Plasma Gasification: The Next Generation of Waste-to-Energy (WTE) Solutions

Gasification India
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New Delhi, India
WE HAVE A GLOBAL WASTE PROBLEM

Landfills causes:

- Greenhouse gas emissions
- Unnecessary land occupation
- Effects health and wellbeing
- Water contamination through leaching
- Clean-up issues for future generations

BIOMASS
1.3 BN Tonnes/year

MSW
1.3 BN Tonnes/year

HAZARDOUS
400 MM Tonnes/year

TIRES
10 MM Tonnes/year

FACTS ON GLOBAL LANDFILLING/DUMPING:

- 43% of waste is landfilled
- 38 Sites out of 50 largest sites threaten marine/coastal regions
- 64 Million people impacted by 50 largest sites (Equivalent to France’s population)
- 750+ people died in 2016 due to poor waste management at sites
- US $10-$12 Billion illegal annual waste business turnover
- 10% accounted GHG emissions by 2025 if no action is taken

Source: SWANA, ISWA, UN

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STRATEGIC ALIGNMENT WITH INDIA’S NEXT PHASE OF ECONOMIC DEVELOPMENT

- Meet the Government’s Swachh Bharat (Clean India Mission) goals
- In-line with the Ministry of Environment, Forest and Climate Change Rules and Regulations
- In-line with the Solid Waste Management Rules 2016; 2000
- Enhanced waste collection and segregation
- Enhanced environmental protection with regulations in place

- Alter NRG has a global presence
- Working with India and its neighboring countries in realizing their waste management initiatives
- Collaborating with sound waste management practice, waste reduction, and energy recovery
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India is Faced with Growing Waste Problem (an Opportunity for Renewable Technologies)

- Annual GDP growth: 7%
- Population: 1.34 Billion
- Waste generation: Currently, 80 million Tonnes/year
  - By 2050: 430 million Tonnes
  - 80% is landfilled and 20% is treated/recycled
- Additional waste streams:
  - Hazardous/medical: 5 Million Tonnes/year
  - Biomass: 150 Million Tonnes/year
  - Tires: 1 Million Tonnes/year
- Land use:
  - Existing landfills reaching capacity
  - Cannot be expanded further
  - Damage due to leachates
- Environmental issues and ongoing concerns:
  - Inadequate waste collection/disposal
  - Dioxins and furans emissions

Creating Tomorrow’s Opportunities:

- Efficient treatment of multiple waste streams
- Reduce carbon footprint and overall environmental impact
- Ability to retrofit and upgrade the existing industries
- Plasma Gasification waste-to-energy is a clean and environmentally friendly solution
What Does Plasma Gasification Do?
Divert Waste from Landfills and Make Syngas

- Over 30+ years of development
- Commercially operating facilities – 15+ years
- Processes a variety of feedstocks
- Multi-billion $ investment

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Westinghouse Plasma Corporation
SYNGAS – A FUNDAMENTAL BUILDING BLOCK

• Syngas produced via plasma gasification, is a fundamental building block for multiple forms of renewable energy:
  – **Syngas-to-power** is a proven path in producing electricity via renewable value chain
  – **Syngas-to-liquids** represents significant value, that can be utilized to produce ethanol, jet fuel, diesel, DME and other high-valued commodity end-products
India’s Waste Problem Has Significant Energy Equivalents

**Estimated Municipal Solid Waste**
- **Solid Waste**: 350,000 Tonnes/day
- **Syngas**: 3.6 Million Btu/day (OR)
- **Liquid Fuels**: 300,000 Bbls/day (OR)
- **Electrical**: 17.5 GW Capacity

**Estimated Waste Biomass**
- **Waste Biomass**: 329,000 Tonnes/day
- **Syngas**: 3.4 Million Btu/day (OR)
- **Liquid Fuels**: 283,000 Bbls/day (OR)
- **Electrical**: 16 GW Capacity

**Estimated Hazardous Waste**
- **Hazardous Waste**: 13,150 Tonnes/day
- **Syngas**: 137,000 Btu/day (OR)
- **Liquid Fuels**: 11,000 Bbls/day (OR)
- **Electrical**: 650 MW Capacity

**Estimated Waste Tyres (ELT)**
- **Waste Tyres**: 2,200 Tonnes/day
- **Syngas**: 23,000 Btu/day (OR)
- **Liquid Fuels**: 1,900 Bbls/day (OR)
- **Electrical**: 110 MW Capacity
WHO WE ARE - SUNSHINE KAIDI GROUP OF COMPANIES

- $6 billion USD Company
- 11 China subsidiaries and 4 US subsidiaries
- Kaidi builds, owns and operates power facilities
- Currently permitted to build 3000+ MW in China

- Proven EPC capabilities
- Proven expertise in Hydro, Wind and Concentrated Solar Power (CSP) generation
- Owns key technologies
- Owns land for Biomass Production
- Development of BTL Projects

President Xi Jinping visited Kaidi Biofuel Facilities in 2013

Alter NRG (Lead plasma gasification business & project development; manage project investments globally)
Westinghouse Plasma (Provide plasma gasification island and equipment; support project engineering and commissioning)
RES Kaidi LLC (Provide Fischer-Tropsch (FT) equipment; support project management & engineering)
Skyfuels (Provide concentrated solar equipment; support engineering)
HOW DOES PLASMA GASIFICATION WORK?
**How Does Plasma Gasification Work?**

**Feedstock Flexibility**
- Industrial Waste
- Commercial Waste
- Waste Biomass
- Household Waste
- Medical Waste
- Tires
- Coal
- Other feedstocks

**Clean Syngas**
- Tar free
- 250 to 300 BTU/scf
- 2:1 CO/H2

**Product Options**
- Power
- Liquids
- Chemicals

**Vitrified Slag**

**Plasma Torches**

**Air & Oxygen**

**3 Seconds (No furans or dioxins)**

**850 °C**

**1000 °C**

**1650 °C**
ALTER NRG PLASMA GASIFICATION PROCESS

FEED HANDLING
PLASMA GASIFICATION, SLAG & METAL RECOVERY
GAS COOLING
COARSE PARTICULATE REMOVAL
FINE PARTICULATE & HEAVY METALS REMOVAL
SULPHUR REMOVAL
END PRODUCT(S)

Municipal Solid Waste: 1000 tpd (4000-5000 Btu/hr)
Other Inputs: Flux Material: 141 tpd
Coke: 40 tpd

Syngas
2.5 - 3.5 Million MMBtu/year

Gas Turbine
HRSG
Boiler
Steam Turbine
Steam Turbine
FT Reactor

Slag: 250 tpd
Coarse Particulate Matter: 20 tpd
Fine Particulate Matter & Heavy Metals Removed: 20 tpd
Sulphur Removed: 0.1-1 tpd

Combined Cycle Power 45-50 MW Capacity (Gross) Base load production
Steam Cycle Power 20-25 MW Capacity (Gross) Base load production
Liquids 945-950 Bbbls/day

For Sale to Market
For Sale to Market
For Sale to Market
For Sale to Market
For Sale to Market

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WESTINGHOUSE PLASMA TORCHES: THE ENGINE OF THE PLASMA GASIFICATION PROCESS – only 2% to 5% parasitic load

MARC 11L rated for 1100 kW
MARC 11H rated for 2400 kW
MARC 3 rated for 80kW to 300kW
MARC 4.5 rated for 280 kW to 530 kW

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ALTER NRG & WESTINGHOUSE PLASMA GASIFICATION SOLUTION: PROVEN COMMERCIAL OPERATIONS

1983 Madison, PA, USA
- Multi-waste: 48 tpd Demo Facility
  - P5 Gasifier

1995 Kinuura, Japan
- Incinerator Ash
  - P5 Gasifier

1999 Yoshii, Japan
- MSW: 24 tpd
  - P5 Gasifier

2002 Mihama-Mikata, Japan
- MSW & Sludge: 24 tpd
  - P5 Gasifier

2003 Utashinai, Japan
- MSW & ASR: 220 tpd
  - W15 Gasifier

2009 Pune, India
- Hazardous Waste: 78 tpd
  - P5 Gasifier

2012 Wuhan, China
- Waste Biomass: 150 tpd
  - W15 Gasifier

2013 Shanghai, China
- Medical Waste & Fly Ash: 30 tpd
  - P5 Gasifier

2014 UK
- Gasifier & Auxiliary Modules Delivered
  - G65 Gasifier

2017 Multiple projects
- MSW, RDF, biomass, hazardous, tires, etc.
  - All Gasifiers

LESSONS LEARNED:

- Over 100 types of feedstocks successfully gasified; vitrified
- Ash can be vitrified successfully
- MSW can be gasified
- Emissions' values measured; limits achieved successfully
- Plasma gasifier successful at commercial scale
- Emission limits met
- Scale-up issues resolved
- Gasifier geometry optimized
- Hazardous waste successfully destroyed; vitrified
- Over 600 types of feedstocks processed on a commercial scale
- Design information gathered for biofuels facility
- Successful medical waste destruction program in China
- Ready for scale-up
- Gained understanding of large scale, oxygen-blown operation
- Resolved feed system challenges
- At various development stages
- Some at advanced Engineering stage
MULTIPLE PROJECTS AT VARIOUS DEVELOPMENT STAGES
IDENTIFIED PROJECTS WITH SITES AND ADVANCED ENGINEERING WORK UNDERWAY

- South Korea: 3 Projects
- Vietnam: 2 Projects
- Thailand: 2 Projects
- Europe: 2 Projects
- Middle East: 3 Projects
- India: 3 Projects
- North America: 2 Projects
- South America: 2 Projects
- Australia: 3 Projects
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Waste-to-Energy not only create syngas opportunities, but also represent global GHG/CO₂ reduction opportunity

Environment and climate change:

- Global CH₄ emissions from landfills/dumps are estimated between 9 to 70 Tg/year (1 Tg=1 million tons). (Source: Global Biochemical Cycles)
- CO₂ emissions from landfills could be reduced by 589 MtCO₂e in 2030 - assuming full implementation of current technologies

Benefits of integrating newer technologies:

- Integrating WTE/EFW facilities (material recycling and energy recovery) within municipalities enables ‘smart city living’ strategies
- WTE/EFW enables the diversion of waste from landfills/dumps and reduces CH₄/CO₂; also, reduces health risks and associated costs
- Additional benefits available by integrating Carbon Capturing (CCS) with WTE/EFW
THE WRAP UP

• Growing population/urbanization in India is driving waste volumes and environmental concern

• Waste management is a global challenge but presents multiple opportunities
  o Provides economic benefit and employment opportunities
  o Mitigates environmental issues, impacts climate change and lessens health degradation
  o Reduces GHG and CO₂ emissions

• Utilizing WTE/EFW diverts multiple wastes steams from landfills/dumps and generates renewable energy in the form of power, liquid fuels, other chemicals or fossil fuel replacement

• WTE/EFW is complementary to waste reduction, reuse and recycle
  o Enables governments/municipalities to maximize economics and efficiencies of efforts
  o Stimulates ‘circular economy’ and ‘zero waste’ strategies by treating ‘post-recycled’ waste.
  o Waste-to-Energy drives syngas utilization on a local and global basis

Assumptions:
* Combined waste volumes (MSW, Biomass, Hazardous, Tires)
** Downstream product options are estimates only; relative to the Btu energy value of the waste feedstock

GLOBAL WASTE (COMBINED)*
279 Million Tonnes/Day
(1.2 Billion Tonnes/Year)

SYNGAS**
2.5 Billion Mmbtu/Day
(OR)

LIQUID FUELS**
239 Million Bbls/Day
(OR)

ELECTRICITY**
13,920 GW Capacity (Gross)
Base load production
AlterNrg

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THANK YOU