COMPREHENSIVE MATERIAL MANAGEMENT STRATEGY FOR SOLID WASTE MANAGEMENT FOR THE STATE OF CONNECTICUT

Integrated Solid Waste-To-Energy & Recycling Management Plan

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Preface

By combining industry-leading, patented technology with decades of experience in waste and energy projects, Trilogy WC is a full-service, waste conversion platform that is solving America's waste problem in an environmentally friendly and economical way.

We turn MSW, industrial, wastewater, and agricultural waste problems into sources of green energy and jobs while eliminating the need for landfills and other waste disposal/conversion methods that pollute our communities, create liabilities, and slow economic growth.

Figure 1: Astarta Power Plant and Water Treatment Facility, Globino, Ukraine

Table of Contents

1.0 Introduction

1.1 Integrated Solid Waste Management

The methods, technologies, and policies for the management of Municipal Solid Waste (MSW) underwent a period of intensive evaluation and review from the mid 1960's to the mid 1980's. Federal, State and Local governments, along with private sector service providers and the environmental activist community all participated in these efforts to resolve the interrelated issues of dwindling landfill capacity and the environmental consequences of solid waste disposal. The result of that evaluation is the management philosophy commonly identified as Integrated Solid Waste & Recycling Management (ISWRM) plan. This philosophy has been further refined to include the concept of converting 95% of our waste into various forms of energy and/or useable products.

Perhaps the most fundamental goal of ISWRM is to reduce the amount of waste that must ultimately be placed in landfills for disposal. Conservation of landfill space results from effective ISWRM operations. Our overall objective is to reduce the waste that goes to a landfill to zero but in reality this plan will reflect the effect of placing only 5% or less of generally inert materials into the landfill versus 100% and the potential extension of the overall life of each landfill. As you go through this plan you will notice several technologies that we can utilize to reduce the percentage of the inert material by either pyrolysis or gasification. The resultant material will be able to be either placed in a landfill at a much reduce amount or land applied. These materials will be free of any contaminants.

ISWRM is, at its most basic level, a system to manage solid waste through a combination of techniques and programs. ISWRM presents no single solution; it is based on the premise that multiple solutions are needed to address the various elements of waste management and the waste stream. ISWRM plans are designed to address the fact that the municipal solid waste stream is made up of distinct components that can be managed separately.

Another fundamental component of ISWM plans is that they are based on local conditions and circumstances. There is no standard set of technologies or programs for an ISWM plan. The nature of the local area, its population, the nature of its waste stream, and the local resources, economics and environment are the keys to designing an ISWM plan to address local and national needs.

ISWM plans rely on the concept of strategic planning. This means that waste management policies must be established for the long term, and that the planning processshould also involve anticipating changes that are likely to occur in the future. The elements of the ISWM plan, their capacity, and the composition of the waste stream itself need to be regularly assessed as a part of the planning process. The entire strategic planning process of ISWM needs to be an ongoing effort to assure the success of the system.

Flexibility needs to be built into all the elements of an ISWRM plan. This means flexibility in the basic elements of the ISWRM plan, and in the design of the components of the system, to enable them to accommodate change. This flexibility allows an ISWRM plan to respond to changes in regulatory programs, local needs, and changes in the solid waste stream, both in composition and volume.

ISWRM is based on using the various options available for different segments of the waste streams in a hierarchy of waste management alternatives. The hierarchy of management options should be used to evaluate the system components against community needs.

Each of the elements in the hierarchy is interrelated with the others. An essential component of ISWRM plan planning is assuring that the waste management options chosen to complement each other.

The hierarchy of ISWRM as defined in this plan is Handling, Separation, Recycling, Composting, Anaerobic Digestion, Pyrolysis and/or Gasification and Landfill or Land Application. The hierarchy can be visualized as a pyramid, with Separation at the top, and Landfill or Land Application as the base.

2.0 The Waste Management Hierarchy

The Trilogy WC, LLC. ("Trilogy WC") consortium has extensive experience in similar Waste Diversion and Waste to Energy projects across the World. The clear separation of the municipal solid waste components is key to the entire performance and operation of each of our waste diversion facilities. "Clean" separated products are the feed source to the next stage of each waste to energy process.

The clean organics will be processed utilizing Anaerobic Digestion (AD). Our team of expert scientists, engineers, and project specialists has significant experience with this AD process and knows the value in separating the non-organics from the organics before entering the first stage of digestion. Our goal, with innovative, proven technology, along with conventional equipment is to provide feed to the digesters at a 99% organic level. Based on our experience with similar plants, with the low content of non-organics, the digester tanks can be operated for seven to ten years before required cleaning.

2.1 Waste Pickup

As part of our services, Trilogy WC could provide assistance to find reliable pickup services and trucking services from the various groups of waste pickup and hauling companies that we have worked with in the past. We also have the ability to assist current waste pickup and hauling companies upgrade and modernize their fleet with fuel efficient and electric vehicles.

2.2 Waste Handling

Once the waste has been picked up as a part of curb side service or collection points, it could be either delivered directly to our facility or sent to a waste transfer station then to Trilogy WC, LLC. ("Trilogy WC) Waste to Energy facility. At the facility waste hauling vehicles will enter an enclosed waste receiving facility that will have doors that will open and close behind each vehicle as it enters the facility. This enclosed waste handling area has been designed with an air treatment system that will minimize or eliminate waste smells reaching the outside. Then the waste material will be off loaded with pure recycling materials being placed in separate bins and mixed waste being placed in larger bins that will feed the Materials Recovery Facility which will separate all recyclable materials from organic materials and send them to separate areas for processing. During this process bags will be opened so materials can be observed and separated and sent into the appropriate processing areas.

2.3 Sorting

Even with an active recycling program many materials that could be recycled end up in a landfill. To rectify this problem and achieve clean organic material for treatment, Trilogy WC will be utilizing a Materials Recovery Facility (MRF) system for separation of all waste materials. This system will separate all recyclable materials into different collection bins to be recycled or treated for creation into another product. This process eliminates the need for costly numerous curbside pickups that are currently being conducted. The MRF allows for all waste to be picked up in one container or truck.

All plastics #1 through #7 will be separated from the waste stream and processed, on site, in a pyrolysis system that will create oils and Syncrude or gasification system capable of converting the long molecule plastics back into its original form as crude oil. The oil and Syncrude can be sent to a refinery and refined to diesel fuel or converted directly into electricity using a HFO (heavy fuel oil) generator.

If volumes of the Syncrude are large enough a refinery can be developed to create diesel onsite. The diesel is a Class 2 diesel and has a Renewable Identification Number (RIN) of 5 for an Alternative Diesel Fuel and produces a RIN credit of 1.5.

See the below table as the estimate of the various fractions of the MSW that will be separated in this first step in the hierarchy of the IWSRM concept.

2.4 Details of the Separation System

- **Paper, cardboard, grass clippings, woody wastes, green yard waste, and organic food waste** will be processed in an anaerobic digester on site and turned into pipeline grade quality compressed natural gas for distribution through the existing pipelines.
- **Glass** will be crushed and provided to a glass recycler who will transport it from the facility or process it on site into use-able products.
- **Ferrous and nonferrous metals** will be separated and then sold to a scrap metal recycler.
- **Number 1 PET plastics** can be separated and sold to a plastic recycler or placed in the pyrolysis system for creation of a Syncrude.
- **Number 2 to 7 plastics, along with carpets, textiles, and other rubberized products** will be processed by the pyrolysis system or a gasification system for eventual conversion into diesel fuel.
- **Waste tires** of all sizes will be run through a pyrolysis system to create a Syncrude and carbon black or a gasification system on site and converted to oil.

Figure 2: Waste separation schematic flow diagram

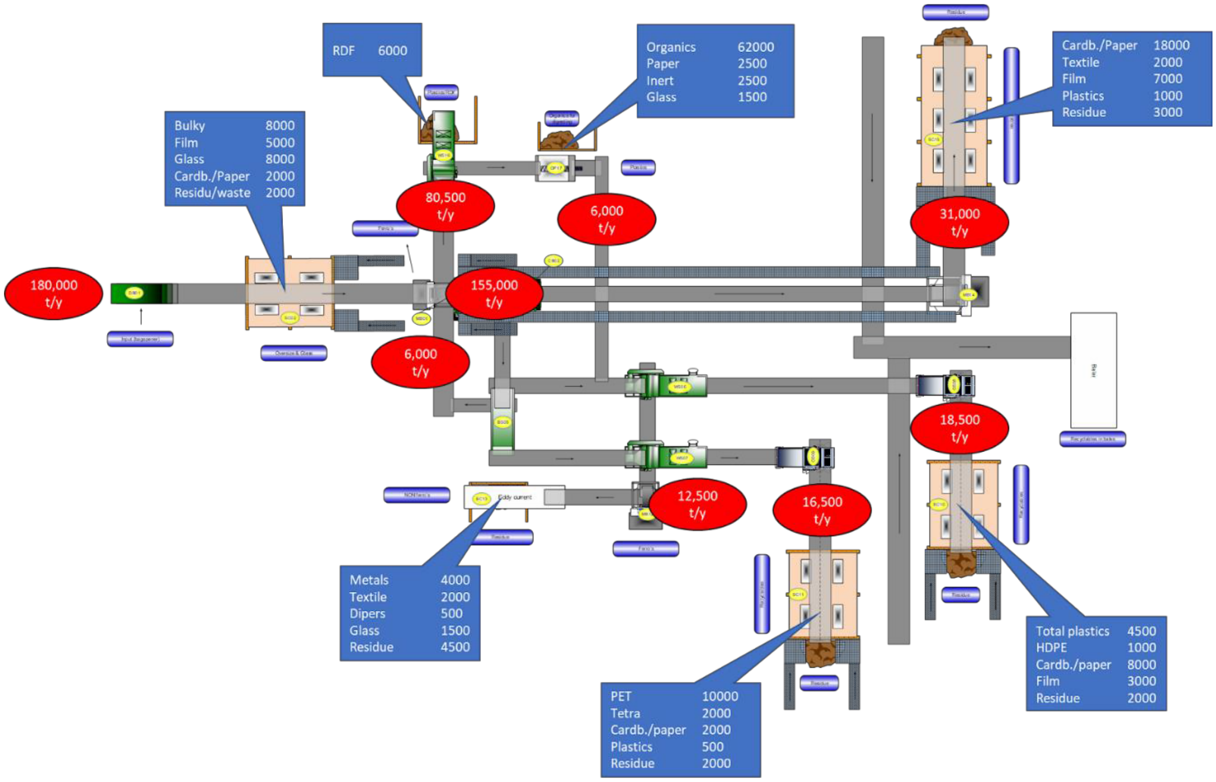
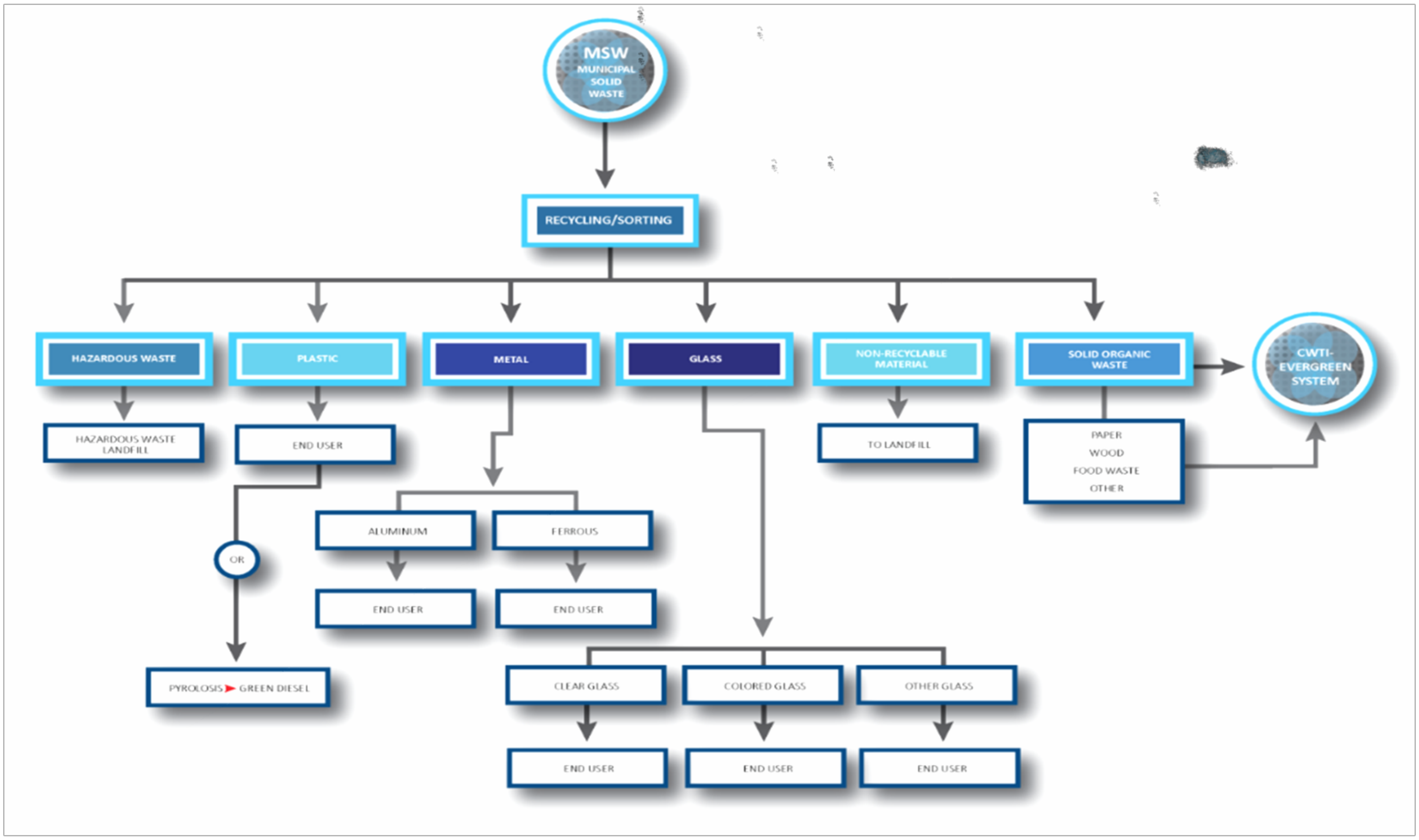


Figure 3: Municipal solid waste sorting process.



2.5 Recycling

Recycling has always been an option in waste management programs. Recycling consists of separating materials from the waste stream, either at the source, or by recovering materials from mixed waste prior to disposal, turning those materials into commodities, often through some form of processing or re-packaging, and returning those materials to the stream of commerce as a feedstock for new products or processes.

Recycling programs typically consist of educational elements to encourage participation (in voluntary programs), compliance and enforcement mechanisms (in mandatory programs), collection programs for source separated materials, processing facilities for source separated materials and recovery of materials from unsegregated wastes, and marketing programs to deliver the recovered commodities to the stream of commerce.

Although individual programs may differ, most address the recycling of a set of basic materials such as containers made of aluminum, glass, ferrous metal and plastic, and paper products such as corrugated cardboard and newspaper.

Participation by waste generators in collection programs plays a significant role in recycling programs, by assuring a steady stream of materials for the market. This means that educational and informational efforts have to be an ongoing component of recycling programs.

Two factors typically exert the most influence in determining which materials will be addressed in recycling programs. The first is legislative mandates. Many state legislatures have identified a list of materials that are to be included in local recycling programs, as well as a target percentage for the recovery and recycling of those materials. The other principal factor is the market demand for the recovered materials. If a stable market for recovered materials is available, preferably at the local or regional level, they can be considered as potential candidates for recycling. Without a stable and reliable market for recovered materials, recycling programs may accumulate quantities of material which may eventually have to be disposed of rather than recycled.

Trilogy WC proposes to recycle as the market allows. When market forces dictate economic and volume recycling, then it makes sense to contribute to this stream of material. When conditions do not allow for this option, then we concentrate on the conversion of these materials to energy or other useable products.

2.6 Composting

Composting is a sub-area of recycling that addresses a fraction of the organic portion of the solid waste stream. At its most basic level, composting uses the action of microorganisms to process waste materials and produce a product that can be used as a soil amendment.

Some industries and segments of the agricultural community have long been using composting as a means to reduce their waste generation and enhance the productivity of their farmland. While some communities have also had long standing composting programs, particularly for yard wastes and leaves, as part of their waste management systems, the impetus for wider application of this waste management tool arose in the late1980's in response to legislativemandates for recycling and waste reduction.

The most common material handled in composting programs is yard waste and leaves. They can also be collected and processed in centralized programs, alone or in combination with other wastes. Wastewater treatment sludge is the material which is most frequently combined with yard waste in centralized composting programs. This combination can be very effective, as it can produce a quality, marketable product, and resolve two waste management issues. While wastewater treatment sludge, meeting the appropriate standards, can be directly applied to some agricultural lands, the long-term reliability of land application as a disposal method, combined with limitations of land application on a day-to-day basis due to weather, make composting of wastewater sludge an attractive alternative for sludge management.

Composting, like recycling, is very dependent on the availability of markets for its products to assure program success. The marketability of compost products is itselfdependent upon the quality of the compost. Both regulations and market demand determine how a given compost product may be used.

We prefer the enclosed, tunnel type composting as we can eliminate odors and improve the efficiency of the process while producing a very high-quality product. Again, composting is a market driven commodity and as the market changes, options will exist to convert the material into electricity and/or natural gas and/or liquid fuels.

Figure 4: Operating compost facilities.

3.0 Anaerobic Digestion

The organics will be converted into natural gas and carbon dioxide through a 150-year-old process called Anaerobic Digestion. This process has been improved through the decades and more recently in the last 5 years to become a very efficient process for any type of organic conversion into renewable energy. This digestion process will be completed in a series of tanks with heights approaching 25 meters. The raw biogas will then be processed in a membrane gas cleaning system which will separate the natural gas into pipeline grade gas as well as food grade carbon dioxide. Carbon dioxide can be sold to a number of industrial applications including greenhouse, food preparation, carbonated beverage, and welding industries. The goal will be to utilize 99% of the biogas produced in the digestion process for useful, renewable purposes. Organics are estimated to contain approximately 50% water and 50% organic solids. The digestion process will require a pumpable slurry of between 13-15% solids and will require the addition of a liquid source. The design will include utilizing liquid human wastewater from a municipal system or individual septic systems. The use of this water in the digestion process will reduce the load on the wastewater treatment plants and create an additional waste stream recovery.

The un-hydrolyzed solids from the digestion process will be separated from the water to be utilized as fertilizer. The digestion process does not alter the Nitrogen, Phosphorus, Potassium (NPK) or micronutrients that were used to grow the organic material to begin with. They will be concentrated in the solid fraction of the digester outflow and become useful for recycling fertilizer repeatedly. This will help reduce the over nitrification of soils and keep the NPK out of the streams and groundwater.

After the digestate water has been cleaned through a patented nano filtration system, it can be reused as process water within the digestion process or any use in the community. The filtration process kills all pathogens that could be in the water at a 100% rate.

3.1 Process Fundamentals

The Energy Park project meets investor return requirements by converting approximately 95% of the solid waste stream, previously destined to be deposited into a landfill, into energy and useable products. By completing these conversions on site, the profitability of the operation is increased significantly.

The organic portion of the MSW, or garbage, amounts to approximately 65% of the total waste stream and will be converted into methane gas through the AD process. This material is very wet, with an approximate 50% water content. Incineration of this material is practiced in many locations, albeit in an inefficient manner. Incineration requires the moisture to be evaporated before the remaining organics can create a net energy output. The process often requires the diversion of dry combustible material to sustain the process. This process is energy-intensive and often energy-negative, requiring additional energy supply such as gas or fuel oil to sustain the combustion.

By comparison, anaerobic digestion processes the wet waste material, such as the organic portion of the MSW and human wastewater, into a slurry that is digested by the bacteria. The carbon in the slurry is biologically converted to biogas (methane) by these naturally living bacteria that can be used as a fuel directly to produce natural gas or used by Gensets to produce electrical power. The energy yield and environmental benefits from anaerobic digestion technology far exceeds the yields and benefits seen in a typical incineration process.

Furthermore, typical incineration of MSW releases a variety of harmful chemicals in the flue gases. The gas must be scrubbed to safeguard public health. Emission of these gases is eliminated through the use of anaerobic digestion and modern gasification processes while retaining the plastic and other components for recycling and/or energy creation. The biogas created through the anaerobic digestion process will be run through a power and/or natural gas generation process and converted into electricity, then placed on the existing grid system or natural gas pipeline. The energy sales are by far the largest source of revenue with our team's technology.

3.2 Process Equipment

The basic equipment required in the AD portion of the Energy Park plant, excluding the separation system, includes the following for processing 100-1000 tons per day of substrate:

1. Transportation of biomass to the site will be by others.

2. Covered and sealed concrete bunkers or steel tanks for wet feedstock and covered, ventilated storage space for dry feedstock. The size of the bunker and storage space depend on daily supply of feedstock.

3. Mobile front-end loaders to transport material to the various feed systems.

4. Scale with load cells or a metered conveyor will feed the right mixture of the feedstock into the conditioning tank and/or pre-conditioning hopper.

5. Conditioning equipment consists of equipment to prepare the feed for efficient processing.

6. Hydro pulper style slurry mixing tanks will be used to make a slurry with a 15% solids consistency. This mixing tank, which combines solid feedstock, liquid feedstock, and recycled water, will be fitted with a bottom outlet design suitable for pumping the slurry mix to the first (pre-hydrolysis stage) of the process.

7. Sealed tanks, arranged in series, make up the hydrolysis stage of the process. These steel or concrete tanks, coated with a spray lining, will vary in size, relative to the digestibility of the feedstock, and will each be fitted with slurry pumps and/or mechanical stirring systems.

8. The total digester capacity, including hydrolysis, will be determined by the current and anticipated total organic feed stock. Depending on the hydrolysis tank sizes required, the methanogenesis digester capacity will vary again dependent on the total feed. These units will be spray lined with a protective coating. Manholes will be designed to allow for mechanical agitation and/or tank maintenance. Also, sampling ports and gas circulation equipment will be included.

9. Digester output will be fed into a digestate treatment unit, generating clean water and a concentrate that will be fed into a screw press or centrifugal separator to separate liquid digestate from hydrolyzed solids, which will exit the separator as a fertilizer product with a moisture content of approximately 70-75%.

10. The liquid separated from the digester solids can be recycled to the front end of the process (feedstock mixing) or discharged.

11. The fertilizer product will be harvested and shipped from the facility in bulk form or bagged for retail markets.

12. The biogas harvested from the final stage in the digester will be scrubbed of water and other contaminants, compressed and discharged for sale as biogas OR will be scrubbed of water and some contaminants and fed into a turbine or an engine to produce green electricity. Electricity production is optional and may be generated in the next stage.

13. Process scale biochemical analysis instrumentation, such as on-line gas chromatography, TOC analyzer, ORP/pH analyzer will provide fully automated, real-time process monitoring with control feedback, tied into other pertinent tests, for evaluation and monitoring of the content of the tanks.

14. A fully automated, input/output capable, customized software-driven process control system, including automatic sampling and monitoring, with “read and feed” technology, will be installed, providing a precise and complete system control. In addition to temperature, pressure, liquid level and liquid / gas flow monitors, the system will include process scale, fully automated, real time biochemical analysis instrumentation, such as on-line gas chromatographs, TOC, ORP and pH monitors with control feedback. Using this system, the Trilogy process will be controlled both on site and/or remotely, via internet link from our headquarters.

15. A small laboratory will be installed on site to verify data from the process control system and provide back up in the event of device failure in the process control system.

Figure 5: Waste diversion input, process, and output diagram.

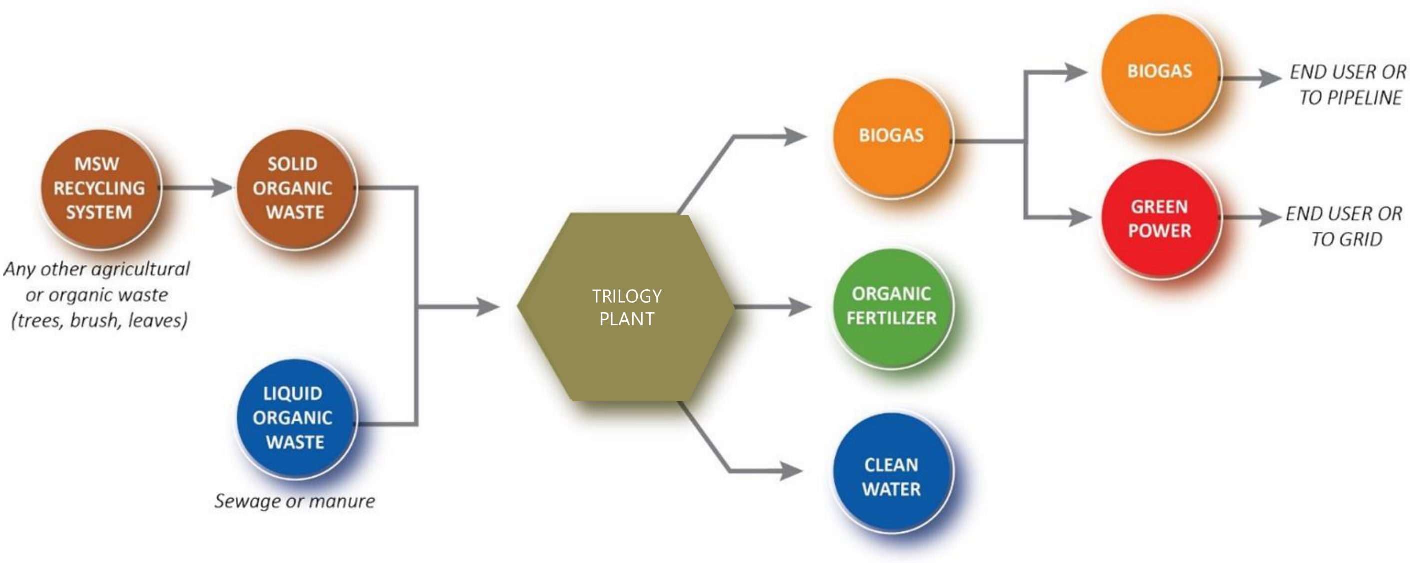
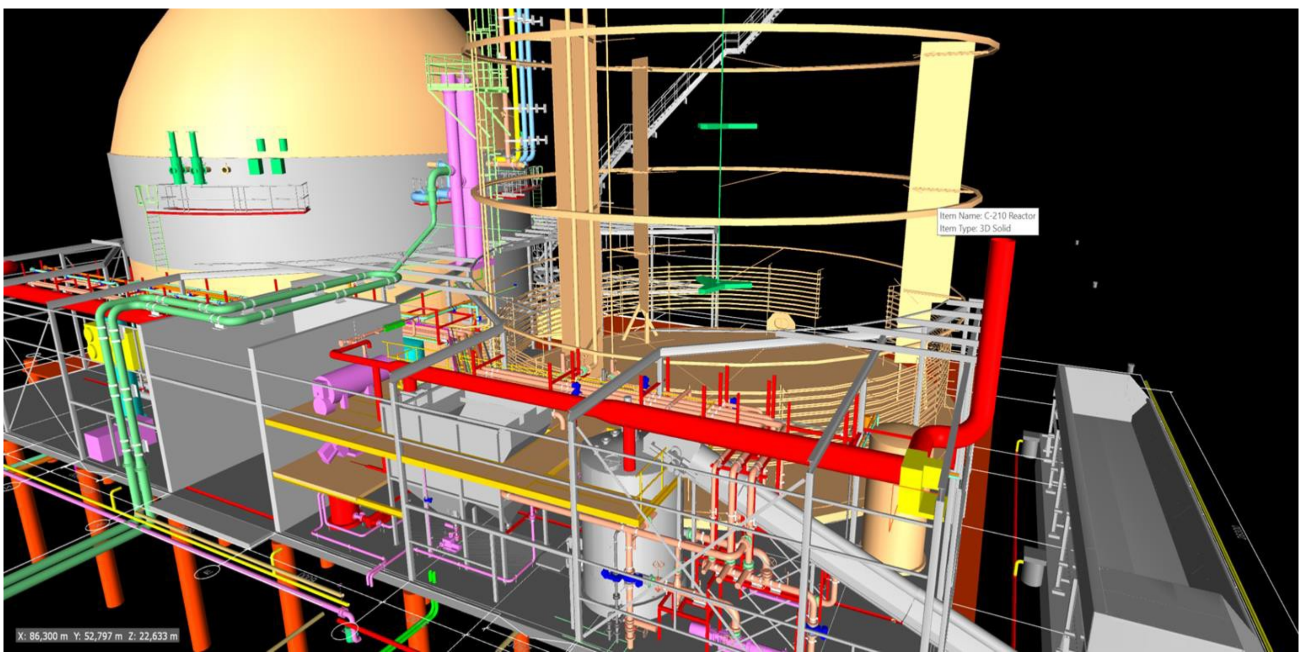


Figure 6: Operating energy park producing biogas and electricity from various organic waste sources.



Figures 7 and 8: Typical waste processing technology prior to digestion and typical 3-D design phase for an operating Waste-to-Energy Energy Park plant.

4.0 Pyrolysis and Co-Pyrolysis

The Pyrolysis and Co-Pyrolysis technologies use a unique process that involves an enhanced thermal carbonization technology. First, a fast pyrolysis technology that uses rotary kiln will be utilized to melt the plastics to make an oil. Then the tires will be carbonized into carbon black and woods will be carbonized to make charcoal or biochar. The metal from the tires will be left for recycling. Secondly, the pyrolysis syngas will go through a thermal oxidation process where a portion of the syngas will used to sustain the heating of the pyrolysis technology. Then the remaining syngas will be put through a series of condensers to produce biocrude oil. By combining the pyrolysis, oxidation, and distillation technologies into a single process with multiply pyrolysis chambers for different feed materials, multiple high value carbon products will be generated. The making of biocrude oil will be achieved with simple tower condensers as the syngas passes through to return to the thermal oxidizer as its fuel. When non-halogenic plastics are used in separate pyrolysis chambers from biomass or blended with biomass (co-pyrolysis), then a high-quality oil is formed in the condenser. Non-halogenic plastics are plastics that do not contain chlorine, fluorine, sulfur, and other halogens. By tight control of the condensers' temperatures, the plastic mass is thermal converted to 80% oil by weight.

4.1 The Chemistry Results

The chemistry of this process is thermal conversion of biomass of various types to make charcoal, biocrude oils, and syngas (methane and hydrogen) by slow pyrolysis is known. Using a portion of the syngas as the self-sustaining heat source for the pyrolysis chambers by thermal oxidation and pollution control is unique. The pyro gases from plastics are similar to wood because they are hydrocarbon molecules without the carbon cellular structure.

- For the pyrolysis of sorted plastics (750 F), the weight yields are 80% oil, 15% syngas, and 5% solids
- For the co-pyrolysis of 50/50 biomass and plastic (750 F), the yields are 60% oil, 25% syngas, and 15% solids.
- Plastics Oil – 133,000 Btu/gal; 108 F flash point; density 0.87 g/cm3; Octane 86; Diesel Index 33
- Biomass/Plastics Oil – 128,000 btu/gal; 105 FP; density 0.84 g/cm3; Octane 81; Diesel Index 31

4.2 Product Value and Application

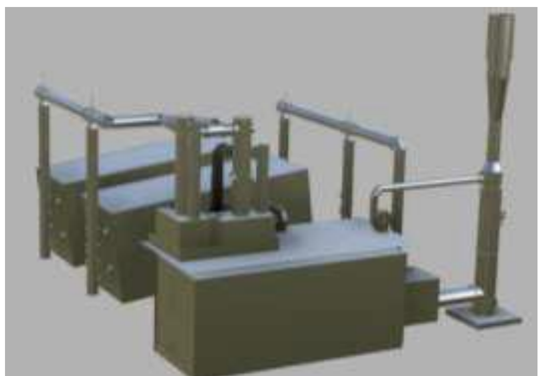
The process is the most efficient and economical process because it can use plastics/tires/biomass waste streams to produce multiple value-added products. The best high value biofuel oil product is the high energy content and very similar properties to diesel. Very little refining is required for the plastics, tires and/or Biomass/plastic blended fuel oil.

4.3 Biomass/Plastics Co-Production Facility

A biomass-plastics co-pyrolysis biofuel oil production process added to the production of charcoal or advanced carbon products such as biochar or carbon black, would have multiple high valued-added products from biomass, plastics, and tire waste streams. Multiple pyrolysis chambers allow for separate or blended products to be developed.

4.4 Digestate to Pyrolysis

The digestate that is remaining from the digester system can be utilized in this system as a substitute or in addition to the biomass. This process will further reduce the digestate that is organic to 20 percent of its mass. The remaining material will be a biochar material and any rocks or sand grains that worked their way through the digester.



Figures 9 & 10: Pyrolysis and Co-pyrolysis unit in Missouri

Figure 11: Char and Wire from Whole Tire Pyrolysis system. (Economics: No Shredding Equipment)

5.0 Gasification

Gasification Facilities includes a Processing Facility on the front end to remove undesirables , Waste Dryers to extract moisture from the waste and convert the waste into higher quality Refuse Derived Fuel (RDF), an Air Fed Gasification System operating at temperatures in the range of 800 to 1,000 ºC to convert the RDF to synthesis gas, Cyclones to reduce the particulate matter concentrations in the synthesis gas, a Slagging Unit to remove the carbon from the ash and convert the ash to slag, a high end flue gas treatment system consisting of an Acid Gas Removal Unit, Ammonia Scrubber, Electrostatic Precipitator, Bag House with Carbon Injection Unit, and Stacks.

In addition, the system features an onsite integrated Wastewater/Water Treatment System, which treats water from the ground, cleaning water, and wastewater from the onsite sanitary facilities to boiler feedwater standards, and then uses the water as makeup process and cooling water. The design also includes an integrated office and control system, maintenance facility, and associated buildings.

The primary advantages of the Gasification Facility proposed, compared to other waste to energy facilities, are as follows:

1. The Gasification System operates at a temperature of 1,000 ºC, which is high enough to destroy all complex organics, including creosote and other chemicals that may have been used to treat the waste, and converts these chemicals to synthesis gas, consisting mainly of CO, H_2, CO_2, H_2O, and N_2.

2. The Gasification System includes a Cyclone to treat the synthesis gas between the Gasifier and Combustion Unit. The Cyclone removes more than 70 percent of the particulate matter and heavy metals, reducing the ash loading on the HRSG Steam Boiler and air pollution control system. This increases the life of the HRSG Steam Boiler, reduces maintenance costs, and reduces the size and cost of the air pollution control system.

3. The Gasification System utilizes a very high efficiency, multi-phase Steam Turbine and Generator for conversion of the high temperature and high-pressure steam to electrical power. The efficiency of the system is on the order to 0.8 to 1.1 kWh/ton of RDF, which is more than twice as efficient as incineration, pyrolysis, and plasma systems.

4. The Air Pollution Control System includes an Acid Gas Removal Unit, Ammonia Scrubber, Electrostatic Precipitator, Bag House with Carbon Injection, and Stack. The Air Pollution Control System reduces emissions concentrations by more than

3 orders of magnitude for particulate matter, heavy metals, dioxins/furans, and VOCs compared to the flue gas concentration, thus allowing the Gasification System to be classified as a Green Energy System.

5. Trilogy WC added a dryer to preheat the various waste going into the Gasifier and recovers water from the feedstock. Drying the waste increases the thermal efficiency. The water is treated to Boiler feedwater standards and is used as makeup process water and cooling water in the facility.

6. The Gasification System provides high-energy output at a very low capital and operating cost, as compared to other gasification systems, waste to energy incineration systems, and plasma systems.

7. A Slagging Unit is added to convert Carbon in the ash into synthesis gas. This increases the thermal efficiency of the system by approximately 10 percent and removes Carbon from the ash. Once the Carbon has been removed from the ash, the ash is suitable for use as a sand replacement in concrete and/or concrete block production. In addition, the Slagging Unit increases the temperature of the ash to 1,450 °C, which melts the ash and converts the ash to slag, which is non-leaching. The slag from the Gasification System will be used in concrete block production and will not be placed in the Inert MSW Landfill.

8. All water in contact with the waste, process water, cooling water, and wastewater from the Processing Facility, Gasification Facility, and sanitary facilities will be treated to Boiler Feedwater Standards and will be reused as makeup process and cooling water. The Facility will not connect to the Municipal Water Supply, will use no city water, and will not discharge any water to the Municipal Sewer System. As a result, the system reuses 100 percent of the process and wastewater, qualifying the system as a Green Facility.

Trilogy WC collects the water in contact with the wood, the cleaning water from the facilities, and wastewater from the sanitary facilities at the site, and harvests rainwater or ground water to provide 100 percent of the water requirements for the operation of the facility. Trilogy WC takes no water from the municipal water supply system, discharges no wastewater to the sewer, and discharges flue gas from the Stack at concentrations that are a minimum of 100 to 1,000 times lower than USEPA Air Quality Standards. In addition, we take no electrical power from the Grid, and disposes no waste byproducts in the landfill. No other waste to energy facility in the world operates at this level of efficiency and provides such a high level of protection of the environment.

Figure 12: Operating gasification facility.

Figure 13: Operating gasification facility, interior view.

6.0 Landfill

Landfills are the single most widely used waste management method in the United States. Landfill disposal capacity is a necessary component of any ISWM plan. This is the case because even though all the above listed waste reduction methods, not all materials can be utilized for other purposes.

Landfills represent the base of the hierarchy, and the one depletable resource of the ISWM plan. Once waste is placed in a landfill for disposal, that capacity is irrevocably lost, and must eventually be replaced. In addition to losing this capacity, theISWM plan must close, care for, and continue to monitor landfills that have reached their capacity. These are the reasons landfill capacity conservation is one of the fundamental objectives of ISWM plans.

Trilogy WC is purposing to target a reduction of 95% of the current waste directed towards the landfill. With only 5% of generally inert waste going to the landfill, the life of landfill increases by 20 times. Therefore, a landfill with a 20-year life becomes 400 years or generations of use versus current methods.

However, Trilogy WC has a goal of Zero waste to the landfill. By treating the digestate with either pyrolysis or gasification processes, the remaining material would be reduced further to grit, sand, rock and char/ash material that could easily be land applied. Then materials like wall board and electronics will be landfill until we can find a recycler or construction demolition facility that can take them.

7.0 Execution Strategy

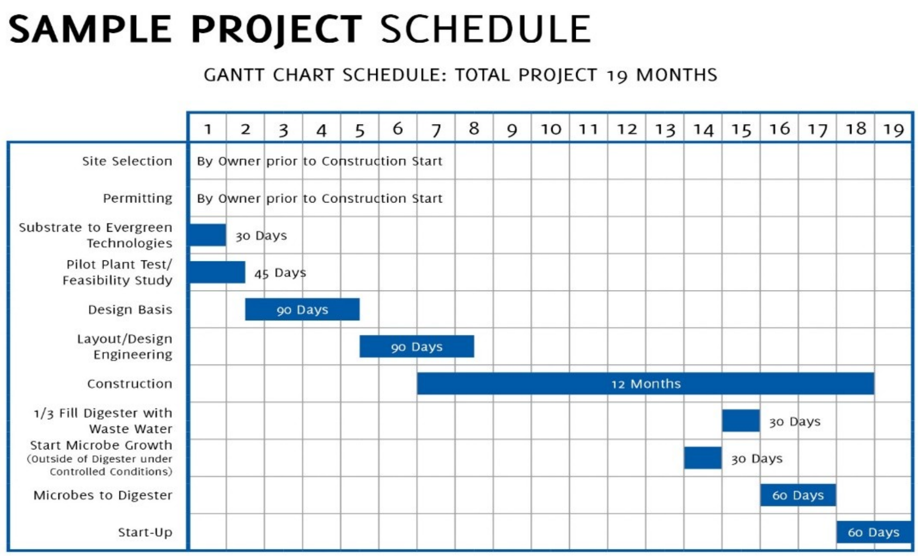
The Waste to Energy Plant project will be developed using a turnkey approach. The process from planning to a completed in the ground project will take 19-to-24-month development period as shown in the Gantt chart provided on the following page. The goal of the project is to recover resources by not filling space in the landfill, while alleviating additional environmental issues, such as reducing or eliminating future landfill leachate production and treatment. We will utilize optimally implemented technologies and management techniques to maximize the project benefits. We utilize turnkey delivery methods to ensure the project is completed on time and on budget to meet project objectives.

Professional experience and lessons learned from past similar projects allows us to develop mechanisms and methods to properly address and respond to the following obstacles:

- Lack of reliable empirical data on waste streams causing process and output data to be assumed. Issue addressed by researching and collecting project-specific data prior to commencing the engineering design phase.
- Lack of available infrastructure and trained personnel in the region to adequately develop and implement the energy project. Issue addressed by conducting a thorough enumeration of needed skill sets and identifying infrastructure needs to support and develop the project.
- Measuring project effectiveness in terms of the following parameters:
- **Successfully achieving project intent and objectives** is measured by adherence to properly developed project design specifications and standards. We develop and define the project goals, specifications, and standards in collaboration with our local partners and regulators. We utilize these metrics to establish project milestones to be achieved at each stage.
- **Project quality** is continually monitored and ensured by a group of licensed professionals. We require our partners to have a well-established quality assurance and quality control program, which measures key parameters such as following the standard of care doctrine to achieve project requirements.

8.0 Timetable and Project Schedule

See the below chart which represents the timeline for the proposed project. The first step in this process will be to designate and/or acquire the necessary land located at the current landfill. We have estimated that if/when the approval is received to move forward, we will require three months of initial engineering, followed by six months to acquire permitting, and 19 months for final design, construction and start-up. With supply chain issues, we estimate approximately 25 months to complete the project.



9.0 Waste Management Plan

The waste plan for the next 10-year period will consist of continuing to landfill at the current rates of approximately 25,000 tons per year, for the next 25 months while design, permitting and construction takes place. At the start-up of the Waste to Energy Park, we propose to consolidate the waste in the area to approximately 200,000 tons per year. This waste will consist of MSW, yard waste, sewage sludge and other liquid waste available. We propose to acquire enough land to allow for growth in the communities that surround the existing landfill. The below table summarizes the 10-year plan.

Table 2: Ten year expected waste tonnage plan distribution to Energy Park and Landfill.

	Tonnage to	
Year	**Energy Park**	**Landfill**
2023	0	25,000
2024	0	25,000
2025	200,000	10,000
2026	200,000	10,000
2027	206,000	10,300
2028	212,180	10,610
2029	218,550	10,930
2030	225,110	11,260
2031	231,860	11,590
2032	238,820	11,940

Waste Management Assumptions:

- For 25 months, tonnage to the landfill will remain similar to current volume.
- Begin transporting waste to the Waste to Energy Park site at the 200,000 tpy at month 26.
- A 3% increase in tonnage begins in 2027.
- 5% or less of total tonnage directed back to landfill or to land application as inert material.
- The 5% landfilled inert material is primarily non-organic (wallboard, electronics, medical waste, etc.).
- Trilogy WC will enter into agreements with other local counties, private haulers, private food production plants to acquire the previously additional noted tonnage.

10.0 Financing Arrangements

Trilogy will finance 100% of the costs associated with the ISWRM. All that is required from the State of Connecticut is assistance in securing, long term feedstock agreements for the MSW and any other types of waste to be processed.

11.0 Next Steps

Steps Needed to Proceed – Development Team and County Representative

1. Secure suitable approximately 15 to 20-acre land parcel.
2. Secure tonnage plan for 200,000 tons per year of the various wastes necessary for the waste to energy park operation.
3. Set up contracts for local Civil Engineering firms to provide oversight of initial geotechnical and environmental drilling at the site.
4. Begin the process of obtaining offtake agreements for the various energy and other products produced.
5. Begin working with the necessary local, municipal and state regulatory agencies to obtain permits for the project.
6. Provide engineering design development phase through approximately 20% of the overall design for the entire project and site.
7. Work with national EPC contractors to obtain a guaranteed maximum price (GMP) for the energy products developed from the Waste to Energy Park.
8. Begin equipment procurement with initial priority on long lead time items.
9. Complete design construction documents and permitting phase. Continue with equipment procurement phase.
10. Complete construction of the multiple phased waste-to-energy Park project. The construction phase will be coordinate with the critical path of the equipment setting schedule.
11. Grow microbes onsite approximately 2-3 months prior to project startup.
12. Complete commissioning, startup, and operation of the Waste-to-Energy project.

12.0 Summary and Recommendations

The role of landfills in the United States and around the world are changing significantly. With the various technologies discussed, it is now possible to convert the vast majority of waste materials into various forms of energy and useable products. All of the technologies discussed, have been used by the development team in many projects around the world. Our team is capable of reducing waste entering municipal solid waste landfills in Connecticut by 93 to 95% or more, while creating an economically viable operation. We require no financial assistance from the local governmental authorities, only support for permitting approvals defined in the previous sections.

Again, as stated in the plan preface section, we intend the Waste to Energy Park concept to become a part of Connecticut's CMMS and not a replacement for it. Our goal is to reduce the waste currently landfilled to the lowest level possible with proven turn-key technologies. We will continue to optimize this process to further reduce landfill usage, thereby extending its overall life.

In conclusion, we are confident the development team will provide a full-service package, from engineering design to start-up and to successful operation and transfer of the Waste to Energy Park. The development team is composed of the most complete biomass-to-energy conversion group available anywhere in the world. The team members are well known in their respective areas of expertise, ranging from microbiology and analytical chemistry to process engineering and power generation. Our team will provide single-source expertise in all facets of waste biomass-to-power conversion.

The consortium will provide initial production estimates for the Waste to Energy Park based on our experience in feedstock processing and conversion and energy plant operation, which spans more than two decades. We utilize and rely on extensive test results based on feedstocks such as wood and forestry wastes, municipal wastewater solids, and organic portions of MSW, all of which continues to produce consistently high-performance data over the past fifteen (15) years. The consortium conducted performance testing of MSW combined with municipal wastewater over a six (6) month period and the successful results have been independently verified.

The consortium designed and constructed many of these waste-to-energy plants around the world, as listed in the appendix. This experience and know-how combined with our patented technology and financing capabilities will enable the development team to successfully complete the Connecticut Waste to Energy Park project. Once approved, the development team will provide accurate final facility sizing and liquid capacity processing and production, capital cost, operating cost and cash flow pro forma, leading, ultimately, to the delivery of a state-of-the-art production facility, precisely customized to the area surrounding Connecticut.

APPENDIX A: Project Experience

Trilogy Consortium Project Experience

Evergreen Energy Mercer Plant	
Location	Mercer, Wisconsin, USA
Capacity	8,000 cubic feet per day of biogas through anaerobic digestion
In operation since	Trials from 2008-2010
Input materials	Aspen wood and human waste
Special features	Natural gas production from hard cellulose
Delivered product	Design of the process in a lab then total engineering, procurement, and construction

Power to Grid/Heat to Customer (Biomass AD) Jointly with OHbE	
Location	Stadskanaal, Netherlands
Capacity	2.000 kWe
In operation since	2012
Input materials	Cattle manure and agro residues
Special features	Ammonia elimination; heat utilization for local hospital
Delivered product	Engineering package

Evergreen Energy Mercer Plant	
Location	Mercer, Wisconsin, USA
Capacity	12,000 cubic feet per day of biogas through anaerobic digestion
In operation since	Trials from 2011-2013
Input materials	Municipal solid waste and human waste
Special features	Produced natural gas to determine output and financial data
Delivered product	Total engineering, procurement, and construction

OTF – Plant Power (AD) Joint Project with Nivoba	
Location	Kislang, Hungary
Capacity	4.000 kW and biogas for steam production
In operation since	2012
Input materials	Cattle manure, straw and agro residues
Special features	Steam production
Delivered product	Conceptual engineering; further implementation is waiting financing

Nasonville Dairy – Energy Plant

Location	Nasonville, Wisconsin, USA
Capacity	2 MW
In operation since	Engineering completed in 2013; permitting underway with start-up anticipated in 2016
Input materials	Cheese production waste materials
Special features	Two-state anaerobic digester with full scale production 750 wet tons/day used to produce biogas to generate power in addition to the thermal recovery
Delivered product	Design-build documents delivered with guaranteed maximum price

ABC Board Company (biomass for board)

Location	Wijster, Netherlands
Capacity	50,000 tons per year
In operation since	N/A
Input materials	Raw biomass fibers
Special features	Cradle-to-cradle end product
Delivered product	Feasibility, business plan, preparation for permits, engineering in progress – expected start-up Q2 2017

Rembrandt Renewable Energy Plant

Location	Renville, Wisconsin, USA
Capacity	Renewable natural gas 776,000 MMBTU/yr
In operation since	2014
Input materials	Chicken litter, ethanol plant corn syrup, milk processing waste, dairy manure, meat processing plant solids, and turkey litter
Special features	600 ton/day anaerobic digestion plant, nutrient recovery facility with P&K (5/9/5) 35,000 tons/yr, and ammonium sulfate (8/0/0/9) 24,000 tons/yr
Delivered product	Design-build documents delivered with guaranteed maximum price

Astarta - Plant Power (Biomass AD)

Location	Globino, Ukraine
Capacity	15,000 kWe equivalent/production of 7,000m^3 biogas/hour
In operation since	1^{st} phase, Dec. 2013/ 2^{nd} phase March 2014
Input materials	Beet pulp and maize silage
Special features	Biogas upgrading and water treatment facility
Delivered product	Engineering package; construction and commissioning support

Nij Bosma Zathe – Retrofit – Power to Grid, Heat to Grid & Gas to Grid (Biomass AD)

Location	Leeuwarden-Goutum, Netherlands
Capacity	700 kWe; 5,000,000 nM^3/year – 36,000 tons biomass/year
In operation since	2014
Input materials	Cattle manure, grass and wood chips
Special features	Retrofit of existing AD facility; proposed AD technology according US patented Hogen® process
Delivered product	Engineering package for retrofit and financing

Biogas Kootstertille – Gas to Grid (Biomass AD)

Location	Kootstertille, Netherlands
Capacity	SDE 1.25mM^3/hour/8,000,000nM^3/year; 75,000 ton biomass/year
In operation since	2014
Input materials	Cattle manure, grass, and wood chips
Special features	Proposed AD technology according US patented Hogen® process
Delivered product	Engineering package for retrofit and financing

Prince Edward Island – Potato Processing Plant

Location	Prince Edward Island (PEI), Canada
Capacity	Confidential
In operation since	Engineering completed 2013, construction in 2016
Input materials	Potato processing waste materials
Special features	300 ton/day anaerobic digestion plant, nutrient recovery facility option in discussions
Delivered product	Design-build documents delivered, waiting on guaranteed maximum price and construction agreement

Phoenix – CAFO Manure Digester/Gasifier Analysis Project

Location	Pinal County, Phoenix, Arizona, USA
Capacity	20 MW with annual generation of about 155.2 GWh (with packed manure)
Capacity	1.3 million MMBTU/year, 167 MMBTU/hour (with slurry manure)
In operation since	Concept development and feasibility reports completed 2013
Input materials	Animal manure and municipal solid waste
Special features	36 CAFOs in the region produce 4.6 million tons of both packed and slurry manure, Integrated Waste Management approach together with County's municipal solid waste; conversion of the biogas to electrical MWH
Delivered product	Arizona Public Service Commission formulating an Environmental Portfolio Standard for their overall Megawatt-hour sales

ABC Board Company (Board and Biogas) with Dabar Ingenieros Valencia, Spain

Location	El Ejido, Andalusia, Spain
Capacity	50,000-ton board and 3 MW for electricity and heat
In operation since	N/A
Input materials	Biomass fibers from tomato and pepper
Special features	Own energy production; cradle-to-cradle end product
Delivered product	Feasibility, business plan, permits documents; waiting for financial close; engineering in progress; expected start-up Q2 2017

Palestine – Power to Grid (Biomass AD)

Location	Hebron, Palestine Territory; farm lined AD facility
Capacity	340 kWe
In operation since	Scheduled for Q1 2017
Input materials	Cattle manure and agro residues
Special features	Project partly funded by EVD/NL foreign affairs
Delivered product	Feasibility and engineering package completed; waiting for permit approval; detailed engineering in progress; tasks: project management, supply of key equipment and (local) construction

South Korea – Power (Biomass from Sewage / AD)

Location	Incheon/Seoul, South Korea; AD facility linked to sewage plant
Capacity	1,800 kWe
In operation since	Scheduled for Q4 2016
Input materials	Sewage sludge and food residues
Special features	A digestate dryer and wastewater treatment system included
Delivered product	Feasibility study and conceptual engineering completed; scheduled in 2014, complete EPCM contract; waiting for financial close

Biogas Wijster – Gas to Grid (Biomass AD)

Location	Wijster - ETP, Netherlands
Capacity	1.250nM^3/hour - 10,000,000nM^3/year; 90,000 ton biomass/year
In operation since	Scheduled start Q1 2017
Input materials	Cattle manure, grass, and wood chips
Special features	Proposed AD technology according US patented Hogen® Process
Delivered product	Engineering package for permit and SDE application; permits & SDE awarded; project owner is waiting for financing

ESP Plant Power & Fertilizer (Biomass AD) with Dabar Ingenieros Valencia, Spain

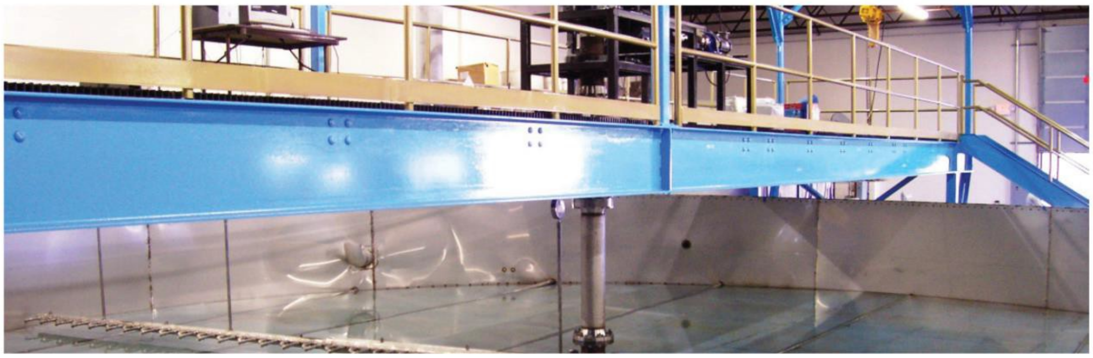
Location	Torre Pacheco I, Murcia, Spain
Capacity	1.000 kWe
In operation since	N/A
Input materials	Cattle manure and agro residues
Special features	Evaporator and dryer for biofertilizer
Delivered product	Full permit and engineering package; construction on hold for financing

ESP Plant Power & Fertilizer (Biomass AD) with Dabar Ingenieros Valencia, Spain

Location	Torre Pacheco II, Murcia, Spain
Capacity	1.000 kWe
In operation since	N/A
Input materials	Cattle manure and agro residues
Special features	Dryer for biofertilizer
Delivered product	Full permit and engineering package; construction on hold for financing

ESP Plant Power & Fertilizer (Biomass AD) with Dabar Ingenieros Valencia, Spain

Location	Guadassuar, Murcia, Spain
Capacity	1.000 kWe
In operation since	N/A
Input materials	Cattle manure and agro residues
Special features	Dryer for biofertilizer
Delivered product	Full permit and engineering package; construction on hold for financing



ESP Plant Power & Fertilizer (Biomass AD) with Dabar Ingenieros Valencia, Spain

Location	Sarrion, Teruel, Spain
Capacity	1.000 kWe
In operation since	N/A
Input materials	Cattle manure and agro residues
Special features	Dryer for biofertilizer
Delivered product	Full permit and engineering package; construction on hold for financing

UK – Power to Grid (Biomass AD)

Location	Methwold, East Anglia, United Kingdom
Capacity	1.600 kWe
In operation since	N/A
Input materials	Pig and broiler manure and agro residues
Special features	Feedstock supply and digestate offset completely within the same estate
Delivered product	Full permit and complete engineering package; construction on hold for financing