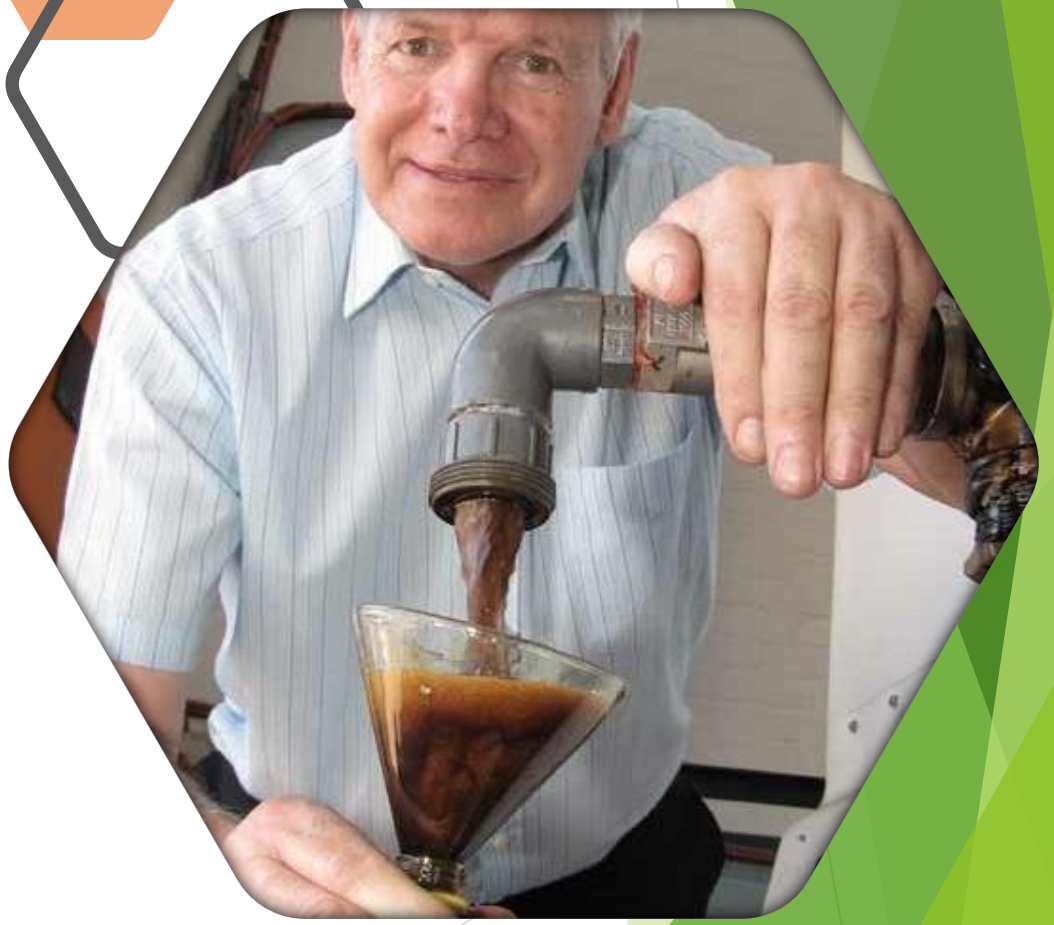
GrahamTek™

FUEL TECHNOLOGY WASTE
to ENERGY

The History

The use of Pyrolysis as a means to extract/recover oil from rubber and plastic has been in use for several decades. In the early 1950's Bell Laboratories in the US started researching the commercial viability of Pyrolysis. Pyrolysis is a favoured model to recycle used tyres and other hydrocarbon plastics and there are several suppliers offering equipment that is in use globally. It is a preferred method above that of incineration as the process does not create toxic metal residue or Dioxins and Furans as hazardous gasses. Since the mid 1980's the commercial use and application of Pyrolysis has been introduced in the market space and is widely used. Today Pyrolysis is a proven technology. The research materials, demonstration facilities, existing commercial facilities and plants under construction provide ample proof that Pyrolysis is neither new nor untested.



The Process

This treatment process of waste into usable products reduces the reliance on fossil fuels and natural resources and at the same time reduces the impact of un-degradable waste that is harmful to the environment.

The Process

- The technology uses a patented process of thermal mechanical cracking where the long carbon chains in the carbon waste are divided into smaller carbon chains, which changes the physical attributes of the waste.
- Carbon containing general waste is inserted into a reactor chamber and is decomposed under heat creating a vapour in the absence of oxygen and any chemical catalysts. There is no combustion or incineration of the waste. The vapour is condensed where the carbon chain is “cracked” through a mechanical process that is part of the uniqueness of the technology and a significant part of the Intellectual Property that resides in this technology.
- The vapour forms a synthetic gas or SYNGAS that is converted into Light Fuel Oil (LFO) and Heavy Fuel Oil (HFO) as it passes through the Thermal Cracking Units (TCU). By-Products include LFO, Marine Diesel Oil (MDO) and Marine Gas Oil (MGO).
- The technology is a closed loop system designed for zero emissions throughout the process with a series of scrubbers and condensers ensuring no hazardous gases, ash or other hazardous materials are released from the system.

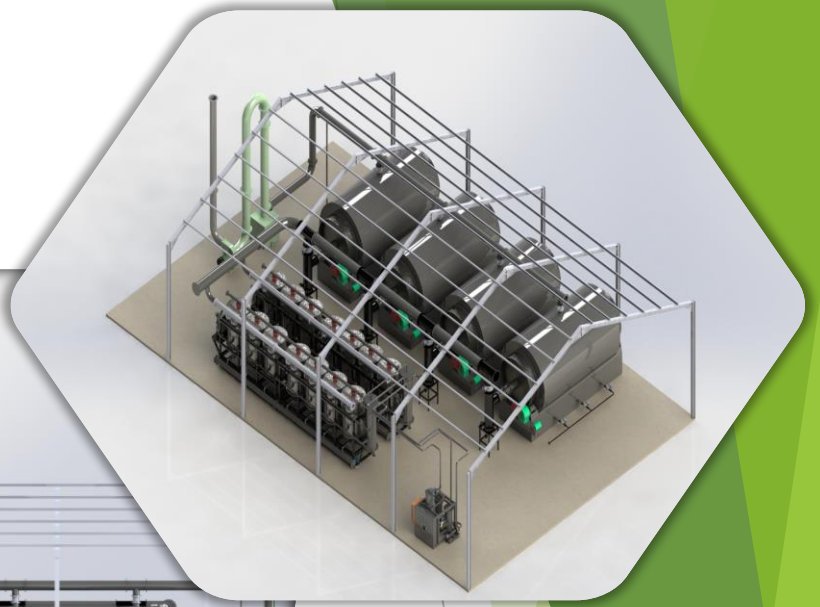
The Plant

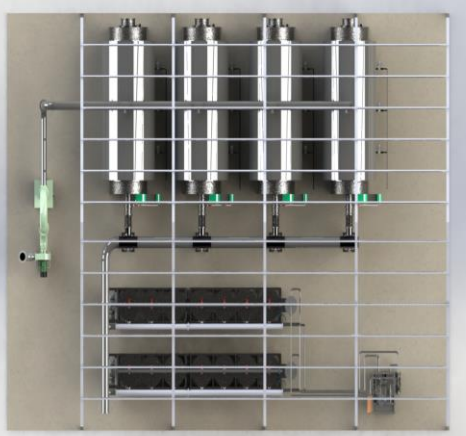
The main product purpose of the GrahamTek™ Waste-to-Energy technology is to provide energy in the form of oil or gas, with high quality by-products of carbon char, scrap metal & glass. Feedstock includes hydrocarbon waste recycling, tyre recycling, waste oil recycling, oil refinery cutter stock, e-waste recycling, municipal solid waste recycling and medical waste recycling.

The Plant

- The Plant has a minimal processing footprint of 500 m^2 under roof and a further 500 m^2 to sort and process the incoming waste and the residue waste from the process, making the footprint a total of 1,000 m^2 of operating space.

- The plant can recycle up to 20 tonnes of waste per day or 400 tonnes per month, which produces on average 200,000 litres of oil and 100 tonnes of carbon black per month. The plant is modular and scalable and can be configured for higher processing volumes.





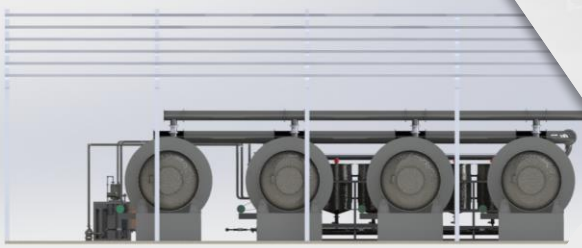
- The plant has several built-in safety features including prevention, pressure and flow rate monitoring, as well as mechanical emergency stoppage. In addition the plant functions completely off-grid and has been designed to feed power back into the grid.

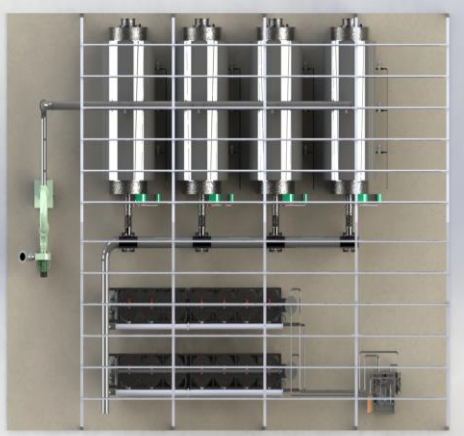
- There is minimal noise pollution; the noise emanating from the plant is mostly from a 4kw motor for power generation on site. The generator removes the reliance on external power and is an additional safety feature. Additional safety is provided through the global 24x7 remote management of the system by GrahamTek operations in Cape Town, South Africa.

Trails

A 5 year development cycle and 12 months of trial production was completed with the current status as follows:

- A fully closed loop design with no environmental impact. Current EIA to test against EU emission standards.
- A fully commissioned CAPEX of ±US$ 0.05 per litre produced
- No chemical catalyst required for carbon link separation and its GTL (Gas to Liquid) process, reducing production cost to less than US$ 0.08 per litre (excluding feedstock).
- A design with consistent results over multiple waste streams and waste stream blends such as Tyres, e-Waste, Medical Waste and general household waste.
- Produces consistently high quality Refuse Derived Fuels (RDF) such as Furnace Oils and Diesel from multiple hydrocarbon waste streams, on European RDF Standard.
- Use of the equipment reduces Landfill Airspace by 97% resulting in increased life of existing landfill sites for Waste Management companies.
- A design with consistent results over multiple waste streams and waste stream blends such as Tyres, e-Waste, Medical Waste and general household waste.
- An operating footprint of ±1,000 m^2.





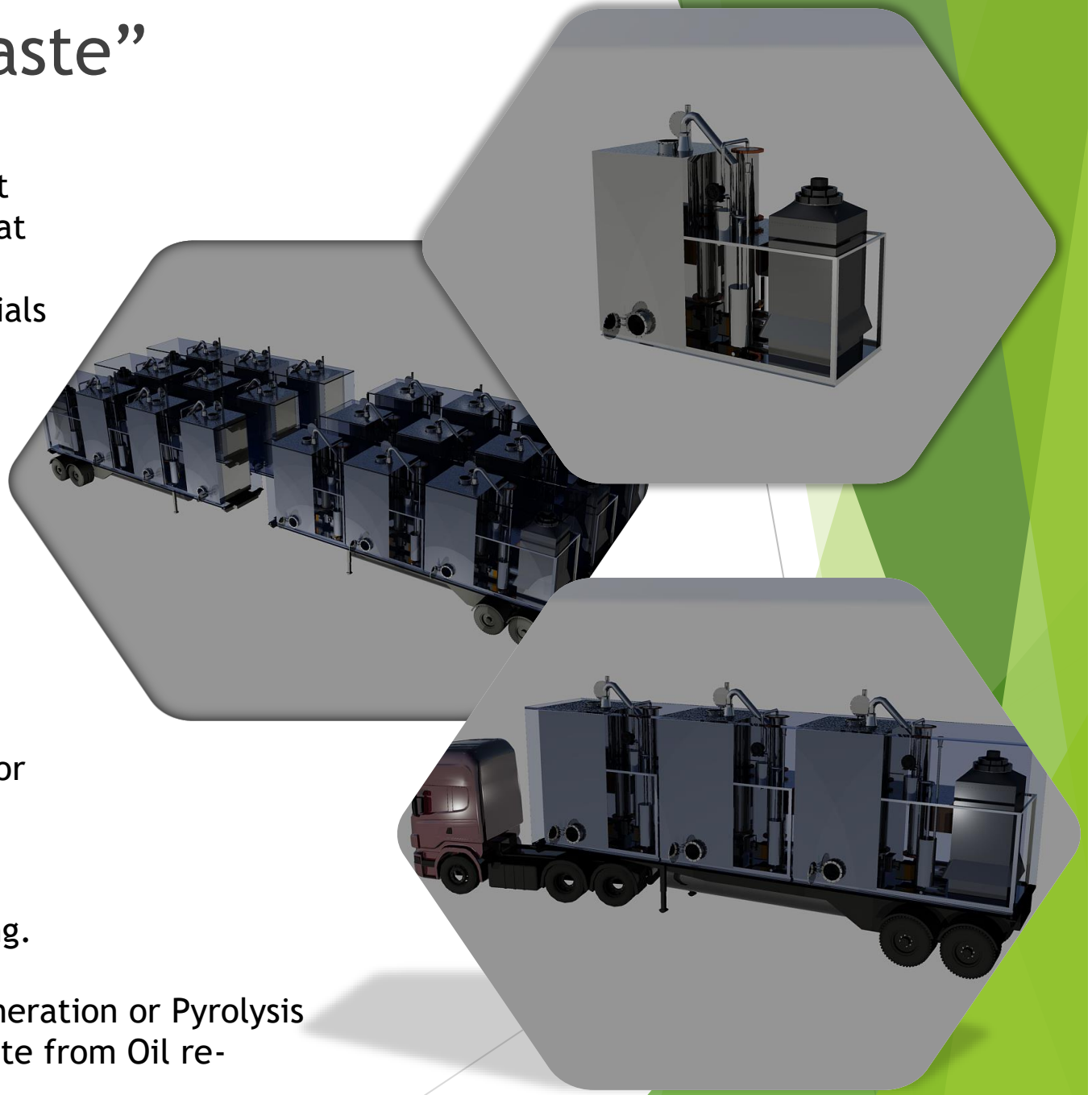
Waste Categories

The proposed Waste Management Activity is classified as a Waste Recycling and Recovery process using Pyrolysis based Thermal Treatment in line with the Waste Management Hierarchy and the requirements of the various Policies on Thermal Treatment of Waste - including Pyrolysis as a Complimentary Waste Management option. This Waste Management Activity is further defined as a Waste Minimisation Programme and creates high quality Refuse Derived Fuels.

Category A: “Hazardous Waste”

Means any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment and includes hazardous substances, materials or objects within business waste or residue deposits as outlined below:

- (4) Waste from Petroleum Refining and Natural gas Purification.
- (6) Waste from Organic Chemical Process: (b) MFSU of Plastics, Synthetic Rubber, Manmade Fibres; (e) Pharmaceuticals
- (12) Oil Waste & Liquid Fuels: (d) Oil/Water Separator Waste; (e) Waste of Liquid Fuels.
- (14) Other non specified; (c) Unused and off-spec batches; (f) waste from barrel cleaning/tank cleaning.
- (17) Waste from Waste Treatment Facilities: (a) Incineration or Pyrolysis Waste; (g) Metal containing shredded waste; (h) Waste from Oil re-generation.



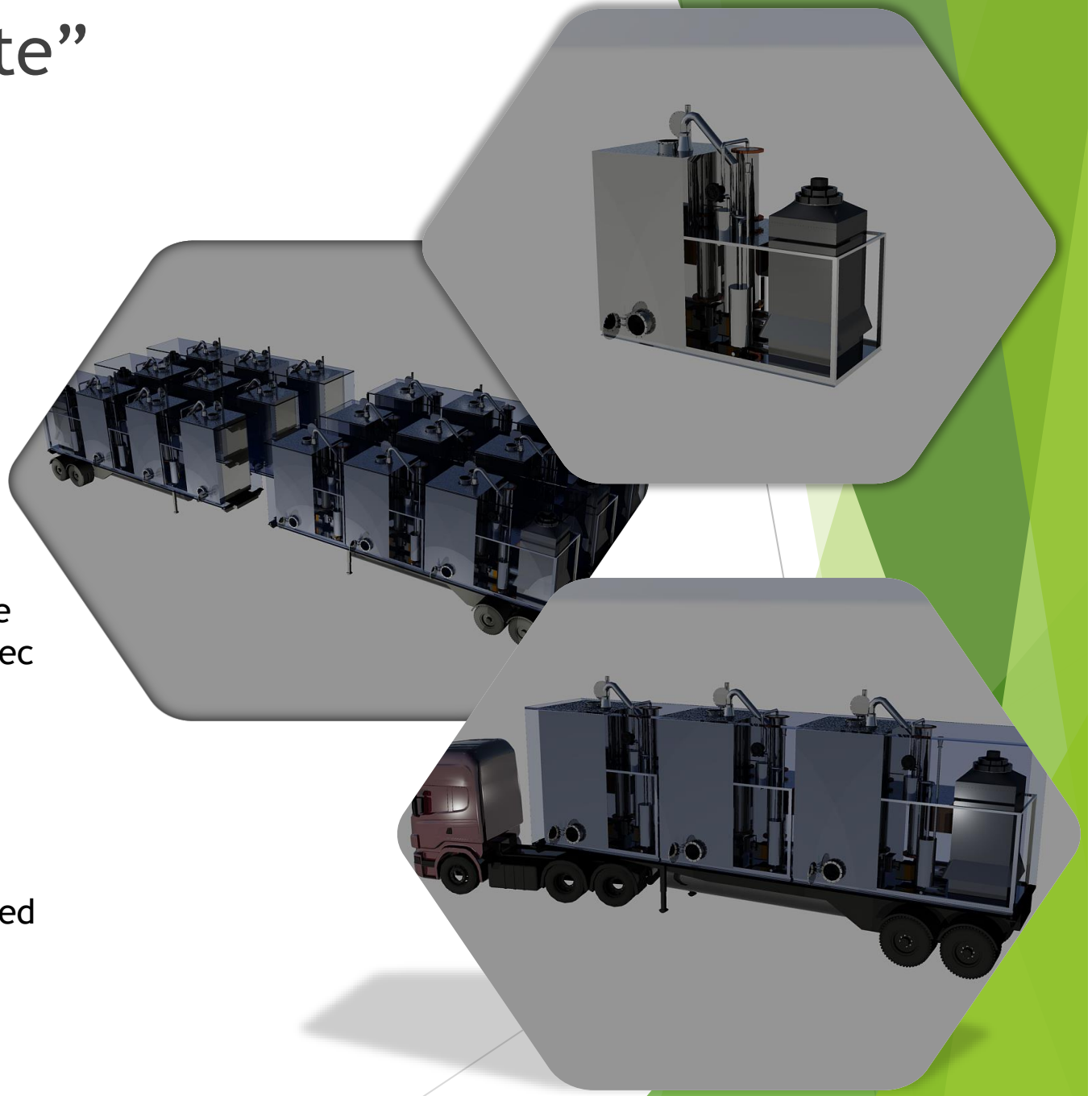
Category B: “General Waste”

Means waste that does not pose an immediate hazard or threat to health or to the environment, and includes:

- (a) Domestic Waste
- (b) Building and Demolition Waste
- (c) Business Waste
- (d) Inert Waste
- (e) Any waste classified as non-hazardous waste in terms of the regulations made undersection 69 of NEM:WA, and includes non hazardous substances, material or objects within business, domestic, inert, building and demolition wastes.

Category C: “Business Waste”

- (4) Waste from thermal Process: (a) Waste from other combustion plants and power stations.
- (7) Oil Waste and Liquid Fuel: (a) Oil waste
- (8) Other Waste not Specified: (a) End-of-Life vehicle and machinery; (b) Electronic; (c) Unused and off-spec batches.
- (10) Waste from Waste Treatment Facilities: (a) Incineration or pyrolysis waste; (d) Metal containing shredded waste; (e) Waste from mechanically threated waste (sorting, crushing, shredding, pelletizing).



Waste Categories used in Process:

GW10 - Commercial & Industrial Waste

GW18 - Waste of Electric & Electronic Equipment (WEEE) from which hazardous components/substances have been removed

01 – Large Household Appliances

02 – Small Household Appliances

03 – Office, Information & Communication Equipment

04 – Entertainment, Consumer Electronics & Toys, Leisure, Sport & Recreational Equipment & Machinery

05 – Lighting Equipment

06 – Electric & Electronic Tools

07 – Security and Healthcare Equipment

08 – Mixed WEEE

GW51 - Plastic

01 – Polyethylene Terephthalate (PET)

03 – Low Density Polyethylene (LDPE)

04 – Polypropylene (PP)

05 – Polystyrene (PS)

06 – Other Plastics (HDPE)

GW54 - Tyres

Excluded Waste Streams

The following waste is excluded from any process of GrahamTek™ Fuel Technology, any waste that consist of or includes:

- Anatomical, Infectious or Biologically Active Medical/Health Care Waste.
- Asbestos Containing Waste.
- Bio-Hazardous Waste.
- Entire Batteries.
- Explosives.
- Mineral Acids and Corrosives.
- Radioactive Waste.
- Any POP Containing Waste.
- Unsorted Municipal Waste.
- Unknown or Unidentified Wastes.

Waste Regulations

The regulatory framework varies from country to country and within regions of countries. GrahamTek™ has evaluated some of the more sensitive regulations and designed its standard Equipment Set to meet the more stringent regulations. For larger scale operations a full Environmental Assessment Study would typically be required. GrahamTek™ uses Worley Parsons, a global partner, as its Environmental Assessment Consultants. The list below provides the context to a basic EIA for the Standard Plant Design.

- **GNR 921: s3(2) Category A - Basic Assessment** – "The sorting, shredding, grinding, crushing, screening or bailing of general waste at a facility that has an operational area in excess of 1000m2."
- **GNR 921: s3(3) Category A - Basic Assessment** – "The recycling of general waste at a facility that has an operational area in excess of 500m2, excluding recycling that takes place as an integral part of an internal manufacturing process within the same premises."
- **GNR 921: s3(4) Category A - Basic Assessment** – "The recycling of hazardous waste in excess of 500kg but less than 1 ton per day calculated as a monthly average, excluding recycling that takes place as an integral part of an internal manufacturing process within the same premises."
- **GNR 921: s3(5) Category A - Basic Assessment** – "The recovery of waste including the refining, utilisation, or co-processing of waste in excess of 10 tons but less than 100 tons of general waste per day or in excess of 500kg but less than 1 ton of hazardous waste per day, excluding recovery that takes place as an integral part of an internal manufacturing process within the same premises."
- **GNR 921: s3(6) Category A - Basic Assessment** – "The treatment of general waste using any form of treatment at a facility that has the capacity to process in excess of 10 tons but less than 100 tons."
- **GNR 921: s3(7) Category A - Basic Assessment** – "The treatment of hazardous waste using any form of treatment at a facility that has the capacity to process in excess of 500kg but less than 1 ton per day excluding the treatment of effluent, wastewater or sewage."

Air Emissions

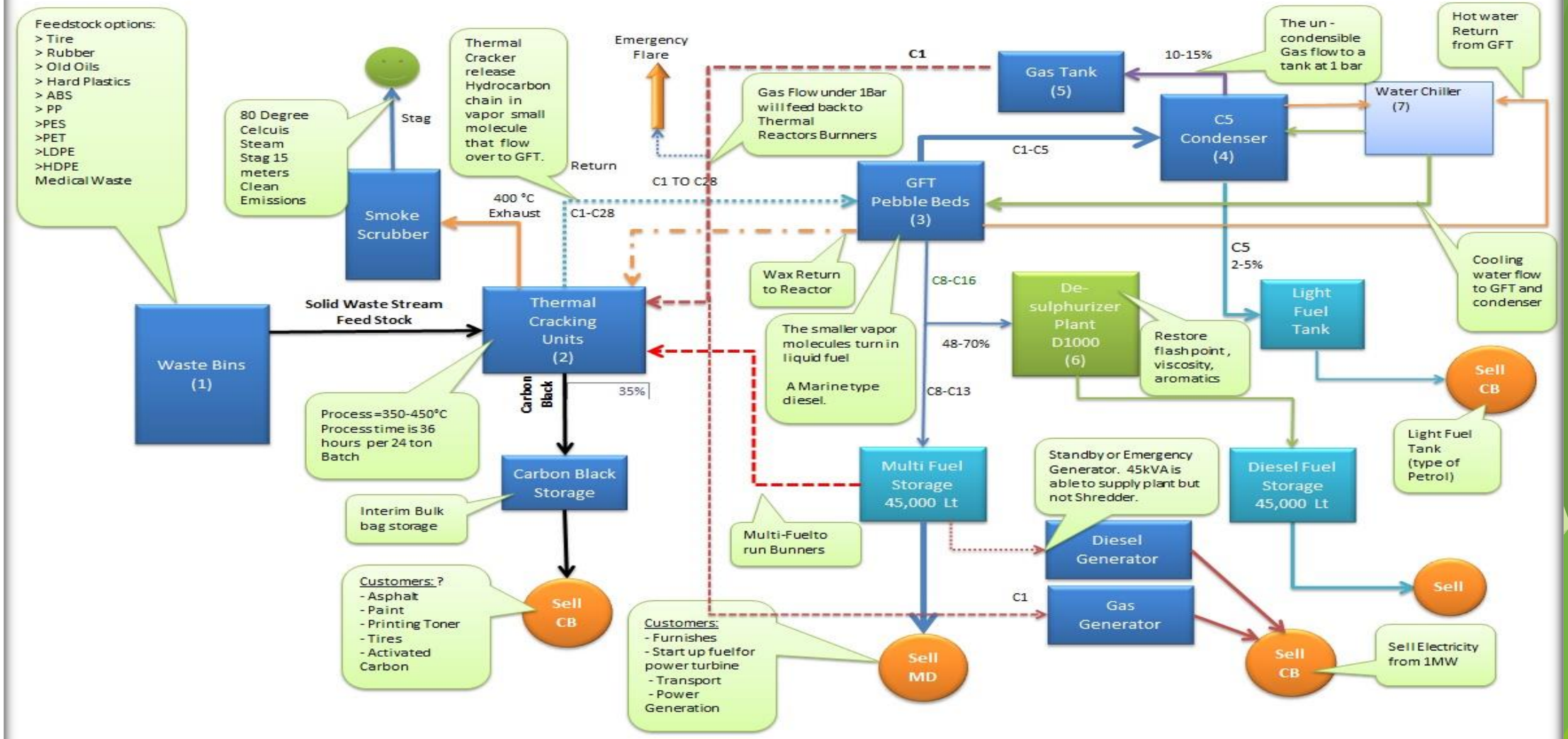
The air emissions from the system are within the EU regulatory framework and are as follows:

TEST	EU STANDARD	GrahamTek™ STANDARD
CO	50mg/m3	20mg/m3
SOx	50mg/m3	39mg/m3
NOx	200mg/m3	45mg/m3
Dioxins & Furans	0,1mg/m3	<0,1mg/m3
Particulates	10mg/m3	<10mg/m3
TOC (Total Organic Carbon)	10mg/m3	<10mg/m3

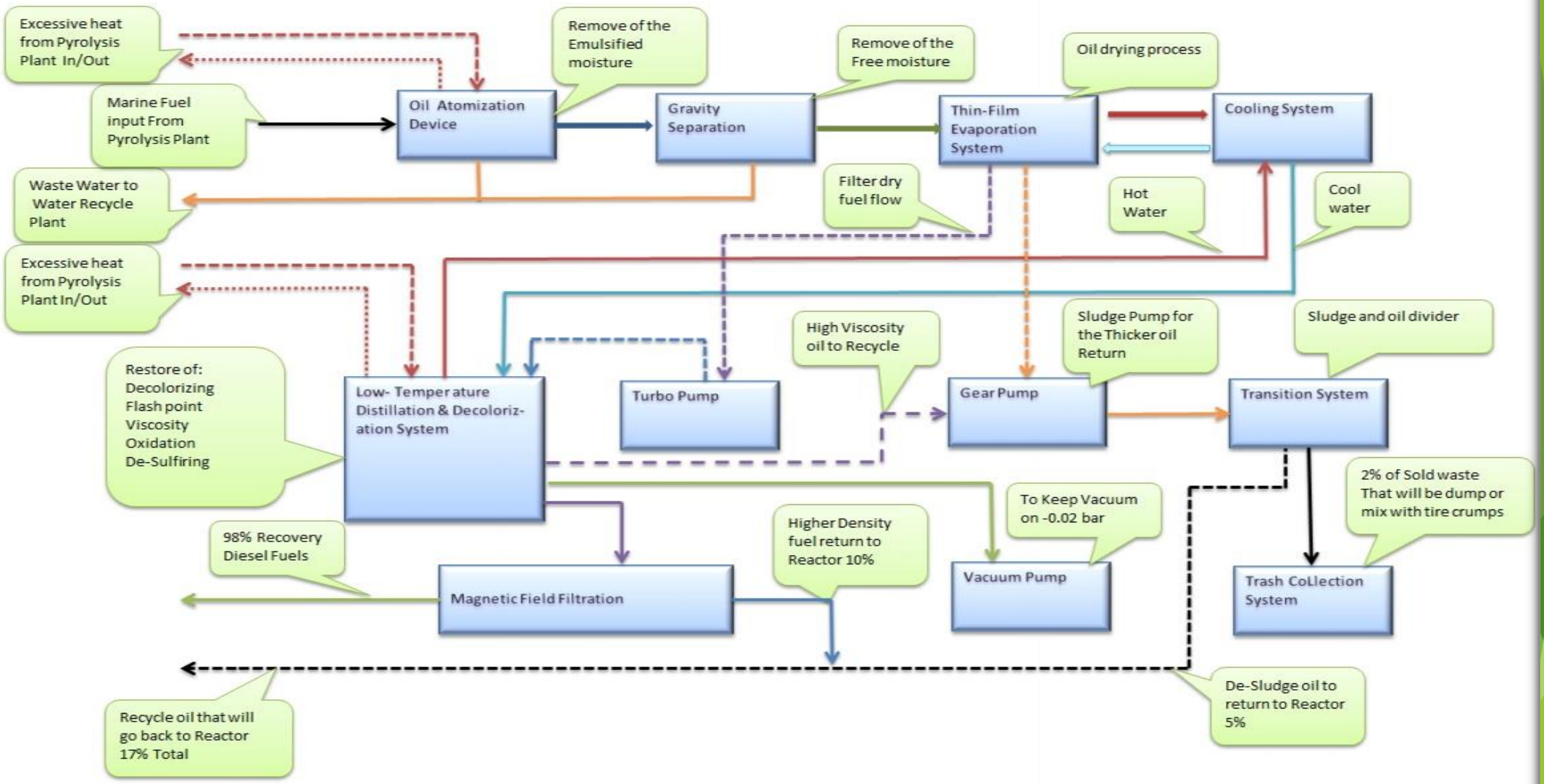
System Specifications WASTE-to-FUEL:

PARAMETER	SPECIFICATION
Delivery Standard	Delivered as a full turnkey system and commissioned by GrahamTek™ at the client's location using the client's contracted waste streams. The performance parameters are recorded on Calibration Certificates of the Equipment
Equipment Group	400Ton per month and scalable in quantum of 400Ton units
Heating Chambers	4x6Ton utilised to 80% Weight Capacity ir 70% Volume Capacity i.e 20Tons per cycle, internal operating temperature 450Deg C, External Chamber Temp +- 80Deg C, Internal Pressure – (minus) 2Bar (Entire System is under Vacuum)
Gas to Liquid (GTL Oil Units)	2 x 7 Sets, Operating Temp +- 100Deg C.
Loading Cycle	2hrs per 20Tons (Max)
Heating Cycle	4 Hrs
Cooling Cycle	8 Hrs
Decomplication and GTL Cycle	20 Hrs
Maximum recommended Cycles per Month	18
Waste Categories	Any hydro carbon containing waste – wet or dry. Waste tires cab be inserted in full without any pre-preparation work.
Chemical Catalyst	NONE
Chemical Cleaning	Caustic Cleaning on Pepple Beds 1x per year.
Water in System for GTL	+- 3700L (1000 Gallons) initial load – closed loop no attrition.
Water Consumption for Cooling	+- 1000L (260 Gallons) per cycle.
Fuel Oil Produced	+- 12 500L (3400 Gallons) per Cycle (Subjected to Waste Stream, Lowest Yield is 45% (Tires), Highest Yield 81% (e-Waste), Average from Municipal and General Plastic waste +- 65%.
Carbon Black Produced (Byproduct)	Subject to Waste Stream, 9 Tons per Cycle (Tires), 1,8Tons (e-Waste), Average 3,1Tons per cycle.
External Power	No Reliance on External Power Source
Storage Requirement	3x 22000L (5200 gallon) Fuel Tanks.
Operating Footprint	500 Square Meter (5400 Square Foot)
Waste Stream Loading and Storage Area	500 Square meter (5400 Square Foot)
Net Waste Management result	Reduction of Landfill Waste by 96%

THERMAL DECOMPOSITION
GRAHAMTEK TECHNOLOGY MODEL D24



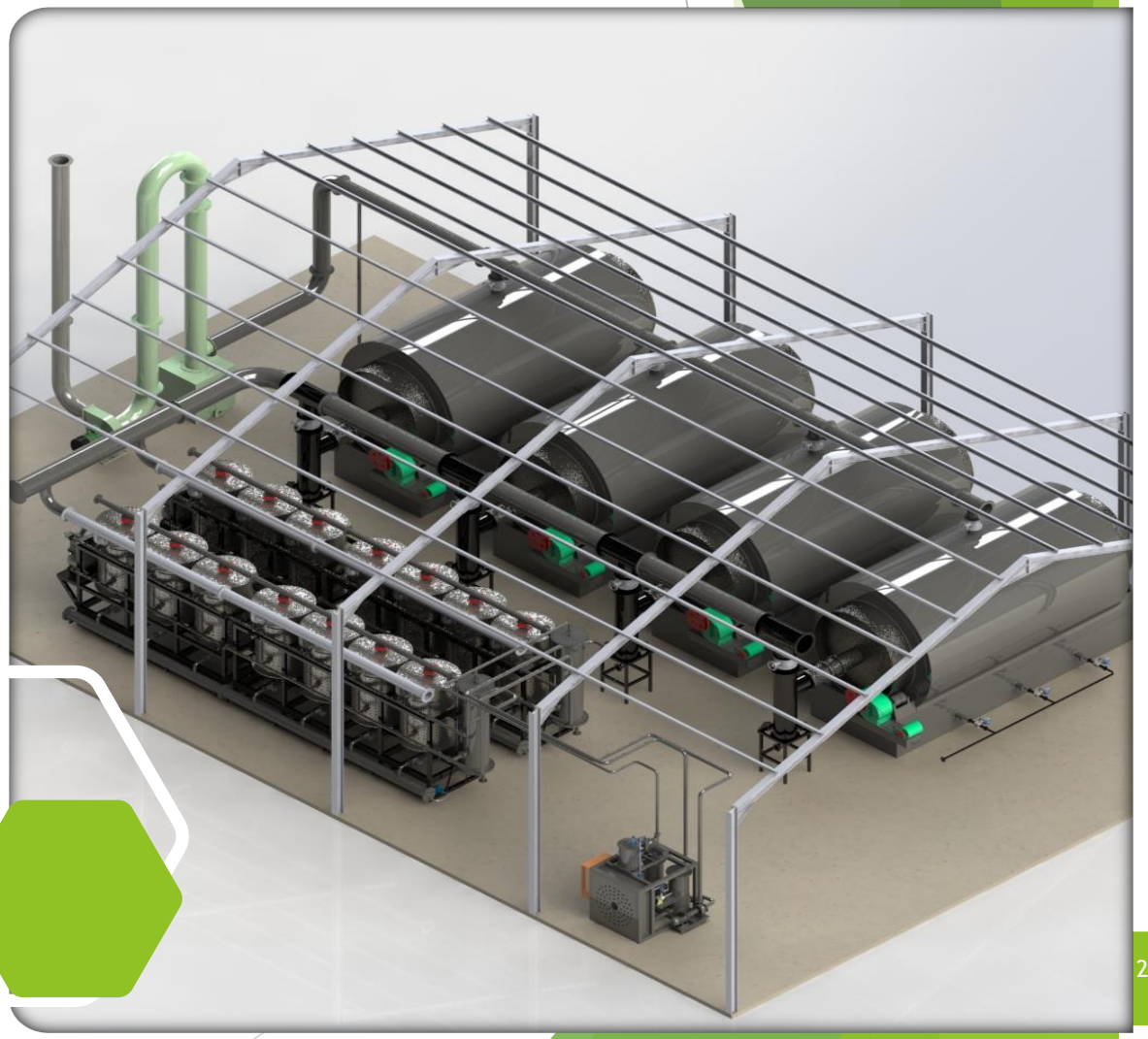
MULTI-FUEL TO DIESEL CONVERSION SKID MODEL DD1000



GrahamTek™ Waste-to-Energy Competitive Advantages

The GrahamTek™ technology is significantly different to other known technologies and systems, it is an innovative hybrid solutions using an technological advancement of the basic pyrolysis model. It is able to combine waste streams through a process of thermal mechanical treatment where most hydrocarbon waste streams can be converted into furnace oils for further refining to diesel fuel and carbon black. The additional differentiators are:

- The Technology is Modular and Scalable up to 400T/day.
- The Standard Production Unit Process 400T/M which equates to approximately 5,000T of waste or approximately 20,000cubic meters of waste per annum that can be prevented from going to landfill.
- The System can be applied to either generate Electricity from waste or Fuel Oils from waste.
- The technology is a solution to government goals of zero waste to landfill.
- It was developed with the environment in mind, therefore it is a closed loop, low emission and zero effluent system.
- The system uses no chemicals during the waste treatment process.
- It utilizes a GrahamTek™ patented technology where carbon chains are mechanical divided to extract oil – there is no reliance on catalytic chemicals.
- The system has a high degree of flexibility to adapt to feedstock (waste streams) variations with various blending formulations and technical advancements built in to the technology.



Commissioning of Botrivier Plant 15

Thank You

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