ALTERNRG

A LEADING PROVIDER OF CLEAN ENERGY SOLUTIONS

PLASMA GASIFICATION VS. INCINERATION

June 2010

Westinghouse Plasma Corporation

a division of Alter NRG Corp.

WHAT IS PLASMA GASIFICATION?

- Plasma gasification uses heat - as hot as the sun's surface - to break down waste materials into a useful product called synthesis gas 'syngas'
- Syngas can then be used to generate
  - Power
  - Steam
  - Liquid fuels such as ethanol or diesel
  - Hydrogen
  - Fertilizer Compounds

- Benefits of plasma gasification:
  - Significant reductions in carbon footprint and overall pollution
  - Creates an affordable and stable energy source
  - Uses renewable and recurring resources
  - Qualifies for financial incentives and credits
  - The Westinghouse technology is being used in commercial facilities that have been operating for over 7 years

THE PLASMA GASIFICATION PROCESS

HOUSEHOLD WASTE
INDUSTRIAL WASTE
COAL
BIOMASS
PETCOKE

FEED HANDLING → GAS COOLING → GAS CLEAN-UP → SYNGAS

OPERATING COST PER UNIT

$0 to $4/mmbtu
$0 to $4.22/GJ

POWER <$20/MWh

ETHANOL <$1.25/gallon

STEAM

- The facility exports 80% of the energy input to Syngas
- Plasma torches use 2% to 5% of the energy input

air or oxygen feed

plasma torch

metal is recycled and slag output is used for construction

- Gasification is not incineration
- Gasification creates Hydrogen and Carbon Monoxide: An energy rich gas stream

WIDE VARIETY OF FEEDSTOCKS
LOW $ COST

→ FLEXIBLE PROCESS
GASIFIER

→ WIDE VARIETY OF PRODUCTS
HIGH $ VALUE

WHY GASIFICATION AND INCINERATION ARE DIFFERENT

"Both gasification and incineration are capable of converting hydrocarbon-based hazardous materials to simple, nonhazardous byproducts.

However, the conversion mechanisms and the nature of the byproducts differ considerably, and these factors should justify the separate treatment of these two technologies in the context of environmental protection and economics."

U.S. Department of Energy, National Energy Technology Laboratory (NETL)

GASIFICATION IS NOT INCINERATION

"The definition (of gasification/pyrolysis) reflects our policy intent to provide gasification/pyrolysis (along with anaerobic digestion) with an increased level of support (2 Renewable Obligation Certificates (ROCs) per MWh) where it presents potential advantages in efficiency for using biomass and waste over standard incineration.[1]"

The UK Department of Energy and Climate Change

[1]Advanced conversion technologies paragraph, page 19, Reform of the Renewables Obligation Consultation Document, May 2007, www.berr.gov.uk/files/file39497.pdf

KEY BENEFITS OF WPC PLASMA GASIFICATION TECHNOLOGY

Environmental Benefits

- The WPC technology creates a syngas:
  - Which can be converted into power, steam, liquid fuels, hydrogen or fertilizer compounds
  - With very low quantities of NOx, Dioxins and Furans
- Non-gaseous, inorganic components are converted to molten slag which is removed as vitrified by-product, safe for use as a construction aggregate
- Potential to recycle fly ash back into gasifier for vitrification and reuse.
- Plasma gasification results in substantial net decreases in greenhouse gas (CO_2 equivalent) emissions versus traditional landfilling and incineration
- In a combined cycle process, sulfur and other contaminants in the syngas are removed by proven gas cleanup equipment before the syngas is converted into other energy products

TECHNOLOGY COMPARISON

	Plasma Gasification	Incineration
Feedstock Flexibility	• Ability to mix feedstocks such as –MSW –Industrial Waste –Commercial & Institutional Waste –Hazardous Waste –Tires Waste	• MSW and other common waste streams
Fuel Created	• Syngas (Carbon Monoxide and Hydrogen)	• Heat
End Product Opportunities	• Replacement fuel for natural gas and fuel oil • Power via Steam cycle • Power via Combined cycle • Process Steam • Liquid fuels (ethanol, diesel) • Hydrogen • Fertilizer compounds	• Power via Steam cycle • Steam
Overall Plant Efficiency	• Combined Cycle Process: 1 tonne of municipal solid waste is capable of creating 1000 kWh of power via combined cycle configuration	• Steam Cycle Process: 1 tonne of municipal solid waste generates between 550-650 kWh of power[1]
Emissions	• **NOx:** <36 ppmvd • **SO_2:** <1.05 ppmvd • **Hg:** <1.4 µg/dscm	• **NOx:** 110-205 ppmvd • **SO_2:** 26-29 ppmvd • **Hg**: 28-80 µg/dscm
By-product	• Inert, non-hazardous glassy slag • Salable as an aggregate building product or rock wool • Particulate generated from cleaning the syngas is recyclable	• Hazardous Fly Ash • Incinerator Bottom Ash

http://www.window.state.tx.us/specialrpt/energy/renewable/municipal.php

ENERGY RECOVERY FROM WASTE - ALTER NRG TECHNOLOGY IS COMMERCIALLY PROVEN

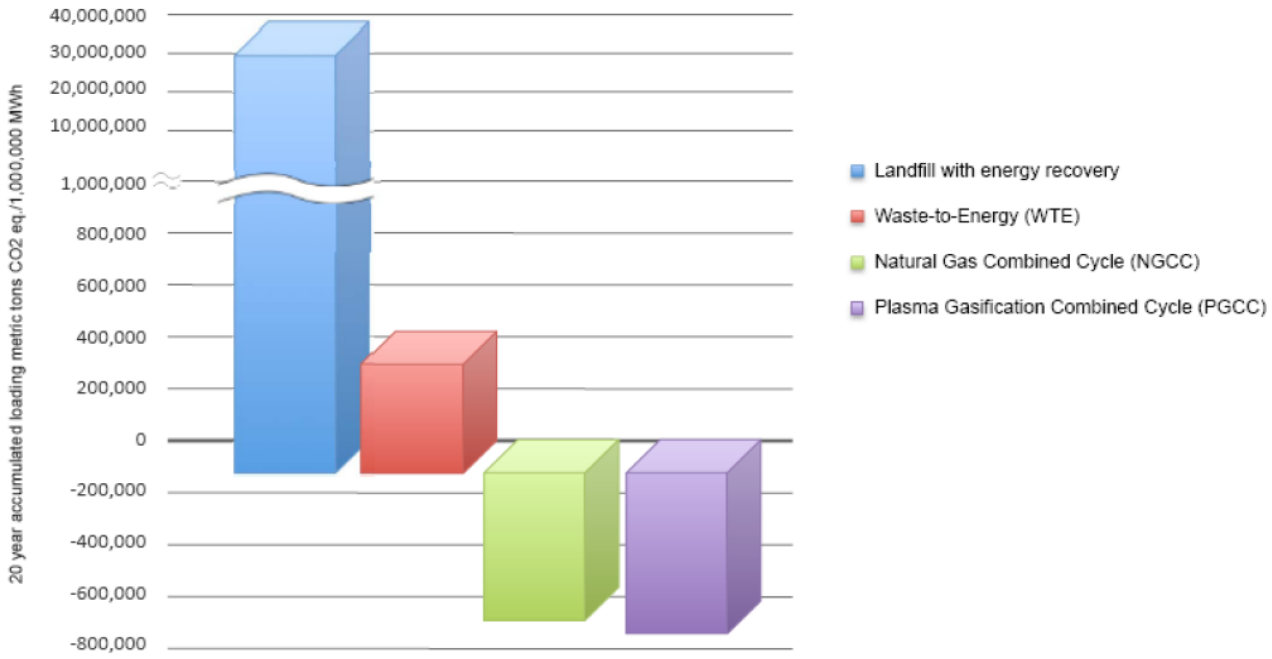
"Utashinai and Mihama-Mikata are the only plasma gasification plants processing MSW in the world on a commercial basis at this time ... As a result of Juniper's visit we consider that the Utashinai and Mihama-Mikata plants demonstrate the WPC plasma gasification process can perform in a commercial environment and that they are 'bona-fide' references."

Juniper

LIFE CYCLE COMPARISONS

• On a life cycle basis plasma gasification is environmentally superior when compared to other competing technologies

Figure 2: Twenty year accumulated GHG loading for four power generation options. Results compared on a basis of 1,000,000 MWh.



Scientific Certification Systems Report, January 2010

• **A distinct advantage of plasma gasification is its from its ability to produce an energy rich syngas to power a combined cycle power island.**

Assumptions: Twenty year accumulated GHG loading for three waste disposal options. Results compared on a basis of 274,550 metric tonnes of MSW per year. The zero axis on the chart represents emission level form baseload regional grid emissions in the Northeastern Power Coordinating Council (NPCC) National Energy Reliability Council (NERC) sub region.

DIOXINS AND FURANS

- Our plasma gasification process mitigates the formation of dioxins and furans

Dioxins & Furans form between 400-800˚ F

The temperature of the syngas when it exits the gasifier is ~1,000-1,200^{0}F, it is immediately quenched to temperatures below 400^{0}F

The Syngas does not remain in the temperature range where Dioxins and Furans form

High residence times within the reactor ensure tars are cracked and minimize particulates from exiting with syngas stream

Dioxin emissions from modern energy from waste plants are very small compared with other common environmental sources such as building and forest fires, and even fireworks.

Department for Environment Food and Rural Affairs 2006 Consultation

ENERGY RECOVERY FROM WASTE – PLASMA GASIFICATION IS CLEAN

- ENSR validated Alter NRG's anticipated emissions levels for a 750 tonne-per-day MSW integrated gasification combined cycle (IGCC) facility which concluded that emissions for NOx, PM, SO_2, HCl, CO, Hg and PCDD/PCDF would all be lower that EPA regulated standards and lower than six recently approved incineration facilities in the USA

ENSR | AECOM

Comparison of Resource Recovery Incinerator Permitted Emissions Limits to Anticipated Alter NRG IGCC WTE Emissions Levels (US EPA Units)

Pollutant	units	Recently Permitted Incineration Facilities in USA (200-800 tpd MSW)	Canada - CCME	US EPA New Source Performance Standards	US EPA Section 111(d) Emissions Guidelines	Alter NRG MSW IGCC WTE (750 tpd MSW)
NOx	(ppmvd)	110-205	293.32	150	205	36.66
PM	(mg/dscm)	16-27	28.08	20 - 24	25 - 27	4.21
SO2	(ppmvd)	26-29	136.94	30	29 - 31	1.05
HCl	(ppmvd)	25-29	69.4	25	29 - 31	6.48
CO	(ppmvd)	100	68.66	100	100	19.27
Hg	(µg/dscm)	28-80	Tier 3 Metals	50 - 80	80	<1.4
PCDD/PCDF	(ng/dscm)	13-30	0	13 - 30	30 - 60	0

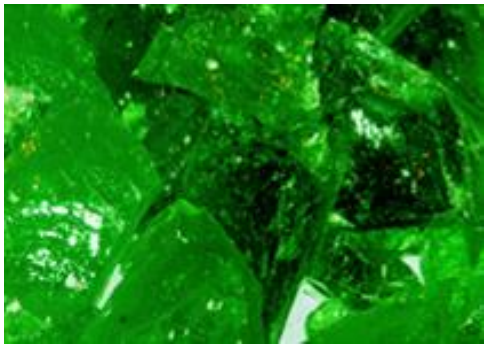
INCINERATOR ASH VS. VITRIFIED SLAG

INCINERATOR ASH

- Fly ash may contain dioxins and furans
- Under EPA regulations incinerator ash must be tested and pass the Toxicity Characteristic Leaching Procedure (TCLP) test. Ash that does not pass the TCLP test is classified as hazardous waste and requires special disposal

WESTINGHOUSE PLASMA VITRIFIED SLAG

- Testing done on slag from the Mihama-Mikata facility shows that this slag is inert/non-leaching and would not contaminate soil or drinking water. It is used in local cement production
- Slag flows out the bottom of the gasifier and allows for the separation of metals
- In addition to the metals recovered, vitrified slag can be used as rock wool, floor tiles, insulation, landscaping blocks or road aggregate



PLASMA GASIFICATION SUMMARY

- Better Economics
  - For similar capital and operating costs we generate ~ 50% more energy from the waste in a combined cycle configuration
- Better Environmental Performance
  - Plasma gasification creates significantly less emissions when compared to recently permitted incineration facilities in the US[1]
  - Non-hazardous, inert slag can be sold and used for construction purposes in comparison to incinerators where landfilling is still necessary to dispose of ash
- Decreased Carbon Footprint
  - Significantly reduced carbon footprint per unit of energy produced[2]

[1]ENSR|AECOM

[2]Scientific Certification Systems Report, January 2010

Appendix

COMMON MISPERCEPTIONS

Westinghouse Plasma/Alter NRG Gasification	
MYTH	**REALITY**
Plasma Gasification is incineration in disguise	Unlike incineration which combusts waste, plasma gasification converts waste feedstocks into syngas, which is cleaned through a pre-combustion process, that can then be used to generate power, steam, liquid fuels, hydrogen, or fertilizer compounds
Plasma gasification creates a "toxic soup" of air emissions	Through the use of plasma gasification some toxins are eliminated. Others are captured through pre-combustion clean-up to levels that meet and in some cases exceed emission requirements. But, in common with all other waste systems and despite the claims of some companies, it is not a zero emission technology
Plasma gasification technology is risky and unproven	Current "Westinghouse powered" operating facilities are operating beyond "pilot" scale at 220 tonnes-per-day and have been for over 7 years
Plasma gasification undermines sustainable strategies	Plasma gasification works in conjunction with the waste hierarchy - even after efforts to reduce, reuse, recycle and compost, there is still residual waste generated. Rather than send this residual waste to a landfill where harmful greenhouse gas emissions are released, capture the energy value of the waste through plasma gasification energy recovery facilities
Plasma gasification is not energy efficient	Depending on the configuration, the Westinghouse Plasma/Alter NRG Gasification process captures the maximum amount of energy that is input.
Capital costs are unrealistic	Independent third parties – Worley Parsons, Uhde Engineering Shanghai, and AMEC/BDR have vetted our technology and provided cost estimates for a complete plasma gasification facility – the prices are comparable to that of incinerators Plasma: $4,500/kW vs. Incinerator: $5,000/kW

MIHAMA-MIKATA VITRIFIED SLAG

Slag from the Mihama-Mikata facility has been put through a number of leachate tests including the Japanese JLT-46, NEN-7341 and the American TCLP analysis. These tests were conducted by two independent laboratories Shimadzu Techno-Research Inc. and ALS Laboratory Group. The results show that the Mihama-Mikata slag components are below the test detection limits and the slag is considered non-leaching. Below is a chart showing some of the results from the JLT-46 tests

MIHAMA-MIKATA SLAG JLT-46 TEST RESULTS				
Heavy Metal	**Unit**	**Method Detection Limit**	**Average Measured Value of Slag**	**JLT-46 Limit**
Arsenic	mg/L	0.001	<0.001	0.01
Cadmium	mg/L	0.001	<0.001	0.01
Chromium VI	mg/L	0.005	<0.005	0.05
Lead	mg/L	0.001	<0.001	0.01
Mercury	mg/L	0.0001	<0.0001	0.005
Selenium	mg/L	0.001	<0.001	0.01

Notes: mg/L = parts per million (PPM)

JLT-46 performed by Shimadzu Techno Research, Inc., Kyoto Japan on Mihama-Mikata slag samples received from Kamokon

SHIMADZU

ALS