The Team Gemini Closed-Loop System
for Waste and Waste Water
Electrical Energy and Thermal Heating / Cooling

Overview
Industry Development Featuring

- Energy Efficiency
- Water Conservation
- Water Recycling
- Renewable Energy Production
- Waste Processing
- Bio Ethanol Production
- Bioc Fuel + JetFuel Production
- Synthetic Oil Production
- Natural Animal Farming
- Manure Separation
- Food Production
- Food Processing
- Environmental Protection

Gemini Synergy Center Benchmark

- Team Gemini has designed and engineered in each of its Industry Cluster Models a general concept of Energy and Waste Water “closed-loop” System with the following rules:
  - No waste water discharge into the environment / public sewage system
  - No Digestate (effluent) discharge from Biogas Plants into the Sewage system, nor Lagoons
  - Power and Thermal Heat Production from Biogas and/or Syngas Production to offset Project Energy costs + Bio Fuel Production
  - Reuse of recycled (potable grade) Water for Irrigation, Cleaning, Toilet flushing

Team Gemini Closed-Loop System
Any kind of organic Farm waste is going to the Biogas Plant

Solid Manure
Mixed Manure
Is going to the Biogas Plant
Pre-Treatment process and into the Biogas Plant

Liquid Manure is going to the dewatering process
For Nitrogen removal
Sludge is going to the Biogas Plant

Truebridge Farms of Maine
• Farm Waste
• Solid Manure
• Mixed Manure
• Liquid Manure
• Process Flow

Bio Extrusion process
Celluloses and hemicelluloses are decomposed and liberated from lignin layer

Ammonia Stripping
Phosphate Removal
Sulfuric Acid Removal
Creates Revenue Streams

Nitrogen Separation
New Revenues

Digester
Effluent
Discharge

Vibrating Sieve
Support of decanter
Separation of particles (> 75 μm)

Small Flow Rates

Large Flow Rates

Concentrated Fertilizer
New Revenue

No Phosphates
No Sulfuric Acids
No Chemicals
No Environmental Harm
New Revenue

Bio Extrusion is a proven process for faster digestion and a 26% higher biogas yield, no lignin layer built up

The Bioextrusion process was developed by us and is based on hydrothermal (thermo-mechanical) disintegration and has proven its worth for material and energetic usage of fiber plants. During the process the substrate is shortened and partly decomposed into its cell structure by a double-screw extruder with high temperature and pressure resulting in alternating load and multiple pressing/relaxation cycles in the machine. The biogas yield increases due to a better biochemical availability and a strong enhanced surface area. This leads to the formation of new bacteria strains and an improved C/N-ratio, because celluloses and hemicelluloses are decomposed and liberated from the embedding lignin layer. The 5- and 6-times sugar is faster available. Low-molecular and fast transforming substances like alcohol and other compounds develop.

Farm Waste Manure Handling
Small Farm Size

- UDR MonoTube
  - Dimensions: 12ft diameter by 45 ft high (incl. gas storage)
  - Daily Capacity: 8 tons organic feedstock at up to 18% solids
  - Retention Time: 10 to 15 days (depending on the feedstock)
  - Generated Power: 30 to 110 kW (depending on the feedstock)
  - Seismic Tank Foundation: 30 inch reinforced concrete pad (if requested)
  - Installations: less than 2 weeks
  - Start Up: 4-6 weeks (depending on the feedstock)

- All-In-One

Mid- to Large-Sized Farms

- Multiple Up flow-Down flow-Reflow (UDR) Tanks

Farm Waste and Organic Waste streams. Organic Waste streams include:
- Pig Manure (Liquid + Solid Manure)
- Corn Stover, Corn Cobs, Straw + Hay-Waste
- Agriculture Waste + Farm Waste
- Feed Mill Waste + Organic Waste from Food Processing Plants
- Fats, Oils, and Grease (FOG) from Processing Plants
- Slurry Waste from Ethanol Production Plants
- Fruit Waste from Retailer
- Potato Waste
- Cabbage Waste
- Silage Waste
- Spent Grains from Breweries
- Waste from Grain Handling and Processing Facilities
- Lawn Waste
- Leaves and Shrubs
- All other Organic Waste

Biogas Plant
Up Flow + Down Flow Tank System

Digester Tank System

- Very high operating pressures
- Large volume
- Suitable for mammalian urine and fluid food
- Low pressure gas tight
- Low investment and operating costs compared to steel tanks
- Quick installation
- High operational reliability
- Excellent heat retention

Double-Membrane Roof Biogas Collection

Harsh Weather Conditions

Solid enclosed Digester Roof Biogas Collection Chamber inside

Biogas Production Equipment
Jet Agitator in Digester Tank

Variable stirring positions
Intelligent substrate-flexible mixing system ISM

Basic Feedstock Pre-Treatment

• PlurryMaxx

Biogas Production Equipment
CHP Unit
Epower production from 64 kW up to 100 kW
Thermal Heating + Cooling Production

CHP Unit
Epower production from 125 kW up to 2.0 MWh
Thermal Heating + Cooling Production

Combined Heat and Power Units
Comprehensive Basic Scope of Supply all in one Module

- Advanced & Solid Frame Structure
- High Efficiency Gas Base load Engine
- Extra Large Oil Capacity Sump
- Auto Makeup Lubrication System
- Double-Bearing Synchronous Generator
- Biogas Blower / Compressor w. Sensors
- Gas Train & Bio-or Natural gas Fuel System
- Advanced Two-Stage Fuel/Air Mixer
- Micro Process Digital Electronic Ignition
- Heat Value Fluctuation Detection
- Multi-Level Heat Extraction System
- Thermal Circulation System with Pumps
- Thermo Hydronic System w. Exp.Tank

- Heat Exchanger (Jacket & Exhaust)
- Exhaust System / Silencer
- Ultra Low Emissions Capability
- Thermal Heat Extraction & Pumps
- Super Silent Advanced Cooling System
- General Digital Control System
- Utility Grade Switchgear
- Protection Devices & Relays
- Electronically operated Circuit Breaker
- On-Line Remote Control & Monitoring
- Comprehensive Factory Testing

Your Benefits and Advantages:
- Fully integrated H2S and Siloxane Treatment Systems
- Most cost-effective Solution
- Activated Carbon Filter Media specifically developed for

H2S and Siloxane Removal
- Maintenance Free Design
- Process optimized Configuration
- Proven Technology applied at Thousands of Biogas Plants

Fully integrated H2S removal Siloxanes Dehumidification Reheating

CHP + Biogas cleaning to Methane Gas
Hot Water output @ 197F permanent
3-Way discharge for Hot Water
1) Bio Digester Tank Heating
2) Free for fueling Boiler Tanks
3) Free for fueling Heat Exchanger

Offset on CNG  80%
Existing Gas Burner remain in place for Back-up only

Heat Recovery recycled
Exhaust Heat from CHP @ 397F permanent
8400 hrs. p.year runtime
Boiler Tank + Steam Boiler
Heat Exchanger

CHP Thermal Heat Distribution
4 ways using Bio Methane Gas:

1. Fueling CHP Units for ePower production + Thermal Heat Production
2. Fueling Gas Processing Refinery for Bio Fuel Production
   a. Bio Diesel
   b. Jet Fuel
   c. Synthetic Oil
3. Bio Methane Gas liquefaction for Automobile Fuel
4. Bio Methane Gas infiltration to CNG Gas Lines

Upgrading Biogas to Methane Gas

CO₂, H₂O, H₂S, NH₃, partially N₂ & O₂
MSW Waste processing is converted into Syngas WLE Waste liquefaction

- Fueling CHP Units for ePower production + Thermal Heat Production
- Fueling Gas Processing Refinery for Bio Fuel Production
  - Bio Diesel
  - Jet Fuel
  - Synthetic Oil Methane
- Gas liquefaction for Automobile Fuel
- Methane Gas infiltration to CNG Gas Lines

Pre-sorted in categories:
- a) metals
- b) glass
- c) copper recycled

Cellulosic fibers = wood scabs-card board - to WLE processing
Plastics all kinds = film, polyethylene, PVC and other to WLE processing

4 ways using Methane Gas:

Upgrading Syngas to Methane Gas
The following input materials are suitable in WLE processing:

- Strictly waste materials (no competition with food plants)
  - Any type of wood (trunks, branches, chips, saw dust, also treated wood like railway sleepers,
    furniture etc.)
  - Any type of plastics, also PVC
  - Municipal Wastes, also contaminated
  - Straw, Corn Stover, reed grass, rice straw
  - Residues (compost) from anaerobic digestion processes
  - Shells, stones, kernels, husks from nuts, fruit, grain
  - Press cake from oil and fruit pressing
  - Materials washed ashore, on dykes or on weirs
  - Slaughter house waste (hides, carcasses, bone meal)
  - Animal manure
  - No limitation in respect to input moisture
  - Safe elimination of toxic input materials such as Cl, S, Br, Cr, Hg etc. is assured.

- A) liquefaction
  - The raw materials are mixed in a saturated salt solution
  - A chemical reaction at about 200 °C loosening the bonds of molecular structures and causes disintegration and dissolution
  - Complex cellulose / lignin molecules are degraded into soluble organic salts
  - Mineral (insoluble) particles settle to the bottom of the reactor vessel
  - If necessary, specific additives are added, the binding of toxic elements such as chlorine, bromine, heavy metals, etc. in insoluble compounds, which are then also removed by sedimentation.
  - The remaining solution is an aqueous solution of organic salts and phenolic constituents

- B) gasification
  - The liquid solution is pumped to the gasifier, in which a clean, tar-free synthesis gas (H2 + CO) produced
  - The salts from the solution set to be a melt along the walls of the carburetor from, from which they flow off and recovered for reuse in the reactor.

- C) Conversion into Bio Fuels / or electricity
  - The synthesis gas produced is expanded, cooled and converted into electricity in a CHP / or the Synthesis gas produced is going to further Gas Processing for Synthetic Oil / Bio Fuel production
  - However, excess heat is the process itself are available, in addition also for various external applications
Introducing:

**GGL-100**

gulf process gases llc

100 barrel per day
Fisher-Tropsch
Gas-to-Liquids
Modularized
Production Plant
... Natural Gas or other
Methane-rich Feedgas
Conversion to Diesel or
Synthetic Oil

[www.gulfgases.com](http://www.gulfgases.com)

Gas Processing Refinery Bio Fuel Production
GGL Plants Create 10x Value from Natural Gas through a Gas Conversion Process that makes Full-Synthetic Oils, Waxes & Distillates.

$0.10 per Lb
Natural Gas
(~$4/MMBTU)

$1.00 per Lb
Synthetic Oils
(~$7/gallon)

$5 million
EBITDA
($8 million Revenue)

$18 million
CapEx
(Full Installed Cost)

3.5 Years

GGL Plants are designed to Run on a variety of different Feedstocks.

- Natural Gas
- Associated Well Gas
- Vent Gas & VOC’s
- Flare Gas
- Anaerobic Digester Biogas
- MSW Landfill Gas
- Pyrolysis Gas
- Ethane
- NGL’s
- Naptha

Industry proven Technologies

- Fischer Tropsch (synthesis of liquid hydro carbons)
- CLARIANT Catalyst
- Montz Separation Technology

Gas Processing Refinery  Modular
Organic Farm Waste Processing Bio Fuels
**CLARIANT: Cellulosic Ethanol Production**

A fleet test trialling E20 fuel is demonstrating that second generation biofuels are technologically ready and available.

**CLARIANT Catalyst Technology**

Nitrous Oxide emissions

The Clariant catalyst EnviCat N2O used in the EnviNOx process removes almost completely the nitrous oxides and other nitrogen oxides in the tail gas of nitric acid plants.

**Bio Diesel Production**

The new catalyst can be easily integrated into existing plants without structural modifications. The mixture of nitrogen and hydrogen gas circulates in the ammonia synthesis reactor through two or three layers filled with AmoMax-10 known as catalyst beds.
GSC Closed-Loop Waste Water System

- The TG closed-loop for Energy + Waste Water System collects all Waste Water streams on-site with a Vacuum-Drain System, preventing:
  - Pipe Clogging
  - Backflows
  - Pipe Contaminations
  - Odor into the Environment
  - Any discharge into City Sewage System

Reuse of Recycled Waste (potable Water Quality)

- Cleaning Water
- Flushing Toilets
- Irrigation System
- Steam Boiler Tanks
- Hot Water Boiler Tanks
- Heat Exchanger

Waste Water Recycling & Reuse
Animal Drinking water supply method
Cleaning Well Water into potable water quality
for Animal Health protection

Membrane Bio Reactor
Skit-mounted

Applications:
- Residential
- Commercial
- Industrial
- Agricultural
- Municipal

Waste Water Sludge is going into the Biogas Plant

Waste Water System Design & Applications
Fresh Water Supply from Well
Well water is considered “Potable Water” and needed for animal drinking water supply and liquid feeding. To prevent any contamination to the animal Feeding system, any phosphate/sulfur content from the well water will go through the MBR treatment first, resulting in clean drinking water supply.

Fresh Water Supply from Rain Water Harvesting
New Tank Size: 10,000 gallons

Waste Water Sludge is going into the Biogas Plant

Fresh Water Supply & Treatment

From Liquid Manure Separation to:
Ultra Filtration + Reverse Osmosis

Membrane Bio Reactor
Animal Health Protection
Drinking Water Supply + Liquid Feeding to Animals

Distilled clean water Output + recirculation

Concentrated Fertilizer production Output

80% Water conservation + cost savings on Water
Water Treatment Technologies

- Manufactured in the US
- Design-built - Engineered in Germany
- Design-built Tank System
- Pumps and Manifolds + Vacuum Pump System
- Macro Screening + Micro Screening + Fine Screening
- DAF System + Electro DAF System
- Membrane Bio Reactor
- Hygienization + Decoloration
- Ultra Filtration + Reverse Osmosis
- Decanter + Centrifuges
- Vibrating Sieves

Water Micro Floatation Technologies

Waste Water Sludge
Organic Waste
AD – processing

Anaerobic Digestion
With Patented Test Bed Digester
Up Flow - Down Flow - Re-Flow System

Electric Power Production
Thermal-Heat Production

Team Gemini Closed Loop Water Recycling

The information contained in this presentation (including any accompanying attachments) is intended solely for its authorized recipient(s), contains trade secrets and is confidential. As such, this presentation and any attachments and/or documents contained herein may not be disclosed, disseminated or distributed to any unauthorized third party(ies) without the express written consent of Team Gemini LLC.
National Enforcement Initiative:
Preventing Animal Waste from Contaminating Surface and Ground Water

Typical existing Waste Water Lagoons on Animal Farming + Food Processing Plants

Advanced Nutrient Satellite Monitoring by the EPA

Harmful Algal Blooms & Cyanobacteria

Team Gemini proprietary Closed Loop Technology

- Solid Manure / Mixed Solid / Liquid Manure automated Handling on Farms
- Solid + Liquid Manure Separation, new integration + retrofit integration
- Phosphorous + Sulfur + Ammonia reduction + processing
- Biogas AD Plants for single small Farm up to large Animal Farm operation,
- for Food Processing Plants (Poultry + Pigs + Cattle + Vegetable + Eggs + Fish)
- Concentrated Fertilizer Production + Grade A pelletized Compost Production
- Renewable Energy Production + Bio Fuel Production

Cleaning Waste Water Lagoons + Lakes + Rivers
Team Gemini
Development

Design + Layout + process Engineering
Business Concept

E P C M Engineering Procurement Construction Management

Technology Integration

Richard Haugner  C T O  Team Gemini LLC
richard.haugner@teamgemini.us

Thank You