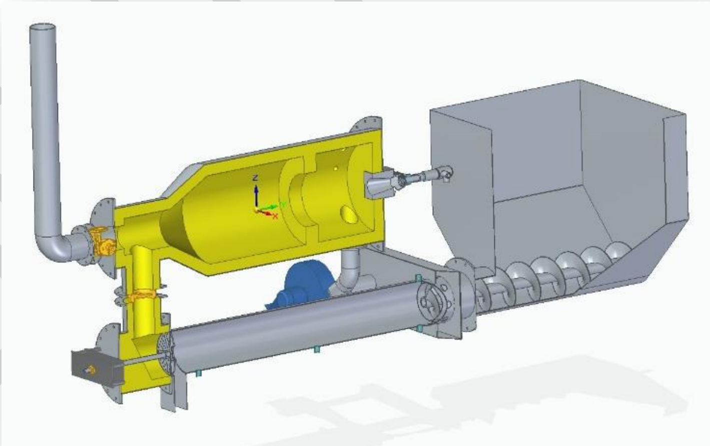
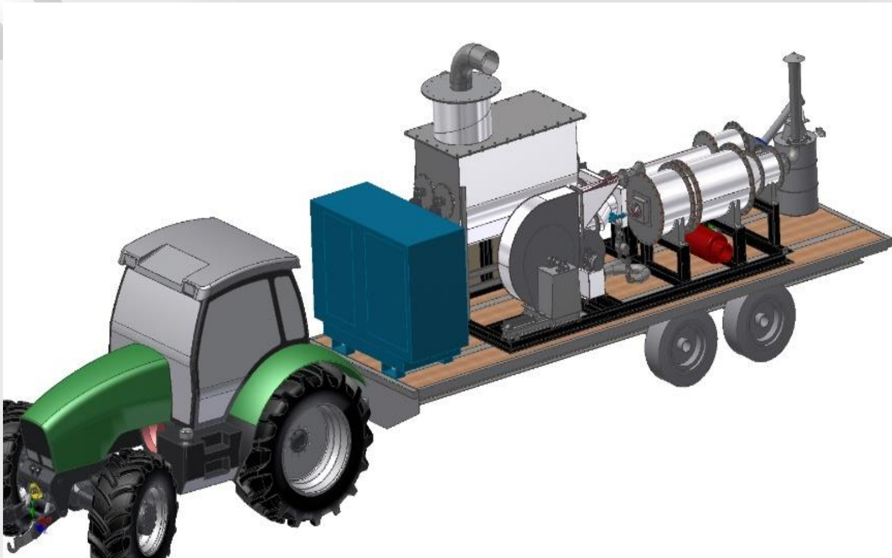
EIP Project - Biomass to Biochar for Farm Bioeconomy (BBFB)

Project Overview:

The Biomass to Biochar for Farm Bio-Economy (BBFB) project will demonstrate the production of biochar from a variety of agricultural and forestry unutilised biomass streams. The project will work closely with farmers and land managers to set-up trials of the biochar products in the same areas that produced the biomass to test and verify the benefits of soil application in further field research to determine the full benefits of biochar in Irish conditions.



Biochar is a charcoal-like product produced by heating biomass in low oxygen conditions to 400°C +. At this temperature much of the volatile contents are removed leaving a stable, carbon-rich biochar with an open porous structure. Biochar and charcoal have been used for millennia as soil improvers and as an addition for animal feeds.



Mobile Pyrolysis Unit

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About PGE

Premier Green Energy is an Irish technology design and engineering company that develops advanced thermal treatment technologies for clients to enable the recovery of carbon and renewable energy from biomass sources as well as from municipal and industrial sources.

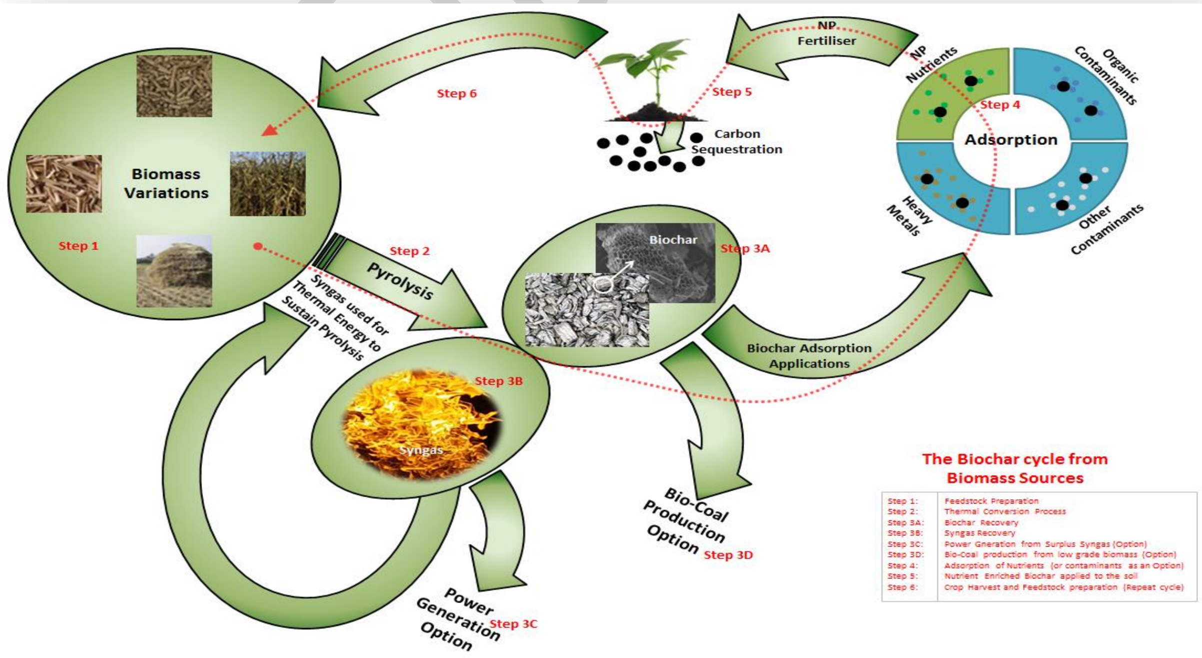
Premier Green Energy is located at Cabragh Business Park, Thurles, County Tipperary where it employs a multidisciplinary team that has design, manufacturing, installation and commissioning capabilities. PGE's goal is the provision of superior biofuels and waste-to-energy conversion systems that provide cost effective, flexible, efficient and environmentally-friendly solutions to clients' resource management and energy supply requirements.

While the concept of pyrolysis has been in existence for hundreds of years, PGE has, over the past number of years, focused its efforts to develop and refine pyrolysis processes to meet modern standards and expectations. Advanced Thermal Treatment has undergone rapid technological development over the last 10 to 15 years and much of this change has been driven by EU Directives, especially the Waste Incineration Directive (2000 76 EC), the Industrial Emissions Directive (2010 75 EU) and implementation legislation specific to the waste management sector.

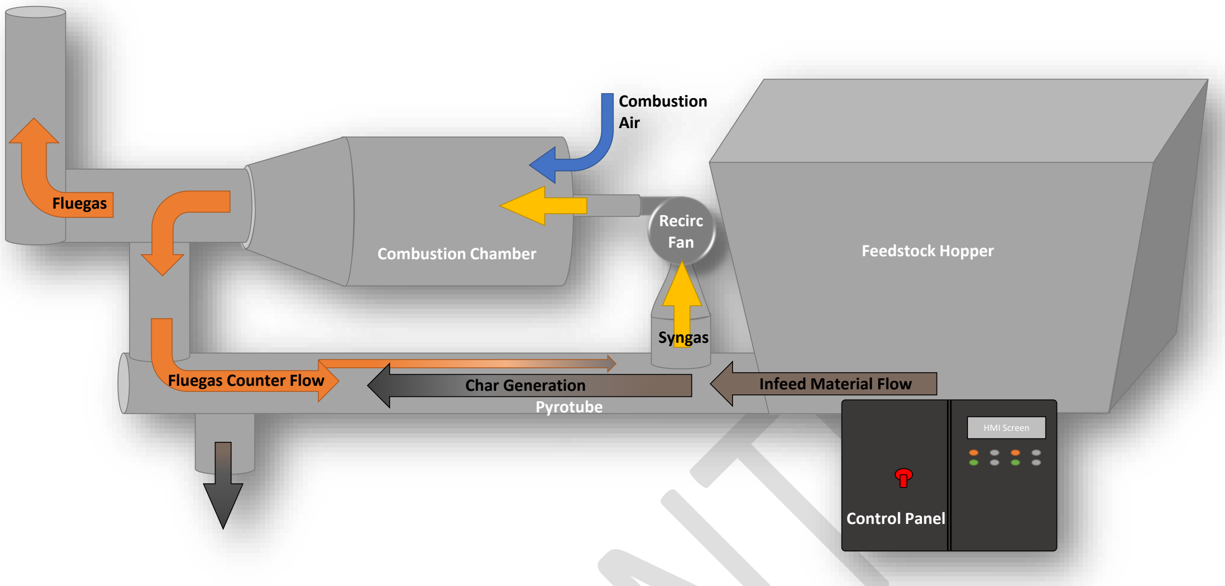
Introduction to Pyrolysis

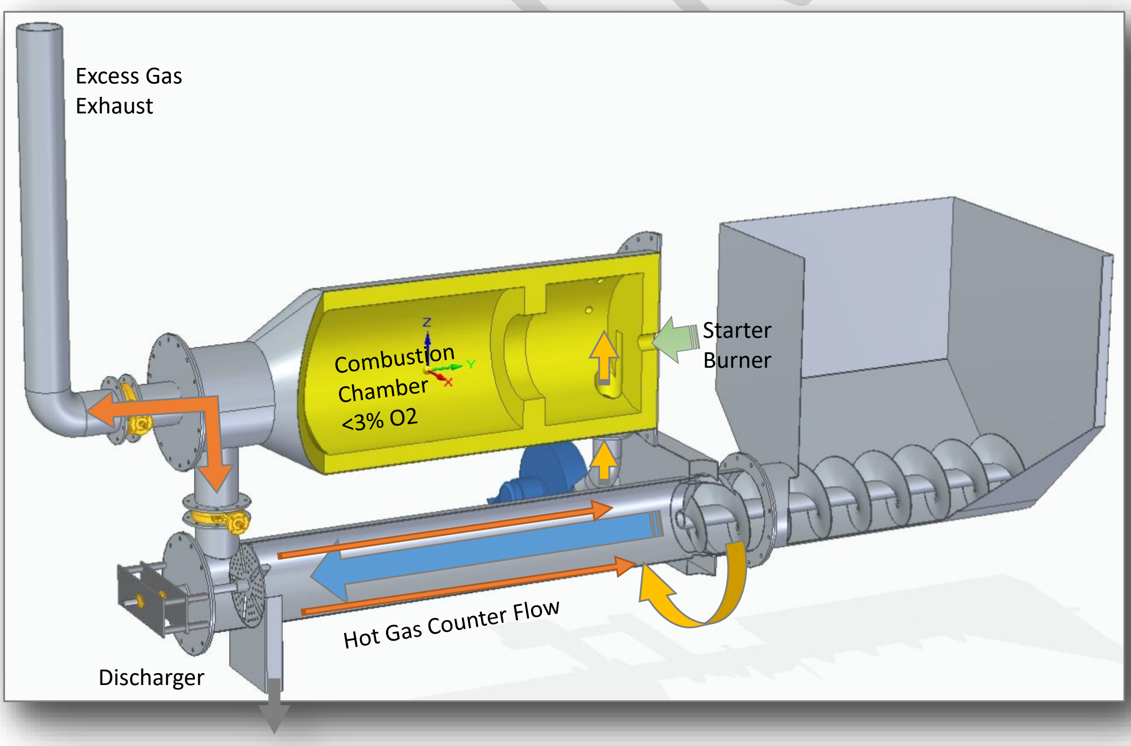
Pyrolysis is a well-known and firmly established technology for the thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen. It is a special case of thermolysis, typically operating at temperatures in excess of 400°C and is most commonly used as an efficient technique for converting biogenic wastes, biofuels and other valuable waste materials into a mixture of solid and gaseous outputs in the form of char and syngas respectively. The char stream is a combination of non-combustible inorganic materials and carbon, while syngas consists of Hydrogen, Methane, Carbon Monoxide, Carbon Dioxide and smaller quantities of higher chain hydrocarbons. The relative proportions of the pyrolytic output products can be altered by variations in process control parameters, including operating temperature, feedstock residence time and rate of heat transfer.

Pyrolysis is an endothermic process and requires thermal energy to be applied; this can be achieved either indirectly via thermal conduction through the walls of a reactor vessel or by direct contact heating with feedstock exposed to high temperature inert gases. The atmosphere within the conversion reactor is such that oxygen content is sufficiently depleted to prevent any potential for combustion of the feedstock product. The lack of oxidation and lack of a diluting gas in the form of Nitrogen means that the net calorific value (NCV) of syngas from a pyrolysis process is invariably higher than from a gasification process given the same feedstock composition.



Process Flow Diagram



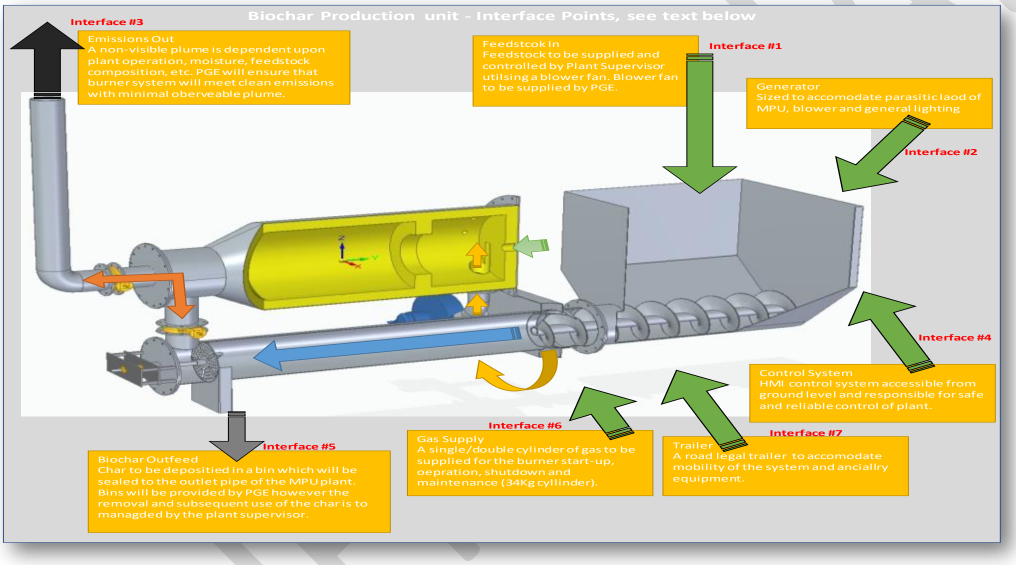


Key Design Features

Functional Design Specification

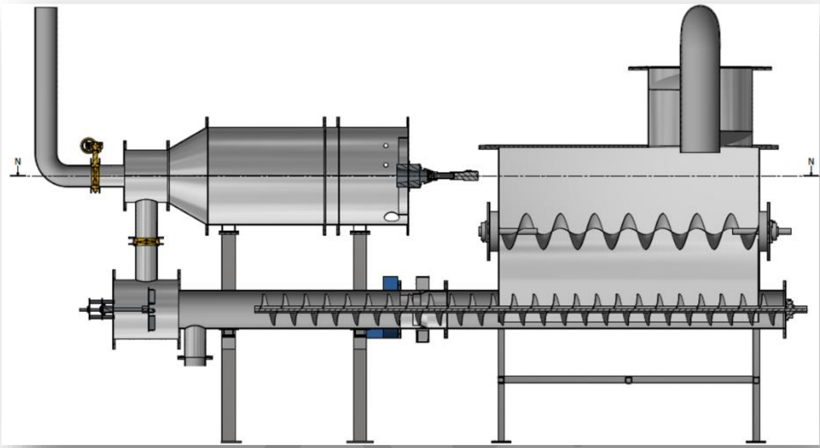
A functional design specification for the Mobile Pyrolysis unit was compiled at the commencement of the MPU design phase to allow the scope of work to be agreed and the specification of plant to be established.

Material preparation, interface points, electrical parasitic load, weight distribution, process flows and general design intention of the MPU were agreed which resulted in the acceptable design solution.



- **Interface #1:** Feedstock In: Feedstock to be prepared, supplied, and controlled by plant supervisor.
- **Interface 2**: Power Supply: A Generator is to be supplied to facilitate maximum electrical load which will allow mobile use of the plant.
- **Interface#3:** Emissions Out: Burner Operation will meet clean emissions with minimal observable plume.
- **Interface#4:** Control System: A HMI control system accessible from ground level will control plant devices and instruments to ensure safe operation of plant.
- **Interface#5**: Biochar Discharge: Biochar will be discharged from an outlet chute with a manual slide valve. A char bin will be tightly sealed to the discharge chute and will require the plant supervisor to inspect and exchange bins as required.

- **Interface#6:** A propane gas cylinder port for burner start up and shut down is installed where the provision of gas will need to be considered by the plant supervisor.
- **Interface#7:** Tow Trailer: A road legal trailer will be supplied where the MPU will be mounted and secured to the trailer bed along with the generator and ancillary equipment.



Generic Control and Safety Features

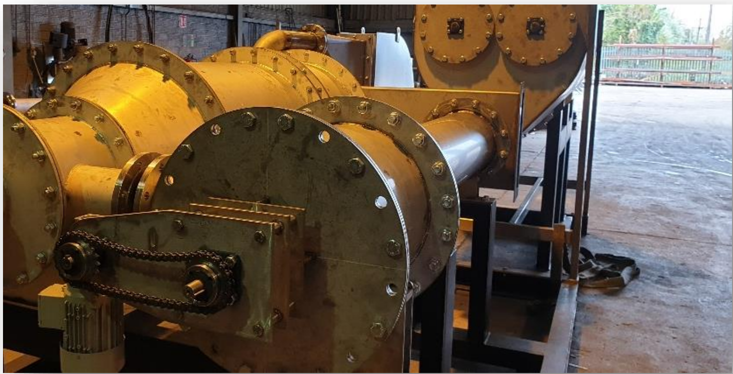
The MPU design offers a safe operation application by:

- having a defined circulation of syngas,
- the combustion chamber is maintained above the ignition temperature of the syngas,
- there is a shut-off to the pyrotube whereby all the flue gas can be diverted to the chimney to avoid circulation through the feed bed.
- At the start of the process, the combustion chamber can be fully preheated before any hot gases are allowed into the feed bed. There will be a warm-up period during which time there will be emissions. Furthermore, pyrolysis gas generated in the pyrotube should be capable to be combusted virtually instantly upon generation.
- The combustion burner is controlled by a flame safety unit.
- If the gas circulation fan fails, there will be no gas input to the pyrotube and the process will decay and eventually cool.
- There is sufficient stored heat in the combustion chamber to burn away residual syngas.
- Combustion gases will vent to the chimney.
- Hot gas will divert to the chimney or to the pyrotube based on the temperature forward of the discharger to maintain the temperature here at the set point (anticipated to be circa 500°C+/-100°C).
- Ability to shut the pyrotube valve and ultimately shut off the gas fan if the temperature becomes too high in pyrotube or combustion chamber.

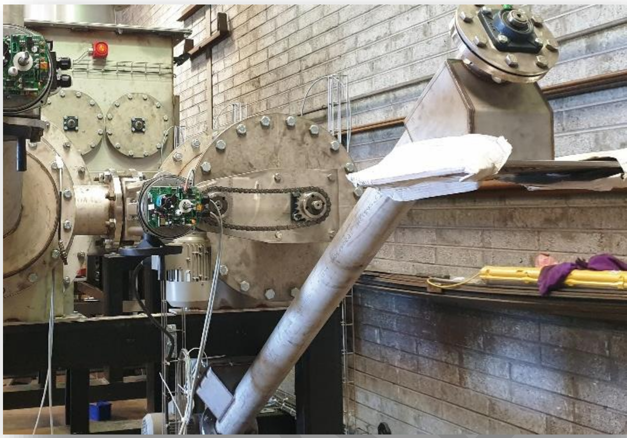
Key Designed Components

1) The infeed system has been designed and fabricated to include a simple but robust hopper design with a main feed auger and allowance for 2 additional augers if required to assist material flow. The hopper design is inclusive of a lid with an inlet port in a cyclonic infeed system which allows the material to be conveyed inwards whilst facilitating the displacement of the excess air. PGE have also included an exit hatch at rear of the hopper to allow materials to be easily withdrawn if the hopper needs to be emptied.

2) The Pyrotube is the location where feedstock materials are converted from their original material forms, into a biochar material. The pyrotube is a long tube, devoid of oxygen and which is heated to circa 500-600C. The pyrotube is fed with materials by the main feed auger from the infeed hopper. The rotational speed of the auger determines the throughput. The auger initially creates a "plug" at the inlet side of the pyrotube which is then forced through the reactor. The pyrotube also has a char extract scrapper system at the rear of the reactor along with a gas recirculation plenum.



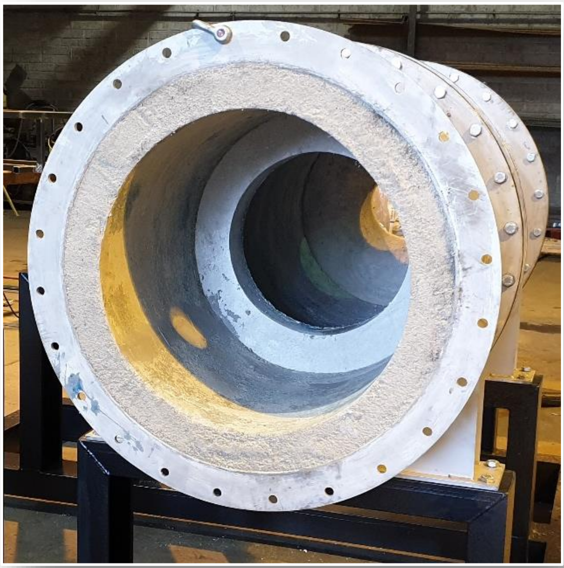
3) The char extract system has been upgraded to include an inclined auger and manual slide valve which is also fitted with a gear box and motor. This system will enable char to be gravity fed into a char bin whilst being able to maintain a safety seal.



4) The combustion chamber is a high temperature furnace system that is mounted in parallel with the pyrotube. The combustion chamber has a gas burner mounted on the front end which enables the furnace to be preheated to the desired temperature. The furnace is divided into 2 chambers separated by a choke ring. The first chamber allows the gas burner to be mounted and also has a number of ports and instruments included to allow the syngas to be recirculated along with the supply of combustion air.

The second chamber within the furnace ensures the correct residence time and appropriate combustion parameters has been achieved.

The outlet port from the combustion chamber has two high temperature divertor valves; one of the valves allows the hot combustion gases



to be recirculated through the pyrotube whilst the second valve allows excess pressure and heat to be exhausted to atmosphere.

5) The overall system is controlled by a control panel that houses the electrical components, breakers, speed drives, PLC, and the HMI screen. The control panels have been fitted and nested under the curve of the infeed hopper. Electrical cables have been fitted between the actuators, fans, and motors back to the breakers and speed drives in the electrical panel. Instruments have also been fitted to include temperature, pressure, and oxygen sensors.

The programming of the system based upon simple control philosophy has been initiated to enable safe operation of all the relevant motors, fans, and instruments. The design of the HMI control screens has also been developed to allow ease of operator navigation, control, and operation.

Principle of Operation

1.1 The design utilises direct heating of the feedstock by passing flue gas from the combustion of syngas in counterflow to the material feed in a reaction tube. Hot flue gas heats and pyrolysis the feedstock; gasification and combustion of the char at the hot end of the reaction tube is avoided by controlling the oxygen content in the flue gas to below 3%.

1.2 There is no temperature control of the syngas combustion chamber: It must run at the specified oxygen level to avoid damage to the quality of the discharged product. The temperature that the combustion chamber runs at is therefore dependent on the calorific value and volume of the syngas. Temperature could be limited because:

- The syngas is diluted by the heating flue gas
- The moisture content of the feedstock is high

Feedstock with excessive moisture or insufficient moisture may cause the temperature in the combustion chamber to fluctuate and to be either; too high posing a risk to the control valves and a danger of positive feedback in the reactor, or too low causing a risk for quality of char and syngas being produced. To control the rate of pyrolysis and hence syngas production, flue gas can be proportioned between the reactor return loop and the chimney. In most circumstances the design intent is to operate with the flue gas exhaust valve fully open whilst the cross over valve is proportioning according to temperature and pressure profile.

1.3 Char is discharged based on temperature, with the temperature set to a figure at which devolatilization is considered substantially complete. A discharging paddle breaks up the brittle char and causes it to fall into the sealed intermediate hopper and then further augered from this hopper through an inclined scroll into a large discharge bin where it is allowed to cool.

1.4 Fresh material is fed at a rate set to maintain a fixed temperature gradient along the reactor tube as the finished char is discharged, and an equilibrium is sought between flue gas flow through the reactor, char discharge and material feed. The flue gas as it proceeds through the reactor cools and acquires first syngas and then moisture. The mixture of flue gas, syngas and moisture is extracted from the reaction tube at the cold end by a fan and sent to the combustion chamber where it is oxidised back to flue gas. Part is discharged to the chimney and part is sent back through the reactor.

2.1 Plant Safety

There are a number of safety aspects to be taken into account when operating the MPU. Trained and experienced personnel should only operate the plant. The following safety elements should be considered alongside a risk assessment and safety assessment.

Follow the Start-up Run and Shutdown procedures as outlined below and elsewhere in this document. Plant inspection, maintenance and a risk assessment need to be performed prior to every start up to ensure safe operation.

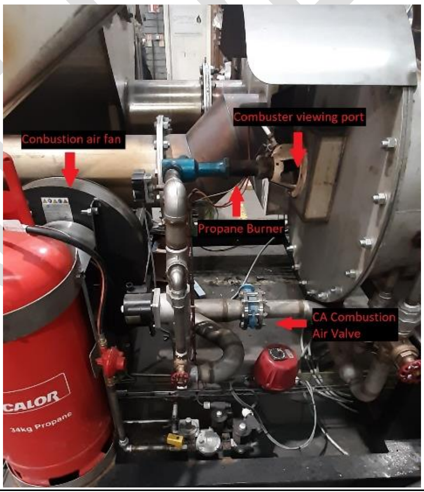
The development of a start-up, shutdown, and pre-transit checklist is advisable to ensure that all aspects concerning the storage, transport and operation of plant is performed in a safe and reliable manner.

Hazards

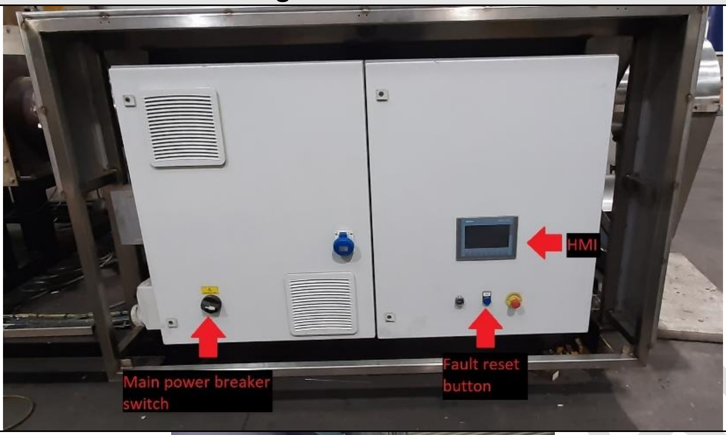
- High temperatures involved in the pyrolysis process create number of hot surfaces and potential for damage to property or personal injury.
- Compressed propane cylinders used for heat up and shut down burner need to be properly handled and secured.
- Machine Guards are fitted for personal protection and can only be removed for maintenance when power supply has been isolated.
- Improper operation of the plant and not following outlined start up and shutdown procedure has the potential to cause damage or cause personal injury.
- To mitigate the risk of fumes or potentially dangerous gases personal gas monitors should always be worn during plant operation.
- All operator involvement with material handling systems should be minimised to avoid entanglement.
- Maintain a safe distance and boundaries around the MPU.

2.2 Component overview & Images

See images of key components attached below. See accompanying images of plant components during build and commissioning of plant.

Description	Image and Illustration
Figure 1 • Discharge Auger • Discharge Slide Valve	
Figure 2 • Combustion Air Fan • Combustion Viewing Port • Propane Burner (FNA) • Combustion Air Valve	

Description	Image and Illustration
Figure 3 • ESTRO Flame Control Box	
Figure 4 • Char Discharge intermediate hopper and access hatch	

Description	Image and Illustration
Figure 5 • Main Power Breaker • Fault Reset Button • HMI Screen	
Figure 6 • Syngas Recirc Fan	
Figure 7 • Exhaust Valve (VEV)	

<table>
<tr><th>Description</th><th>Image and Illustration</th></tr>
<tr><td>Figure 8
• VSDs in Control Panel
(Left to Right)
○ Feed Auger
○ Discharge Auger
○ Syngas Recirc Fan
○ Char Scrapper</td><td>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<tr><td>Figure 9
• Cross Over Valve (RGV)</td><td>


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2.3 Start-up checks

When the MPU is installed in a location and is ready to commence operations please follow the steps highlighted in the checklist. These steps are guideline steps which are to prompt the operator to perform the necessary steps. Operator competency, awareness and plant experience is necessary to ensure all appropriate steps are taken.

The Start-Up process includes the following:

- Trailer Set-Up
- Generator Start-Up
- Pyrolysis System Start-Up

The pre-start up inspection steps include but are not limited to the following:

- Visual inspection of Pyrolysis Equipment.
  - (See Checklist of Components at Start-Up – Sign & Date, see below recommend checklist)
- Generator diesel level checked.
- Generator Oil level to be checked.
- Visual Inspection of generator.
- All covers should be fitted and sealed no opportunity for air ingress can be allowed as the process is dependent on keeping low oxygen levels in the reactor.
- Char bin must be properly fitted to discharge auger ensuring a sealed system.
- Rotational check all motors (after generator has been enabled)
  - Ensure operation visually of discharge auger, discharge scraper and gas booster fan *(Figure 6 Figure 9)*,
  - Gas Recirc fan set at constant speed -0.5 millibar,
  - Check Infeed screw motor, sprockets, chain, and chain tensioner,
- Hopper filled with feedstock.
- Hopper lid closed.
- Bump start the infeed auger until Pyro tube has material at the inlet (after generator is enabled).
- Propane tank to be full at start up.

	Mobile Pyrolysis Unit System Check and Operation Safety Checklist (Please keep on record information and keep on file)	Insert Tick once Task is Complete ✓
Generator Check (See Generator Manual for detailed info)		
●	Diesel Level Check	
●	Oil Level Check	
●	Power up generator.	
●	Look for alarms on Generator Screen	
●	Perform Visual Inspection once powered on	
Trailer Check		
●	Chocks in position at front and rear of wheels	
●	Hand brake Latched and Wheels Locked	
●	Barriers Installed	
●	Towbar Jack Lowered and secured	
●	Trailer and Warning Signage Visible	
Pyrolysis System Pre-Start Up Check		
●	Inspection and maintenance Flanges replaced and secured	
●	Char Bin Installed, locked and secured	
●	Char Discharge Slide Valve Opened/Closed	
●	Feedstock Hopper lid and port hole Opened/Closed	
●	Fire suppression systems available and accessible	
●	Personel gas detection system worn by operator	
●	Errect barriers and create perimeter aroudn the MPU and work space where possible. Ensure no flammable products or fire risks remain within the perimeter.	
●	Remove any excess dust or debris from the trailer bed and from the system	
●	Install a full Propane Barrel and connect to flexible gas pipe	
●	Ensure gas tightness on propane barrel coupling	
●	Partially open gas valve on propane barrel	
●	Install Data Stick to Record Data	
Pyrolysis System Start-Up (See Manual)		
●	Power on Main control panel	
●	Wait for systems to set and communicate	
●	Initiate start plant up and then enable burner operation on ESTRO control box	
●	Wait for flame detection signal	
●	As combustion chamber is heating up, prepare feedstock and material handling system	
●	Visually observe and check char scrapper, char discharge and feed auger operation to ensure all motors are operational and rotating in the correct direction	
●	Ensure all flanges and inspection ports are closed to avoid air ingress into the system	
●	Set Gas Recirc Fan at a constant speed to achieve the desirable pressure limit (-0.5mbar)	
●	Enable the infeed auger screw to partially fill the pyrotube and allow temperatures to start to rise in the pyrotube.	
●	Once the pyrotube achieves the desirable temperature setting, then enable the infeed scroll to operate at a slow speed which can gradually increased once syngas is observed and stable operation is confirmed	
●	Observe temperature profile across the plant	
●	Observe pressure profile on the pyrotube	
●	Observe char extraction and syngas	

Name:

Date & Time:

Comments/Observations:

3.1 Start-up procedure

Please note that a local Risk assessment must be completed prior to operation and start-up of plant which takes in account local environment and surroundings. Also, safety measures must be put in place with respect to Personal Protection Equipment, Hot Works Operation, Manual Handling, Working at Height, Machinery Operation, Dust Generation, Gas Detection, Fire Suppression, Gas cylinders, Electrical Systems, Feedstock Storage and Char Storage. Also, warning signage should be mounted and made visible at all times during operation.

Once checklist is complete, and all safety measures performed then follow these steps:

- Enable Start-up of the diesel generator.
- Once generator has started and is fully operational then enable the blue reset button on main control panel of the MPU.
- Ensure System is healthy and that the logo in the top left is green indicating system has no faults.
- Ensure infeed hopper is full.
- Charge the pyro tube with feedstock using the infeed auger manual override,
- Press the plant enable button and wait for start propane burner manually prompt.
- Start Propane burner.
- Wait for temperature to approach 450 – 500 degrees at T1.
- Temperature will also increase in the combustor indicated by the increase in flue temperature which can be upwards of 700 degrees when syngas begins to be produced from the feed stock in the pyro tube.
- Enable feed button will appear when the system is satisfied temperatures are OK to start the input of feed stock to the Pyro tube.
- Select a slow and gradual increase in rate of feed to ensure a smooth transition to char/syngas production. An initial slow feed maintains temperature and pressure in plant which can be gradually increased once syngas is being produced and plant has stabilised.

3.2 Normal Operation

Once system has been initiated and it has achieved the correct temperature profile according to the desired char recipe, then the following steps and guidelines can be considered.

- Optimum feed rate is to be determined for each feedstock type based upon their physical characteristics, bulk density and chemical composition however the following guidelines can be considered appropriate for certain biomass materials:
  - Dry woodchip – 5Hz
  - Wet Woodchip – 3Hz - 5Hz
  - Finely chopped rushes or straw like materials – 15Hz to 25Hz
- Using an appropriate rate of feed that has been initiated in a gradual manner, syngas production should then start to evolve and will become more obvious where it is expected that a steady flow of syngas will occur within 30mins of the commencement of the initial feeding.
- Syngas return temperature will often fluctuate but should maintain around 200ºC -350ºC degrees. (A low temperature syngas return in combination with a high Mbar pressure is a sign of potential blockage in the gas path of the MPU. If this is sustained for a long period then the syngas return to the combustion chamber will be impacted and plant performance will subsequently be impacted. System shut down for inspection and maintenance may be required).
- It is recommended that the FNA Burner remains operational until syngas combustion can be visually seen in the combustor. Syngas combustion usually creates a slight decrease in flue gas temperature. Syngas combustion with some propane injection maybe required for certain feedstock types to maintain stable combustion operation. When combined these gases will produce temperature of approximately 750ºC degrees in the flue pipe.
- Flame sensor in the combustor will show readings of between 75% and 80% when steady syngas flow is being achieved.
- At a feed rate of 5Hz on dry woodchip flue gas temperature will settle and will balance at approx 750ºC – 850ºC.
- Once stable syngas flame and combustion temperatures are achieved it is possible to turn down the FNA Buner and to isolate the propane cylinder. The rate at which the propane is reduced is dependent on the syngas return that is resultant of the decomposition of the feedstock. Feedstocks characteristics and compositions impact syngas volume and quality to be able to maintain MPU operation. In the event that the syngas recirc is insufficient to sustain combustion parameters, then the plant operator can make an effort to alter the feed rate in order to achieve improved syngas production. Feed rate is adjustable Via the HMI.

- During syngas combustion a swirling turbulent flame with a bright orange glow can be observed through the viewport on the propane burner mounting.
- Whilst operating the combustion unit on syngas it is important for the operator to pay attention to flue gas temp where it is likely to fluctuate during the transition period from when there is supplemental propane support to when there is syngas only operation. Temperatures exceeding 650ºC on the flue gas exit should be maintained where possible.
- If temperature is not maintained, the operator must then manually re-start the FNA propane burner and repeat the above steps for syngas switch over at the next opportunity.
- To avoid temperature loss in the combustion chamber the FNA Burner should be restarted without delay.
- Operator will be alerted when flame signal is combustor is lost.
- The MPU is essentially a biorefinery that produces two primary products; syngas and char. Whilst syngas production has commenced and system is attempting to achieve stable operation, char production is ongoing.
- A char inspection port is located prior to the bin attachment.
- The port allows for access for the operator to determine char quality and char flow rate.
- The inspection port must remain closed at all times, with the exception of during char inspection routines. It is essential to avoid the risk of air ingress or the self-combustion of char upon exit of the system.
- Depending on the throughput rate and the feedstock characteristics the resultant biochar will accumulate in the char bin and it will fill up.
- It is possible to change the Char bin whilst maintaining plant operation by pressing the Char bin button on the HMI which will disable the char extract auger and will allow the operator a period of time to exchange the full bin with an empty bin (2 Bins were supplied with the MPU).
- To avoid bridging of material and fouling within the pyrotube only a short period of time is allowed to facilitate the exchange. The slide valve must manually be closed while the char bin is removed and remain closed until the new bin is fitted. As soon as empty bin is installed the slide valve can be reopened.
- Continue the operation of the MPU whilst maintaining the temperature, pressures, flow rates and observe char levels within the bin.

3.3 Shutdown Procedure

Once system has been safely operated and it is time to initiate a shutdown please adhere to the following steps and guidelines to facilitate a safe shutdown.

- The infeed hopper should be emptied of feedstock to avoid heat dissipating back into the hopper and potentially creating an unnecessary fire risk.
- Enable system shutdown on HMI screen.
- Reenable the Propane burner so that any flammable gases can be properly combusted prior to emission to atmosphere.
- The bypass (RGV) valve will automatically close to avoid recirc of syngas through the pyrotube.
- The infeed auger should remain enabled to disperse and clear any contents remaining in the Pyro tube.
- With the RGV valve in closed position the pyrotube temperature should start to reduce. When the temperature within the pyrotube has sufficiently cooled to below 150ºC then the syngas recirc fan can be disabled.
- The Propane Burner can then be shut down.
- The infeed auger can be disabled.
- Combustion air fan can be left in operation mode to assist with forced cooling of the combustion chamber in quick manner. However, the fan can also be disabled once the temperature is at a safe level to allow it to naturally cool (ie below 250ºC).
- Once system is cooled it is safe to power down system including the generator.
- It is then safe to move and relocate MPU if required.
- Only perform inspections and maintenance when system is powered down and cool.

3.4 Emergency Shutdown Procedure

In the event of loss of power, a mechanical failure or loss of burner operation, the MPU can be safely shut down where several observations and precautions must be heeded. Safety systems, personal protection equipment and suppression systems must always be at hand. Safety perimeter around system must be maintained.

- Conveyor feed must be disabled (if mains connected). Minimise feedstock in the system where possible. Remove any excess debris and materials including biochar.
- Hopper lid to be closed and infeed system to remain sealed.
- Isolate propane gas valve.
- Remove propane cylinder (only if feasible and safe to do so).
- RVG valve to be closed (In the event of power loss this can be done with handle on the valve head).
- FVG valve to be opened 100% (In the event of power loss this can be done with handle on the valve head).
- Maintain safe distance from MPU while cooling as residual syngas in the system will need to escape.

Once power is re-established or fault is reset it may be feasible to restore operation of plant subject to precautions and safety systems being implemented.

4.1 Maintenance Checks for the Pyrolysis Unit

Please find recommended maintenance activities to ensure safe and reliable mechanical operation of the plant.

- All Bearings to be greased on weekly basis or after 20hours of operation.
- Gearbox oil on all motors should be checked monthly to ensure it is maintained at optimum levels.
- Visual inspection of motor gearbox should be performed daily to ensure fans are operational and there are no oil leaks from seals.
- Chain tension on feed drive needs to be checked for tension daily.
- Propane Burner electrodes need to periodically be cleaned and spark gap adjusted.
- Crossover section will need periodic cleaning which will vary depending on feed stock as small particles from the feed stock can be drawn into the gas path during operation.
- The syngas recirc plenum will require inspection and cleaning between operation runs.
- Ensure system is clean and free of debris. Remove any excess dust from around motors, combustion chamber, hot surfaces, and control panels.
- Manually operate bypass valve and flue gas valve to ensure that they are freely operating and unhindered.
- Check tie-down bolts and secure items prior to mobilising plant.

4.2 Generator Checks

The MPUs safe and efficient operation is dependant on the electrical generator so it is essential that the generator is inspected and maintained in line with the manufacturer's guidelines and specifications. See engine manual provided within the engine enclosure.

- Daily & Weekly checks:
- Cooling system:
    - Radiator air restriction, hoses, connections, fluid concentration, belts and louver operation
- Air intake system:
    - Check for leaks, holes and loose connections.
- Fuel system:
    - Check Fuel levels and fuel pump operation.
- Exhaust system:
    - Check for leaks, restrictions and flush condensation cap

- Electrical system:
  - Review meters and battery fluid. Recharge battery if needed.
- Check oil and lubricant levels on generator.

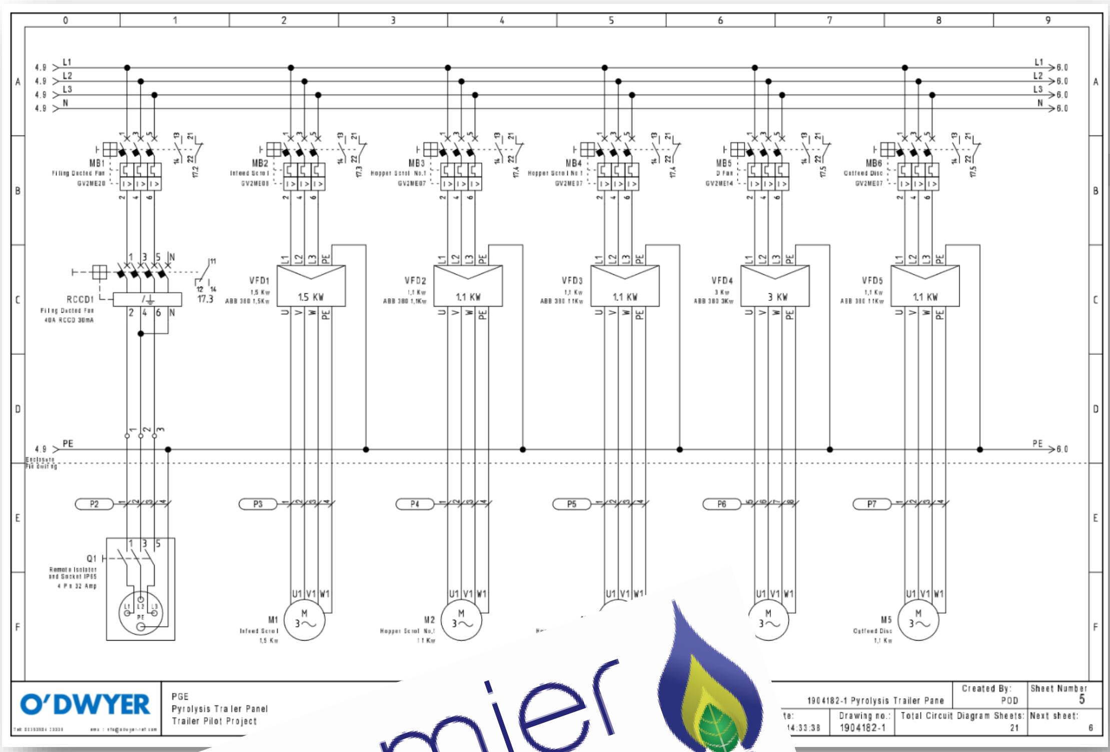
4.3 Trailer Checks

- Brakes and bearings should be tested to ensure that they are in good operating condition every time the trailer is mobilised.
- Tyres should be checked to ensure there is sufficient thread and pressure within tyre. Wheels should be inspected for cracks, dents and distortion. Wheel nuts should be torqued to proper specification.
- Ensure trailer lights re fully operational.
- Grease the levelling jack.
- Trailer Registration is fully attached.

Appendix 1 – Electrical Schematic & Wiring Diagram

See Dropbox Link

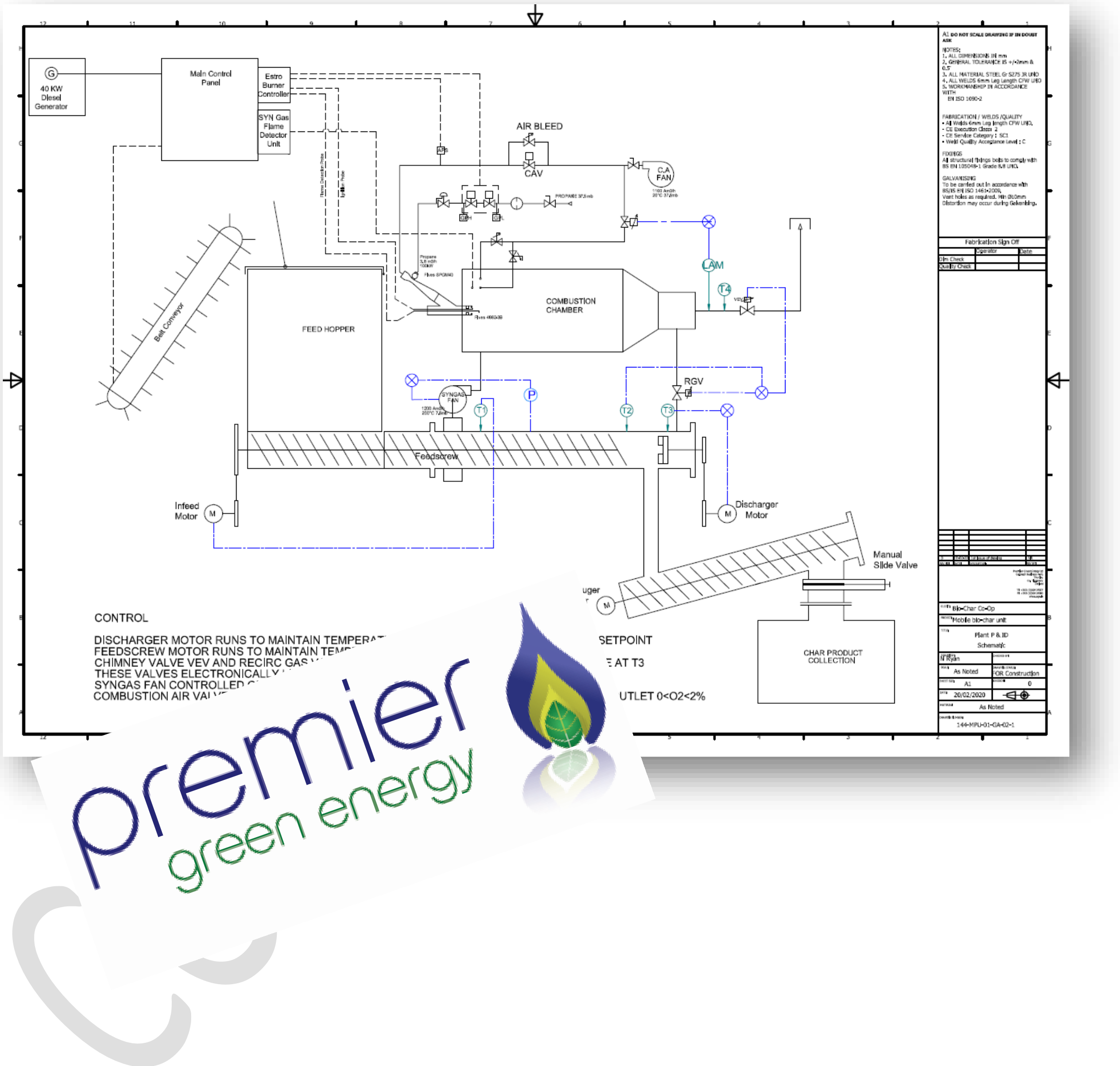
https://www.dropbox.com/s/zh9ml6z0ipswgws/Trailer%20Electrical%20Drawings.pdf?dl=0



Appendix 2 – Process & Instrumentation Diagram

See Dropbox Link

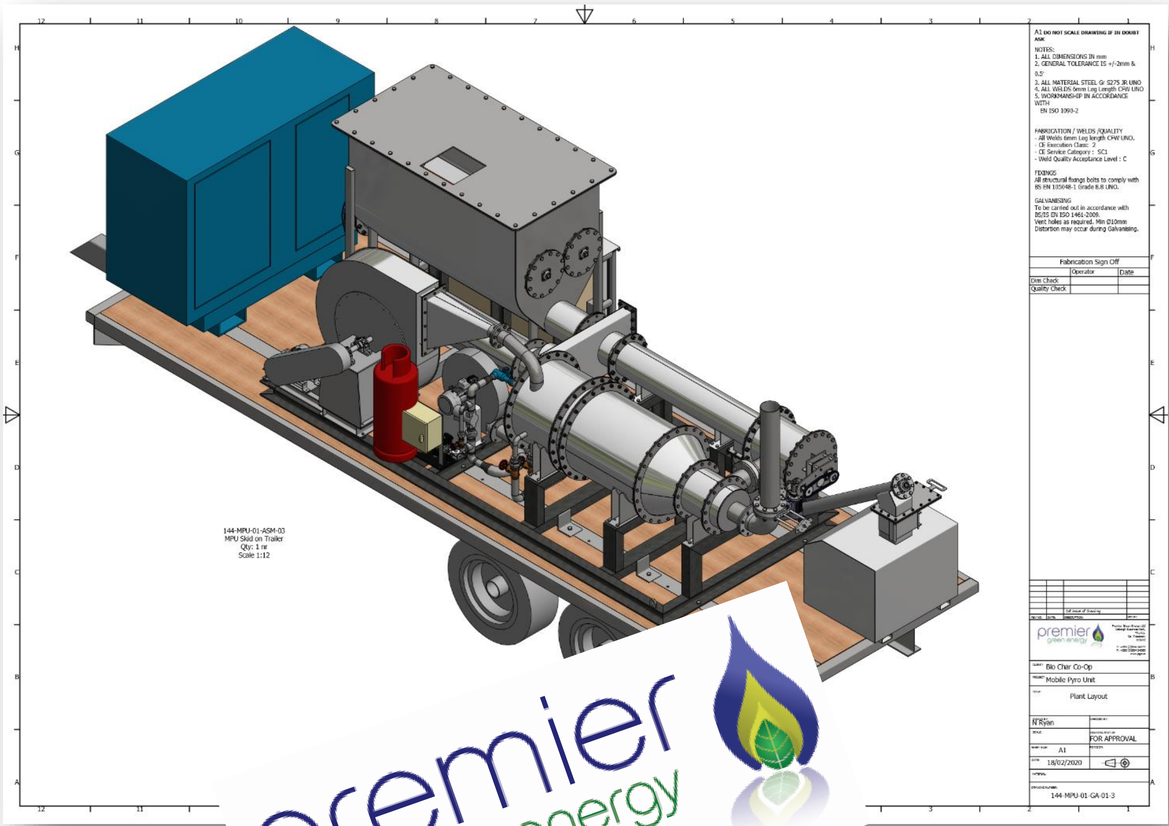
https://www.dropbox.com/s/7ir6tfe0fjy1opr/MPU_%20P%20%20ID.pdf?dl=0



Appendix 3 – Model of MPU & Tech Drawings

See Dropbox link

https://www.dropbox.com/s/g5e8ezdns7isrzh/O%26M%20Manual%20Drawings.pdf?dl=0



Appendix 4 – Software Handover File

See Dropbox link

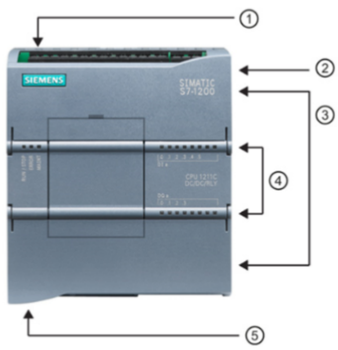
https://www.dropbox.com/s/p8tb3nvy6ja3f4b/BtB%20trailer_handover.zap16?dl=0

1.1 Introducing the S7-1200 PLC

The S7-1200 controller provides the flexibility and power to control a wide variety of devices in support of your automation needs. The compact design, flexible configuration, and powerful instruction set combine to make the S7-1200 a perfect solution for controlling a wide variety of applications.

The CPU combines a microprocessor, an integrated power supply, input and output circuits, built-in PROFINET, high-speed motion control I/O, and on-board analog inputs in a compact housing to create a powerful controller. After you download your program, the CPU contains the logic required to monitor and control the devices in your application. The CPU monitors the inputs and changes the outputs according to the logic of your user program, which can include Boolean logic, counting, timing, complex math operations, and communications with other intelligent devices.

The CPU provides a PROFINET port for communication over a PROFINET network. Additional modules are available for communicating over PROFIBUS, GPRS, RS485, RS232, IEC, DNP3, and WDC networks.



① Power connector
② Memory card slot under top door
③ Removable user wiring connectors (behind the doors)
④ Status LEDs for the on-board I/O
⑤ PROFINET connector (on the bottom of the CPU)

Several security features help protect access to both the CPU and the control program:

- Every CPU provides password protection (Page 87) that allows you to configure access to the CPU functions.
- You can use "know-how protection" (Page 89) to hide the code within a specific block.
- You can use copy protection (Page 90) to bind your program to a specific memory card or CPU.

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Manual, 01/2015, A5E02486774-AG 15