool evolving over 25 years of conducting a wide range of feasibility studies. In its AD format, TEAM© uses 225 or more inputs to estimate mass, energy, air emissions, and nutrient balances for a wide range of feedstocks. Specific outputs include, but are not limited to, estimates of energy generation and co-product production, based on daily and annual mass balances.

Using these physical parameters, the model generates a projected income statement, balance sheet, and statement of cash flows using standard accounting templates. Because it is EXCEL-based, the model is widely adaptable to simulate the technical and financial performance of a variety of suspended and attached growth digesters, including plug-flow, complete mix, and fixed-film reactors. TEAM© is also adaptable to simulate the

technical and financial performance of a wide variety of other energy technologies. TEAM© was awarded a Certificate of Registration by the U.S. Copyright Office in accordance with title 17, United States Code[1].

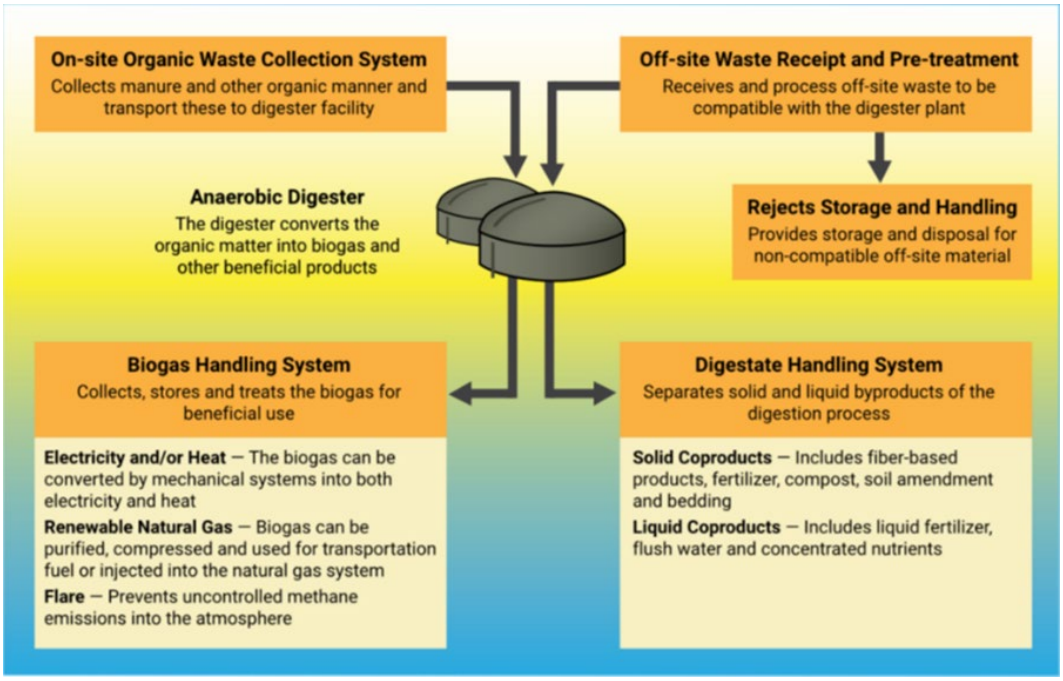
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- Identify waste stream quantities and qualities.
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- Discuss other issues and areas of concern, including state and federal incentives and other related project requirements.

General Project Description

AD is a process where bacteria break down organic matter—materials such as animal manure, wastewater biosolids, and food wastes—in the absence of oxygen. Figure 2 shows a general flowchart of an AD system.

FIGURE 2: Simplified AD System Flowchart[2]



[1] See Appendix A

[2] U.S. Environmental Protection Agency. (2021). AgSTAR Project Development Handbook. SEE: https://www.epa.gov/agstar/agstar-project-development-handbook

One AD process technology often used for dairy manure is a completely-mixed stir tank digester, or CSTR. CSTR digesters process manure and other putrescible organic materials with **total solids (TS)** concentrations of 8%-12%. "Plug-flow" type AD systems require thicker material, while more dilute manure feedstocks use a covered anaerobic lagoon.

Typical dairy manure, directly deposited by a cow, is about 12%-14% TS. Adding water from normal farm operations like parlor washing reduces the TS concentration down to a more usable range. Depending on feedstock type, CSTR digesters normally run with a **hydraulic retention time (HRT)** of 15-25 days.

HRT stands for the digester's holding capacity and is related to the total amount of gallonage the digestion tank will hold. Ultimately, HRT is a critical design parameter that will be calculated by the AD system engineers. An insufficient HRT will lead to a failed digester.

The manure feedstock is sent first to a mixing pit, which allows the manure TS to be adjusted to the desired TS concentration level by more dilution if needed. AD systems often use a mixing pit with a capacity roughly equal to one day's manure output. The manure is normally heated before adding it to the digester's reactor to avoid thermal shock.

Both the mixing pit and reactor are heated with the waste heat produced by the engine's cooling system. CSTR digester volumes can range considerably, up to tank capacities of 1.5 million **cubic feet (ft^3)** or more. This is a daily capacity of a bit more than 25,000 gallons of manure/digester. Larger volumes are managed by adding more reactors.

A cover, made from either fixed or flexible membrane materials, is placed over the reactor to support anaerobic conditions and to trap the methane-rich biogas. When the raw biogas is recovered from the digester, it is first de-watered and then processed to remove the corrosive **hydrogen sulfide (H_2S)** that is embedded before use. At scale, the most common application is electricity production using a modified natural gas or diesel internal combustion engine in combination with a generator.

There are conditions of what feedstocks are acceptable for use in an AD system. The best rule of thumb is to first match the AD technology to the feedstock, and especially its TS concentration. A wide variety of AD process types are available, each performing the basic AD function in their own unique way. For example, feedstock TS concentrations of less

than 3% might consider using a covered anaerobic lagoon or a "high-rate" type of AD system, such as a fixed-film digester,[3] instead of a CSTR digester.

Not all organic feedstocks are created equal, and they are categorized by the digestible percentage of their TS concentration. Generally, the TS from dairy manure should have a **volatile solid[4] (VS)** concentration of 80% or higher. Less than 5% of the incoming solids should be mineral inerts (e.g., sand), and ideally the feedstock should have no plastic or metal contamination.

Renewable Natural Gas

This report's consideration is to develop a relatively simple thermal-electric process, where the biogas electricity and hot water by burning it an engine with a dedicated power generator. This study does not make any provision for **renewable natural gas (RNG)**, which is a highly purified product made from biogas. To become RNG, all water vapor, carbon dioxide, and other impurities must be removed. RNG can then be injected into the natural gas grid and used as a substitute for a fossil fuel[5].

Because of their greater potential to reduce methane emissions, dairy-based digesters normally rank as being hugely profitable RNG projects. As a result, RNG project development is at a "fever pitch" in the United States. Like any gold rush, this is not necessarily a good thing, as there is a growing backlash over California's lucrative dairy biogas market[6].

Due to the complexity of developing an RNG project, it is far beyond the budget for the current scope of work. Yates/Somerset should contact an RNG project developer directly if there is an interest. If there is a match of interest, the RNG system developers would pay for the required studies.

Co-Digestion with Other Organic Wastes

Multiple types of organic materials can be processed in an AD system; it is a practice called co-digestion. Adding other organic materials increases biogas output, and is a potentially major revenue stream through tipping fees. Projects can offer to take certain organic materials from waste haulers for a lower fee than charged by those charged by landfills and still make a profit.

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[3] Farm Energy. (2019). Types of Anaerobic Digesters. SEE: https://farm-energy.extension.org/types-of-anaerobic-digesters/

[4] Volatile solids (VS) are the TS fraction made up primarily of digestible organic matter.

[5] Biomethane Supply Chain. (2016). Clean Energy Compression. Renewable Natural Gas Production, Distribution, and Sales 101. SEE: https://www.youtube.com/watch?v=vlbvmed2wX8

[6] A Battle Is Underway Over California's Lucrative Dairy Biogas Market. 28 December 2023 by Inside Climate News. SEE: https://insideclimatenews.org/news/28122023/milking-it-battle-underway-california-dairy-biogas-market/

Organic wastes that can be co-digested with manure include food residuals from supermarkets, restaurant, and cafeteria food wastes. Other digestible sources include food processing wastes, energy crops, crop residues, and various fats, oils, and greases. Each organic material has its own individual chemical and physical properties that decide the efficiency of how it biologically breaks down, and produces varying amounts and quality of biogas.

The **Organic Resource Locator (ORL)**, developed by the New York State Pollution Prevention Institute, is a web-based mapping tool that provides information on organic waste resources and their use in New York State. The ORL may better enable the identification of potential co-digestion resources in the proposed project area. For more information, use the website link in the footnotes below[7].

Site Description

The four dairy farms evaluated in the scoping study responded to a farm waste management questionnaire. The collected information included information on the herd type and number of head at each farm, along with the type of waste removal system. Of particular interest was the daily flush water volume.

Only one of the farms shown in Figure 1 ("Farm D") uses a hydraulic flushing system for manure management. As a result, the manure TS concentration is greatly reduced, and the dilution makes the manure unsuitable for use by a CSTR-type system. As a result, this herd was not used in the evaluation.

The three remaining farms use manure scraping systems with low water usage, creating a manure feedstock that is in an ideal CSTR range. Farms B and C have much higher animal stocking than Farm D, and jointly account for about 95% of the combined herd. These farms also all use bedding materials such as sawdust and manure solids. They would be excellent candidates for using the solids recovered post-digestion[8].

All three farms receive electrical service from Niagara Mohawk, d.b.a National Grid. Two of these farms use three-phase power, which simplifies the interconnection of any potential engine-generator to the grid. The site locations (Farm A, B, and C) are shown in Figure 3.

[7] Organic Resource Locator. New York State Pollution Prevention Institute. SEE: https://www.rit.edu/affiliate/nysp2i/organic-resource-locator

[8] Appendix B provides the TEAM© inputs and outputs used in this study.



These three farms have a total combined herd of 6,950 head, or around 9,600 **animal units (AU),** including 2,330 head of dry cows and young heifers. Assuming an 85% manure recovery rate and average manure production values, the digester's dairy manure feedstock is estimated to total about 91,000 gallons/day. An added 15,300 gallons/day of parlor and other water used by the dairy[9]. The manure is assumed to be delivered to the AD system free of charge.

An AD system includes manure mixing tanks, an anaerobic reactor, and an engine-generator having heat recovery capabilities. The system also includes a storage lagoon with sufficient volume to hold the discharged liquid filtrate effluent. After the digestion process, the effluent will be separated into its solid fiber and liquid filtrate fractions.

The CSTR digester, running in the 95°-105°F temperature range, would be fed from an engineered manure collection system. The manure feedstock is projected to be in the range of 11%-13% TS concentration once reaching the digester[10]. The HRT will normally be in the 15-25 day range.

The digester's reactor would likely be a round concrete tank with sufficient volume to meet the HRT specifications. The tanks should be designed for an easy clean-out of any

[9] The impact of rainwater co-mingling with the manure was not evaluated. Specific management practices should be implemented if rainwater could dilute the feedstock TS concentration excessively. System engineers should take this into account and provide specific direction during the project's design phase.

[10] Actual TS concentrations will vary and are based on water usage by each farm.

accumulated sand and other fine solids that eventually will deposit over time. Depending on the specific project, tanks could be 120-140 feet in diameter, with depths of 18-20 feet.

The digester tank could be partially buried to conserve heat. The digester cover will likely be an inflated high-density polyethylene or equivalent top. The biogas will be metered, pressurized, and pumped to an engine-generator that is sized for the system's biogas output.

Parasitic electricity is needed for the electric motors used for digester mixing and for moving materials through the AD system. The power requirement is estimated to be roughly 6%-8% of the total annual generation. At 8%, this is a parasitic electrical load of 810 MWh/year. The biogas will be de-watered and H_2S is removed by using a scrubber. As a result, fewer oil changes are needed and engine life increases. O&M costs are reduced as a result.

Given the engine sizing and fuel loading rate, the engine-generator is assumed to have a heat rate requirement of 9,530 **British thermal units (Btu[11])** to produce one **kilowatt-hour (kWh)** of electricity. The collected manure feedstocks could produce enough methane to fuel an engine with a maximum nameplate capacity of 1,260 **kilowatts (kW[12])**.

TABLE 1: Project Inputs and Outputs	
Digester Feedstock Collected (gallons/day)	106,000
Biogas Output (SCF/minute)	370
Methane Output (MM Btu/year)	105,000
Power (kW)	1,260
Electricity Sales (MWh/year)	10,150
Thermal (gallons/year #2 diesel equiv)	94,300
Thermal (gallons/year propane equiv)	139,900
Ammonium Effluent (tons/year NH3 equiv)	700
Dairy Fiber (yards/year)	22,800

Assuming an annual capacity factor[13] of 92%, an estimated 10,150 **megawatt-hours/year (MWh/year[14])** of electricity is available for sale. Larger loads could be serviced by multiple engine-generators, and this project would likely be specified as a two-unit package.

Hot water will be recovered from the engine cooling jacket and exhaust, and circulated to a heat exchanger to heat the mixing tank and digester to the desired operating temperature. Part of the water used for engine cooling could also be available as co-

[11] For reference, a single matchstick can produce roughly 1 BTU of heat during its burn time.

[12] One MWh is equal to 1,000 kWh.

[13] With down time for maintenance only, this means the system is running 92% of the year on a 24 hours/day basis. Roughly, one month of the year is required on a periodic basis as the maintenance down time.

[14] kW stands for kilowatt, a standard unit of power that is equal to 1,000 Watts. It is important to note that a kW is a measure of power, not energy. A kWh is used to quantify the rate at which energy is used or produced over time.

generated hot water. This hot water could be used for sanitary parlor washing or space heating, offsetting any fuels now bought. For example, the potential is the energy equivalent of 94,300 gallons of #2 fuel oil or 139,900 gallons of propane.

Using the solid and liquid digestate residues from the AD process can also have added benefits. For example, during the AD process, much of the organic bound nitrogen in the raw manure is reduced into dissolved ammonia by de-amination. Organic materials are digested, and the bacterial action releases an equivalent to ammonia (NH_3).

More than 90% of all recovered nutrients are contained in the liquid filtrate fraction. When the digester's effluent is spread on the ground, bacteria convert it into intermediate nitrite, which is then further converted into plant-usable nitrate. The recovered NH_3 equivalent, totaling 700 tons/year, could be used as a substitute for most conventional nitrogen-based fertilizers, if needed. Each farm has a **Nutrient Management Plan (NMP)**, and the specialists involved in preparing those plans may be consulted to decide the usefulness of the recovered fertilizer.

All manures produce recoverable solid fiber. Fiber is recovered by using mechanical solids separation equipment such as screw presses or vibrating screens. When digested and composted, this fiber has physical attributes like moist peat moss.

The recovered fiber, totaling 22,800 yards/year, could be used for freestall bedding or for most horticultural purposes. Successful use of bedding made from recovered solids has been proven on many dairy farms with AD systems. These farms usually report a somatic cell count that is equal to or lower than for herds bedded on sawdust.

Siting Considerations

When considering the siting of an AD system on a dairy farm, several factors need to be accounted for to ensure optimal functionality, environmental compliance, and safety. Here are some considerations:

- **Feedstock Proximity:** Placing the digester close to the manure source minimizes transportation costs and simplifies logistics. This proximity also helps in managing a fresh supply of feedstock and the return of digested material for use as fiber and fertilizer.
- **Land Availability:** Adequate space is needed not just for the digester itself, but also for associated infrastructure such as storage tanks, feedstock preparation areas, and possibly areas for the end-products.
- **Topography and Soil Conditions:** The site should be on stable ground with suitable soil conditions to support the weight of the digester and related

structures. Consideration of the local topography is important to avoid areas prone to flooding or erosion.

- **Access to Utilities:** Reliable access to three-phase electricity, water, and possibly gas networks is essential for the operation of the digester. This includes considerations for power supply for pumps, mixers, heaters, and other equipment.
- **Transportation Infrastructure:** Good road access is important for the transportation of materials to and from the site, including feedstock, digestate, and potentially generated biogas.
- **Potential for Expansion:** Consider future expansion possibilities in the initial site planning to accommodate increased feedstock or enhanced technology.
- **Odor Control:** Anaerobic digesters can reduce typical manure odors, but bringing in offsite feedstocks like food waste could create new odor concern. Downwind neighbors and local communities may require that odor control measures be implemented. Such control measures include using an enclosed tipping floor having negative ventilation, or having carbon filtration lids installed on food waste storage tanks.
- **Water Source Protection:** Ensure that the digester's location and operation do not negatively affect local surface or ground water sources.



Given the Farm B and C's herd size, a potential AD project site location is likely in the highlighted area. The two waste storage lagoons in the center-left are probably associated with "Farm B." The footprint area needed for a manure-only AD system could be in the

range of five to eight acres depending on siting considerations. For scale, the dimensions of a perfect square that is about eight acres in size would be 600 feet by 600 feet.

Involving experts in site evaluation, such as environmental consultants and engineers, can help in making a well-informed decision. Additionally, reviewing case studies or examples of existing dairy farm digesters can provide practical insights into effective siting strategies. Experienced providers of AD systems will have added insights.

FIGURE 5: An Exceptionally Large AD System[15]



Thousands of similar projects have shown the commercial aspects of using the biogas made by an AD system to produce electricity. The largest digester now running in the U.S. is in Wisconsin. It is a 16-unit anaerobic digester that uses the manure from 11 dairies. An added water filtration system aids in reducing phosphorus runoff and helps improve farming practices[16]. This facility is capable of processing more than 900,000 gallons/day

[15] Photo Credit: Digested Organics.

[16] America's largest manure digester supports producers' environmental goals. 19 January 2023. Progressive Dairy. SEE: https://www.agproud.com/articles/56581-americas-largest-manure-digester-supports-producers-environmental-goals

of dairy manure, roughly eight times larger than this proposed project. This exceptionally large AD system has a total site footprint estimated to be 30-35 acres.

Economic and Financial Considerations

This section evaluates the cost-effectiveness of the proposed project, including initial capital costs, ongoing operational costs, and potential revenues including available government incentives.

Capital Costs

AD systems are growing to be larger in scale, as the dairy industry responds by increasing farm herd sizes to remain competitive in today's market. Project costs were estimated on a +/- 20% basis, likely valid through Fall 2023. Cost estimating was complicated by supply chain issues, increased product demand, and inflation.

Table 2 provides the project's Sources and Uses of Funds statement on a "turn-key" construction budget basis. Turn-key means the transfer of ownership occurs after the system is installed and operational. The project's total construction budget is $9,065,000, and includes the CSTR digester tank, engine-generators sized for the load with biogas conditioning system, a flare for burning excess biogas[17], storage for influent and effluent, and a solids separation system.

The construction budget also includes items such as project management,

TABLE 2: Sources and Uses of Funds Statement

USDA REAP	$1,000,000
USDA EQIP	$450,000
Enterprise Equity	$3,683,000
Senior Debt	$7,367,000
TOTAL SOURCES OF FUNDS	**$12,500,000**
Anaerobic Digester, Manure Pits & Solids Separator	$2,775,000
Engine-Generator, Biogas Conditioning & Flare	$3,950,000
Project Management, Engineering & Permits	$1,550,000
Electrical Interconnection	$515,000
Miscellaneous	$275,000
TOTAL CONSTRUCTION BUDGET	**$9,065,000**
USES OF FUNDS OWNER'S BUDGET	
Owner's Budget	$1,359,750
Contingency	$2,075,250
TOTAL OWNERS BUDGET	**$3,435,000**
TOTAL USES OF FUNDS	**$12,500,000**

[17] For instance, when the engine is turned off for maintenance.

engineering and permits, interconnection to the electrical grid, along with miscellaneous costs such as construction insurance. The balance of the uses of funds includes an Owner's Budget for line-items such as construction loan interest, working capital, and debt service reserve. Along with a contingency factor valued at $2,075,250, these items brought the total project cost to a total of $12,500,000.

Operating and Maintenance Costs

Key **operating and maintenance (O&M)** costs are listed in Table 3. Plant labor will require two employees to run the proposed AD system. Fully-loaded hourly wages are estimated to be $40.00/hour, which includes a $10.00/hour benefit. Employees will routinely work in feeding the digester and performing the required daily engine-generator O&M.

Daily labor includes items such as checking engine and biogas meters, digester pH and temperature, recording the assembled data, and unclogging pumps from obstructions caused by foreign materials when needed. In addition to outside independent engineering and feedstock testing services, an off-site supervisory contract would be made with the AD system provider to help oversee technical performance.

TABLE 3: Key Cost Assumptions

Project Life (years)	20
Discount Rate (%)	10
Digester Labor (fully-loaded $/hour)	$40.00
Digester O&M ($/day)	$80.00
Engine O&M ($/MWh)	$20.00
"Buy-All" Electricity ($/MWh)	$210.00
H_2S Removal ($/MWh)	$10.00

In addition to labor, general digester O&M costs are estimated to be $80/day. Engine O&M is estimated to cost $20/MWh of electricity generated. This expense covers all outside labor needed for engine maintenance and related materials. Engine O&M typically needs oil changes every two weeks. After about 20,000 hours, a top end rebuild of the engine may be necessary. The replacement of engine heads normally occurs at intervals of 8,000 to 12,000 hours.

The project would take part in the state's Value Stack structure[18, 19], which requires all generated power to be immediately exported to the wholesale market under a **"Buy-All/Sell-All"** agreement with National Grid. The "Buy-All" part of this agreement is the

[18] Decision tree to identify electricity tariff options available, Part 1. (September 2020). Cornell College of Agriculture and Life Sciences, Dairy Environmental Systems Program. SEE: https://ecommons.cornell.edu/server/api/core/bitstreams/4abb1291-f6c9-411b-b6b8-16ad23fe70d8/content

[19] RATE SCHEDULE SC-6 — Purchase of Electric Energy and Capacity from Customers with Qualifying On-Site Generation Facilities. (2023). Niagara Mohawk Power Corporation. This service is for customers with a qualifying generation facility that sells energy (kWh) and capacity (kW) of more than 100kW to National Grid. SEE: https://ets.dps.ny.gov/ets_web/search/searchShortcutEffective.cfm?companyID=3569016&serviceType=ELECTRIC&psc_num=220

parasitic electricity used by the AD system, and calculating its site-specific cost is complicated. For example, New York's average "Buy-All" commercial electricity rate ranges between $60/MWh and $210/MWh. To cover any downside risk, the largest value was used in the analysis.

The project will also use outside engineering, feedstock testing services, accounting services, and insurance. Because the AD system is assumed to be agricultural property, there are no project-related property taxes. Combined expenses, along with depreciation, were estimated to total $1.480 million.

Revenues

Key revenue factors are listed in Table 4. Under the utility's "Buy-All/Sell-All" agreement, the project's **"Sell All"** energy is the electricity generated on-site and immediately exported to the wholesale market.

Estimating this study's "Sell-All" rate also had several impediments. First, the project's electric utility interconnection site first needs to be established before a "Sell All" compensation value can be determined. Other considerations of the Value Stack are addressed in further detail in a later section.

The project's "Sell-All" value was estimated using a calculator recommended for use by anaerobic digester projects[20,21]. Using the calculator, a "Sell All" compensation rate was estimated to be $110.00/MWh. Given the estimated annual sales of 10,150 MWh, "Sell All" power revenues totaled $1.12 million/year.

TABLE 4: Key Revenue Assumptions

"Sell All" Power Sales ($/MWh)	$110.00
IRA Production Tax Credit ($/MWh)	$30.00
D3 eRIN Value ($/eRIN)	$2.40
Compost ($/yard @ 10% Sales Volume)	$25.00

In lieu of taking an **Investment Tax Credit (ITC)**, the facility qualifies for a **Production Tax Credit (PTC)**. The Inflation Reduction Act of 2022 extends the current PTC framework for qualified facilities that begin construction prior to January 1, 2025[22]. The PTC tax credit was assumed to be $30.00/MWh. Given the estimated annual sales of 9,950 MWh, PTC revenues totaled a bit more than $300,000/year.

[20] Solar Value Stack Calculator. New York State Solar Program (NY-Sun). SEE: https://www.nyserda.ny.gov/All-Programs/NY-Sun/Contractors/Value-of-Distributed-Energy-Resources/Solar-Value-Stack-Calculator

[21] For reference, the proposed project would be in Niagara Mohawk's "LOAD ZONE B-SUB-ZONE 29 – GENESEE."

[22] The Inflation Reduction Act: Key Provisions Regarding the ITC and PTC. (2022). The Federal Law Review. SEE: https://www.natlawreview.com/article/inflation-reduction-act-key-provisions-regarding-itc-and-ptc

A new federal policy that will have an impact on the project's revenues is a recent rulemaking made by the **U.S. Environmental Protection Agency (EPA)** to the **Renewable Fuel Standard (RFS)** program[23].

This EPA rulemaking will create a new market for credits called "**eRINs**" that are for renewable electricity from biomass, including biogas from AD facilities, which is generated and used to charge electric vehicles. eRINs will be a product like **Renewable Identification Numbers (RINs)** now used for fuels such as renewable natural gas under the RFS[24,25].

EPA's reported preferred method for implementing the eRIN market will be using relationships between renewable electricity producers and electric vehicle manufacturers. Contractually, this method will show that renewable electricity is being used as a transportation fuel by the manufacturer. It is believed that producers and manufacturers will equally split a facility's net generation and that eRINS will be calculated using a conversion rate of 6.5 kWh/eRIN.

The proposed rules are taking much longer than expected to be completed by the EPA, and it is uncertain when the eRIN market will become operational. Upon final rulemaking, obtaining eRINs will be an EPA administrative process of filing an application, receiving EPA's approval for being a part of the program, and then registering the specific eRIN product using EPAs Central Data Exchange. It is reported that the EPA administrative process usually takes six to nine months to get a pathway approved once the application had been filed[26].

Given their similar classifications under the RFS today, the manure is assumed to be classified as a D3 RIN. This study assumed that the future value of the eRIN product would be 80% of its average 2021 value. Given the gross available generation being sold and other administrivia, a total of 718,000 D3 eRINs would be available for sale. As a result, eRIN sales were estimated to be $1.723 million/year.

Other potential operating income could include the recovered fiber, to be sold as a compost material used for horticultural purposes or as a freestall bedding replacement. The system includes a screw-press or equivalent mechanical separator that can recover

---

[23] The RFS was created under the Energy Policy Act of 2005, with the goal of replacing the fossil fuels used in the transportation sector with lower-carbon bio-based fuels.

[24] Biocycle. (December 20, 2022). Unpacking EPA's e-RIN Proposal. SEE: https://www.biocycle.net/epa-e-rin-proposal/

[25] The National Law Review. (December 9,2022). Electrifying the Renewable Fuel Standards: EPA Proposes a Major Expansion of the Renewable Fuel Standard Program. SEE: https://www.natlawreview.com/article/electrifying-renewable-fuel-standards-epa-proposes-major-expansion-renewable-fuel

[26] EPA's final ruling is expected to clarify the definition of eRIN eligibility, and any eRIN revenue projection now being made may be subject to change.

solids with a 35% TS concentration from the digested effluent. The dairy fiber was assumed to be sold for $25.00/yard. Only 10% of the estimated 22,800 yards of fiber recovered every year was sold, and fiber revenues estimated to be $114,000/year.

While combined revenues totaled $2.141 million, there are two more co-products having no assumed value in the analyses. Other studies could look at expanding the use of the co-generated thermal energy or the value of the ammonium-rich effluent. These could potentially add tens of thousands of dollars in new project revenues.

Financial Analysis

It was assumed the project would be financed using one-third equity and two-thirds debt, with the debt fraction being financed as a simple loan at a 7.0% interest rate for a 12-year period.

The project would qualify for a total of up to $1.45 million in federal grants offered though the U.S. Department of Agriculture, subject to available funding. There may also be potential financial assistance from NY State or possibly non-traditional federal resources. If available, more grant funding would increase the project's financial performance.

TABLE 5: Summary Income Statement *(Thousand $)*	***PROJECTED***				
As of the years ended,	Year 1	Year 2	Year 3	Year 4	Year 5
Net sales	1,116	1,116	1,116	1,116	1,116
Cost of goods sold	(1,431)	(1,431)	(1,431)	(1,431)	(1,431)
Gross profit	(316)	(316)	(316)	(316)	(316)
Other operating income	2,141	2,151	2,160	2,170	2,180
Gross profit & other operating income	1,826	1,835	1,844	1,854	1,864
Operating expenses	(49)	(49)	(49)	(49)	(49)
Operating income	1,777	1,786	1,795	1,805	1,815
Nonoperating income (expense)					
Interest expense	(516)	(487)	(456)	(423)	(388)
	(516)	(487)	(456)	(423)	(388)
Income	1,261	1,299	1,339	1,382	1,427
add Depreciation	746	746	746	746	746
less Principal Payments	(412)	(441)	(471)	(504)	(540)
Cash flow before taxes	1,595	1,604	1,613	1,623	1,633

As summarized in Table 5, during the project's first year combined income summed to $3.257 million/year and combined expenses summed to $1.480 million. First-year before tax income, which includes interest expenses, was equal to about $1.261 million. After the calculations needed for treating depreciation and principal payments, the first-year pre-tax cash flow was estimated to be $1.595 million.

The nominal percentage growth rates for project O&M and for finished product prices (e.g., electricity) were assumed to be zero percent. This dampens the expectations that there will be significant real increases in the value of inputs and outputs. It also presents a

more realistic perspective of their value in today's economy, thus avoiding potentially misleading margins projected during the AD system's later years of operation.

The Base Case scenario yielded a positive income and cash flow in every year of the project's life. The project has a projected simple payback period of 1.4 years as shown in Table 6. The project is estimated to generate about $13.38 million in cumulative cash flow during its first 10 years of operation. Assuming no income distribution to the owners, total equity was calculated to increase to $18.98 million after 10 years of operation.

TABLE 6: Projected Base Case Merit Statistics	
Simple Payback Period (years)	1.4
Average Cash Flow (thousand $/year)	$1,561
10-Year Pre-Tax Cumulative Cash Flow (thousand $)	$13,380
10-Year Owner's Equity (thousand $)	$18,980

Given the assumptions, the proposed project shows fundamentally strong financial performance. Under these stated conditions, the AD system should continue to be favorably considered on a go-forward basis by any interested parties.

However, changes to the analysis assumptions could a negative financial outcome. Of specific concern is that 50% of the annual revenues would be derived from the D3 eRIN credits, emphasizing the importance of the eRIN program to the project's financial success.

Grants, Incentives and Other Factors

This section discusses other areas of interest, including grants, tax credits, and related project permitting requirements.

Grants

Several federal grant and incentive programs are available for on-farm AD systems. Currently in New York, only the **U.S. Department of Agriculture (USDA)** offers dedicated grant funding through their **Natural Resource and Conservation Service (NRCS)** and **Rural Development** offices. No other programs were available at the time the report was written[27]. These two separate programs are described in detail below.

USDA-NRCS Environmental Quality Incentive Program (EQIP): In the past, this program has made grant awards up to a maximum of $450,000 roughly $760/AU. Nationally, the average award is roughly $280,000 per farm. Specific amounts vary by

[27] NYSERDA has offered grant and other funding for AD systems in the past, but has no current incentive programs.

State and County. Application is prepared by the farm's local NRCS office and submitted to the state for funding. The time frame from submittal of the original application to notification of the grant award is typically 4-12 months. Money pays out at completion of project when certified by an Agricultural Engineer.

This program has a dedicated digester fund. The application does not require proof of bank financing or construction drawings. Historically, farms have applied for this grant first and then used it to support bank loan requests or other grant applications.

Also, this grant can be assigned to others and can help with the bridge loan financing; digester companies will often carry up a percentage of construction costs until end of project in return for "assignment of payment" of the EQIP grant.

The best way to go about applying for this money is to work directly with the NRCS office in your county.

Albion Service Center
(585) 589-5320

Natural Resources
Conservation Service
Contact
Heath Eisele
heath.eisele@usda.gov

Farm Service Agency
Contact
Larry Meyer
larry.meyer@usda.gov

USDA-Renewable Energy for America program (REAP): This program provides 50% matching funding up to $1,000,000 per project. Award announcements are made about 3-4 months after the application deadline. The application is quite detailed, so allow at least 2-3 months or more to prepare the application. Most grant awards are good for at least two years from the day the award contract is signed between the owner and the grant agency. Upcoming application windows: March 31, June 30, September 30, 2024.

This application requires a solid plan for implementing the project including:

- Bridge loan or other project financing documentation,
- Bid quote from a digester company,
- Project technical specifications report, including digester tank sizing, biogas production, engine size, and kWh outputs.
- Business level feasibility study.

USDA-REAP LOAN GUARANTEE: Additionally, REAP provides guaranteed loan financing. The loan guarantee percentage is published annually in a Federal Register notice. REAP loans approved in 2024 will receive a guarantee on 80% of the total loan amount. Applicants work with their chosen Lender to establish and justify the guaranteed loan

term and interest rate. There is an initial loan guarantee fee, currently 1% of the guaranteed amount. There is a loan guarantee retention fee, currently 0.25% of the outstanding principal balance, paid annually. Reasonable and customary fees for loan origination are negotiated between the borrower and lender.

The lender will conduct a credit evaluation using credit documentation procedures and underwriting processes that are consistent with generally accepted prudent lending practices and is consistent with the lender's own policies, procedures, and lending practices. For more information contact the USDA Rural Development office in New York.

Gary Pereira
Energy Coordinator
(315) 530-3433
gary.pereira@usda.gov

Tax Credits

The following is an overview of the Tax Credits available for investments made in Renewable Energy Systems. Most notably, the Federal Business Energy Investment Tax Credit (ITC). The ITC has been amended several times, most recently with the Inflation Reduction Act of 2022. This bill established new prevailing wage and apprenticeship requirements for larger systems to qualify for the full 30% tax credit. The Department of the Treasury issued Initial Guidance on these requirements on November 30, 2022[28].

Energy Investment Tax Credit (48) Base Credit:

> **Value:** 6% of qualified investment (basis of energy property)
>
> **Effective Date:** Facilities beginning construction before 1/1/25.
>
> **Qualifying Facility:** Fuel cell, solar, geothermal, small wind, energy storage, biogas, microgrid controllers, and combined heat and power properties.
>
> **Projects under 1 MW** Projects that begin construction after 2021 and before 2025 can receive the full tax credit of **30%**. These projects do not need to meet the new labor standards established by the Inflation Reduction to receive the full 30% tax credit.
>
> **Projects over 1 MW** that begin construction no later than January 1, 2025, will receive a base tax credit of 6%. However, projects can qualify for the full 30% tax credit if they ensure that all laborers and mechanics involved in the construction of

[28] Reference: https://www.whitehouse.gov/cleanenergy/clean-energy-tax-provisions/

the project or the maintenance of the project for five years after project completion are paid wages at rates that are not less than prevailing wages. Projects must also ensure that qualified apprentices perform a percentage of total labor hours.

Clean Electricity Investment Tax Credit (48E): Section 13702 of the Inflation Reduction Act created a new tax credit, the Clean Electricity Investment

Value: 6% of qualified investment

Effective date: Tax Credit to replace the traditional ITC for systems placed in service on or after January 1, 2025.

Qualifying Facility: Facilities that generate electricity with a greenhouse gas emissions rate that is not greater than zero and qualified energy storage technologies.

Bonus Credits: Credit is increased by five times for projects meeting prevailing wage and apprenticeship requirements. Credit is increased by 10% for projects meeting certain domestic content requirements for steel, iron, and manufactured products. Credit is increased by 10% if located in an energy community.

Domestic Content Bonus: For projects in which 100% of any steel or iron that is a component of the facility and 40% of the manufactured products that are components of the facility were produced in the United States can qualify. The IRS issued Notice 2023-38 in May 2023, which provides further guidance on the domestic content bonus.

Energy Community Bonus: For projects that are located within an energy community. To qualify, a facility must be located at one of the following: (i) a brownfield site, (ii) a metropolitan or non-metropolitan statistical area which (A) has (or, at any time during the period beginning after December 31, 2009, had) 0.17% or greater direct employment or 25% or greater local tax revenues related to the extraction, processing, transport, or storage of coal, oil, or natural gas, or (B) has an unemployment rate above the national average for the previous year, or (iii) a census tract or a census tract that is adjoining a census tract in which a coal mine has closed after 1999 or a coal-fired electric generating unit was retired after 2009. For projects that are under 1 MW and projects that are larger than 1 MW and meet the labor requirements specified above, the Energy Community Bonus increases the tax credit by 10%. For larger projects that do not meet the labor requirements, the Energy Community Bonus increases the tax credit by 2%. The Treasury Department notices: Notice 2023- 29 (initial guidance) Notice 2023-45, Notice

2023-47 . The Department of Energy has a GIS map showing the locations of qualifying energy communities.

Credit Monetization: Section 13801 of The Inflation Reduction Act of 2022 also set up procedures for other parties to monetize certain tax credits, including this one, for equipment placed in service on or after January 1, 2023, and through December 31, 2032.

The **direct pay** option allows non-taxable entities to directly monetize certain tax credits. The provisions apply to nonprofits, a state or political subdivision thereof, the Tennessee Valley Authority, Indian tribal governments (as defined in Section 30D(g)(9)), any Alaska Native Corporation (as defined in Section 3 of the Alaska Native Claims Settlement Act), or any corporation operating on a cooperative basis which is engaged in furnishing electric energy to persons in rural areas. Such applicable entities can elect to be treated as having made a tax payment equal to the value of the tax credit they would otherwise be eligible to claim. The entity can then claim a refund for the excess taxes they are deemed to have paid. The option effectively makes this tax credit refundable for these entities.

The act also allows eligible taxpayers to **transfer** all or a portion of their eligible tax credits to an unrelated taxpayer. Transfers must be reported to the IRS and only one transfer is permitted. Must be elected no later than the due date for tax filing for the tax year the tax credit is claimed.

Production Tax Credit for Electricity from Renewables:

Value: 0.3 cents/kW, inflation adjusted

Effective Date: Projects beginning construction before 1/1/25.

Qualifying Facility: Facilities generating electricity from wind, biomass, geothermal, solar, small irrigation, landfill and trash, hydropower, and marine and hydrokinetic renewable energy.

Clean Energy Production Tax Credit:

Value: 0.3 cents/kW [inflation adjusted]

Effective date: Facilities placed in service after 12/31/24. Phase-out starts the later of (a) 2032 or (b) when U.S. greenhouse gas emissions from electricity are 25% of 2022 emissions or lower.

Qualifying Facility: Facilities generating electricity for which the greenhouse gas emissions rate is not greater than zero.

eRINs: As discussed earlier, the EPA completed the Renewable Fuel Standards for the 2023-2025 period, but the ruling did not publish the expected eRIN rules. The EPA said it will continue to work on potential paths forward for the eRIN program, and has delayed the final ruling on eRINs until mid-2024[29].

The project's financial success is highly dependent on the eRINs. Likely the eRIN market will be fully operational by 2025, but the issue needs resolution during the project's next phase, if any. Numerous factors are proposed for the selling and buying of eRINs. Not all of them are fully transparent, and it is prudent to plan accordingly.

Permitting

As with any construction project, permits must be obtained. The table below summarizes the permits typically required in New York and timelines for applying and obtaining them.

Table 7: General Permitting Requirements

Permit Type	Permit/Agreement	When to Apply	Timeframe
Construction	NYS DEC Storm Water	When preparing bid packages for hiring construction contractors	1-3 months
Construction	NYS DEC Erosion and Sediment Control Plan	When preparing bid packages for hiring construction contractors	1-3 months
Construction	Township Building Permit	When design drawings are complete and stamped	1-3 months
Engine-Generator	DEC -Division of Air Resources Air Permit/ Registration Certificate	After selecting engine size as manufacturer specifications	2-3 months

[29] EPA Finalizes New Renewable Fuel Standards, 21 June 2023. SEE: https://www.epa.gov/newsreleases/epa-finalizes-new-renewable-fuel-standards-strengthen-us-energy-security-support-us

		are required. Permit is issued for a specific engine make/model	
Electrical Utility Interconnection	Electrical Utility Impact Review Study - Coordinated Electric System Interconnection Review	After selecting engine-generator size and vendor has prepared one-line electrical drawing as the review is for a specific generator make/model	9-12 months
Electrical Utility Interconnection	Electrical Utility Interconnection and Metering Agreement	Prepared after receipt of the interconnection review	3-4 months
If Applicable: Food waste handling	DEC Solids Waste Management Facility registration (pending food waste sources and quantities)	At time of initiation of project design	2-4 months

Working with the Utility

The project owners should contact their local electric utility as early in the project design and development process as possible. The timeline for interconnecting the project can be lengthy, often with unforeseen delays in project implementation due to strict utility requirements. The utility will want to prepare an interconnection study to determine if the overall local power grid will need upgrades such as larger capacity transformers or new three-phase power lines.

Coordinated Electric System Impact Review (CESIR): The first step in interconnecting a biogas project is to notify the utility and prepare paperwork for them to complete a comprehensive electrical review of the site location and nearby transformers capabilities. In New York, this study is referred to as a "CESIR" by the NY Public Utilities Commission. Energy projects are required to pay a fee to the utility to perform this interconnection

study. In the recent past this study costs $4,500 - $6,000; the fee is constantly subject to change in the upwards direction.

Time frame for an interconnection study is 60 working days, which usually results in taking a total time of 3-4 months. Once completed, this study is only valid for nine months and may need to be revised if the project breaks ground at a point in time beyond this.

Interconnection and Interconnection Costs: Rural farms often are still connected to the utility line using single phase power. The state of New York does not allow biogas projects to interconnect on single phase power and, therefore, if the project location is on single phase power the utility will need an upgrade. The cost to upgrade from single-phase to three-phase power is upwards of $100,000 per mile. As a downside, the project may be providing benefits to the regional infrastructure by creating new access to three-phase power, with the burden of cost being the sole responsibility of the AD project's owner.

Value of Distributed Energy Resources (VDER or the Value Stack[30]): In New York State the value stack is a mechanism to compensate **distributed energy resources (DERs)**, such as anaerobic digesters, for the energy they produce and provide to the grid. The compensation is in the form of bill credits and is based on several factors, including:

- Energy Value: Accounts for the wholesale price of electricity.
- Capacity Value: Found by the peak hour of electricity usage.
- Environmental Value: Accounts for the positive environmental impact.
- Demand Reduction Value: Offers more credit if energy is sent to the grid during peak demand times.
- Locational System Relief Value: Varies based on the demand for electricity in different areas.

The Value Stack works through the following process:

1. A developer develops and interconnects a DER, such as an anaerobic digester.
2. The electricity produced by the system is injected into the grid.
3. The utility decides the value of the energy produced using the Value Stack method.
4. The utility allocates the monetary value of the energy produced to the off-taker's bill.
5. Off takers pay a subscription fee to the DER developer. This process repeats each month.

[30] The Value Stack: Compensation for Distributed Energy Resource. NYSERDA. SEE: https://www.nyserda.ny.gov/All-Programs/NY-Sun/Contractors/Value-of-Distributed-Energy-Resources/Value-Stack-Resources

For calculating the Value Stack, NYSERDA offers a publicly available calculator that estimates project revenue based on three years of backward-looking historical wholesale market energy and capacity prices[31]. The calculator, which incorporates a range of forward-looking prices, was designed to provide an estimate of potential future revenue.

It is important to note that the Solar Value Stack Calculator was primarily developed for solar projects. Therefore, while it might give a general idea of the energy compensation ($/MWh) for a digester, the specific compensation might vary. The Calculator was unable to estimate compensation amounts for capacity (kW) and for demand reduction. As a result, this estimate may slightly underestimate the actual value. For the most accurate information, it is recommended to contact NYSERDA or other professionals familiar with New York's value stack system and AD projects[32].

Further questions regarding general interconnection and metering issues may be directed towards Jason Pause at DPS, jason.pause@dps.ny.gov

Next Steps

Yates/Somerset now have an identified AD system site showing excellent technical and financial potential. This pre-feasibility study is but one small step in the development process, and the following may be helpful in moving the project forward.

Project Definition

This topic was briefly discussed during the kick-off meeting. The group revealed two complimentary outcomes for the definition of a successful project, what is a "win" if you will. The first outcome was that a dairy manure AD system would be built, the second was that Yates/Somerset would receive some form of financial benefit from a project.

Yates/Somerset, along with all interested parties, need to define the next set of goals for what constitutes a success. The project's goals need to be fully developed to achieve the best outcome using the most suitable business structure.

Continue Building Support

In the past, Yates/Somerset worked with the Western New York/Niagara Region Farm Bureau to gather added project support. This emerging coalition, along with others, needs to continue building local and regional project support. Among other interested parties,

[31] Solar Value Stack Calculator. New York State Solar Program (NY-Sun). SEE: https://www.nyserda.ny.gov/All-Programs/NY-Sun/Contractors/Value-of-Distributed-Energy-Resources/Solar-Value-Stack-Calculator

[32] NOTE: Jennifer Pronto was formerly a research assistant at Cornell University who provided specific information on the VDER system to AD project developers. She has since become a Project Development Engineer at BerQ RNG, a company the develops renewable natural gas projects from dairy, industrial and landfill sites.

this could include area dairy producers, generators of digestible organic materials, and county and state legislators.

There are also experts at Cornell University who have been involved with AD digester projects in New York through the College of Agriculture and Life Sciences Pro-Diary program. The **Dairy Environmental Systems (DES)** works with develop and introduce innovative methods in dairy waste management and treatment. These systems are targeted to enhance animal well-being, system efficiency, environmental compliance, and overall farm profitability. Their goal is to better position dairy producers to make informed business decisions to further individual farm and industry-wide growth and sustainability[33].

Orleans and Niagara counties also have three congressional representatives and staff that could be briefed on the project. In these situations, an ask by Yates/Somerset for additional federal assistance might not be entirely out of place.

- Congresswoman Claudia Tenney represents the 24th Congressional District as a member of the House Committee on Ways and Means and the House Committee on Science, Space and Technology.
- Congressman Joseph Morelle represents the 25th Congressional District as a member of the House Appropriations Committee and as Ranking Member of the Committee on House Administration.
- Congressman Brian Higgens represents the 25th Congressional District as a member of the House Committee on Ways and Means (Subcommittee on Health and Subcommittee on Trade) and the House Committee on the Budget.

Local Project Development

Deploying an AD project involves several stages, from initial planning to commissioning. Here are some typical stages: Project Definition; Full Feasibility Study; Site Selection and Design; Permitting and Regulatory Compliance; Construction and Installation, and Startup and Commissioning. Each stage requires careful planning and execution.

Yates/Somerset might consider the best solution is to use an AD system developer for the project's future phases[34]. A project developer would cover the costs, and an AD system would be installed and become operational. The financial benefit downside is the

[33] Dairy Environmental Systems. SEE: https://cals.cornell.edu/pro-dairy/our-expertise/dairy-environmental-systems-des

[34] No publicly available up-to-date list of companies that develop AD projects was found. The American Biogas Council is largest AD industry association, and it keeps a sortable on-line membership list that includes AD project developers. SEE: https://americanbiogascouncil.org/

developer will take a share of the profits equal to the financial risks undertaken by building the project.

Should Somerset/Yates choose to pursue local project development, a special purpose entity or public benefit corporation should be founded with a charter defining the new organization's goals. The **New Company (NewCo)** would hire a person to function as its Managing Director.

The position would be responsible for spearheading organizational efforts and overseeing the project through to its start-up and commissioning. On behalf of NewCo and with support of Yates/Somerset, the Managing Director position would lead tasks such as:

- Form NewCo
- Develop a Request of Proposal solicitation and the selection process for procuring a "Turn-Key" AD system.
- Collect bids from AD companies and, working with a selection committee, choose the company most suited for the work.
- Lead grant application efforts, and work with the AD company to prepare any applications for funding opportunities.
- Initiate interconnection discussion with the electric utility, with the support of the AD company.
- Outreach to congressional delegation and other interested parties.
- Begin discussion with potential lenders.
- Host quarterly NewCo shareholder meetings.
- Principal contact with AD company during construction phase.

Conclusions

This study identified a potential AD system site that shows excellent technical and financial potential. What happens next will require all interested parties to better define the desired outcomes and pathways to ensure success.

The evaluation brings one major conclusion. Having a full range of revenue-producing co-products that increase profit makes a significant difference to a financial analysis. Quite simply, it is difficult to justify an AD system based only on the revenue received from electricity sales. A project becomes a profitable biorefinery when it produces energy, fuels, and chemicals having a high value and low-carbon footprint.

Table 8 provides the foundations for a successful farm-based AD system. This may lead to new economic development opportunities supplying high-end products that builds on

local agricultural expertise. That could create a win/win situation for those deriving the benefits of using an AD system, along with another agricultural entities such as algae farms using the digestion co-products as inputs for its production process.

Table 8: Foundations for Success[35]

Action	Desired Outcome
Success Plan Developed	Identify and define project goals. Specify the parameters to address and how to meet them.
Experienced Team Selected	Work with an experienced team to initiate and successfully implement your project.
Feedstock Supply Secured	Identify all suitable feedstocks. Assess them for biomethane potential and assay their anaerobic toxicity.
Most Appropriate Technology Used	No AD technology can be used for all situations or feedstocks. Technology plan must match feedstock type and amounts used.
Biogas Use Optimized	Consider market availability, capital and operating costs, and potential revenue to determine how the best use for biogas.
Digestate Use Assessed	Determine the need for on-site and consider external markets for products such as bedding, fertilizer, or salable compost.
Off-Take Agreements Developed	Establish off-take agreements with final users with the price, amount, and specification for delivered products.
Added Benefits Evaluated	Consider including climate, health, sustainable food supply, and life quality issues like odor control.
Sustainable Business Model	The project should be cost-effective, as well as meet your financial goals.
Operation and Maintenance Plan	Good O&M practices are key for optimal and uninterrupted operation.

[35] AgSTAR Project Development Handbook, 3rd Edition. SEE: https://www.epa.gov/agstar/agstar-project-development-handbook

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DO NOT WRITE HERE OFFICE USE ONLY

APPLICATION RECEIVED DEC 15 2004

ONE DEPOSIT RECEIVED DEC 15 2004

TWO DEPOSITS RECEIVED

FUNDS RECEIVED

MORE ON BACK ▶ • Complete all applicable spaces (numbers 5-9) on the reverse side of this page. • See detailed instructions. • Sign the form at line 8.

DO NOT WRITE HERE

Page 1 of ____ pages

Appendix A: TEAM© Certificate of Registration by the U.S. Copyright Office p2

* DCR correct. Later year date is print run only authority phone conversation with Phil Lusk on 5/16/05

EXAMINED BY FORM TX

CHECKED BY

CORRESPONDENCE Yes

FOR COPYRIGHT OFFICE USE ONLY

DO NOT WRITE ABOVE THIS LINE. IF YOU NEED MORE SPACE, USE A SEPARATE CONTINUATION SHEET.

PREVIOUS REGISTRATION Has registration for this work, or for an earlier version of this work, already been made in the Copyright Office? 5

☐ Yes ☑ No If your answer is "Yes," why is another registration being sought? (Check appropriate box.) ▼

a. ☐ This is the first published edition of a work previously registered in unpublished form.

b. ☐ This is the first application submitted by this author as copyright claimant.

c. ☐ This is a changed version of the work, as shown by space 6 on this application.

If your answer is "Yes," give: Previous Registration Number ▶ Year of Registration ▶

DERIVATIVE WORK OR COMPILATION a 6

Preexisting Material Identify any preexisting work or works that this work is based on or incorporates. ▼

See instructions before completing this space.

Material Added to This Work Give a brief, general statement of the material that has been added to this work and in which copyright is claimed. ▼ b

DEPOSIT ACCOUNT If the registration fee is to be charged to a Deposit Account established in the Copyright Office, give name and number of Account. a 7

Name ▼ Account Number ▼

LegalZoom.com DA092487

CORRESPONDENCE Give name and address to which correspondence about this application should be sent. Name/Address/Apt/City/State/ZIP ▼ b

Phil Lusk [626534]
Unit 4, 200 E. Spring Creek Drive
Pierre, SD 57501

Area code and daytime telephone number ▶ 605.224.4334 Fax number ▶

Email ▶ plusk@pipeline.com

CERTIFICATION* I, the undersigned, hereby certify that I am the 8

Check only one ▶
- ☐ author
- ☐ other copyright claimant
- ☐ owner of exclusive right(s)
- ☑ authorized agent of Phil Lusk

Name of author or other copyright claimant, or owner of exclusive right(s) ▲

of the work identified in this application and that the statements made by me in this application are correct to the best of my knowledge.

Typed or printed name and date ▼ If this application gives a date of publication in space 3, do not sign and submit it before that date.

Christopher D. Ahn Date ▶ 12/13/2004

Handwritten signature (X) ▼

X [signature]

Certificate will be mailed in window envelope to this address:

Name ▼
Phil Lusk

Number/Street/Apt ▼
Unit 4, 200 E. Spring Creek Drive

City/State/ZIP ▼
Pierre, SD 57501

9

- Complete all necessary spaces
- Sign your application in space 8

1. Application form
2. Nonrefundable filing fee in check or money order payable to *Register of Copyrights*
3. Deposit material

Library of Congress
Copyright Office
101 Independence Avenue, S.E.
Washington, D.C. 20559-6000

As of July 1, 1999, the filing fee for Form TX is $30.

*17 U.S.C. § 506(e): Any person who knowingly makes a false representation of a material fact in the application for copyright registration provided for by section 409, or in any written statement filed in connection with the application, shall be fined not more than $2,500.

June 1999—200,000
WEB REV: June 1999

☆U.S. GOVERNMENT PRINTING OFFICE: 1999-454-879/49

Appendix B: TEAM© Project Inputs and Outputs

MODEL INPUTS

PROJECT ID: **Yates/Somerset Pre-Feasibility Study**
PROJECT NAME: **FINAL**

	SAE	PHYSICAL CONSTANTS
INPUT 01 ====>	5.63	Methane Generation (scf/pound COD destroyed)
INPUT 02 ====>	912	CH4 Energy Content (LHV Btu/scf)
INPUT 03 ====>	60.0	Raw Biogas CH4 Content (%)
INPUT 04 ====>	4,500	Raw Biogas H2S Content (ppmv)
INPUT 05 ====>	0.24	RNG H2S Content (ppmv)
INPUT 06 ====>	0.05	RNG N2O Content (%)
INPUT 07 ====>	0.05	RNG O2 Content (%)
INPUT 08 ====>	10,000	Electric Utility Heat Rate (Btu/kWh)
INPUT 09 ====>	3,413	Electricity Energy Content (Btu/kWh)
INPUT 10 ====>	6.5	eRINs (kWh/eRIN)
INPUT 11 ====>	12.987	RIN Conversion Factor (RIN/MM BTU)
INPUT 12 ====>	138,700	#2 Fuel Oil Energy Content (LHV Btu/gal)
INPUT 13 ====>	93,500	Propane Energy Content (LHV Btu/gal)
INPUT 14 ====>	77,000	Ethanol Energy Content (LHV Btu/gal)
INPUT 15 ====>	114,000	Gasoline Energy Content (LHV Btu/gal)
INPUT 16 ====>	127,000	Ultra-Low Sulfur Diesel Energy Content (LHV Btu/gal)
INPUT 17 ====>	8.75	Manure Density (pounds/gallon)
INPUT 18 ====>	8.35	Food Waste Density (mean pounds/gallon)
	2.00	Compost Conversion (cubic yards/ton)
INPUT 19 ====>	8.347	Water Density (pounds/gallon)
INPUT 20 ====>	8.347	Heat Capacity of Water
INPUT 21 ====>	1.106	COD:VS Ratio
INPUT 22 ====>	1.216	NH3 Equivalency Factor
INPUT 23 ====>	12,234	N Energy Content (Btu/pound)
INPUT 24 ====>	2.288	P2O5 Equivalency Factor
INPUT 25 ====>	4,175	P2O5 Energy Content (Btu/pound)
INPUT 26 ====>	1.205	K2O Equivalency Factor
INPUT 27 ====>	1,245	K2O Energy Content (Btu/pound)
INPUT 28 ====>	4.08E+00	NOx Emission Rate/AP-42 (pounds/M Btu)
INPUT 29 ====>	3.17E-01	CO Emission Rate/AP-42 (pounds/M Btu)
INPUT 30 ====>	5.88E-04	SO2 Emission Rate/AP-42 (pounds/M Btu)
INPUT 31 ====>	7.71E-05	Particulate Emission Rate/AP-42 (pounds/M Btu)
INPUT 32 ====>	95.86	CA Gasoline Baseline Carbon Intensity (g CO2e/MJ)
INPUT 33 ====>	94.71	CA Diesel Baseline Carbon Intensity (g CO2e/MJ)
		PROJECT CONSTANTS
INPUT 34 ====>	20	Project Life
INPUT 35 ====>	21	Construction Period (months)
INPUT 36 ====>	365	Food Waste Collection (days/year)
INPUT 37 ====>	365	AD Plant Operation (days/year)
INPUT 38 ====>	92.0	GenSet Capacity Factor (%)
INPUT 39 ====>	8.00	AD System Parasitic Electrical (% of Load)
		THERMAL GENERATION CHARACTERISTICS
INPUT 104 ===>	100	Generator Max Loading Rate (Rated Capacity %)
INPUT 105 ===>	1	Unit #1 Generator Size (0=Calculated, 1=Stated)
INPUT 106 ===>	1,259	Unit #1 Specified Generator Size (kW)
INPUT 107 ===>	9,533	Unit #1 Heat Rate (BTU/kWh)
INPUT 108 ===>	36	Unit #1 Mechanical Efficiency (BTUe/BTUt)
INPUT 109 ===>	49	Unit #1 Thermal Efficiency (BTUe/BTUt)
		ANAEROBIC DIGESTER
INPUT 115 ===>	0	Added Dilution Volume (gallons/day)
INPUT 116 ===>	100	Recycled Dilution Water (%)
INPUT 117 ===>	100	Digester Temperature
INPUT 118 ===>	100	Feedstock Temperature
INPUT 119 ===>	8.00	Target Digester COD Loading Rate (mg/l)
INPUT 120 ===>	0.37	Target Digester VS Loading Rate (lb/ft3/day)
INPUT 121 ===>	22	Target Digester VS HRT (days)
		POST-DIGESTION SOLID/LIQUID SEPARATION
INPUT 131 ===>	30	Post-Digestion Separation Factor (%)
INPUT 132 ===>	5	Post-Digestion TS Fiber Fraction (%)
INPUT 133 ===>	15	Water Evaporation Loss in Fiber Static Piles (%)
INPUT 134 ===>	180	Lagoon Storage Period (days)
INPUT 135 ===>	8	Storage Pond Average Depth (ft)
INPUT 136 ===>	6	Pumping Period (hours/day)
INPUT 137 ===>	1	Irrigation Dilution Factor
		NUTRIENT RECOVERY FACTORS
INPUT 138 ===>	75	N (%)
INPUT 139 ===>	100	P2O5 (%)
INPUT 140 ===>	100	K2O (%)
		FINANCIAL FACTORS
INPUT 141 ===>	10.0	Hurdle Rate (%)
INPUT 142 ===>	0	Income Distribution to Owners (%)

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MODEL INPUTS

PROJECT ID: **Yates/Somerset Pre-Feasibility Study**
PROJECT NAME: **FINAL**

INPUT 143 ===>	**30**	On-Site Electric Use Receiveables (days)
INPUT 144 ===>	**30**	Off-Site Electric Sales Receiveables (days)
INPUT 145 ===>	**30**	Co-Digestion Tipping Fee Recievables (day)
INPUT 146 ===>	**30**	D3 RIN Receiveables (days)
INPUT 147 ===>	**30**	D5 RIN Receiveables (days)
INPUT 148 ===>	**30**	Low-Carbon Fuels Standard Receiveables (days)
INPUT 149 ===>	**26**	Payroll & Benefits Accounts Payable (weeks/year)
INPUT 150 ===>	**30**	Non-Payroll and Benefits Cost of Goods Sold Accounts Payable (da
INPUT 151 ===>	**30**	Operating Expenses Accounts Payable (days)
INPUT 152 ===>	**$0**	Annual Asset Replacement ($)
		SOURCES OF FUNDS
INPUT 153 ===>	**$0**	Investment Tax Credit
INPUT 154 ===>	**$1,000,000**	USDA REAP
INPUT 155 ===>	**$450,000**	USDA EQIP
INPUT 156 ===>	**$3,683,333**	Enterprise Equity
INPUT 157 ===>	**$7,366,667**	Senior Debt
INPUT 158 ===>	**7.00**	Senior Debt Interest Rate (%)
INPUT 159 ===>	**12**	Senior Debt Loan Period (years)
		USES OF FUNDS TURNKEY CONSTRUCTION BUDGET
INPUT 160 ===>	**$2,250,000**	Anaerobic Digester
INPUT 161 ===>	**$3,250,000**	Engine-Generator & Biogas Conditioning System
INPUT 162 ===>	**$700,000**	Flare System
INPUT 163 ===>	**$200,000**	Solids Separator
INPUT 164 ===>	**$325,000**	Influent & Effluent Pits
INPUT 165 ===>	**$1,200,000**	Project Management
INPUT 166 ===>	**$350,000**	Engineering & Permits
INPUT 167 ===>	**$225,000**	Miscellaneous
INPUT 168 ===>	**$500,000**	Electrical Interconnection
INPUT 169 ===>	**$15,000**	Interconnection Study
INPUT 170 ===>	**$50,000**	Construction Insurance
		USES OF FUNDS OWNER'S BUDGET
INPUT 171 ===>	**15.0**	Owner's Budget (% of construction budget)
INPUT 172 ===>	**20.0**	Contingency (% of total project cost)
		ENERGY & POWER REVENUES
INPUT 175 ===>	**110.00**	"Sell All" Power Sales ($/MWh)
INPUT 176 ===>	**0.00**	"Sell All" Demand Sales ($/MW)
		eRIN REVENUE FACTORS
INPUT 177 ===>	**100.00**	Tx Efficiency Factor (%)
INPUT 178 ===>	**50.00**	Net Power Generation Sold as eRINs (%)
		OTHER CO-PRODUCT VALUES
INPUT 191 ===>	**$3.50**	#2 Fuel Oil ($/gallon)
INPUT 192 ===>	**$3.00**	Propane ($/gallon)
INPUT 193 ===>	**$25.00**	Compost ($/yard)
INPUT 194 ===>	**20**	Compost (Sales %)
INPUT 195 ===>	**$700.00**	NH3 Equivalent ($/ton)
		VARIABLE COSTS
INPUT 196 ===>	**2.00**	Direct Labor Employees (#)
INPUT 197 ===>	**$30.00**	Direct Labor Cost ($/Hour)
INPUT 198 ===>	**$10.00**	Direct Labor Benefits ($/Hour)
INPUT 199 ===>	**$5,000**	Feedstock Testing ($/Year)
INPUT 200 ===>	**$17,000**	Outside Engineering & Other Services ($/year)
INPUT 201 ===>	**$0**	Other Staff Labor ($/day)
INPUT 202 ===>	**$80**	AD Unit O&M ($/day)
INPUT 204 ===>	**210.00**	System Parasitic Electricity ($/MWh)
INPUT 205 ===>	**2.00**	GenSet O&M (cents/kWh)
INPUT 206 ===>	**1.00**	GenSet H2S Removal (cents/kWh)
		FIXED COSTS
INPUT 216 ===>	**$12,000**	Accounting
INPUT 217 ===>	**$4.10**	Insurance ($/$1000 Valuation)
INPUT 217 ===>	**$0**	Property Taxes

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MANURE FEEDSTOCK ESTIMATOR

PROJECT ID: Yates/Somerset Pre-Feasibility Study
PROJECT NAME: FINAL

	LACTATING COWS	**TOTALS**
OUTPUT 01	Collection Efficiency (%)	85
OUTPUT 02	Total Head	4,620
OUTPUT 03	Total AU	6,855
OUTPUT 04	Collected Head Equivalent	3,927
OUTPUT 05	Collected Animal Unit (AU)	5,827
OUTPUT 06	Average Manure Production (pounds/AU/day)	114
OUTPUT 07	Manure Collected (pounds/day)	666,333
OUTPUT 08	Manure Collected (gallons/day)	76,152
OUTPUT 09	Manure TS (%)	12.7
OUTPUT 10	TS (pounds/day)	84,942
OUTPUT 11	VS (pounds/day)	67,462
OUTPUT 12	COD (pounds/day)	74,613
OUTPUT 13	TKN (pounds/day)	2,622
OUTPUT 14	P (pounds/day)	548
OUTPUT 15	K (pounds/day)	1,690
	DRY COWS AND HEIFERS	
OUTPUT 16	Collection Efficiency (%)	85
OUTPUT 17	Total Head	2,330
OUTPUT 18	Total AU	2,743
OUTPUT 19	Collected Head Equivalent	1,981
OUTPUT 20	Collected AU	2,332
OUTPUT 21	Average Manure Production (pounds/AU/day)	55
OUTPUT 22	Manure Collected (pounds/day)	129,000
OUTPUT 23	Manure Collected (gallons/day)	14,743
OUTPUT 24	Manure TS (%)	17.00
OUTPUT 25	Total Solids (pounds/day)	21,930
OUTPUT 26	Volatile Solids (pounds/day)	18,641
OUTPUT 27	COD Loading (pounds/day)	43,224
OUTPUT 28	TKN (pounds/day)	548
OUTPUT 29	P (pounds/day)	95
OUTPUT 30	K (pounds/day)	229
	TOTAL HEAD	
OUTPUT 31	Total Head	6,950
OUTPUT 32	Total Head AU	9,598
OUTPUT 33	Collected Head Equivalent	5,908
OUTPUT 34	Collected Head AU	8,158
OUTPUT 35	Manure Collected (pounds/day)	795,333
OUTPUT 36	Manure Collected (gallons/day)	90,895
OUTPUT 37	Manure TS (%)	13.4
OUTPUT 38	TS (pounds/day)	106,872
OUTPUT 39	VS (pounds/day)	86,102
OUTPUT 40	COD (pounds/day)	117,837
OUTPUT 41	TKN (pounds/day)	3,170
OUTPUT 42	P (pounds/day)	643
OUTPUT 43	K (pounds/day)	1,918
	DILUTION	
OUTPUT 44	Parlor Water (pounds/day)	127,709
OUTPUT 45	Parlor Water (gallons/15 minute interval)	159
OUTPUT 46	Parlor Water (gallons/day)	15,300
OUTPUT 47	Flush Water (gallons/day)	0
OUTPUT 48	Flush Water (gallons/15 minute interval)	0
OUTPUT 49	Flush Water (pounds/day)	0
OUTPUT 50	SMS Water Added (gallons/day)	0
OUTPUT 51	SMS Water Added (pounds/day)	0
	FINAL FEEDSTOCK VOLUME	
OUTPUT 52	Manure & Water Collected (pounds/day)	923,042
OUTPUT 53	Manure & Water Collected (gallons/day)	106,195
OUTPUT 54	Manure TS (%)	11.6
OUTPUT 55	Total Liquids (pounds/day)	816,170
OUTPUT 56	TS (pounds/day)	106,872
OUTPUT 57	VS (pounds/day)	86,102
OUTPUT 58	COD (pounds/day)	117,837

This consultant's forecast is highly dependent on future events and may be significantly affected by changes in technical and other circumstances. Therefore, this forecast may not be representative of future results.

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MANURE FLOWS ESTIMATOR

PROJECT ID: Yates/Somerset Pre-Feasibility Study
PROJECT NAME: FINAL

		COMBINED DAIRY COWS
OUTPUT 01	106,195	Manure & Water Collected (gallons/day)
OUTPUT 02	923,042	Manure & Water Collected (pounds/day)
OUTPUT 03	11.6	Manure TS (%)
OUTPUT 04	106,872	TS Loading (pounds/day)
OUTPUT 05	86,102	VS Loading (pounds/day)
OUTPUT 06	117,837	COD Loading (pounds/day)
		FINAL FEEDSTOCK
OUTPUT 22	0	Added Dilution Water if Needed (gallons/day)
OUTPUT 23	0	Added Dilution Water if Needed (pounds/day)
OUTPUT 24	923,042	Feedstock Entering Digester (pounds/day)
OUTPUT 25	11.6	Final Feedstock Blend TS (%)
OUTPUT 26	106,872	Final Feedstock TS Loading (pounds/day)
OUTPUT 27	816,170	Final Feedstock Total Liquids Loading (pounds/day)
		REACTOR LOADING
OUTPUT 28	923,042	Total Loading (pounds/day)
OUTPUT 29	462	Total Loading (tons/day)
OUTPUT 30	106,195	Total Loading (gallons/day)
OUTPUT 31	14,196	Total Loading (ft3/day)
OUTPUT 32	168,455	Total Loading (tons/year)
OUTPUT 33	38,761,239	Total Loading (gallons/year)
		REACTOR TREATMENT SIZING
OUTPUT 34	22.0	HRT (days)
OUTPUT 35	2,336,000	Treatment Size (gallons)
		AD INPUTS (tons/year)
OUTPUT 36	168,455	Manure Collected
OUTPUT 37	0	Food Waste Feedstock
OUTPUT 39	168,455	Total
		INTERMEDIATE (tons/year)
OUTPUT 40	6,208	Volatile Solids Destroyed
OUTPUT 41	13,296	Residual Solids
OUTPUT 42	148,951	Liquids
OUTPUT 43	168,455	Total
		AD OUTPUTS (tons/year)
OUTPUT 44	2,397	CH4
OUTPUT 45	4,335	CO2
OUTPUT 46	38	H2S
OUTPUT 47	2.0	N
OUTPUT 48	2.0	O
OUTPUT 49	13,296	Residual Solids
OUTPUT 50	148,951	Liquids
OUTPUT 51	169,022	Total
		POST-DIGESTION SOLIDS SEPARATION
OUTPUT 52	8.2	Final Filtrate TS Concentration (%)
OUTPUT 52	13,296	Residual Solids Entering Separator (tons/year)
OUTPUT 53	3,989	Residual Solids Leaving Separator in Fiber (tons/year)
OUTPUT 54	35.0	Fiber Fraction TS Concentration (%)
OUTPUT 55	11,396	Fiber (tons/year)
OUTPUT 56	22,793	Fiber (yards/year)
OUTPUT 57	9,307	Residual Solids in Filtrate (tons/year)
OUTPUT 58	150,850	Discharge Filtrate (tons/year)
OUTPUT 59	69	Discharge Filtrate (GPM)
OUTPUT 60	6.2	Discharge Filtrate TS Concentration (%)
		FINAL FATE (tons/year)
OUTPUT 61	2,397	CH4
OUTPUT 62	4,335	CO2
OUTPUT 63	38	H2S
OUTPUT 64	2.0	N
OUTPUT 65	2.0	O
OUTPUT 66	11,396	Recovered Fiber
OUTPUT 67	150,850	Discharged Filtrate
OUTPUT 68	169,022	Total
OUTPUT 69	0.3	**ERROR MARGIN (% Final Fate v. Intermediate Step)**

This consultant's forecast is highly dependent on future events and may be significantly affected by changes in technical and other circumstances. Therefore, this forecast may not be representative of future results.

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MANURE & CO-DIGESTION ENERGY BALANCE ESTIMATOR

PROJECT ID: Yates/Somerset Pre-Feasibility Study
PROJECT NAME: FINAL

		MANURE METHANE AVERAGES
OUTPUT 36	219	CH4 Output (SCFM)
OUTPUT 37	315,791	CH4 Output (SCF/day)
OUTPUT 38	115,263,782	CH4 Output (SCF/year)
OUTPUT 39	288	CH4 Output (MM Btu/day)
OUTPUT 40	105,121	CH4 Output (MM Btu/year)
		NET METHANE TO GENERATION
OUTPUT 46	100	D3 eRIN Sourced (%)
OUTPUT 47	0	D5 eRIN Sourced (%)
OUTPUT 48	219	CH4 Output (SCFM)
OUTPUT 49	315,791	CH4 Output (SCF/day)
OUTPUT 50	115,263,782	CH4 Output (SCF/year)
OUTPUT 51	200,001	CH4 Output (Btu/minute)
OUTPUT 51	288	CH4 Output (MM Btu/day)
OUTPUT 52	105,121	CH4 Output (MM Btu/year)
		ELECTRICITY GENERATION
OUTPUT 53	1,259	Calculated Generation Capacity (kW)
OUTPUT 54	1,259	Specified Generator Size (kW)
OUTPUT 55	100	Calculated Fuel-Load Rate (%)
OUTPUT 56	100	Used Fuel-Load Rate (%)
OUTPUT 57	9,533	Unit #1 Heat Rate (BTU/kWh)
OUTPUT 58	10,145,123	Gross Electricity Generation (kWh/year)
OUTPUT 59	(811,610)	less AD Parasitic Electrical (kWh)
OUTPUT 60	0	less Manure Thickening Parasitic Electrical (kWh)
OUTPUT 61	9,333,513	Net Electric Generation (kWh/year)
		CO-GENERATED THERMAL AVAILABLE
OUTPUT 62	1,289	Thermal Recovery (Btu/kWh generated)
OUTPUT 63	13,082	Gross Thermal Recoverable (MM Btu/year)
OUTPUT 64	0	less Parasitic Thermal Required (MM Btu/year)
OUTPUT 65	13,082	Net Thermal Available (MM Btu/year)
OUTPUT 66	0	On-Site Fuel Use (MM BTU/year)
OUTPUT 67	13,082	Thermal Surplus (MM Btu/year)
OUTPUT 68	94,318	#2 Fuel Oil Gallons Equivalent Surplus
OUTPUT 69	139,914	Propane Gallons Equivalent Surplus

This consultant's forecast is highly dependent on future events and may be significantly affected by changes in technical and other circumstances. Therefore, this forecast may not be representative of future results.

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BIOGAS MASS BALANCE

PROJECT ID: Yates/Somerset Pre-Feasibility Study
PROJECT NAME: FINAL

Parameter	Quantity	Units
System Operation	365	days/year
Biogas Production	192,106,303	SCF/year
Biogas Production	526,319	SCF/day
Biogas Production	21,930	SCF/hour
Biogas Production	365	SCFM
Biogas Specific Volume	14.171	SCF/pound
Biogas Density	0.0706	pound/SCF
Biogas Production	6,778	tons/year
Capacity Installed	1,259	kW
Capacity Annual Average	1,158	akW
Gross Generation	10,145,123	KWh
Net Generation	9,333,513	KWh
CH4 Concentration	60.0	%
CH4 Production	115,263,782	SCF/year
CH4 Production	219	SCFM
CH4 Production	200,001	BTU/minute
CH4 Production	288	MM Btu/day
CH4 Production	105,121	MM Btu/year
CH4 Production	2,397	tons/year
CO2 Concentration	39.5	%
CO2 Production	75,785,937	SCF/Year
CO2 Production	144	SCFM
CO2 Production	4,335	tons/year

This consultant's forecast is highly dependent on future events and may be significantly affected by changes in technical and other circumstances. Therefore, this forecast may not be representative of future results.

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DETAILED SOURCES & USES OF FUNDS STATEMENT

PROJECT ID:	Yates/Somerset Pre-Feasibility Study
PROJECT NAME:	FINAL

	CAPITAL SOURCES
$1,000,000	USDA REAP
$450,000	USDA EQIP
$3,683,333	Enterprise Equity
$7,366,667	Senior Debt
12,500,000	**TOTAL SOURCES OF FUNDS**
	USES OF FUNDS CONSTRUCTION BUDGET
$2,775,000	Anaerobic Digester, Manure Pits & Solids Separator
$3,950,000	Engine-Generator, Biogas Conditioning & Flare
$1,550,000	Project Management, Engineering & Permits
$515,000	Electrical Interconnection
$275,000	Miscellaneous
$9,065,000	**TOTAL CONSTRUCTION BUDGET**
	USES OF FUNDS OWNER'S BUDGET
$1,359,750	Owner's Budget
$2,075,250	Contingency
$3,435,000	**TOTAL OWNERS BUDGET**
$12,500,000	**TOTAL USES OF FUNDS**

This consultant's forecast is highly dependent on future events and may be significantly affected by changes in technical and other circumstances. Therefore, this forecast may not be representative of future results.

CASHFLOW SUMMARY (GAAP BASIS)

Project ID:	Yates/Somerset Pre-Feasibility Study										
Proj Name :	FINAL										
		Year $1	Year $2	Year $3	Year $4	Year $5	Year $6	Year $7	Year $8	Year $9	Year $10
INVESTMENT OUTLAYS											
Investment Tax Credit	$0										
USDA REAP	($1,000,000)										
USDA EQIP	($450,000)										
Enterprise Equity	$3,683,333										
Senior Debt	($7,366,667)										
DEPRECIATION	$12,300,000	($745,500)	($745,500)	($745,500)	($745,500)	($745,500)	($745,500)	($745,500)	($745,500)	($745,500)	($745,500)
PRINCIPAL											
Senior Debt		($411,811)	($440,638)	($471,483)	($504,487)	($539,801)	($577,587)	($618,018)	($661,279)	($707,569)	($757,098)
TOTAL PRINCIPAL		($411,811)	($440,638)	($471,483)	($504,487)	($539,801)	($577,587)	($618,018)	($661,279)	($707,569)	($757,098)
INTEREST PAYMENTS											
Senior Debt	$7,366,667	($515,667)	($486,840)	($455,995)	($422,991)	($387,677)	($349,891)	($309,460)	($266,199)	($219,909)	($170,380)
TOTAL INTEREST		($515,667)	($486,840)	($455,995)	($422,991)	($387,677)	($349,891)	($309,460)	($266,199)	($219,909)	($170,380)
REVENUES											
"Sell All" Power Sales		$1,115,964	$1,115,964	$1,115,964	$1,115,964	$1,115,964	$1,115,964	$1,115,964	$1,115,964	$1,115,964	$1,115,964
IRA Production Tax Credit		$304,354	$313,484	$322,889	$332,576	$342,553	$352,829	$363,414	$374,317	$0	$0
D3 eRIN Sales		$1,723,110	$1,723,110	$1,723,110	$1,723,110	$1,723,110	$1,723,110	$1,723,110	$1,723,110	$1,723,110	$1,723,110
Compost		$113,964	$113,964	$113,964	$113,964	$113,964	$113,964	$113,964	$113,964	$113,964	$113,964
TOTAL REVENUES		$3,257,391	$3,266,522	$3,275,926	$3,285,613	$3,295,590	$3,305,867	$3,316,452	$3,327,354	$2,953,038	$2,953,038
VARIABLE EXPENSES											
Direct Labor Hourly		($120,000)	($120,000)	($120,000)	($120,000)	($120,000)	($120,000)	($120,000)	($120,000)	($120,000)	($120,000)
Direct Labor Benefits		($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)	($40,000)
Feedstock Testing		($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)
Outside Engineering & Other Services		($17,000)	($17,000)	($17,000)	($17,000)	($17,000)	($17,000)	($17,000)	($17,000)	($17,000)	($17,000)
AD Unit Operation & Maintenance		($29,200)	($29,200)	($29,200)	($29,200)	($29,200)	($29,200)	($29,200)	($29,200)	($29,200)	($29,200)
"Buy All" Parasitic Electricity		($170,438)	($170,438)	($170,438)	($170,438)	($170,438)	($170,438)	($170,438)	($170,438)	($170,438)	($170,438)
GenSet Operation & Maintenance		($202,902)	($202,902)	($202,902)	($202,902)	($202,902)	($202,902)	($202,902)	($202,902)	($202,902)	($202,902)
GenSet H2S Removal		($101,451)	($101,451)	($101,451)	($101,451)	($101,451)	($101,451)	($101,451)	($101,451)	($101,451)	($101,451)
Feeder Farms Payment		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL VARIABLE EXPENSES		($685,992)	($685,992)	($685,992)	($685,992)	($685,992)	($685,992)	($685,992)	($685,992)	($685,992)	($685,992)
FIXED EXPENSES											
Accounting		($12,000)	($12,000)	($12,000)	($12,000)	($12,000)	($12,000)	($12,000)	($12,000)	($12,000)	($12,000)
Insurance		($37,167)	($37,167)	($37,167)	($37,167)	($37,167)	($37,167)	($37,167)	($37,167)	($37,167)	($37,167)
TOTAL FIXED EXPENSES		($49,167)	($49,167)	($49,167)	($49,167)	($49,167)	($49,167)	($49,167)	($49,167)	($49,167)	($49,167)
Operating Income		$1,261,066	$1,299,024	$1,339,273	$1,381,963	$1,427,255	$1,475,317	$1,526,333	$1,580,497	$1,252,470	$1,302,000
add Depreciation		$745,500	$745,500	$745,500	$745,500	$745,500	$745,500	$745,500	$745,500	$745,500	$745,500
less Principal Payments		($411,811)	($440,638)	($471,483)	($504,487)	($539,801)	($577,587)	($618,018)	($661,279)	($707,569)	($757,098)
Asset Replacement		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Pre-Tax Cash Flow	($2,233,333)	$1,594,755	$1,603,886	$1,613,290	$1,622,977	$1,632,954	$1,643,231	$1,653,816	$1,664,718	$1,290,401	$1,290,401
Cumulative Pre-Tax Cash Flow	($2,233,333)	($638,578)	$965,308	$2,578,598	$4,201,574	$5,834,528	$7,477,759	$9,131,575	$10,796,293	$12,086,694	$13,377,095

This consultant's forecast is highly dependent on future events and may be significantly affected by changes in technical and other circumstances. Therefore, this forecast may not be representative of future results.

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SUMMARY INCOME STATEMENT

Project ID: Yates/Somerset Pre-Feasibility Study
Proj Name : FINAL

		PROJECTED									
As of the years ended,	Construction	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Net sales	-	1,115,960	1,115,960	1,115,960	1,115,960	1,115,960	1,115,960	1,115,960	1,115,960	1,115,960	1,115,960
Cost of goods sold	-	(1,431,490)	(1,431,490)	(1,431,490)	(1,431,490)	(1,431,490)	(1,431,490)	(1,431,490)	(1,431,490)	(1,431,490)	(1,431,490)
Gross profit	-	(315,530)	(315,530)	(315,530)	(315,530)	(315,530)	(315,530)	(315,530)	(315,530)	(315,530)	(315,530)
Other operating income	-	2,141,430	2,150,560	2,159,960	2,169,650	2,179,630	2,189,900	2,200,490	2,211,390	1,837,070	1,837,070
Gross profit and other operating income	-	1,825,900	1,835,030	1,844,430	1,854,120	1,864,100	1,874,370	1,884,960	1,895,860	1,521,540	1,521,540
Operating expenses	-	(49,167)	(49,167)	(49,167)	(49,167)	(49,167)	(49,167)	(49,167)	(49,167)	(49,167)	(49,167)
Operating income	-	1,776,734	1,785,864	1,795,264	1,804,954	1,814,934	1,825,204	1,835,794	1,846,694	1,472,374	1,472,374
Nonoperating income (expense)											
Interest expense	-	(515,670)	(486,840)	(456,000)	(422,990)	(387,680)	(349,890)	(309,460)	(266,200)	(219,910)	(170,380)
	-	(515,670)	(486,840)	(456,000)	(422,990)	(387,680)	(349,890)	(309,460)	(266,200)	(219,910)	(170,380)
Income	-	1,261,064	1,299,024	1,339,264	1,381,964	1,427,254	1,475,314	1,526,334	1,580,494	1,252,464	1,301,994
add Depreciation	-	745,500	745,500	745,500	745,500	745,500	745,500	745,500	745,500	745,500	745,500
less Principal Payments	-	(411,810)	(440,640)	(471,480)	(504,490)	(539,800)	(577,590)	(618,020)	(661,280)	(707,570)	(757,100)
Asset Replacement	-	-	-	-	-	-	-	-	-	-	-
Cash flow before taxes	-	1,594,754	1,603,884	1,613,284	1,622,974	1,632,954	1,643,224	1,653,814	1,664,714	1,290,394	1,290,394

STATEMENT OF OWNER'S EQUITY

Owner's equity, beginning	3,683,330	5,133,330	6,394,400	7,693,420	9,032,700	10,414,660	11,841,910	13,317,230	14,843,560	16,424,060	17,676,530
add Federal, state, and local sources	1,450,000	-	-	-	-	-	-	-	-	-	-
Income before taxes	-	1,261,070	1,299,020	1,339,270	1,381,960	1,427,250	1,475,320	1,526,330	1,580,500	1,252,470	1,302,000
less Distribution to owners	-	-	-	-	-	-	-	-	-	-	-
Owner's equity, ending	5,133,330	6,394,400	7,693,420	9,032,690	10,414,660	11,841,910	13,317,230	14,843,560	16,424,060	17,676,530	18,978,530

Note: The narrative summary of significant forecast assumptions and notes is an integral part of these forecasted statements.

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SUMMARY BALANCE SHEET

Project ID: Yates/Somerset Pre-Feasibility Study
Proj Name : FINAL

		PROJECTED									
As of the years ended,	Construction	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
ASSETS											
Current assets											
Cash	200,000	1,531,070	3,134,200	4,746,720	6,368,900	8,001,030	9,643,420	11,296,360	12,960,190	14,281,350	15,571,750
Receivables	-	267,730	268,480	269,250	270,050	270,870	271,720	272,590	273,480	242,720	242,720
Inventories	-	-	-	-	-	-	-	-	-	-	-
Current assets	200,000	1,798,800	3,402,680	5,015,970	6,638,950	8,271,900	9,915,140	11,568,950	13,233,670	14,524,070	15,814,470
Other assets, at cost	4,225,000	4,225,000	4,225,000	4,225,000	4,225,000	4,225,000	4,225,000	4,225,000	4,225,000	4,225,000	4,225,000
less accumulated amortization	-	(422,500)	(845,000)	(1,267,500)	(1,690,000)	(2,112,500)	(2,535,000)	(2,957,500)	(3,380,000)	(3,802,500)	(4,225,000)
Net other assets	4,225,000	3,802,500	3,380,000	2,957,500	2,535,000	2,112,500	1,690,000	1,267,500	845,000	422,500	-
Property and equipment, at cost	8,075,000	8,075,000	8,075,000	8,075,000	8,075,000	8,075,000	8,075,000	8,075,000	8,075,000	8,075,000	8,075,000
less accumulated amortization	-	(323,000)	(646,000)	(969,000)	(1,292,000)	(1,615,000)	(1,938,000)	(2,261,000)	(2,584,000)	(2,907,000)	(3,230,000)
Net property and equipment	8,075,000	7,752,000	7,429,000	7,106,000	6,783,000	6,460,000	6,137,000	5,814,000	5,491,000	5,168,000	4,845,000
TOTAL ASSETS	12,500,000	13,353,300	14,211,680	15,079,470	15,956,950	16,844,400	17,742,140	18,650,450	19,569,670	20,114,570	20,659,470
LIABILITIES AND OWNER'S EQUITY											
Current liabilities											
Current maturities of long-term debt	411,810	440,640	471,480	504,490	539,800	577,590	618,020	661,280	707,570	757,100	810,100
Accounts payable	-	4,040	4,040	4,040	4,040	4,040	4,040	4,040	4,040	4,040	4,040
Current liabilities	411,810	444,680	475,520	508,530	543,840	581,630	622,060	665,320	711,610	761,140	814,140
Long-term debt, less current maturities	6,954,860	6,514,220	6,042,730	5,538,250	4,998,450	4,420,860	3,802,840	3,141,560	2,434,000	1,676,900	866,800
Owner's equity	5,133,330	6,394,400	7,693,420	9,032,700	10,414,660	11,841,910	13,317,230	14,843,560	16,424,060	17,676,530	18,978,530
TOTAL LIABILITIES AND OWNER'S EQUITY	12,500,000	13,353,300	14,211,670	15,079,480	15,956,950	16,844,400	17,742,130	18,650,440	19,569,670	20,114,570	20,659,470
CURRENT RATIO	NA	4.0	7.2	9.9	12.2	14.2	15.9	17.4	18.6	19.1	19.4
ACID TEST RATIO	NA	3.4	6.6	9.3	11.7	13.8	15.5	17.0	18.2	18.8	19.1

Note: The narrative summary of significant forecast assumptions and notes is an integral part of these forecasted statements.

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FORECASTED STATEMENTS OF CASH FLOWS

Project ID: Yates/Somerset Pre-Feasibility Study
Proj Name : FINAL

		PROJECTED									
As of the years ended,	Construction	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cash flows from operating activities											
Adjustment to reconcile net income (loss) to net cash flows	-	-	-	-	-	-	-	-	-	-	-
Net income (loss)	-	1,261,070	1,299,020	1,339,270	1,381,960	1,427,250	1,475,320	1,526,330	1,580,500	1,252,470	1,302,000
Depreciation and amortization	-	745,500	745,500	745,500	745,500	745,500	745,500	745,500	745,500	745,500	745,500
Change in assets and liabilities											
(Increase) decrease in receivables	-	(267,730)	(750)	(770)	(800)	(820)	(850)	(870)	(890)	30,760	-
(Increase) decrease in inventories	-	-	-	-	-	-	-	-	-	-	-
(Increase) decrease in prepaid expenses	-	-	-	-	-	-	-	-	-	-	-
Increase (decrease) in accounts payable	-	4,040	-	-	-	-	-	-	-	-	-
Increase (decrease) in accrued expenses	-	-	-	-	-	-	-	-	-	-	-
Net cash flows provided by operating activities	-	1,742,880	2,043,770	2,084,000	2,126,660	2,171,930	2,219,970	2,270,960	2,325,110	2,028,730	2,047,500
Cash flows from investing activities											
Purchase of property and equipment	(8,075,000)	-	-	-	-	-	-	-	-	-	-
Disbursements for intangible assets	(4,225,000)	-	-	-	-	-	-	-	-	-	-
Net cash flows used in investing activities	(12,300,000)	-	-	-	-	-	-	-	-	-	-
Cash flows from financing activities	-	-	-	-	-	-					
Net payments on revolving line of credit	-	(411,810)	(440,640)	(471,480)	(504,490)	(539,800)	(577,590)	(618,020)	(661,280)	(707,570)	(757,100)
Principal payments on long-term debt	$7,366,670	-	-	-	-	-	-	-	-	-	-
Proceeds from borrowings on long-term debt	$3,683,330	-	-	-	-	-	-	-	-	-	-
Proceeds from issuance of stock to owners	$1,450,000	-	-	-	-	-	-	-	-	-	-
Distribution to owners	-	-	-	-	-	-	-	-	-	-	-
Net cash flows used in financing activities	12,500,000	(411,810)	(440,640)	(471,480)	(504,490)	(539,800)	(577,590)	(618,020)	(661,280)	(707,570)	(757,100)
Net increase in cash and cash equivalents	200,000	1,331,070	1,603,130	1,612,520	1,622,170	1,632,130	1,642,380	1,652,940	1,663,830	1,321,160	1,290,400
Beginning cash	-	200,000	1,531,070	3,134,200	4,746,720	6,368,890	8,001,020	9,643,400	11,296,340	12,960,170	14,281,330
Ending cash	200,000	1,531,070	3,134,200	4,746,720	6,368,890	8,001,020	9,643,400	11,296,340	12,960,170	14,281,330	15,571,730
Supplemental disclosures of cash flow information											
Cash payments for interest	-	$515,670	$486,840	$456,000	$422,990	$387,680	$349,890	$309,460	$266,200	$219,910	$170,380

Note: The narrative summary of significant forecast assumptions and notes is an integral part of these forecasted statements.

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ECONOMIC MERIT STATISTICS

Project ID: Yates/Somerset Pre-Feasibility Study
Proj Name : FINAL

Discount Rate	10.0	%
Simple Payback Period	1.4	years
Debt to Equity Ratio	1.44	

FIRST YEAR RETURNS

Year One Current Ratio	4.0	
Year One "Acid Test" Ratio	3.4	

FIVE-YEAR RETURNS

Return on Equity	44.5	%
Internal Rate of Return	66.2	%
Net Present Value (%)	4,487	$ Thousand
Average Income	1,342	$ Thousand
Average Cash Flow	1,614	$ Thousand
Cumulative Cash Flow	5,835	$ Thousand

TEN-YEAR RETURNS

Return on Equity	52.8	%
Internal Rate of Return	71.5	%
Net Present Value	8,445	$ Thousand
Average Income	1,385	$ Thousand
Average Cash Flow	1,561	$ Thousand
Cumulative Cash Flow	13,377	$ Thousand

FIFTEEN-YEAR RETURNS

Return on Equity	61.9	%
Internal Rate of Return	71.8	%
Net Present Value	11,328	$ Thousand
Average Income	1,543	$ Thousand
Average Cash Flow	1,656	$ Thousand
Cumulative Cash Flow	22,612	$ Thousand

TWENTY-YEAR RETURNS

Return on Equity	67.1	%
Internal Rate of Return	71.8	%
Net Present Value	13,542	$ Thousand
Average Income	1,631	$ Thousand
Average Cash Flow	1,797	$ Thousand
Cumulative Cash Flow	33,701	$ Thousand

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