

Feasibility Study

PROJECT PHOENIX



DYNAMIC

Prepared for:
Kewaunee County
810 Lincoln Street
Kewaunee, WI 54216

Prepared by:
Dynamic Concepts, LLC
PO Box 436
Waukesha, WI 53187

June 30th, 2016



Acknowledgment: "This material is based upon work supported by the Department of Energy under Award Number DE EE0006222"

Disclaimer: "This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."

Table of Contents

- 0
- 1.0 Executive Summary 3
- 2.0 Project Description 5
- 3.0 Geographic Analysis 8
- 4.0 Biogas Production..... 12
- 5.0 Nutrient Management Analysis..... 14
 - 5.1 Anaerobic Digestion 16
 - 5.2 Coarse Solids Separation 16
 - 5.3 Fine Solids Separation 17
 - 5.4 Suspended Solids Removal 18
 - 5.5 Dissolved Solids Removal 18
- 6.0 Technology Review..... 21
 - 6.1 Anaerobic Digestion 21
 - 6.1.1 Complete Stirred Anaerobic Digester..... 22
 - 6.1.2 Fixed Film Digester 22
 - 6.1.3 Plug Flow Digester 23
 - 6.1.4 Covered Lagoon Digester 23
 - 6.2 Advanced Separation Technology 24
 - 6.2.1 Coarse Solids Separation 24
 - 6.2.2 Fine Solids Separation 24



6.2.3 Fiber Drying System..... 26

6.2.4 Suspended Solids Removal System 27

6.2.5 Dissolved Solids Removal System..... 28

7.0 Market Analysis 29

7.1 Renewable Natural Gas (RNG)..... 29

7.2 Renewable Electricity 31

7.3 Direct Use 31

7.4 Off Farm Feed Stock 31

8.0 Economic Analysis 33

8.1 Capital Cost..... 33

8.2 Operating Cost..... 39

8.3 Financial Modeling 42

9.0 Job Creation..... 44

10.0 Ownership Structure 45

10.1 Value Added Cooperative..... 45

10.2 Limited Liability Company (LLC)..... 45

10.3 Third Part Ownership/Investment..... 46

11.0 Centralized Fertilizer Plant 47

12.0 Conclusion 50

13.0 Sources 52

14.0 Appendix 1: Mass & Energy Balance 53

15.0 Appendix 2: Nutrient Balance..... 54

16.0 Appendix 3: Maps..... 55

17.0 Appendix 4: Capital & Operating Cost Detail 56

1.0 Executive Summary

There were (3) three primary objectives outlined by Kewaunee County for feasibility analysis: energy production, nutrient concentration, and the creation of clean water. Dynamic Concepts has proposed a county wide community biogas agglomeration project by integrating a network of ten proposed community anaerobic digestion facilities through 66 miles of gas piping to a centralized biogas processing facility strategically located along an existing natural gas transmission line. The project, with an estimated \$188 million capital cost, would produce in excess of 7,000 standard cubic feet per minute (scfm) of renewable biogas, by harvesting methane gas from the manure of more than 58,000 equivalent cows across county and reduce manure volumes applied to the land by more than 300 million gallons annually. If realized, this project would be largest of its kind in North America and establish Kewaunee County as a global leader in sustainability, setting a precedent for responsible agriculture for future generations.



Kewaunee County is one of Wisconsin’s premier dairy counties with 95,000 cows and replacement young stock producing over 1.1 billion pound of milk annually. One in five jobs in Kewaunee County is associated with the dairy industry. The county has 16 permitted CAFOs, 15 dairy and 1 beef. These animals produce some 650 million gallons of liquid manure each year.



The management of this manure is one of the most difficult, expensive, and potentially limiting problems facing the dairy industry today. Traditionally, manure is stored in earthen ponds or lagoons and then land applied at a later date. The construction cost of the lagoons or other storage facilities require large capital investments and provide limited benefits to the environment or the farming operations. The average cost to land apply manure is 1.5-2.0 cents per gallon which results in an estimated \$10-\$15 million dollars annually spent hauling and spreading manure on crop land by farms in Kewaunee County.

Manure produced by the dairy industry in Kewaunee County only supplies 50-60% of the nutrient demand in the county. The issues facing Kewaunee County are more directly related to nutrient distribution and the timing of application than a surplus of nutrients.

This feasibility study evaluates the opportunities in Kewaunee County for both biogas generation and utilization as well nutrient concentration and water treatment from both a technical and financial focus. Nutrient concentration and water treatment produce value added nutrient products that can be better utilized to deliver the nutrients where and when they are needed and best utilized.

The proposed project will be the first community system of this scale to include a viable nutrient concentration system (NCS) to reduce the adverse environmental impacts of nutrient loading to ground and surface waters. The integration of nutrient concentration and biogas production on a county wide scale allows for the economically feasible redistribution of nutrients through the reduction of the water in the manure. When implemented, this project will provide water quality protection, agricultural viability, and economic sustainability to the county.

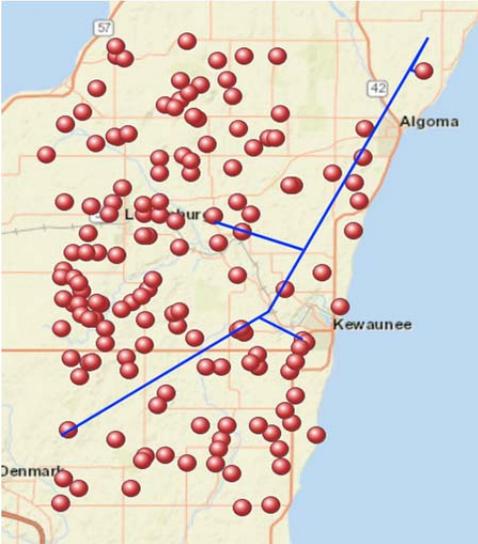


Figure 1.1 Dairy Farms in Kewaunee County

Our initial study efforts determined that Kewaunee County has substantial feed stock from manure and off farm organic waste to support a large methane recovery system. An estimated 86% of the manure produced in Kewaunee County could feasibly be collected and processed. The potential exists in Kewaunee County to produce 286,452 megawatt hours per year of electrical generation through processing manure and other organic waste products. The Wisconsin Public Service Corporation is currently paying \$.04 per kilowatt hour (kWh) for renewable electricity. A project producing electricity is not feasible at this level of power purchase. A project of this scale would require a power purchase price of \$0.13 to \$0.18 per kWh to make the project economically viable and comparative to the current market rates for gas utilization in the form of renewable natural gas (RNG).

Fortunately, there is an interstate natural gas pipeline running through the county (blue line on the map to the right, red dots are dairies). The current market price for renewable natural gas is in the range of \$15 to \$31 per MMBtu. This price can be obtained by utilizing the Renewable Fuel Standard. D3 of the Renewable Fuel Standard is the renewable code for cellulosic biofuel, which includes ethanol, renewable diesel, and now, renewable natural gas.

In summary, our findings indicate that integrating anaerobic digestion (AD), nutrient concentration systems (NCS), and solids processing can accomplish the goals of improving the economics of manure handling while have positive effects on the environment. The system includes ten manure hub and spoke systems and two renewable natural gas conditioning and injection points with the following key highlights:

- **Estimated project capital cost of \$188 Million**
- **Internal rate of return of 18.5%**
- **Production of over 7,000 SCFM biogas or 2,000,000 MMBTU/yr of Renewable Natural Gas (equivalent to 16.6M gallons of gasoline or 344,828 barrels of crude oil)**
- **338,147,110 gallons of clean water produced annually**
- **60,000 less trucks on the county's roads annually**
- **75 new permanent fulltime jobs created**
- **Greenhouse gas reduction over 200,000 tons annually by anaerobic digestion of dairy manure (equivalent to 38,326 passenger vehicles driven for one year)**