GrowTEC 633KW Source Separated Organics and Agricultural Waste Anaerobic Digester

CCEMC Project E120124 Final Report May 2016

Principal: Grow the Energy Circle Ltd.
Chris Perry (president)
Box 210, Coaldale, AB T1M 1M3
Ph. 403-345-3844
Email: ckpfarms@hotmail.com

CCEMC Project Advisor: Dr. Surindar Singh
Executive Director, Renewable & Emerging Resources
Alberta Innovates - Energy & Environment Solutions
1800 Phipps McKinnon Building, 10020 - 101A Avenue
EDMONTON, Alberta, Canada, T5J 3G2
(780) 422 0046
Email. Surindar.Singh@AlbertaInnovates.ca

Project Start Date: May 22, 2013
Project Completion Date: Feb 28, 2016
Total CCEMC Funds Received: $2,858,390.29
Amount of Holdback: $714,597.58
Submission Date: May, 2016

DISCLAIMER

Table of Contents

List of Figures:

List of Tables:

1. EXECUTIVE SUMMARY

The Perry family has a history of innovation and stewardship that spans four generations of southern Alberta farming. Today the Perry farm is a diverse operation comprising 4,000 acres of prime irrigated land producing quality potatoes, sunflowers, green peas, seed canola, and a range of cereals for clients such as Frito Lay, McCain, Lucerne Foods, Hytech Production and Spitz. The Perry's are respected as responsible environmental stewards, applying recognized best practices and use cutting edge technology in its operations. Presently the Farm has installed 20 KW solar PV, 30 tonne of geothermal, practice tractor exhaust sequestration on implements and biological farming practices. Grow the Energy Circle Ltd (GrowTEC), is the latest initiative of this entrepreneurial family, led by Chris Perry as President and CEO.

GrowTEC is a bio-energy venture that is a model of sustainable agriculture. GrowTEC developed a farm scale 633kW anaerobic digester (AD) utilizing waste organics relevant to Alberta, including: source separated organics and agricultural waste. The GrowTEC facility showcases the economic and practical viability of waste diversion and renewable energy generation using commercialized farm scale AD technology while reducing GHG emissions by over 10,000t CO_2e/yr. The facility incorporates multiple innovations to utilize onsite waste streams, converting organic waste into clean, renewable electricity and nutrient-rich/pathogen-free bio-fertilizer. The renewable energy project is replicable across multiple agricultural and waste products.

GrowTEC in its capacity as managing partner of CKPPQ Farms LP, a limited partnership between CKP Farms Ltd. and Perry Quest Ltd. has developed, constructed, commissioned and is presently operating the 633kW biogas /cogeneration facility located along highway #3 near Chin Alberta (SW30-9-18-w4th) in the Municipal District of Taber.

GrowTEC was awarded a renewable energy grant from the Climate Change and Emissions Management Corporation (CCEMC) for 50% of the project (Project E120124). The project cost was originally projected to be $7,145,976 (CCEMC Portion not to exceed $3,572,988). Actual project costs ended up at $7,226,706, with GrowTEC absorbing the extra 1.1%.

The GrowTEC sustainable venture produces enough electricity for over 700 average Albertan households every year. GrowTEC's on farm biogas facility is presently one of only 2 facilities operating in Alberta. GrowTEC uses anaerobic digestion technology designed by PlanET Biogas Solutions Inc. to convert large volumes of biodegradable waste (~25,000 tonnes/year) into four by-products: methane, heat, effluent irrigation water and soil amendments that are nutrient-rich and pathogen-free.

The Methane is directed to a combined heat and power unit (CHP) which consists of a Jenbacher 312 dual fuel (able to run on biogas and natural gas) 900 horse power engine which drives a 633kW generator. The electricity generated is utilized on site and sent to the Alberta Electricity Grid. The effluent irrigation and solid digestate is applied to fields as a soil amendment and the heat is utilized in the process and to heat the ancillary process building.

GrowTEC Biogas Plant Commissioned in November 2014.

2015 - First Year of operation numbers

Organic waste processed	15,000 tonnes (gross weight)
Renewable Power generated	2,372 MWh (330 Alberta households)
Organic Fertilizer produced	15,000 tonnes
Total GHG reductions	5,000 tonnes CO_2e
Actual CO_2e credits	1,000 tonnes (low due to protocol flags and less SSO's)
Electricity Energy Payment	$100,630 (average 2015 AESO Pool Price $33.34/MWh)
Other Revenue	$ 49,000 (tipping fees & other)
Cash Operating Costs	$555,000

2016 & Projected -Operation numbers

Organic waste processed	25,000 tonnes (gross weight)
Renewable Power generated	5,000 MWh (700 Alberta households)
Organic Fertilizer produced	25,000 tonnes
Total GHG reductions	> 10,000 tonnes CO_2e
Actual CO_2e credits	3,000 tonnes (low due to protocol flags and less SSO's)
Electricity Energy Payment	$100,000 (projected 2016 AESO Pool Price $20.00/MWh)
Other Revenue	$ 49,000 (tipping fees & other, future GHG)
Cash Operating Costs	$555,000

Eligible Project Expenses totaled $7,226,706. Of this proponent funds were $3,653,720 and the CCEMC grant portion was $3,572,988. The operation demonstrates a model of industrial synergy and utilizes waste to sustainably generate 24/7 renewable energy (better than wind and sun as these are intermittent).

2. PROJECT DESCRIPTION

2.1 Introduction and Background

The GrowTEC team of Chris and Harold Perry were introduced to the concept of anaerobic digestion and biogas in 2001. The interest in reducing their resource use and carbon footprint was and still is today a primary focus of the family farm. The concept of a biogas facility that converts organic waste into clean and renewable electricity, nutrient-rich biofertilizer and irrigation water seemed like a perfect fit for the direction the farm wished to take.

The founders of GrowTEC have been committed to building a biogas facility since completing a feasibility study in 2008. CKPPQ Farms LP invested over $1,000,000 of capital into the initial approach before the CCEMC grant was awarded in 2013 that included:

- Detailed IMUS system engineering
- Alberta Environment approval
- Alberta Utilities Commission approval: and
- Preliminary site works.

GrowTEC was awarded grants under the BCMDP - Biorefining Commercialization and Market Development Program ($470,000). GrowTEC was also awarded a contract under the BPCP – Bioenergy Producer Credit Program ($0.06/kWh), however was required to pull out of the program due to CCEMC requirements.

GrowTEC's original expression of interest to CCEMC proposed a 1,266 kW IMUS plant; at that time this size was thought to be required in order to achieve reasonable economies of scale. The initial intention was to install an IMUS system. However, the custom engineering and fabrication along with high costs of local trades to install and commission the facility resulted in the smaller IMUS system being uneconomical. This would also result in a lower chance of replication to other sites in Alberta.

GrowTEC decided to take a new approach, and engage a number of potential anaerobic digester vendors who are interested in the opportunity to develop a project under the original vision, including source separated organics (SSOs) and agricultural waste as key feedstocks. The lowered costs were beneficial to GrowTEC and allow for the development of other onsite biogas facilities in Alberta more feasible.

In June of 2013 GrowTEC contracted PlanET Biogas Solutions Inc. of St. Catharines, Ontario to design and build the biogas facility. PlanET Biogas Solutions (PlanET) was chosen because their packaged equipment, custom engineered for our site, greatly reduced the costs required to construct and commission the facility. PlanET has built 12 anaerobic digester projects in Canada and is a subsidiary of German based PlanET Biogastechnik GmbH, one of the leading design-build biogas companies in the world. The PlanET group has built over 400 biogas plants world-wide.

The basis provided to PlanET to consider designing and building the GrowTEC Biogas Facility:

- **Organic Waste Diversion and Feedstock:** Agreements are in place with CKPPQ Farms LP, Lakeside and Hillridge Colonies, Gouw Quality Onions, KCL Cattle Co, JBS and Richardson's for organic waste biomass supply (manure and other organic waste). Discussion with the towns of Coaldale and Taber to determine the potential to divert organic municipal waste from landfill disposal to Growtec's digester.

- **Digestate Soil Amendment Utilization:** Digestate is the digestion by-product, a nutrient-rich and pathogen-free soil amendment. Growtec will recycle the digestate back to CKPPQ Farms which reduces the synthetic fertilizer requirements on the farm.

- **Reduction of Greenhouse Gas (GHG) Emission:** Carbon capture and management is becoming a global industry, GrowTEC looks to be a leader of responsible agriculture through innovative practice. Building a biogas facility is to be an implementation of the best practice possible for a reduced farm carbon footprint and responsible management of organic waste and recycling of nutrients on the farm.
- **Project Duration:** The facility is built for a long term operation with no dates set for ceasing of operations or final closure. The facility will be in operation for >20 years.

- **Construction:** Commencement of construction for the PlanET scope of delivery is for September 1, 2013. Completion of construction is in 2014.

- **Operation:** Commencement of regular operation is anticipated to start in 2014.

- **Public Consultation:** The project was extensively discussed with the public.

Given these parameters GrowTEC and PlanET entered into negotiations over a design, build proposal agreement (DBPA). Using a phased approach GrowTEC enlisted PlanET to construct a 315kW capacity plant and then expanded to 633kW, once operational experience was acquired. This approach allowed GrowTEC to leverage their internal resources for trial and error and then develop low cost solutions for phase 2 plant expansion and efficiency. By implementing a phased approach and packaged equipment, the project mitigated the technology, adoption and financial risks associated with implementing the full 633KW facility first off.

In May 2013 GrowTEC was awarded a renewable energy grant from the Climate Change and Emissions Management Corporation (CCEMC Project E120124) for 50% of eligible project costs. The project cost was originally projected to be $7,145,976 (CCEMC Portion not to exceed $3,572,988). Actual Eligible project expenses totaled $7,226,706. Of this, proponent funds were $3,653,720 and the CCEMC grant portion was $3,572,988. GrowTEC and the principles are sincerely grateful for the CCEMC contribution which enabled the GrowTEC biogas facility to become a reality.

2.2 Technology Description

Anaerobic digestion is a naturally occurring biological process that uses microbes to break down organic material in the absence of oxygen. In engineered anaerobic digesters, the digestion of organic waste takes place in a special reactor, or enclosed chamber, where critical environmental conditions such as moisture content, temperature, and pH levels can be controlled to maximize gas generation and waste decomposition rates. A typical schematic of an anaerobic digestion facility is shown in Figure 1.

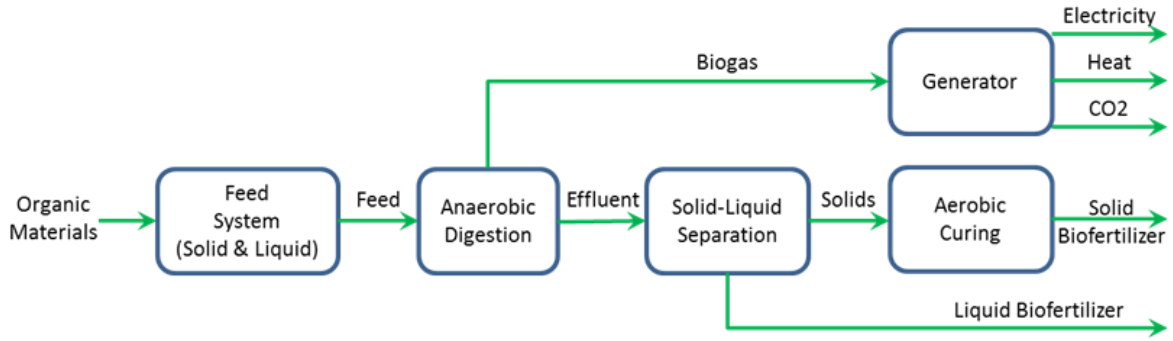


Figure 1. Anaerobic Digestion Process

The process is carried out by anaerobic micro-organisms that convert carbon-containing compounds to biogas. Biogas primarily consists of methane (CH_4), which is the same as natural gas, and CO_2, with trace amounts of other gases. The methane content of biogas typically ranges from 55% to 70%. In an engineered anaerobic digestion system, the breakdown of organic materials to produce methane occurs in weeks, compared to decades under anaerobic conditions in a landfill.

Production of biogas from an anaerobic digestion process will vary depending on the process design, the volatile solids in the feedstock (which varies depending on the composition of the feedstock), and the carbon/nitrogen (C:N) ratio. All of these factors impact the amount of biogas that can be produced through microbiological decomposition. The outflowing digestate is treated in a pasteurizer and then separated into a solid and liquid fraction. The solids are cured and used as bio-fertilizer, and the liquid fraction used as liquid fertilizer for the local crops. Anaerobic digestion generates base-load power, regardless of weather conditions, unlike other renewable sources such as wind, solar, and tidal energy.

The objective of the project was to process agricultural based feedstock material as applied for in the Alberta Environment and Sustainable Resource Development permit application, and granted approval #303238-00-00. The feedstock considered included: cull potatoes and potato tops from the proponent's existing potato storage, sorting facility, and growing operations and other nearby producers, cull onions, potato chip waste from the nearby Frito-Lay facilities (Taber/Lethbridge), livestock manure (e.g., from nearby feedlot, hog, and dairy operations), small amounts of waste oil from potato processors, silage, and residential organic waste from the neighbouring communities of Taber and Coaldale, flume water recycled from the proponent's existing potato storage and sorting facility, potato wash water and processing water containing organics. This

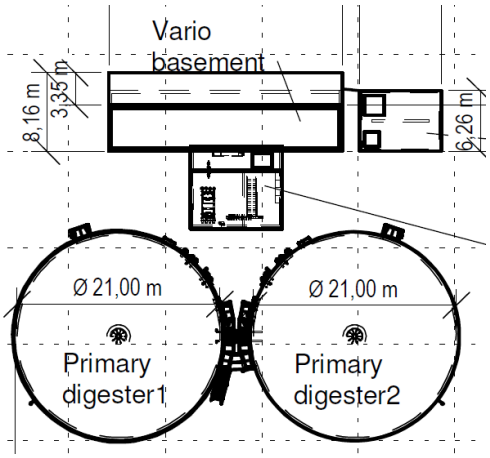
feedstock through anaerobic digestion technology was to be processed into a solid and a liquid fertilizer component while extracting methane gas in order to fuel a 633kW containerized co-gen unit and to provide process heat and electricity for the anaerobic digestion process with the electricity surplus to be fed into the Alberta power grid.

The specific system design from PlanET for GrowTEC was utilized (see section 2.5 work scope in pictures for images):

- The PlanET anaerobic digestion process uses a mesophilic process that operates around 38-degree C.
- The process uses 2 concrete primary digesters with a volume of 2,112m^3 each (21m diameter * 6.1m height). Total digester volume is 4,224m^3
    - The two 2 primary digesters are equipped with in–floor and in-wall heating, two submersible and adjustable Eco Mix agitators and one submersible Eco Paddle agitator, Eco Cover desulphurization netting system + ferric chloride desulphurization system for backup and start-up, PlanET Eco Top double membrane roof system for biogas storage and weather protection, over-/under pressure relief valves, 4 inch rigid insulation, protective green cladding, stairway with access platforms and two inspection windows.
    - The two PlanET primary digesters are built approximately 1.6m into the ground and equipped with a PlanET leak detection system. The leak detection system consists of a 0.8mm PE liner, a geo textile on top of the PE liner and a drainage pipe surrounding the digesters. The PE liner and the geo textile are installed below the layer of insulation of the tank foundation and will be wrapped around the base of the digesters. The PE liner is sealed to the tank walls and the enclosed drainage pipe facilitates leak detection via a connection pipe and a sump.
- Liquid feedstock (manure) is stored in an enclosed below ground concrete storage tank with a volume of approximately 150m^3. This below ground storage tank is 3.20m below ground and has the same PlanET leak detection system as the primary digesters. It is equipped with one submersible PlanET Eco Turbo agitator, an access hatch and a flange connection to facilitate clean and easy filling.
- Solid feedstock is stored within the phase 2 storage building and two enclosed solid feeding systems (PlanET Vario) with a storage capacity of 74m^3 each. The PlanET Vario's consist of a painted steel tub finished with a stainless steel liner, a walking floor feeding system, a weighing system, a hydraulicly operated steel cover and a control system. The PlanET Vario's feed solid feedstock into the PlanET ECO Flow feeding system located in the basement of the adjacent equipment building. This allows for slurring the solid material with the liquid digestate from the primary digesters to make it pumpable. To facilitate direct dumping with an end dump truck, the two Vario's sit in a concrete basement structure approximately 3.2m below ground.
    - The pre-storage tank and the two Vario's are connected to an activated carbon system for odor control.
- The PlanET biogas desulphurization system treats the biogas internally within the primary digesters with the PlanET Eco Cover netting system. The method of treatment is biological

and small amounts of air are blown into the headspace of the digesters to create the reaction between H_2S and O_2 to generate elemental sulphur. A back-up system to the primary desulphurization system is a ferric chloride based desulphurization system (tank + pump).

- Before digested material is separated into the solid digestate and the liquid effluent, the digested material is processed in a pasteurization system at 70 degree C for 1 hour. The PlanET pasteurization system consists of two $5m^3$ stainless steel pasteurization tanks and have a processing capacity of up to $130m^3$/day in a batch process. The pasteurization system is also connected to the activated carbon filter for odour control. Pasteurization at 70 degree C for 1 h provides a pathogen free material for land application.
- The PlanET pasteurization system, the PlanET automatic compact manifold and the facilities control system are located in the equipment building. The PlanET manifold is located in the building basement and utilizes a lobe pump, flow meter and associated piping and valves to allow pumping of material to and from the system.
- Biogas from the 2 digesters are piped underground to a Jenbacher 312, dual fuel 633 kW reciprocating engine. This engine is packaged in a 40ft. container and is used to generate heat and electricity from biogas.
- Biogas from the primary digesters will be flared only during upset conditions, when the gas utilization system (reciprocating engine) are inoperable due to emergency or maintenance.



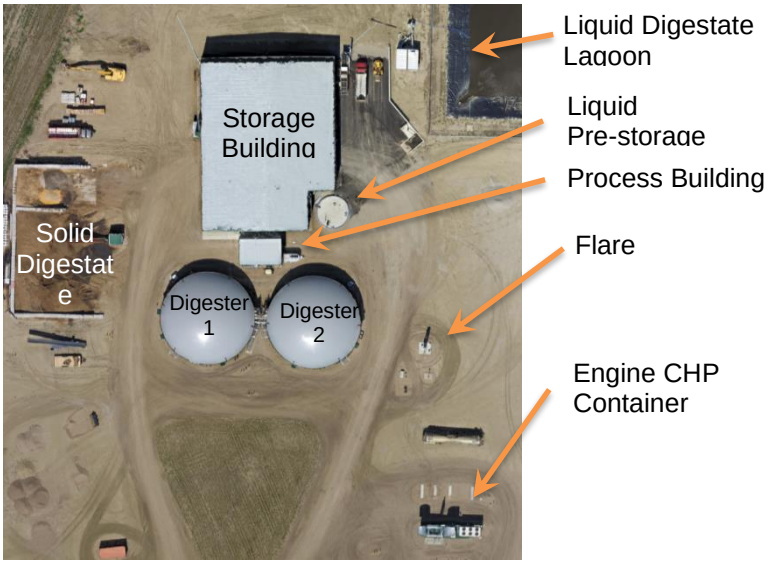


Figure 2. GrowTEC Layout

2.3 Project Goals

GrowTEC's Primary Goal for building the 633KW Biogas Facility was to be a leader in the agricultural field and a model of sustainability and stewardship on the farm. The intent is to create a full self-sustainable circle (hence: Grow the Energy Circle) farm operation utilizing industrial symbiosis, recycling nutrients and energy. GrowTEC sought out to find the most responsible and working technology available to reduce the farms foot print and set a great example for agriculture operations in Alberta and Canada. Farming today uses an incredible amount of resources to produce food for the world, and GrowTEC aims to reduce the resource dependence. GrowTEC was directed to the biogas industry in 2001 and has never looked back. Figure 3. shows why:

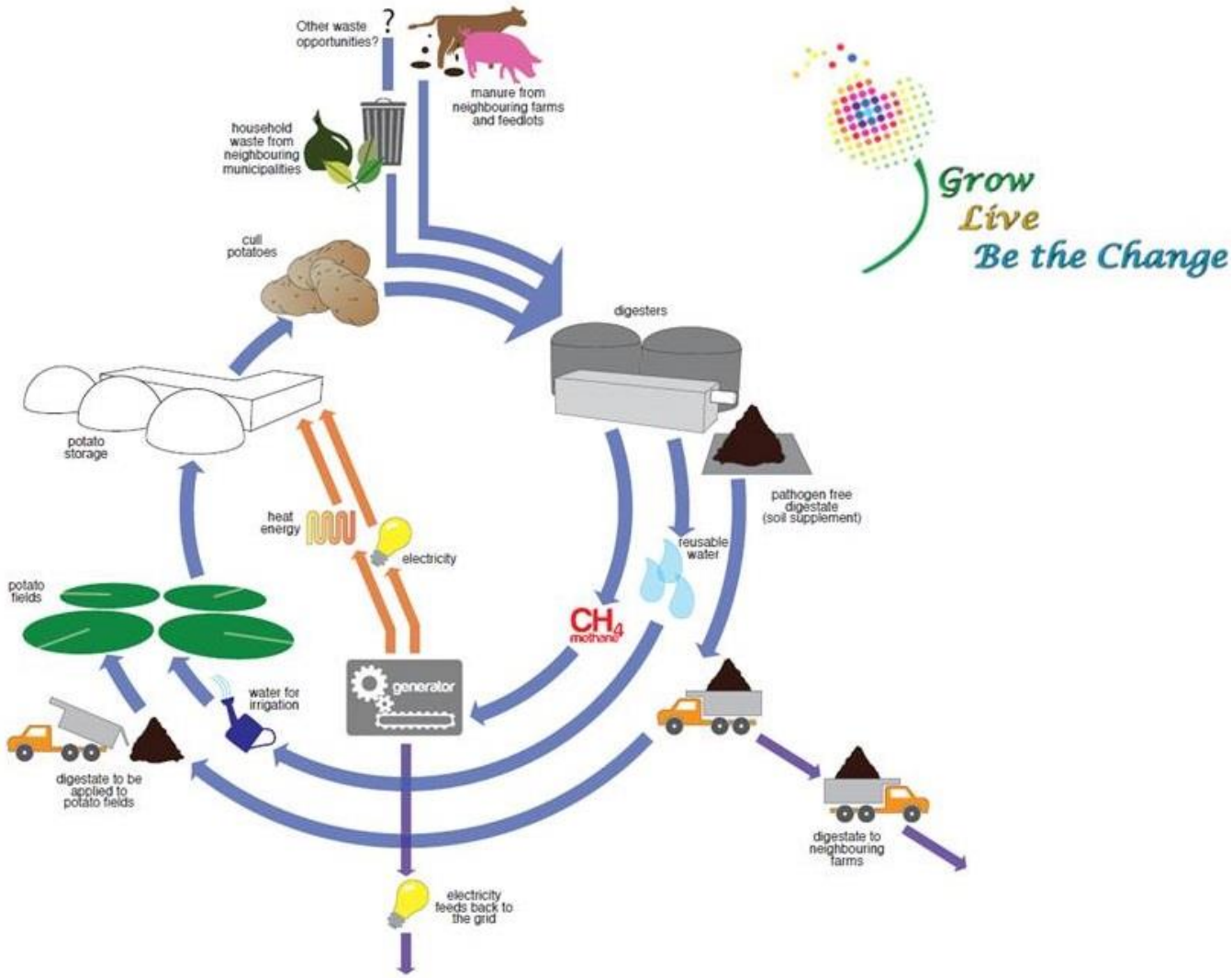


Figure 3. Pictogram of Grow the Energy Circle Operations and Industrial Symbiosis

One of GrowTEC's primary goals was to replace all the electricity used on the CKPPQ farming operation of 4,000 irrigated acres and 25,000 year round potato storage with renewable energy. The farm required 1,060MWh in 2015, The GrowTEC biogas facility generated over 2,500MWh in 2015. GrowTEC is on track to generate 5,000MWhr in 2016 – this is nearly 5 times the requirements of the farm, generated from 24/7 renewable electricity from organic waste.

2.4 Work Scope Overview

The project consists of two phases over a three-year time span. Each phase and corresponding tasks are explained in the project plan in Table 1 (see below), which corresponds to Appendix A in the 3rd amended contribution agreement between CCEMC and Grow the Energy Circle Ltd. Project E120124.

PROJECT PLAN as per 2nd CEMC amending agreement

.

Phase 1: Base Plant

The initial phase will consist of constructing a base anaerobic digester facility utilizing PlanET Biogas Solutions standard/packaged components which greatly simplifies the design and construction process. The base plant will have the full capacity for 633 kW however is targeted to initially generate 350 kW based on the feedstock recipe in the below section.

Milestone 1: Completion of Site Preparation (incl. excavation)
The associated tasks are as follows:

- Complete contract with PlanET and order long lead equipment
- Execute Fortis/Alta Link interconnection process
- Complete preliminary site prep work (everything required before structure construction begins) including: water line, underground works, lagoon excavation, etc.
- Purchase of initial facility equipment (end-dump trailer and loader) which will be utilized for construction

Milestone 2: Completion of Digester Concrete Work, order transformer and MVI for interconnect, Sign up ATCO for upgrade and gas service construction
The associated tasks are as follows:

- Digesters #1, #2, and liquid pre-storage tank formed and poured
- Construction of mechanical building and Vario basement
- Purchase JD724J wheel Loader, DS3-24 Allu Bucket for handling feedlot manure
- Down payment on Scale
- On-going site works

Milestone 3: Delivery of Major equipment, Mechanical and Electrical Works, pivot purchase.
The associated tasks are as follows:

- Installation and completion of the Vario dry-feeders.
- CHP Container arrives on site
- Initiation of construction of Electrical Hook up interconnect with Fortis/Alta-Link
- Construction and Gas utility install
- CPR crossing tie in for effluent irrigation
- Final payment on scale and pipe install for GrowTEC pivot

Milestone 4: Commissioning Completed (Start of Biogas Production)
The associated tasks are as follows:

- Completion of on-site piping and electrical
- PlanET Substantial completion / Holdback release
- Commissioning beginning
- Finalized site works
- Installation of irrigation pivot.

Phase 2: Expansion and Modifications

Milestone 5: Expansion Completed (Start of Biogas Production)
The associated tasks are as follows:

- Digester cleanout / system review
- Phase 2 design / ordering of long lead equipment
- Construction of feedstock storage building and installation of pre-processing system
- Any required modifications to base facility
- Construction and implementation of potato vine harvesting.

Phase 1: 315kW Plant Work Scope Overview

The initial phase constructing a 315kW anaerobic digester facility utilizing PlanET's standard/packaged components went quite well. Original construction start date was delayed slightly due challenges with getting final financing in place and guarantees on the contract.

GrowTEC coordinated, with the support of PlanET, the completion of the electrical interconnect design and amendments to the existing Alberta Environment and AUC approvals. GrowTEC also managed the completion of site preparation throughout the project which included: site works, lagoon, preliminary utility connections, mechanical rough-ins, electrical rough-ins, concrete pads and the feedstock building.

PlanET was the general contractor and handled design, build and construction of the biogas plant for phase 1 per the contract negotiated. This was an excellent choice for GrowTEC and PlanET as a vendor was very good to work with. Some typical construction challenges did occur, some due to delays on shipments coming from Germany. However, when priced, almost all material from Germany was cheaper than that sourced in Canada. This was during the oil boom (Alberta disadvantage), trades / construction labour and material were a challenge to line up and retain at a reasonable cost.

Construction of the plant, static and dynamic commissioning of the plant were complete in October and November of 2014. Handover from PlanET to GrowTEC took place at this time and the engine was commission on natural gas September 30, 2014. With this commissioning successful and the plant ready, filling of the digesters began in October of 2014, and biogas commissioning had begun. By early November the facility was flaring biogas (a good sign). Then on November 17, 2014 the engine was commissioned on biogas and phase 1 of the facility was considered operational!

Phase 2: 633kW Plant Expansion Overview

Phase 2 consisted of adding a processing building to handle feedstocks throughout the season and allow for a space to deal with feedstock contamination as well as pre-processing equipment purchase. Rocks and gravel were the main challenge and remain a challenge still in solid manure feedstock. We were able to clean out the lines that had accumulated a significant pile up of gravel in the system with the purchased vac tanker. An additional tanker has enabled GrowTEC to switch to hauling liquid manure which has significantly less rock issues. There is still an opportunity to utilize solid manure with proper pre-processing which is in the works.

Phase 2 has accomplished the goal of ramping up efficiency and operational capacity to full load. GrowTEC has been operating optimally since March 2016 to present. Phase 2 modifications enabled this to happen and capitalize on feedstock and operations.

2.5 GrowTEC Work Scope in Pictures















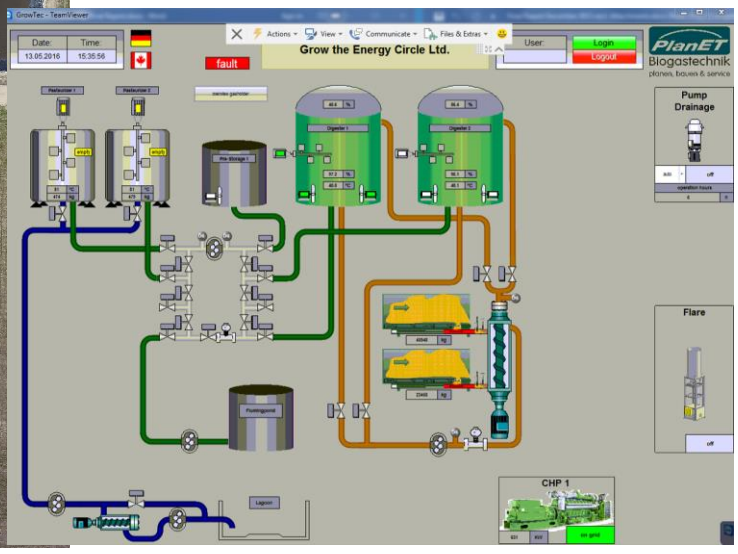







PHASE 1 COMPLETE NOV 28, 2014

PHASE 2 Start Summer 2015



Visualization of GrowTEC biogas plant in operation – May 13, 2016

PHASE 2 COMPLETE FEB 28, 2016

3. OUTCOMES AND LEARNINGS

3.1 Technology Development, Installation and Commissioning

GrowTEC chose PlanET as its vendor to design, build and commission the facility through a Design, Build Proposal Agreement (DBPA).

PlanET's North American subsidiary (pronounced "plan-e-t") was incorporated in October, 2006. PlanET has designed and constructed thirteen (13) anaerobic digester facilities throughout North America. PlanET is an affiliate of PlanET Biogas Group GmbH, which is based in Vreden, Germany. PlanET Biogas Group ranks among the leading biogas plant builders in Germany and Europe, and has designed, constructed and services over 400 anaerobic digestion systems worldwide. The name PlanET stands for "Planning and Application of Energy Technology". PlanET specializes in the design, construction, and service of advanced biogas plants. PlanET in Germany started in 1998, and now has over 250 employees, and 400 operating biogas plants.

Based on the availability of feedstock PlanET helped design a system together with GrowTEC. They then provided a design build proposal agreement (DBPA) to GrowTEC

DESIGN BASIS

The design of the Anaerobic Digester Biogas Facility is based on the following input menu (see attached PlanET Project Calculation – Appendix 14.3):

Substrate	Weight tonnes/year	Total Solids %	Volatile Solids %
Liquid Dairy Manure	4,050	8%	7%
Solid Dairy Manure	833	23%	18%
Feedlot Manure	6,300	23%	18%
Fryer Oil	200	95%	90%
Hog Manure	4,285	22%	17%
Culled Potatoes	6,500	21%	19%
Onions	2,000	15%	14%
Source Separated Organics	0	18%	17%
Potato Processing Water or Water	0	0%	0%
Final Composition	**25,168**	**19%**	**16%**

M

Menu #1 (expected for startup)

Substrate	Weight tonnes/year	Total Solids %	Volatile Solids %
Liquid Dairy Manure	4,050	8%	7%
Solid Dairy Manure	833	23%	18%
Feedlot Manure	1,575	23%	18%
Fryer Oil	200	95%	90%
Hog Manure	0	22%	17%
Culled Potatoes	4,250	21%	19%
Onions	2,000	15%	14%
Source Separated Organics	10,000	18%	17%
Potato Processing Water or Water	0	0%	0%
Final Composition	**25,908**	**18%**	**15%**

M

Menu #2 (expected to optimize the economics)

Table 1. GrowTEC's Feedstock Menu for Anaerobic Digester Design

This was the first shot at GrowTEC's feedstock stream. It is extremely difficult to project a stream of feedstock as it changes constantly, however a starting point is required to design a plant. From this list of available feedstock, the DBPA was offered. The Basics of the DBPA were as follows:

PlanET shall provide project and construction management, labour, materials and equipment necessary to furnish GrowTEC with an operational Anaerobic Digester Biogas Facility, as described in the following fifteen (15) major work packages:

- Two (2) 74 m3 PlanET "VARIO" Dry Feeder Systems
- One (1) PlanET "ecoFlow" Feeding System
- Two (2) 5 m3 PlanET Pasteurization Tanks
- One (1) Primary Anaerobic Digester @ 2,112 m3 (21 m ID x 6.10 m H)
- One (1) Secondary Anaerobic Digester @ 2,112 m3 (21 m ID x 6.10 m H)
- Anaerobic Digester Peripheral Equipment (valves, pumps, piping, etc)
- Related Building Structures (to house control system, pneumatic air system, compact manifold, pasteurization unit, hot water distribution, etc.)
- One (1) Vario Basement Structure
- Substrate Equipment (Compact Manifold and Solid-Liquid Separator)
- Biogas Equipment (Piping & Biogas Analysis Device)
- Packaging, installation and commissioning of free issued CHP Gen-SET
- Biogas Flare: 300 m3 / hour
- Hot Water Distribution System (to serve Anaerobic Biogas System and with connections only for farm loads and possible future third Anaerobic Digester).
- PlanET Process Control System (with remote monitoring and control capability)
- Startup and Commissioning (including three (3) days of onsite operator training by one (1) PlanET person, working with qualified personnel employed by the customer/client

The Anaerobic Digester Biogas Facility is designed for a maximum Organic Loading Rate (OLR) of 4.50 kg volatile solids/m3/day of mesophilic Anaerobic Digester capacity per day. PlanET has adhered to best practice methods when considering minimum Hydraulic Retention Time.

PlanET designed the system to have the ability to produce adequate biogas for a 633kW operating at least 8,000 hours/year. PlanET does not guarantee the biogas output, since PlanET has no control over the quality or quantity of the inputs by the customer/client. PlanET does however warrant that if reasonable quality and quantity inputs are maintained by customer/client and subject to the terms of this DBPA, the system will operate for the purpose for which it is intended. PlanET further warrants that it has the necessary skills, training and experience to construct the Anaerobic Digester Biogas Facility and that it has all necessary rights to construct the facility and that the Anaerobic Digester Biogas Facility will not infringe upon any patents or other intellectual property rights.

The Anaerobic Digester Biogas Facility has been designed to produce biogas with characteristics as follows:

- 50% - 60% methane
- Maximum concentration of H_2S of 200 ppm (dependent on inputs)
- Removal of most of the H_2O.

The system has been designed to produce biogas at an operating pressure of between 1 mbar – 3 mbar. The Anaerobic Digester(s) shall be designed and constructed with a double, concentric overhead membrane. The interior membrane is designed to capture and store biogas while the exterior membrane is designed to provide weather protection to the interior membrane and the Anaerobic Digester itself.

PlanET notes that the design basis of this Anaerobic Digester Biogas Facility is to be a wet, mesophilic Anaerobic Digester with the following design limitations:

- Operating temperature of 35-42 degree C
- Maximum fibre length of input material of 50 mm (2")
- Total solids concentration of between 5-9%.

3.2 Project Outcome

GrowTEC has procured, constructed, commissioned and is operating an operational on-farm biogas facility. This facility will process up to 25,000 tonnes of organic waste each year and produce approximately 5,000MWh of electricity. That is over 700 standard Albertan household requirements for electricity. The renewable electricity is produced 24/7 from waste. 25,000 tonnes will be recycled as pathogen free nutrient amendments back to the farming operation. It is an awesome project. The owners and principals (the Perry Family) are extremely proud of this accomplishment.

3.3 Analysis of Results

GrowTEC has achieved what it set out to do through the CCEMC project. Phase 1 was a building and commissioning phase to get an operational ½ capacity biogas facility up and running. Phase 2 was meant to improve efficiencies through experienced learnings from operating the facility. As you will note in the graph below, the trend line for production is trending a steep curve up toward full production which GrowTEC is presently operating at as of April and May 2016.

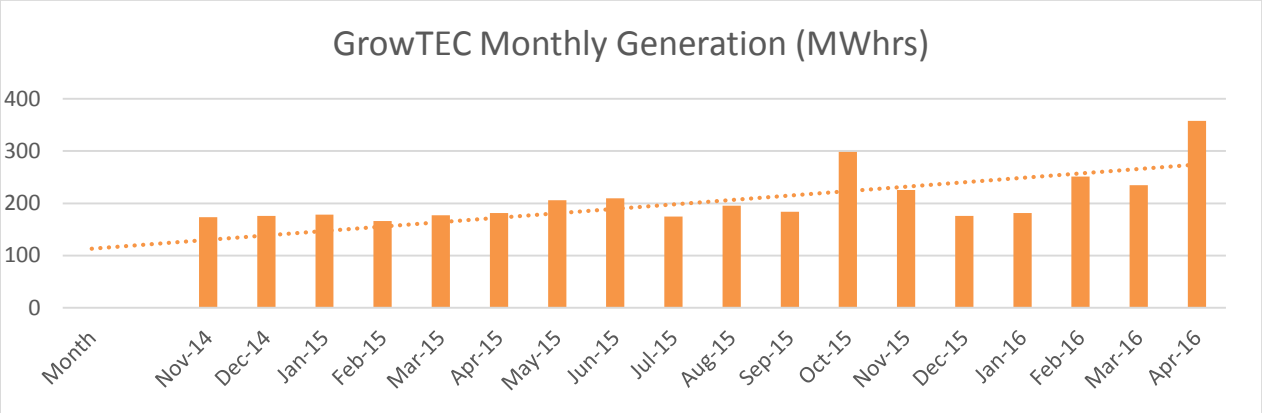


Figure 4. GrowTEC's Production (MWh) History

Unfortunately for GrowTEC the price for market electricity in Alberta is at an all-time low. See Figure 5 for a trend in the market power price (the main source of revenue for GrowTEC).

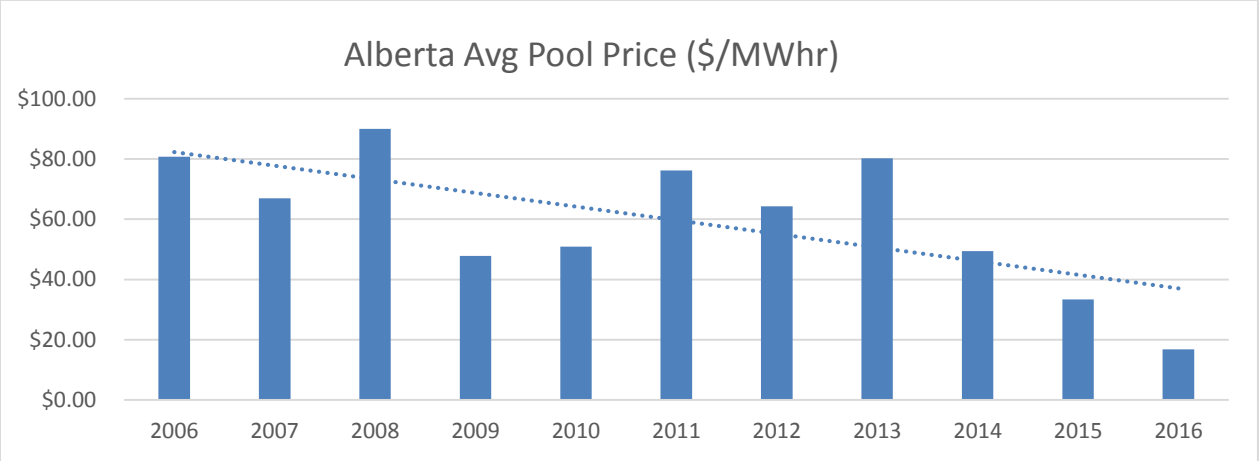


Figure 5. Alberta's Average Yearly Pool Price Trend Since 2006

Even since GrowTEC commissioned the facility and started selling power in November of 2014 the trend for price has gone down, and is presently at an all-time low.

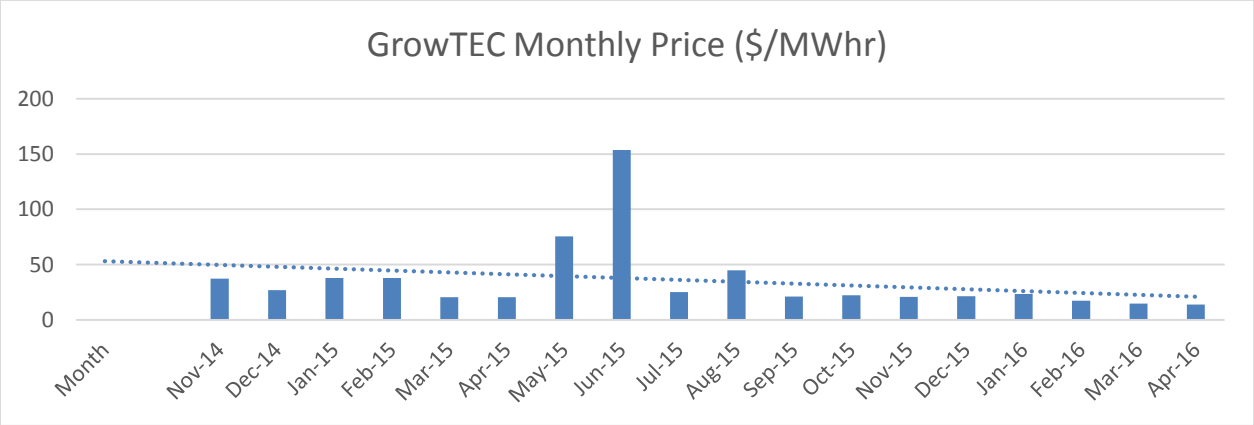


Figure 6. GrowTEC's Monthly Average Price Per MWh Since Commissioning

Since commissioning the plant GrowTEC has been steadily increasing the processing of feedstock and the production of renewable energy from biogas (see Figure 7 below). February and March 2016 saw nearly 2,500 tonnes each month of organic waste diverted and processed.

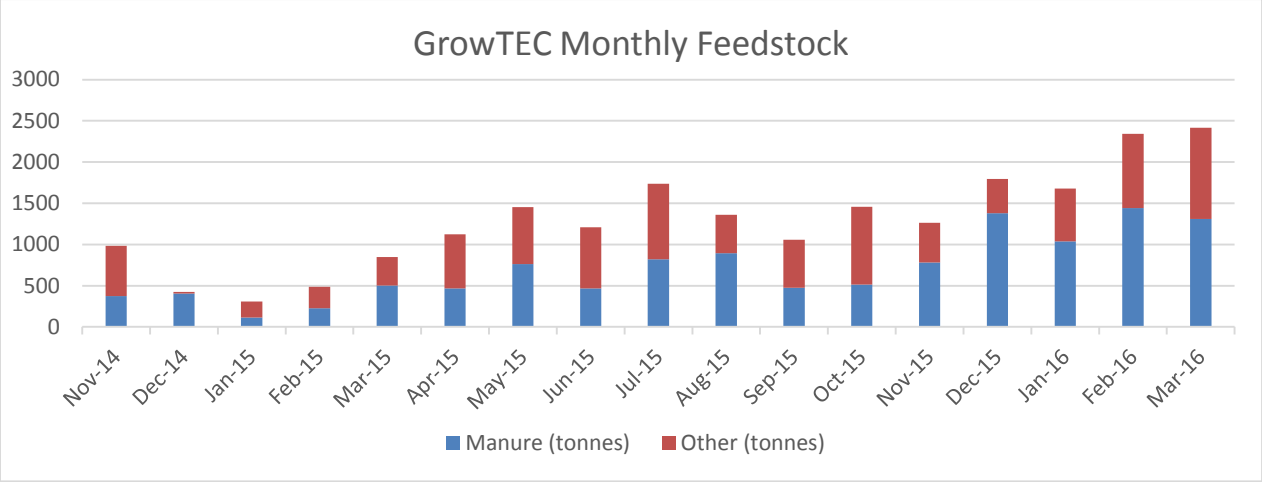


Figure 7. GrowTEC Monthly Feedstock History (tonnes)

GrowTEC has processed over 20,000 tonnes of organic waste to the end of March 2016 to produce 3,400MWh of renewable electricity generated from biogas fed into the Alberta Electricity Grid. Phase 2 has GrowTEC running at full production which will see approximately 25,000 tonnes of organic waste processed each year to produce over 5,000MWh of electricity.

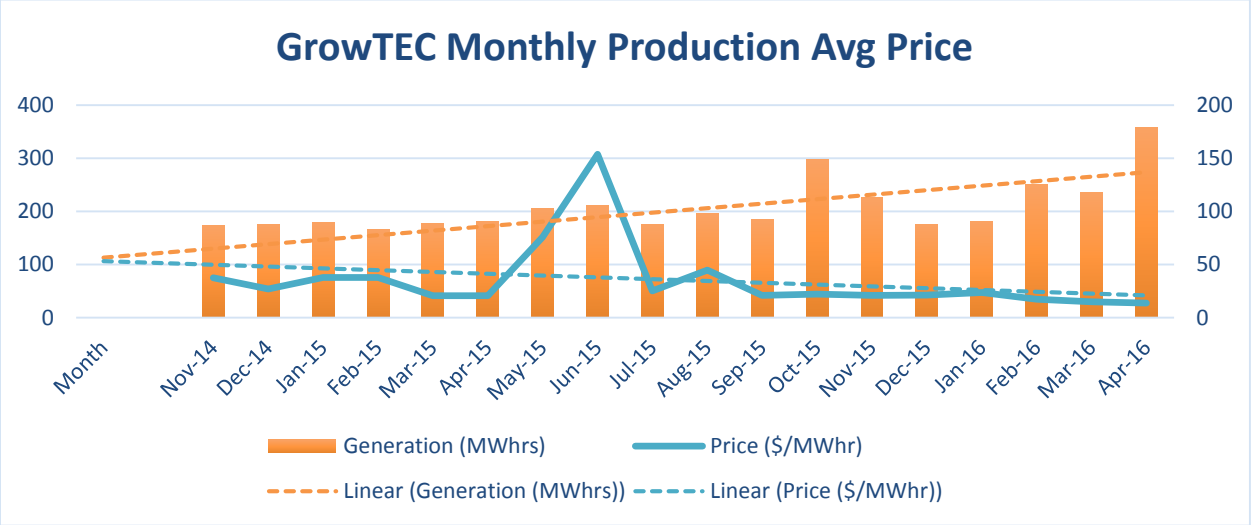


Figure 8. GrowTEC's Trend Lines For Production and Price

One can see from Figure 9 above that 2 general trends are occurring for GrowTEC. GrowTEC is living up to its projected increase in production activity, increasing waste processing of feedstock and in turn increasing renewable electricity production up to near full capacity by March 2016. This is ahead of the original forecast which GrowTEC predicted 2017 to be the first full production year. The other trend is the declining electricity prices and thus revenue for GrowTEC.

No-one predicted the drop in electricity prices that occurred from 2013 at nearly $80/MWh to present levels, it has obviously affected GrowTEC's operations. It must be noted that GrowTEC to receive CCEMC funding was required to withdraw from the Bioenergy Producer Credit Program (BPCP). This Alberta born program provided credit on actual renewable energy produced from biogas at $60/MWh. GrowTEC operated at over a $250,000 loss in 2015 due to the market price. The BPCP program would have been worth approximately $125,000 and significantly helped reduce the loss for GrowTEC.

3.4 GrowTEC Learnings

GrowTEC had a steep learning curve in the regulatory department. GrowTEC is an on-farm biogas facility. The farm regulatory policy is very standard and simple relatively speaking. It is changing and evolving as it should to meet the times best practices, yet at a slow pace. The biogas regulatory process was anything but simple and standard.

Alberta Utilities Commission (AUC) granted GrowTEC Power Plant Approval No. U2012-422 October 1st, 2012. There was a fair amount of overlap with the AESRD application process and the AUC application process. This seemed very redundant at the time. The most challenging aspect of the Power Plant approval for GrowTEC was dealing with the interconnection process. It was extremely expensive, time consuming and frustrating. It did delay our project by 3 months which was expensive. AltaLink at the time required GrowTEC to install outdated communication technology which was nearly impossible to acquire, and the communications dealers (Telus) would not support or guarantee. This caused the delay and attempting to work through the challenges of this were extremely frustrating and time consuming.

The Alberta Environment regulatory process was challenging. We began the regulatory process in early 2011 and were granted an industrial approval as a waste management facility (no. 3032238-00-00) from the Province of Alberta through Environment and Sustainable Resource Development (AESRD) and the Environmental Protection and Enhancement Act. This is partly due to the fact that biogas is a new industry in Alberta and there are no real policies in place specifically for biogas. A number of policies and regulations were utilized from the oil and gas sector which in our opinion were over stringent. There was no previous experience with equipment or some of the process we were attempting to install and led to confusion and challenges around environmental safety.

The additional regulatory cost, along with connecting the facility to the Alberta Electricity grid and connecting utilities to the site was well over $1,000,000. GrowTEC was very grateful for the CCEMC funding which lessened the burden for GrowTEC to bear these costs. Moving forward due to the unfamiliarity with biogas in Alberta, there continues to be an additional operational cost to GrowTEC inclusive of ongoing digestate sampling, soil sampling, groundwater testing and reporting along with other additional costs which are above and beyond the regular practice of farming. GrowTEC for undertaking an innovative and sustainably responsible project is paying a penalty for doing so. This is very unfortunate and we are working with the government and policy makers to hopefully change this for the better moving forward.
A costly lesson for GrowTEC was the original attempt prior to CCEMC funding to design and engineer a built in Alberta solution for biogas. This was not cost competitive to utilizing a vendor

that has experience worldwide building biogas facilities. We were very happy with our choice in the end to enlist PlanET as our technology provider. Having the ability to replicate policy and experienced practice that has been accomplished many times is a very good option forward for streamlining the biogas industry in Alberta. We should learn from other jurisdictions and adjust accordingly for the Alberta demographic in our opinion.

A key operational learning for GrowTEC was processing feedstocks. It was quickly determined there was sound evidence why CLEAN feedstock is highly preferred. Organic waste is a tremendous opportunity, especially feedlot manure and source separated organics. However, contaminants such as rocks, dirt, gravel, plastic and all sorts of foreign objects come with much of the feedstock available. The opportunity of this feedstock moving forward will largely rely on logistically determining a way to get only contamination free organics waste. GrowTEC has purchased equipment and is working on methods to remove some foreign material such as rocks on site.

4. GREENHOUSE GAS AND NON-GHG IMPACTS

4.1 Qualitative Discussion about the GHG Benefits of GrowTEC

GrowTEC completed a greenhouse gas (GHG) emissions reduction report to support the full project proposal to CCEMC in March 2013. The GHG emission reductions report quantification for GrowTEC was supported by Blue Source Canada ULC ('Blue Source') in the production of that report. See *Attachment A. GrowTEC final report – CCEMC FPP Report.pdf.*

The GHG assertion involved quantifying reductions associated with the project compared to a baseline scenario. The most likely baseline, the consumption of electricity from the Alberta Electricity Grid that has been generated through fossil fuel combustion, and the disposal of organic material to landfill, was selected for the quantification via a barriers assessment analysis. On this basis, the project reduced GHG emissions by displacing fossil fuel generated electricity and by avoiding methane emissions from anaerobic decomposition in landfills.

Calculations were carried out in accordance with the Alberta Environment *'Quantification Protocol for the Anaerobic Decomposition of Agricultural Materials, Version 1, September 2007'*. The project scenario was evaluated using the Alberta grid emission factors for production consistent with the Alberta protocols at 0.65 CO_2e/MWh produced.

An estimated annual emissions reduction for the project was 13,623 tonnes CO_2e per year at full capacity (2017 moving forward). This reduction consisted of 3 reduction components from baseline including fertilizer production, organic waste diversion from landfill and renewable electricity production. See Table 2 for details. Formulas and calculation methods can be found in the report.

Biofertilizer produced from the anaerobic digestion process offsets energy intensive synthetic fertilizer. Both the source separated organics (SSO's) and the cull onions would be landfilled in the baseline scenario. Assumptions in this estimate were as follows in Table 2 below.

Emissions in this scenario amounted to 68 CO_2e tonnes (*Attachment A. GrowTEC final report – CCEMC FPP Report.pdf.*), this included allowance for some flaring, venting and feedstock processing which resulted in the NET calculation projected of 13,623 tonnes CO_2e reduced. GrowTEC was able to achieve comparable processing of SSO's and fertilizer production as projected in this original report. Unfortunately, the protocols in place for actual CO_2e credits do not allow for most of the processing that is being done at GrowTEC, so although GrowTEC is still achieving substantial GHG offsets as projected, the allowable credits are significantly less. This was the projected amount based on the variables shown.

Source or Sink	Units	2017 (Full Year)
(B5) Fertilizer Production		
Solid biofertilizer produced`	t	4,247
Nitrogen content of solid biofertilizer	%	2.0%
Liquid biofertilizer produced in Project Scenario	t	6,469
Nitrogen content of liquid biofertilizer	%	0.5%
Biofertilizer - Available Nitrogen to plants (95% available)	t	111
Available nitrogen in Ammonia fertilizer (82%N, 50% available)	t N / t NH_3	0.41
Equivalent tonnes of ammonia fertilizer offset	t	272
Ammonia fertilizer CO_2 application release	t CO2e / t N	5.88
Ammonia fertilizer CO_2 release from production	t CO_2 / t NH_3	1.27
Estimated Emissions	**t CO_2e**	**1,000**
Source or Sink	**Units**	**2017 (Full Year)**
(B8) Co-Substrate Land Filling		
Onions Land filled	t	2,000
SSO land filled (daily)	t / day	10
SSO land filled	t	3,350
Total SSO's and Onions land filled	t	5,350
Methane correction factor (MCF)	none	1.0
Degradable organic content (DOC)	none	0.19
Fraction of DOC dissimilated (DOC_F)	none	0.77
Fraction of methane in off gas from landfill (F)	none	0.5
Methane generation potential (L_0)	t CH_4	522
Oxidation factor (OX)	%	10%
Estimated methane emissions	t CH_4	470
Estimated Emissions	**t CO_2e**	**9,862**
(B10) Grid Electricity Production		
Gross kW's Generated	kW	633
Total Cogenerator electrical output potential in Project Scenario	kWh/day	15,192
Parasitic Load	%	10%
Total anaerobic digester facility electrical load requirement	kWh/day	1,519
Net electricity generation	kWh/day	13,673
Operating days per year	days/year	335
Availability of generators	%	95%
Total net electricity exported	MWh/year	4,351
Estimated Emissions (Industry @ 0.65 t CO_2e/ MWh)	**tCO_2e**	**2,828**

Table 2. GrowTEC's Original Estimated GHG Emission Reductions

See Figure 10 below for accurate numbers indicating the feedstock processed. Note that GrowTEC has processed over 10,000 tonnes of manure and over 8,000 tonnes of other organic waste diverted, and therefor significantly reduced methane emissions from these sources.

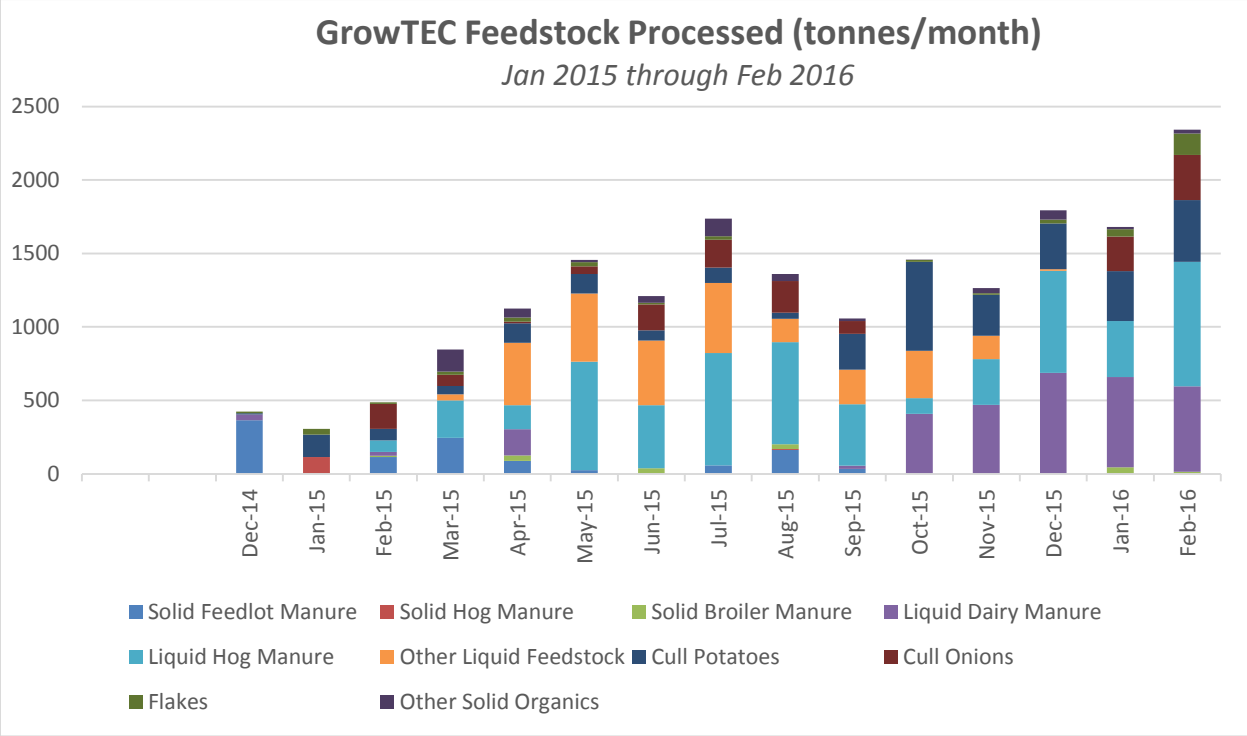


Figure 10. GrowTEC Feedstock Processed by Source

It is worth noting that the Alberta *'Quantification Protocol for the Anaerobic Decomposition of Agricultural Materials'* is currently flagged for review. The anaerobic digestion protocol currently does not allow to quantify and claim a carbon reduction for diverted liquid manure from open storage lagoons into an enclosed anaerobic digester system. The biogas industry in Alberta has been advocating to get this mechanism in place within the protocol, which would substantially help put a real value on the carbon reduction from diverting manure from lagoons thereby reducing methane emissions. Blue Source has been in discussions with Alberta Environment and Parks on this protocol and there is science to validate that for every tonne of liquid manure diverted to a biogas facility from open lagoons would be an approximate CO_2e reduction of 0.22-0.29 tonnes. In GrowTEC's circumstance at 0.25 CO_2e reduction this would add additional offsets of 2,227 tonnes.

Table 3 below shows the actual GHG Emission Reductions achieved by the project from Jan 1, 2015 through Feb 29, 2016. This report was completed by Blue Source recently and is attached as *Attachment B. GrowTEC final report – CCEMC Incremental GHG Summary.pdf*. 832.0 tonnes CO_2e for GrowTEC are the credits considered verifiable for the period today. As one can easily see, this is significantly less than the projected amount, and GrowTEC is hopeful more of the GHG offsets will be recognized in the near future and help the economic feasibility of the biogas industry.

Baseline Emissions	t CO_2	t CH_4	t N_2O	tCO_2e	TOTAL (CO_2e)
Electricity Displacement	0.00	0.00	0.00	1102.16	1102.16
ALL	**0.0000**	**0.0000**	**0.0000**	**1102.16**	**1102.16**
Project Emissions	**t CO_2**	**t CH_4**	**t N_2O**	**tCO_2e**	**TOTAL (CO_2e)**
Fuel Combustion (building use)	43.6265	0.000842	0.000796	0.000000	43.88
Fuel E&P (building use)	3.0252	0.0591	0.000159	0.000000	4.55
Diesel Production	0.0988	0.0078	0.0000	0.0000	0.29
Diesel Combustion	1.9067	0.0001	0.0003	0.0000	1.99
Biogas Vented	0.0000	8.2950	0.0000	0.0000	207.38
Biogas Flared	0.0000	0.0000	0.0000	0.0000	0.01
Electricity Consumption	0.0000	0.0000	0.0000	3.4112	3.41
Biogas Combustion	0.0000	0.0250	0.0236	0.0000	7.67
ALL	**5.0307**	**8.3630**	**0.0013**	**3.41**	**269.19**
Emissions Offset Credits Created	**t CO_2**	**t CH_4**	**t N_2O**	**tCO_2e**	**TOTAL (CO_2e)**
ALL	**-5.0307**	**-8.3630**	**-0.0013**	**1098.75**	**832.00**

Table 3. Actual GHG Emission Reductions Achieved by GrowTEC
(Jan 1, 2015 through Feb 29, 2016)

4.2 Projection of Expected Annual GHG Benefits Going Forward

The projections originally reported on in the CCEMC full project proposal GHG report currently still reflect where the GrowTEC GHG reductions will be. Feedstock amounts are similar although evolve and change as organic waste streams become available and then become unavailable. Regardless, we believe that the prediction accurately reflects the reductions going forward in Table 4 below. This projection uses the amount of 13,623 CO2e reductions from full capacity in 2017 and forward.

All GHGs (t CO2e)	10 year (2014-2023)	20 year (2014-2033)	2050 (2014-2050)
(A) Industry Baseline Emissions	115,265	252,173	416,463
(C) Project Emissions	562	1,234	2,039
Industry Average Reductions (A - C)	114,703	250,940	414,424

Table 4. Project Annual GHG Benefits Going Forward

It should be noted that the actual GHG credits available for GrowTEC are substantially lower than the amount shown. GrowTEC and the biogas industry will continue to advocate for protocols that will allow more of the diverted waste reductions to be verifiable as credits moving forward. Regardless of the actual credits, the project as a whole is a very responsible project resulting in a substantially reduced carbon footprint for our farm and Alberta. The replicated opportunity of this model facility across rural Alberta is significant.

4.3 Potential Future Non-GHG Benefits Resulting from GrowTEC

There are a number of non-GHG benefits resulting from the GrowTEC project. The digestate produced as a by-product of the process reduces odour in the community (as opposed to spreading raw manure for example). The digestate is separated into a solid and a liquid fraction. Both forms are more stable and concentrated than manure, and once processed through the anaerobic digesters and pasteurizers the digestate is also pathogen free. This is a significant benefit for the farm to be able to utilize this facility to guarantee pathogen destruction.

CKPPQ Farms LP is primarily a potato farm at present. Disease carryover and soil inoculation is an ongoing concern and many best practices are in place to limit the disease presence. Cull potatoes that are land spread, or sitting in cull pile pose a threat to the entire southern Alberta potato industry in the form of inoculating diseases such as late blight and spreading that blight to fields at an exponential rate. GrowTEC is able to process the cull potatoes and thus reduce the amount of cull potential inoculum in the area. Through the process GrowTEC is also able to process rotten and diseased potatoes, or potato vines, and destroy the pathogen, resulting in less presence of disease pressure. See attached letter of support from the Potato Growers of Alberta in *Attachment D. GrowTEC final report – Letters of Support.pdf*

An obvious benefit in addition to the GHG emissions reduction from diverting organic landfill waste is the reduced landfill space required. This saves all Albertans. Upwards of 40% by weight of landfill waste in Alberta today is organic in nature. Present opportunities to divert this waste are few in the province and GrowTEC represents a model which could be replicated across the province to provide numerous opportunities to divert organic waste within each demographic. Landfills are extremely costly, subsidized by all Albertans, not to mention numerous negative impacts that go with landfilling waste. The biogas industry provides a great alternative for organic waste management in Alberta going forward.

Biogas facilities provide distributed, 24/7 baseload renewable energy. GrowTEC was visited by executives and board members from the distributed line provider Fortis Alberta in 2015. The executives were very impressed with the facility and have written GrowTEC a letter of support with regards to being a favorable distributed renewable energy provider. This is very significant. Line providers in general are not big fans of renewable energy such as wind and sun renewables as they are intermittent and are a challenge to manage within a very complex system of power generation and distribution across the electricity grid. Biogas is a renewable energy that requires no extra transmission infrastructure, and helps balance the grid from the end of line. This distributed generation helps to clean the power and eliminate power spikes. This is a great benefit to all customers on the local grid supplemented by a biogas generator.

As noted there are numerous non-GHG reduction benefits to the GrowTEC facility. Market access is also relevant. See *Attachment C. GrowTEC final report – Biogas Greatest Hits Summary.pdf* recently presented to the government of Alberta in regards to the biogas industry aligning with many pieces of the climate leadership plan.

5. OVERALL CONCLUSIONS

GrowTEC is learning and evolving every single day. Feedstocks change, come and go, opportunities are abounding and then non-existent. GrowTEC's main stream of revenue is the price received for electricity – When the feasibility was completed in 2007 average price was just under $70/MWh, then it went up and as we finally came on stream for production the price in 2015 came crashing down to just over $30/MWh, the lowest in Alberta history. Present year to date is $15/MWh. GrowTEC was designed to be a long term sustainable project amortized over 20 years with very minimal return. However, we never dreamt we would see a price point of $15/MWh in those 20 years. Challenges are abundant, and we are utilizing equity from the 4th generation farm to sustain the short falls of the present, as the resilient agriculture community in Alberta has done so often.

We are optimistic for the future and Alberta's Climate Leadership plan now has bio-energy as a priority. We are grateful for champions like Minister Shannon Phillips, and past Ag. Minister Doug Horner who support our investment in a greener and more environmentally friendly future in agriculture. Biogas is so much more than just renewable energy, it is an investment that adds resiliency to our backbone agriculture industry in Alberta, greens our electricity grid (75% less GHG emissions than the present Alberta grid) and significantly reduces our carbon footprint while reducing waste at the same time. Plainly put: Biogas is a beautiful thing, and GrowTEC has invested in what it considers the best sustainable practice technology we could incorporate on our farm, we sincerely hope Alberta recognizes this effort and finds value in the industry.

We are extremely grateful for the CCEMC contribution which enabled the GrowTEC biogas facility to be built and operational today. GrowTEC is responsibly managing 25,000 tonnes of organic waste resources. GrowTEC is supplying enough renewable electricity for over 700 homes, baseload 24/7. GrowTEC required no extra transmission lines. GrowTEC is a truly sustainable venture, recycling the nutrients and energy to move toward a self-sustained 4,000 irrigated acre - 25,000 tonne potato farm. Thoughts are things… and today GrowTEC is a reality!

6. NEXT STEPS - GROWTEC'S VISION

- **A Rural Biotech Cluster:** GrowTEC wishes to further create a model of industrial symbiosis, generated by the bioenergy plant through integration with other emerging industrial biotechnology ventures that will capitalize on on-site material and resource utilization, and in return utilize the waste material produced to produce energy in the digester.

- **Organic Waste Utilization:** GrowTEC's operational 633KW on farm scale is replicable by a large number of agricultural operations across the province if market conditions adequately value the carbon and sustainable nature the project. Diversion of organics from landfills is a tremendous opportunity for Alberta.

- **Greenhouse Co-location:** The opportunity to build a greenhouse on site which could utilize residual heat from the process, on-site power for lighting, and clean flue exhaust from the engine are all synergistic

- **Green-Powered ICT Growth:** The digital economy is the fastest growing source of wealth on the planet. The data management industry is the world's fastest growing emitter of greenhouse gases (CO_2). GrowTEC is collaborating with Cybera and Ventus Development Services to build an integrated approach towards growing renewable energy and information and communications technology industries in Alberta and Canada.

- **Precision Agriculture:** Recognizing a digital opportunity in agriculture. GrowTEC, as the vessel for the farms sustainability platform, is enabling "data driven agriculture (DDA)". The goal of DDA is to reduce inputs (water, energy and synthetic fertilizer) by 20%, increase net yield by 20% all by 2020. GrowTEC is collaborating with existing ARD irrigation specialist, agronomists and private precision ag based Sunrise Ag of Taber to demonstrate the feasibility of new practices that can be rolled out to the greater agriculture industry. GrowTEC recognizes the potential to build a green powered technology and agriculture rich business cluster on site that can foster, grow and integrate the precision ag technology available.

Figure 10. GrowTEC Next Steps

7. COMMUNICATIONS PLAN

Chris Perry as president and CEO of GrowTEC is a true advocate for GrowTEC, the biogas industry, and the concept of industrial symbiosis or Bio-clusters. Chris is a regular presenter recognized across the province as an interdisciplinary thinker. Chris has been networking and presenting at numerous workshops and conferences for the past decade, and continues to be a sought after speaker where sustainability in general, sustainable agriculture practice, value added agriculture and bio-cluster are the themes. Chris continuously shares the story of GrowTEC, and acknowledges CCEMC for their contribution.

GrowTEC participates as a member in the Alberta Bioenergy Producer Group (ABPG) as a biogas member. This group brings together bio-energy industries representing bio-fuels, biogas, and bio-mass to energy (forestry). The group is advocating the government on responsible bio-energy value add opportunities for Alberta to invest in the future, for lower carbon intensity industry which can diversify Alberta's economy and provide opportunity for local employment. It is a great opportunity to help balance the conventional energy strength in the province.

GrowTEC maintains a website www.growtheenergy.com along with networking across multiple industries for opportunities around industrial symbiosis. These networking circles include: greenhouse operators, hemp and agricultural fiber processors, information technology and precision agriculture companies with opportunities to locate high speed data transfer and computing mechanisms in rural Alberta.

Chris Perry is presently a member of the Potato Growers of Alberta that communicates on a broad scale across the country for potato related topics. Chris participates in focus groups at both the University of Lethbridge and Lethbridge College for education regarding value adding agriculture and opportunities moving forward. Chris has recently interviewed for a position on the Board of Governors for the University of Lethbridge where his intent, if selected, would be to advocate for student programs around sustainable agriculture and tying in many of the philosophies and principals that brought GrowTEC from dream to reality as an investment for Alberta's future. Indeed, this is the reason Chris was asked to put his name forward for this role, as Chris offers insightful opportunities that focus on a brighter future and help retain the talented youth in Alberta based industries like agriculture.

Agriculture is a backbone of Alberta, investment in sustainable practice in Agriculture like GrowTEC leads to a recycling of wealth and opportunity, creating diversified and resilient opportunities for Alberta's next generations. Chris is a leader in this thought, and continues to share the GrowTEC story, the vision of GrowTEC to come and the opportunities abound for Alberta!