ADVANCED PLASMA POWER

THE Energy from Waste Solution

Advanced Thermal Technologies to Reap the Reward from Landfill Mining

8th International EFW Conference

London

22nd-23rd February 2012

Chris Chapman, CTO

Overview

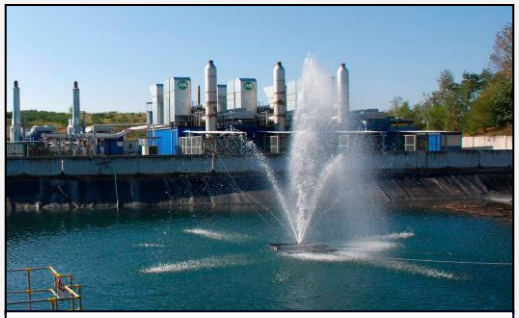
- Introduction to Advanced Plasma Power Ltd
- Background to Belgium Landfill project and Enhanced Landfill Mining (ELFM) concept
- Description of the Gasplasma® Process
- Gasplasma® Treatment of Belgium Landfill SRF
- Gasplasma® Features in respect to Landfill Mining

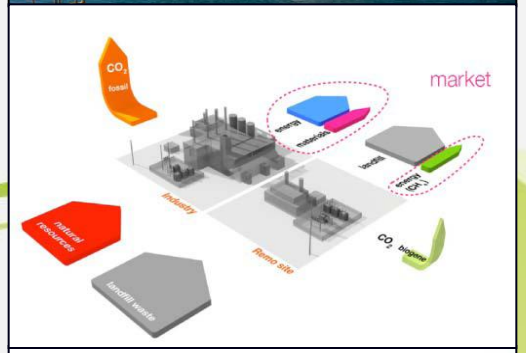
Introduction to APP

- Established in 2005 to develop and commercialise the worldwide patented Gasplasma® EfW technology developed over previous 2 years by Tetronics
- Objective is to be a leading player in the waste to renewable energy market by delivering innovative solutions for responsible resource management
- Swindon plant operating since 2008
- Substantial project pipeline includes waste/engineering companies from UK, Western Europe, USA, Canada, Brazil, Korea, Middle East, Bulgaria, Poland

Closing the Circle: Group Machiels Project

- Recovery of 16 million tonnes of municipal and industrial solid waste stored at the Remo landfill site of Group Machiels in Houthalen-Helchteren/ Limburg, Belgium
- 4 Key Objectives:
  - Maximum recuperation of materials
  - Energy recovery with incorporated materials recuperation
  - CO_2 reduction, use and/or off-set
  - Recuperation of nature





Group Machiels: International Symposium on Enhanced Landfill Mining 2010

Enhanced Landfill Mining (ELFM): The Concept

- ELFM allows storing the waste for its future recovery
- Fully sustainable approach - maximum practical recovery
- Complete reclamation of the landfill site
- Integration of innovative technologies to ensure:
  - Effective recovery of materials
  - High efficiency energy recovery
- Significant reduction in green house gas emissions compared to a conventional landfill
- Carbon reduction and other environmental benefits need to be assigned a proportionate economic value in form of "incentives" to encourage investment

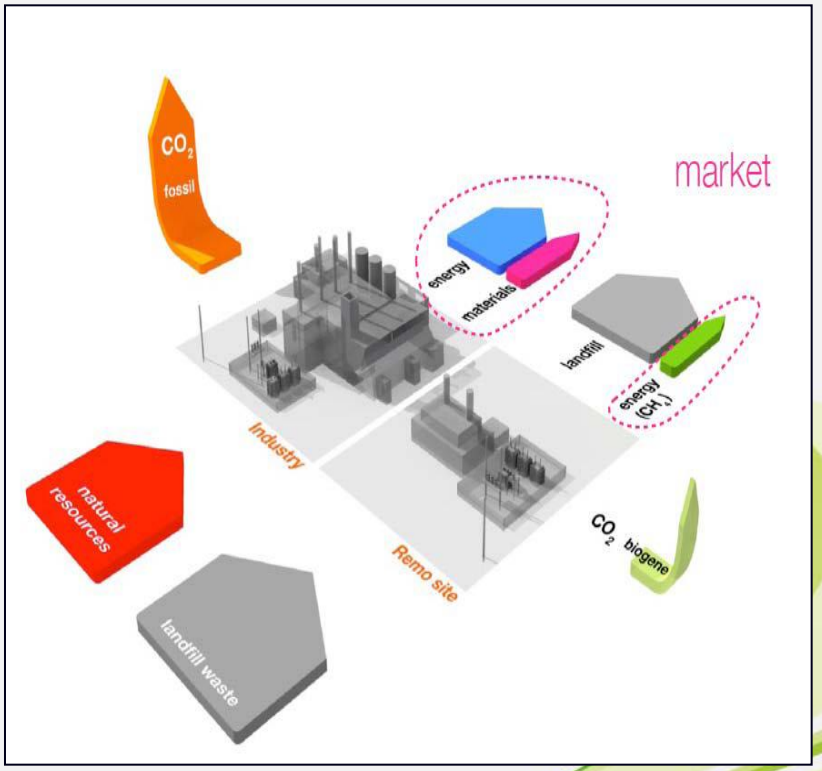
Enhanced Landfill Mining: Waste Characterisation

- Remo site has detailed waste inventory since its inception
- Establish reliability of waste inventory regarding type, amount and location on the site
- Assessment of potential for materials recovery and potential for energetic valorisation validated

Group Machiels: International Symposium on Enhanced Landfill Mining 2010

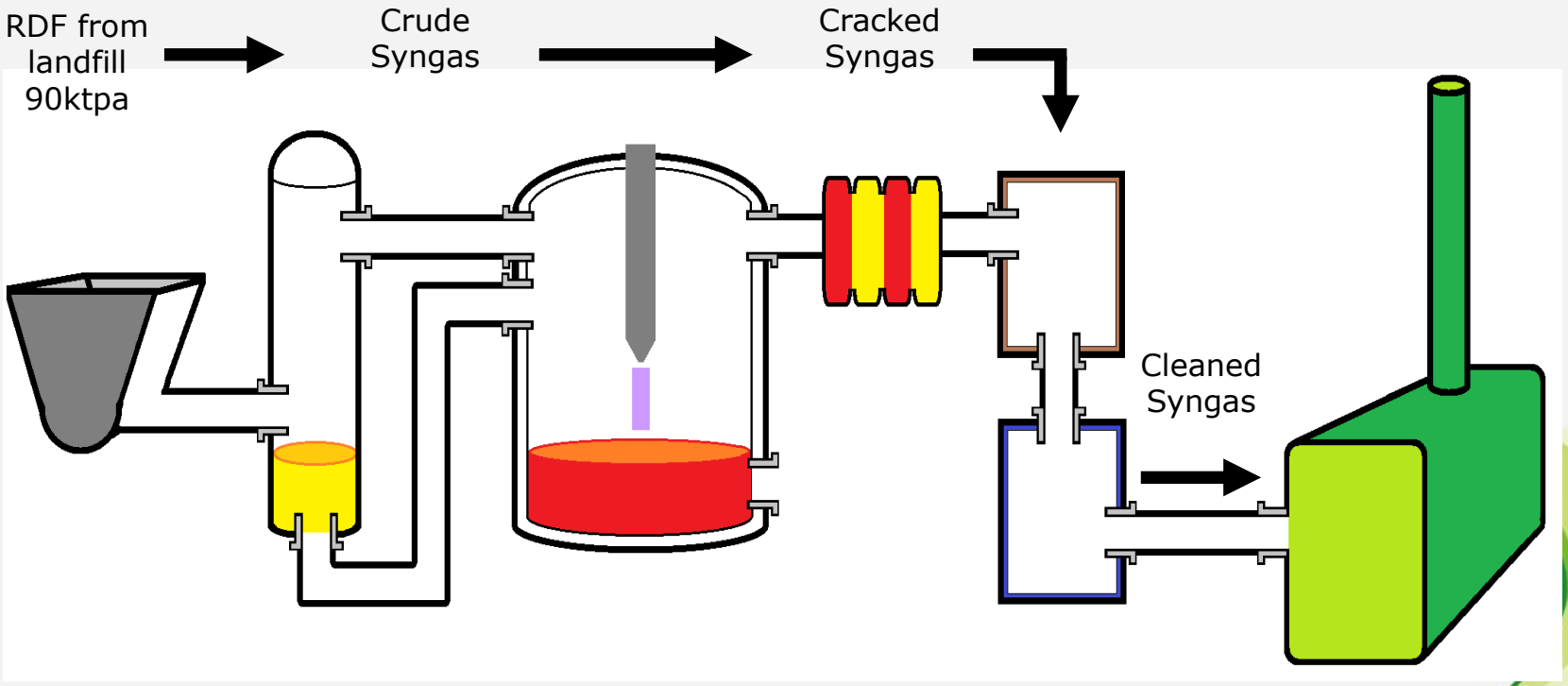
Enhanced Landfill Mining: Carbon Balance

- Carbon Balance assessment of CtC Remo gave CO_2 savings of 1.0 M tonnes over 20 years compared to "Do- Nothing" scenario:
  - Avoids burning of fossil fuels for power/heat generation
  - Carbon offsets from recovered materials
- Additional CO_2 savings may be achieved:
  - From utilisation of heat
  - Production of low C cement materials



Group Machiels: International Symposium on Enhanced Landfill Mining 2010

The Gasplasma® Process



Screw Feed Hopper

Stage 1 Fluid Bed Gasifier

Stage 2 Plasma Convertor

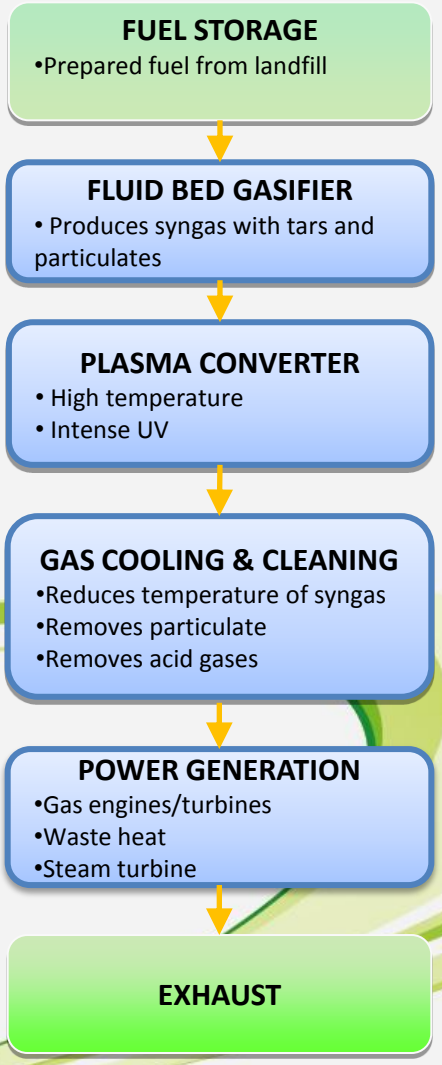
Heat Exchanger

Gas Cleaning Equipment

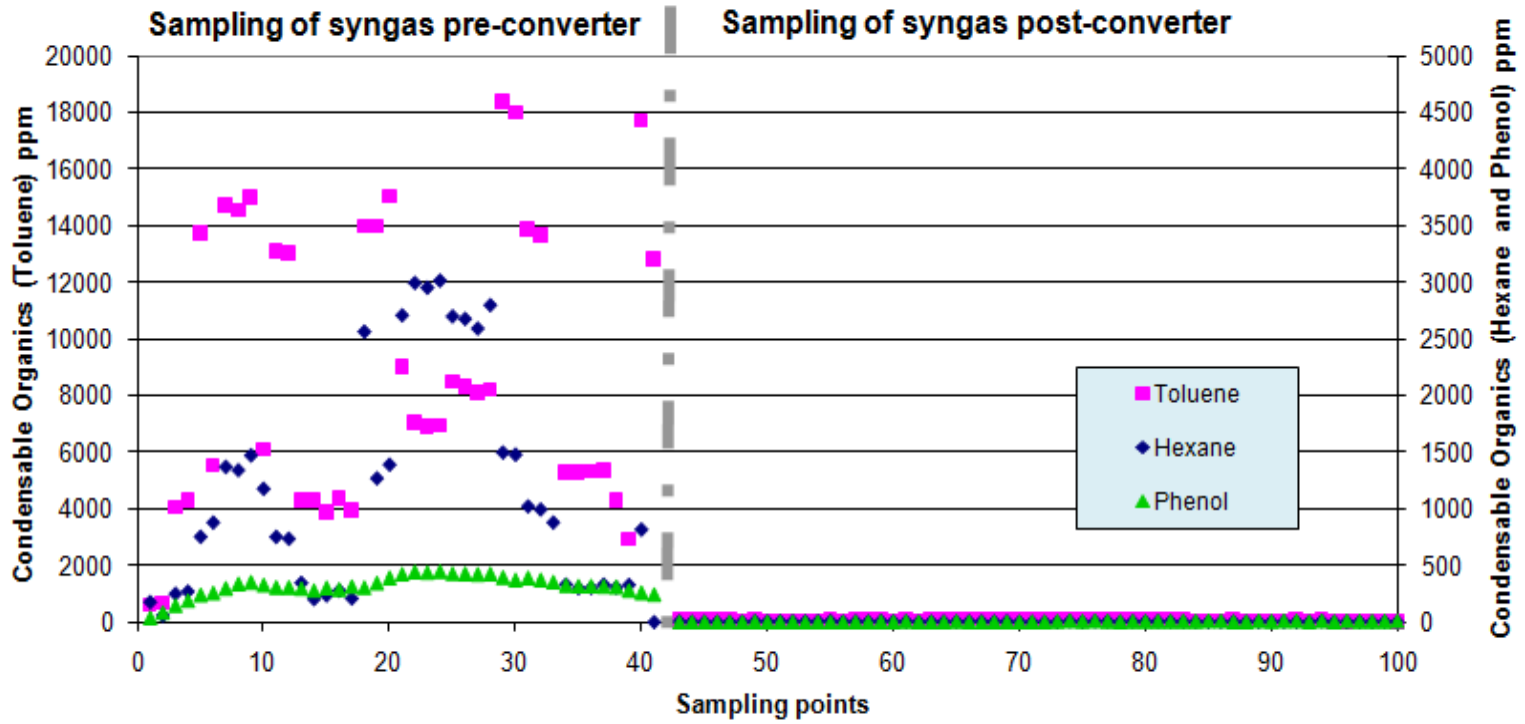
Power Island generating renewable power and heat

The Gasplasma® Process in ELFM

- Prepared fuel from the mining and materials recuperation stages provides the fuel for the thermal process
- Gasifier acts as work horse of the two stage process mitigating the usually high parasitic load required by other plasma plants
- Energy Products of Idaho (EPI) provide the fluidised bed gasifier and have 100 reference plants worldwide
- Tetronics provide the plasma convertor and have 80 reference installations worldwide
- The gas cooling and cleaning process uses conventional industrial equipment
- The power island comprises conventional reciprocating gas engines
- Emissions treatment is managed with proven catalyst technology and is monitored continuously

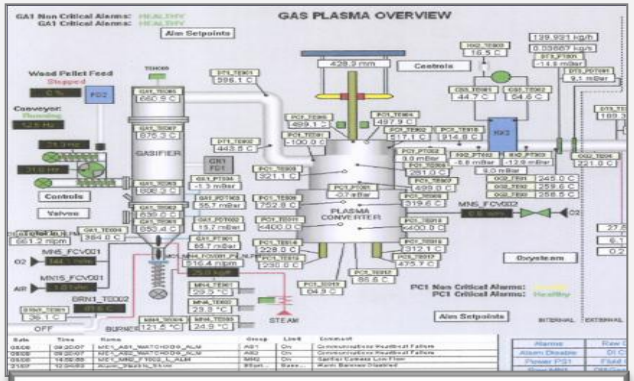


Gasplasma®: Cracking Organics



Gasplasma®: Swindon Plant

- Pilot Plant - 2005 to 2007
- Demonstration Plant – from 2007
- EPI Gasifier
- Tetronics Plasma Converter
- Syngas cooling & cleaning
- 100 kW gas engine
- SCADA
- FTIR gas analysis
- Feed includes RDF, ASR, Mined Landfill, Tyre Crumb, Wood, CCA
- Opportunity to test client materials



Gasplasma®: Treatment of Remo Material

Extensive test work undertaken on two types of materials:

- 1 Simulated material
- 2 Recovered RDFs from Remo mined material, Belgium

- Established optimal process operating parameters for this fuel to attain required plant and environmental performance levels
- Provided valuable data to enable us to optimise the models that support the commercial plant
- The data has also been used to assist specifying equipment and engage with potential suppliers

Key conclusions from test programme :

- Able to deliver required project outputs
- Emissions for the commercial plant will be Vlarem II (and IED) compliant
- High energy conversion efficiency attained

Gasplasma®: Treatment of Remo Landfill Material

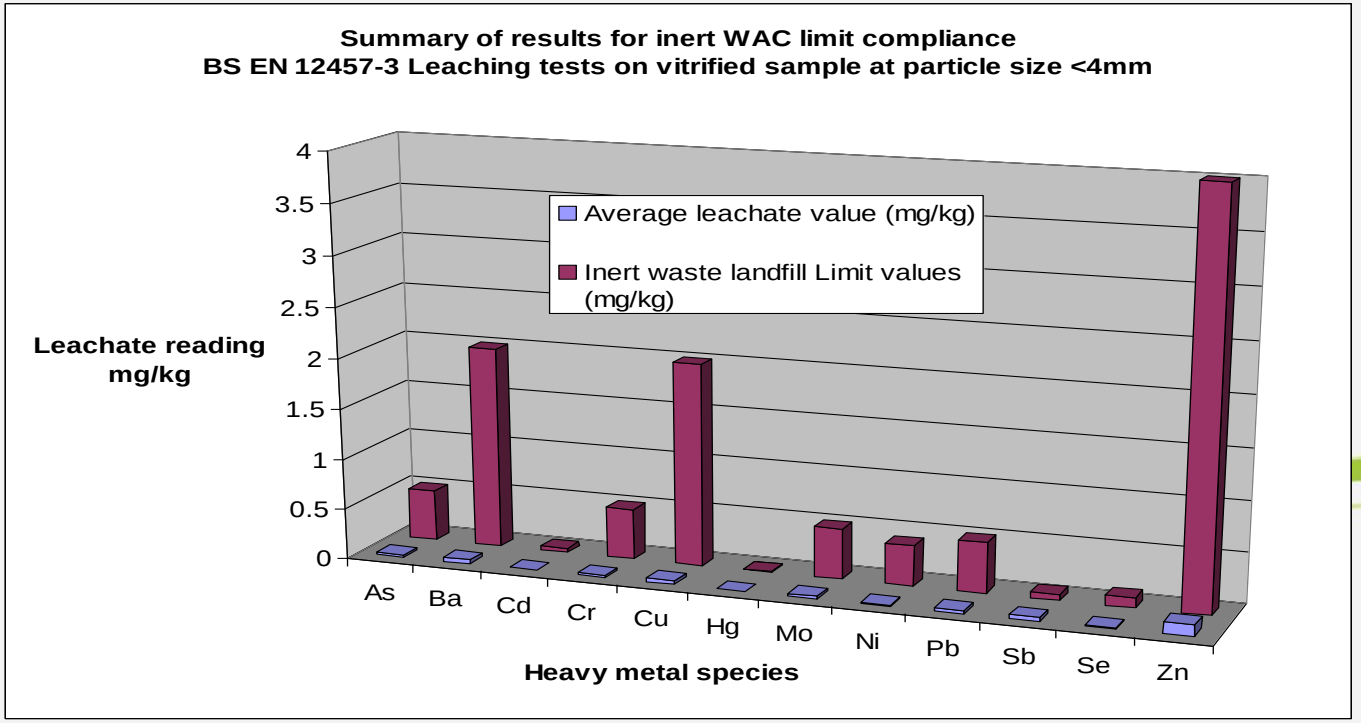
- Energy conversion efficiencies of up to 86% of solid fuel to cold syngas (compared with 73% reported for fluid bed gasifiers in published literature)
- Carbon conversion efficiencies of c.96% compared to c.80-85% reported for fluid bed gasifiers
- Combined cycle conversion efficiencies (i.e. from gas and steam cycle) of up to 43% from syngas to electricity will be attained on commercial plant compared to <25% for a similar capacity plant operating on combustion/steam cycle only. High overall net electrical efficiencies attainable.
- Utilisation of the heat as well as power will significantly increase overall energy efficiency on the commercial plant

Gasplasma® Outputs for Phase 1 at Remo

Total landfill arising	16 million tonnes
Throughput of RDF per line*	90,000 tpa
Gross electrical output	22MWe
Net electrical output to export	18MWe
Power output	135,000 MWh pa
Power for	18,000 homes
Surplus heat for export	13 MW
Plasmarok® - product not a waste	14,000 tpa
Exceptionally low residual wastes	2,000 t APC pa
Bottom ash	Nil
Emissions	IED/ Vlarem II compliant

* Phase 1 is for 1 process line. It is anticipated that there will be 5 lines in total

Gasplasma® Output: Plasmarok®



Mechanically strong, extremely leach resistant

Accepted by EA as a product – not a waste

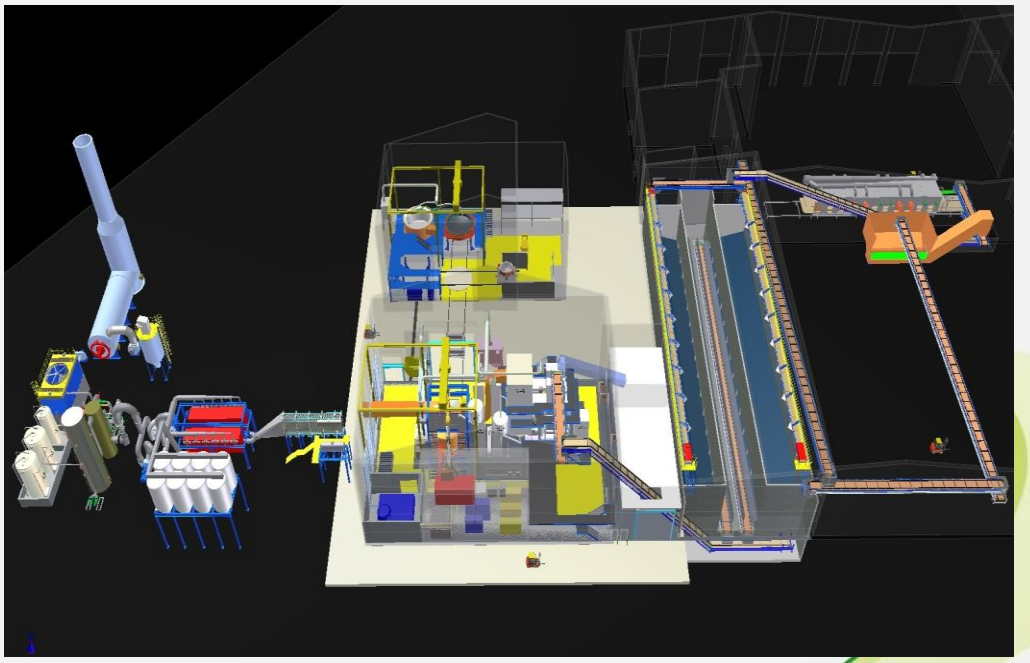
Main constituents: Silica 37%; Lime 31% ; Alumina 16%

Others include: Iron Oxide; Titania; Magnesia; Sodium Oxide; Potash ; Phosphate

Gasplasma®: Physical Layout of Plant

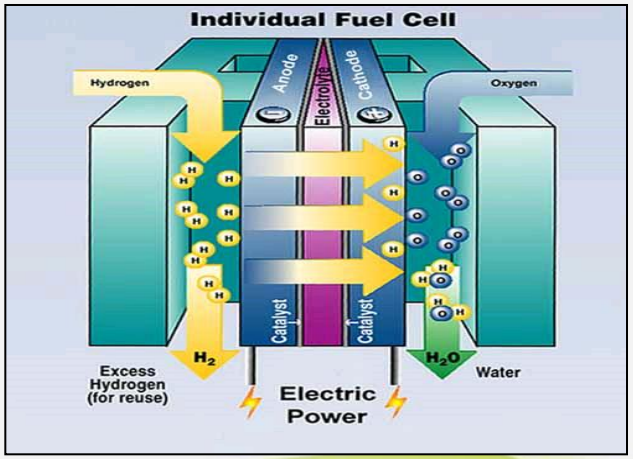
FEATURES

- 150,000 tpa plant needs building of c.10,000 sq.m.
- Standard buildings: Commercial / Industrial sheds:
- Similar profile to warehouse
- Maximum roof height 16 metres
- UK planning status: classed as a Recovery Plant not as waste disposal
- Full site requirement of c.8 acres (3.5 hectares)
- Stack height of c.25 metres (c.10m above roof)

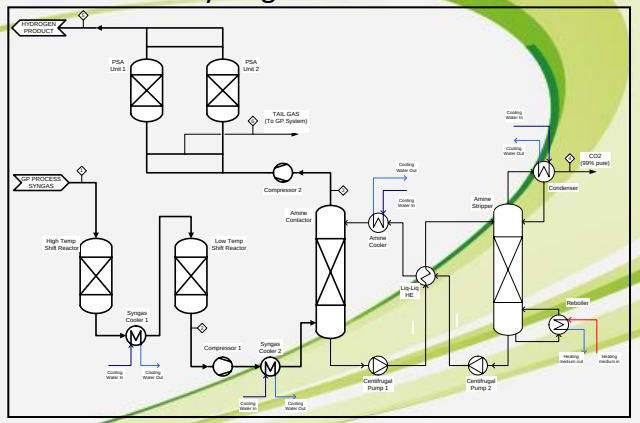


Gasplasma®: A Future Gateway Technology

- High energy conversion efficiency attained
- Syngas is clean and high in Hydrogen
- Ideal precursor for fuel cell applications
  - Suitable with some further clean up for use in high temperature fuel cells (MCFC or SOFC)
  - Carbon Monoxide treated in a water shift reactor to produce more Hydrogen for use in hydrogen fuel cells for distributed energy generation or in hydrogen vehicles
- Potential to produce gaseous and liquid fuels
  - Production of Bio-Substitute natural gas (SNG)
  - Production of Gas to Liquids



Hydrogen Fuel Cell



Summary: Gasplasma® Benefits for ELFM

Efficiency
- High net electrical efficiency
- Heat recovery is feasible

Environmental
- No residual ash
- Plasmarok® – product not waste
- Negative carbon footprint
- IED / Vlarem II compliant emissions

Social
- Low impact upon the community
- Enables reclamation of amenity land

Economic
- Complementary to recycling and MBT
- Reclamation of valuable materials
- Future proof – syngas has multiple applications

Any Questions?

B2 / B3 Marston Gate
South Marston Business Park
Stirling Road
Swindon SN3 4DE
Tel: +44 (0)1793 238550
Fax: +44 (0)1793 834476

Thank you