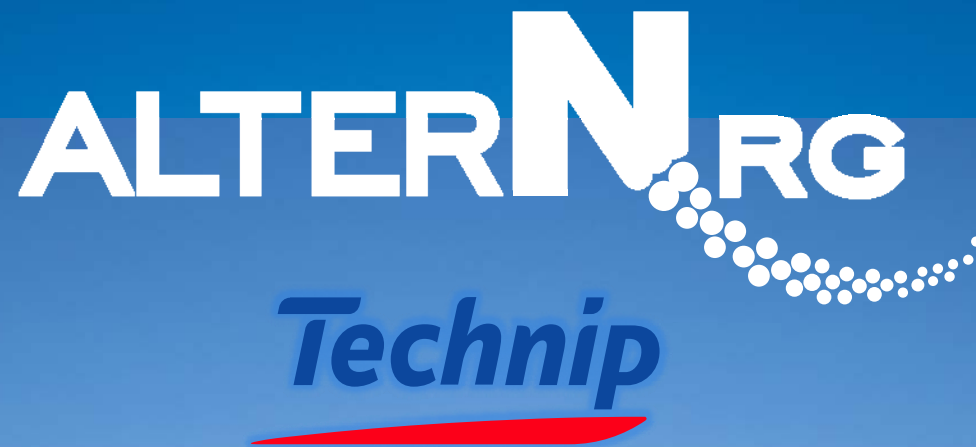


PLASMA GASIFICATION – INTEGRATED FACILITY  
SOLUTIONS FOR MULTIPLE WASTE STREAMS



Gasification Technologies Council, November 2010

Pieter van Nierop- Alter NRG  
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All dollar figures are Canadian unless otherwise stated.

# DEMAND FOR SOLUTIONS...CREATING A DEMAND FOR PLASMA GASIFICATION

- Environmental mandates and regulatory initiatives are driving renewable energy solutions
- Globally, cities around the world cannot expand existing landfills
- Annual waste generation continues to rise globally in newly industrialized countries like China and India
- Global power consumption continues to grow, demand is outstripping supply
- Globally, energy costs are volatile and unpredictable
- Alter NRG Plasma Gasification presents a potential solution:
  - Scalable
  - Economic
  - Flexible
  - Commercially Proven

“WTE helps turn a waste management problem into an energy generating solution...”

***U.S. Environmental Protection Agency***

# ALTER NRG, WORKING WITH TECHNIP, HAS EXPERIENCE AND EXPERTISE TO DELIVER COMPLETE GASIFICATION SOLUTIONS

- A number of global projects utilizing Westinghouse torches
- +20 years experience @ Westinghouse Pilot facility
- 9 years experience @ Japanese MSW/sewage sludge facilities
- 2 years experience @ Indian hazardous waste facilities
- 1 year experience @ co-located Coskata biomass to ethanol facility
- Over \$100MM spent in research, development, testing and operational improvements
- Demonstration facilities under construction
  - Biomass: Wuhan Kaidi, Wuhan China
- Recently announced projects:
  - Air Products: Teesside, UK – 950 tpd MSW to power – combined cycle
  - Geoplasma: St. Lucie, Florida – Air permit issued – 600 tpd MSW to power – steam cycle

# THE ALTER NRG / WESTINGHOUSE PLASMA SOLUTION EXPERIENCE BASE IS A CULMINATION OF MULTIPLE PROJECTS



## 1987 PLASMA FIRED CUPOLA APPLICATION

General Motors; Defiance, Ohio -  
commissioned in 1987



## 2002 WORLD'S 1<sup>ST</sup> COMMERCIAL SCALE PLASMA GASIFIER

Mihama Mikata, Japan -  
operational in 2002



## 2008 WORLD'S LARGEST PLASMA HAZARDOUS WASTE FACILITY

Pune, India –  
commissioned  
in early 2009

## 2010 HAZARDOUS WASTE FACILITY

Nagpur, India –  
ready for  
commissioning



## 1995 INCINERATOR ASH VITRIFICATION

Kinuura, Japan -  
commissioned in 1995



## 2008 WORLD'S LARGEST PLASMA HAZARDOUS WASTE FACILITY

Pune, India –  
commissioned  
in early 2009

## 2010 HAZARDOUS WASTE FACILITY

Nagpur, India –  
ready for  
commissioning



## 1999 PLASMA GASIFICATION OF MUNICIPAL SOLID WASTE (MSW)

Hitachi Metals; Yoshi, Japan -  
commissioned in 1999



## 2009 SECOND GENERATION ETHANOL FACILITY

Coskata  
Lighthouse, U.S. -  
commissioned in  
Sept. 2009

## 2010 BIOMASS-TO- ENERGY FACILITY

Wuhan, China –  
under  
construction



## 1989 INDUSTRY-LEADING TECHNOLOGY

Plasma technology by others  
such as Alcan – **over 500,000  
hours of industrial use**



## 2003 WORLD'S LARGEST PLASMA GASIFIER FOR MUNICIPAL WASTE

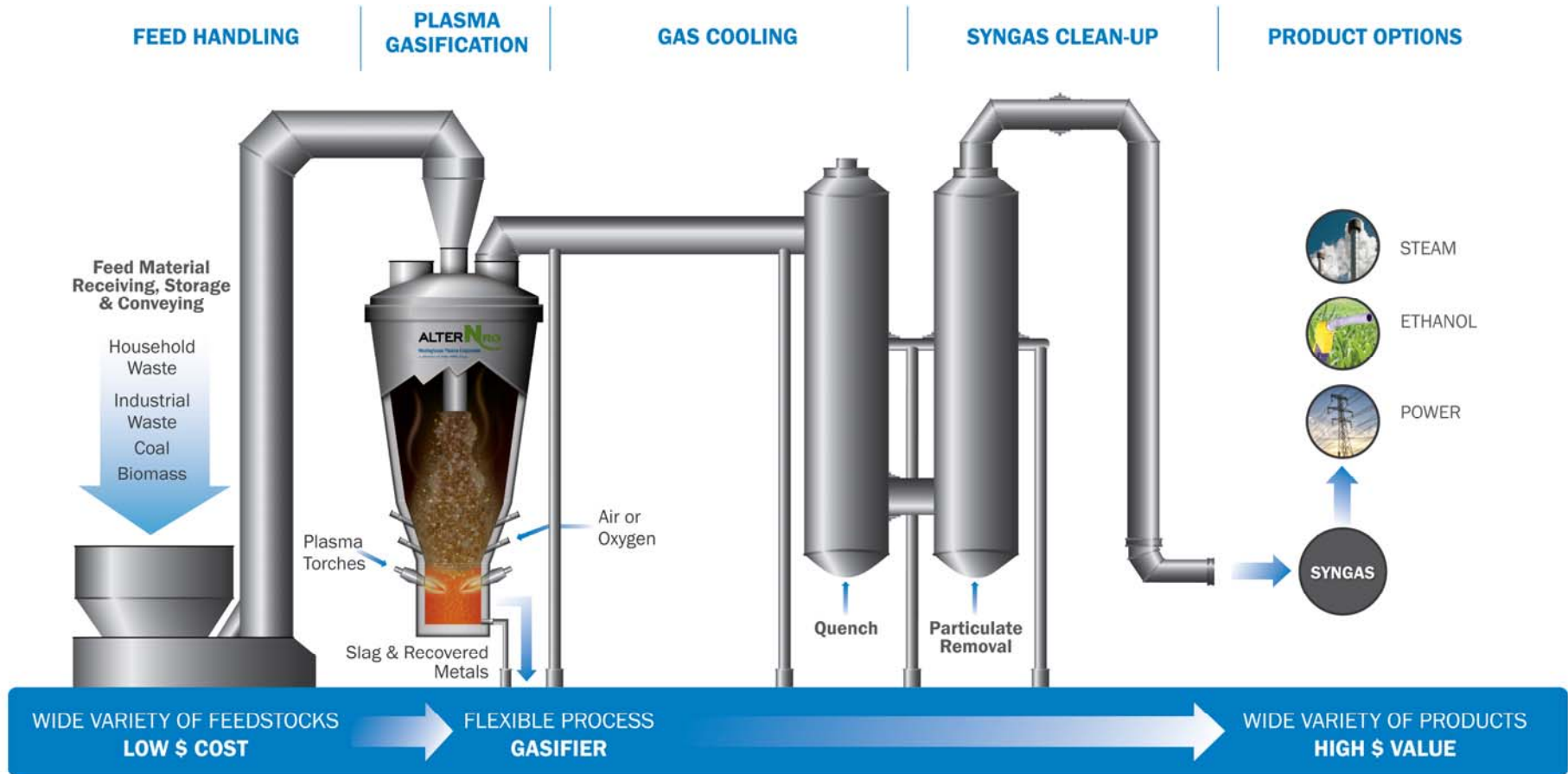
Utashinai, Japan -  
operational in 2003



## 2010 BIOMASS-TO- ENERGY FACILITY

Wuhan, China –  
under  
construction

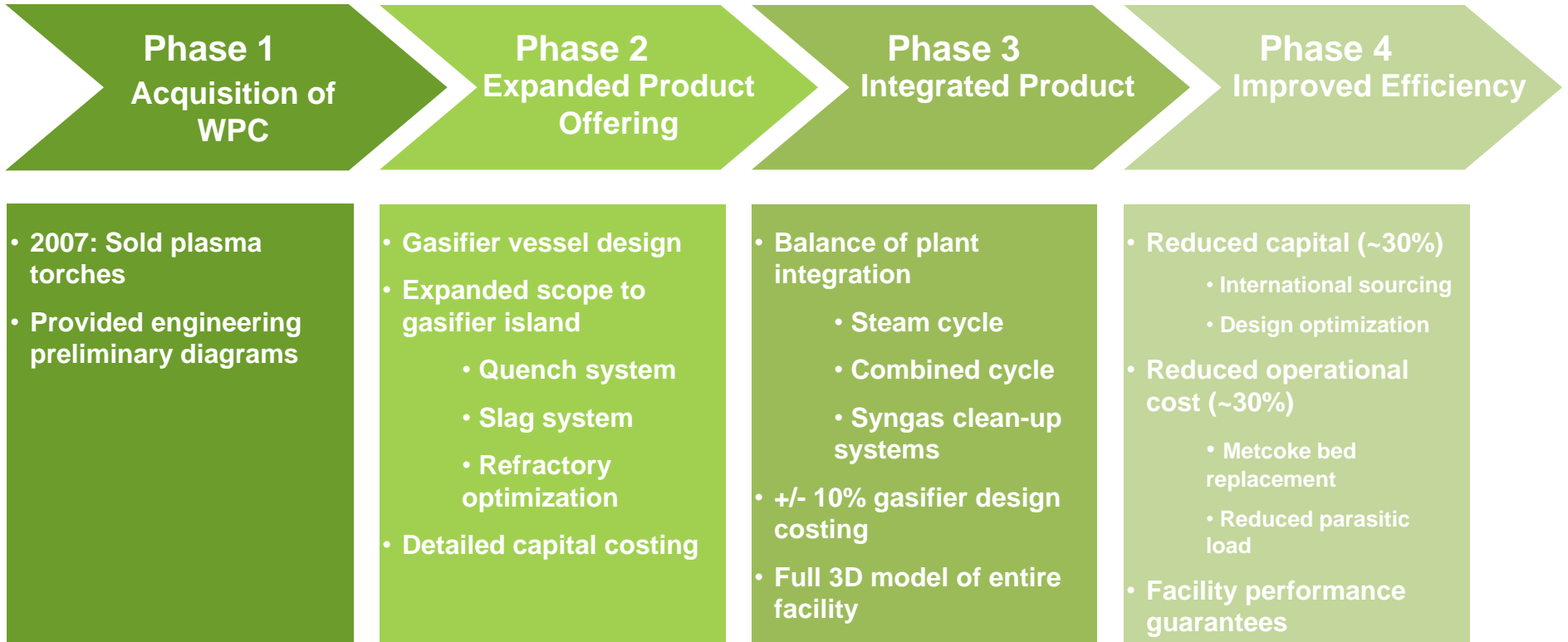
# WHAT IS PLASMA GASIFICATION?



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

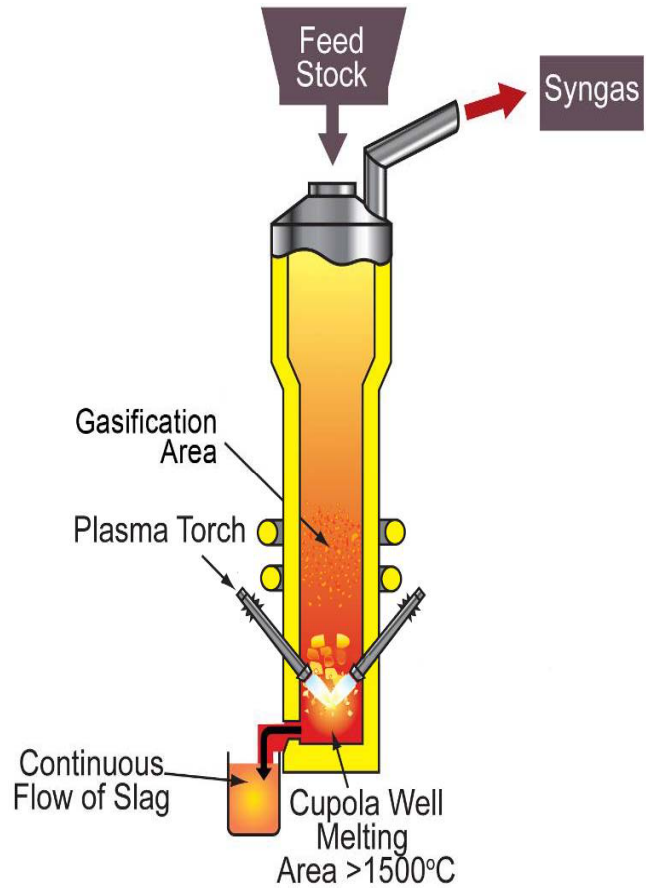
- Gasification is not incineration
- Gasification creates hydrogen and carbon monoxide: An energy rich gas steam

# EVOLUTION OF WESTINGHOUSE PLASMA GASIFICATION UNDER ALTER NRG

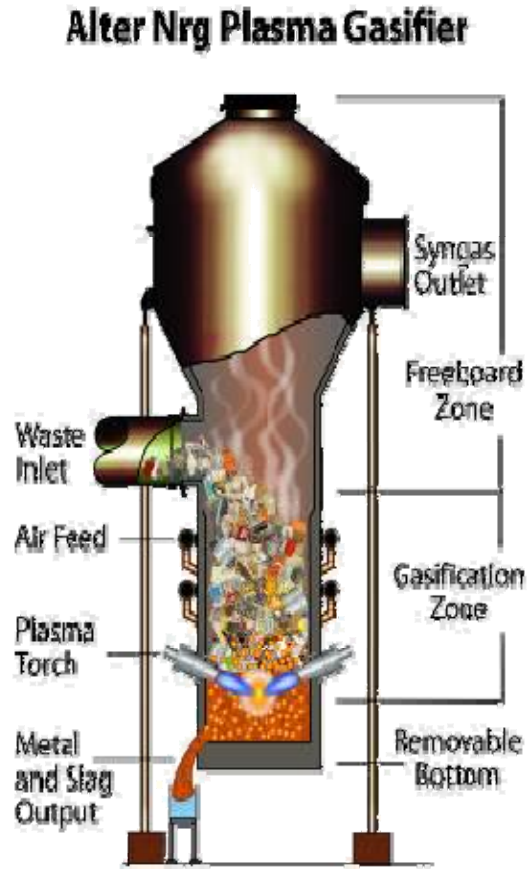


# GASIFIER VESSEL DEVELOPMENT

Pre-Generation 1



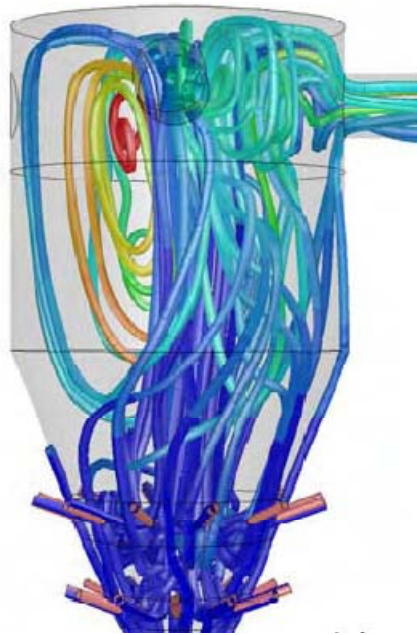
Generation 2



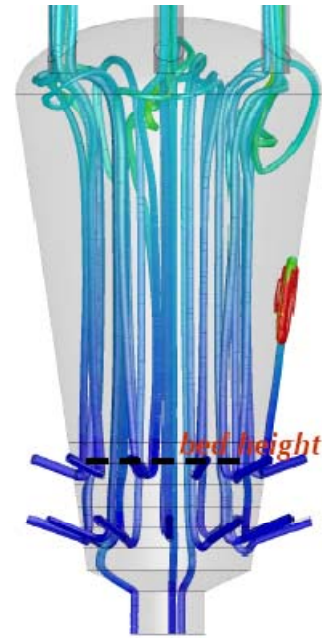
Generation 3/4



# OPTIMIZATION OF GASIFIER DESIGN



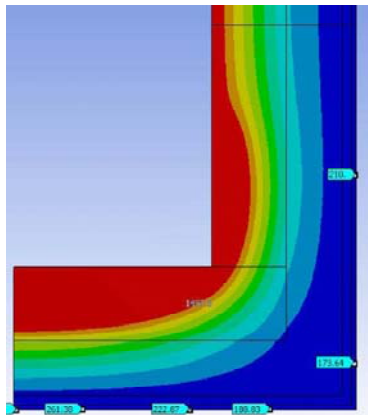
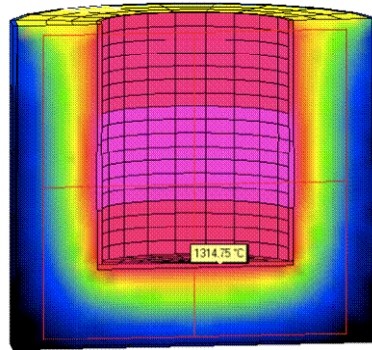
CFD Modeling - Gas flows,  
Temperatures



Optimization of flow reducing  
High velocity zones, minimizing  
carryover

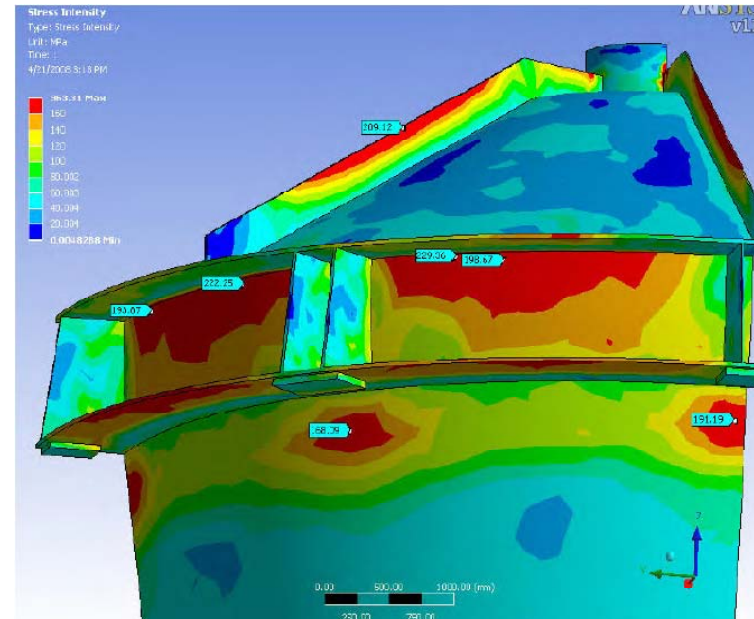
# INCREASING REFRACTORY PERFORMANCE AND IMPROVING VESSEL INTEGRITY

## Refractory Thermal Modeling Work



Prediction of slag freezing plane

## Finite Element Analysis for Vessel Mechanical Integrity



# REPLACE FOSSIL FUEL FOUNDRY COKE BED MATERIAL

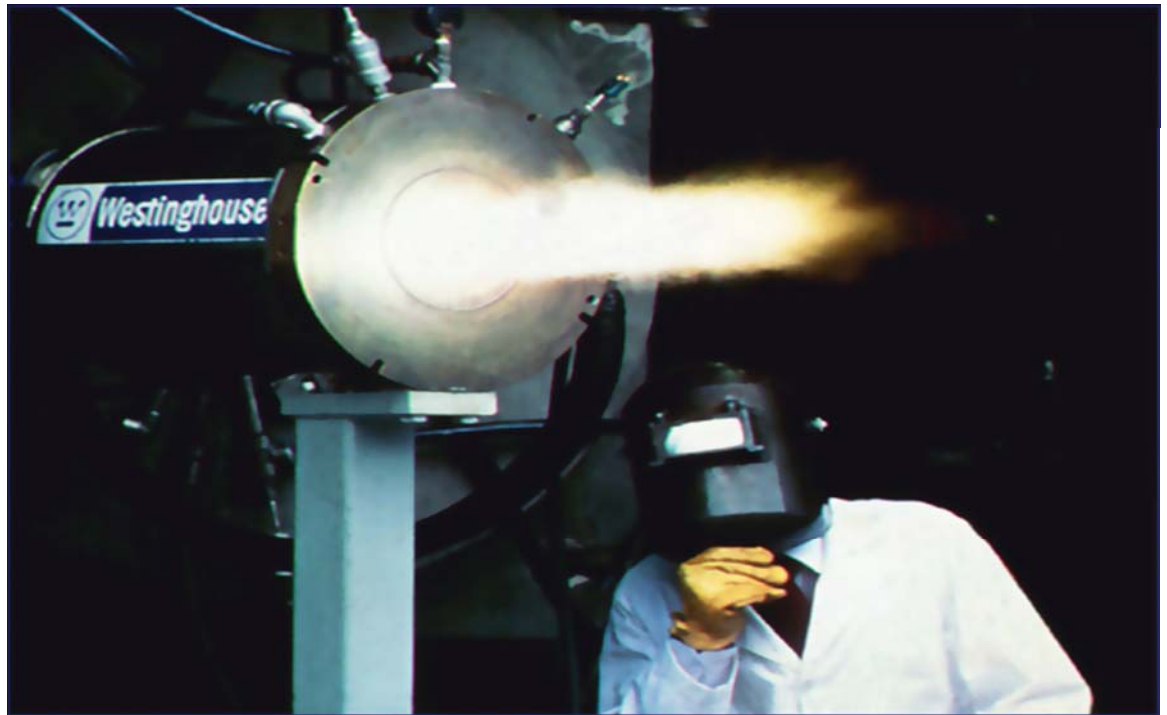
- Foundry coke possesses good attributes as bed material
- However:
  - A fossil fuel with negative perceptions
  - Expensive
  - Not readily available globally
- These shortcomings have been addressed
- Initial Step: pilot plant evaluation on multiple runs. Results were very positive both operationally and economically
- Applied for a provisional patent
- Next Step: Commercial implementation



# IMPROVE TORCH PERFORMANCE

## Torch Development Goals

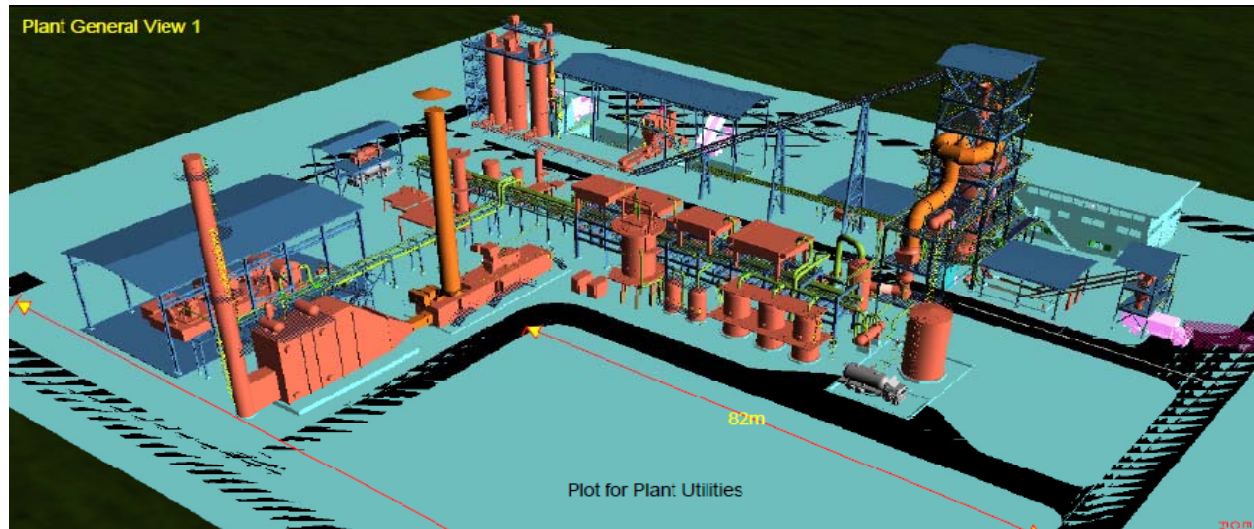
- Reduced operating costs
- Use other gas compositions aside from air
- 10% improved power efficiencies
- Up to 50% increase torch power output



# CAPITAL AND OPERATING COST REDUCTION

Focus of generation 4 technical development is improved design resulting in:

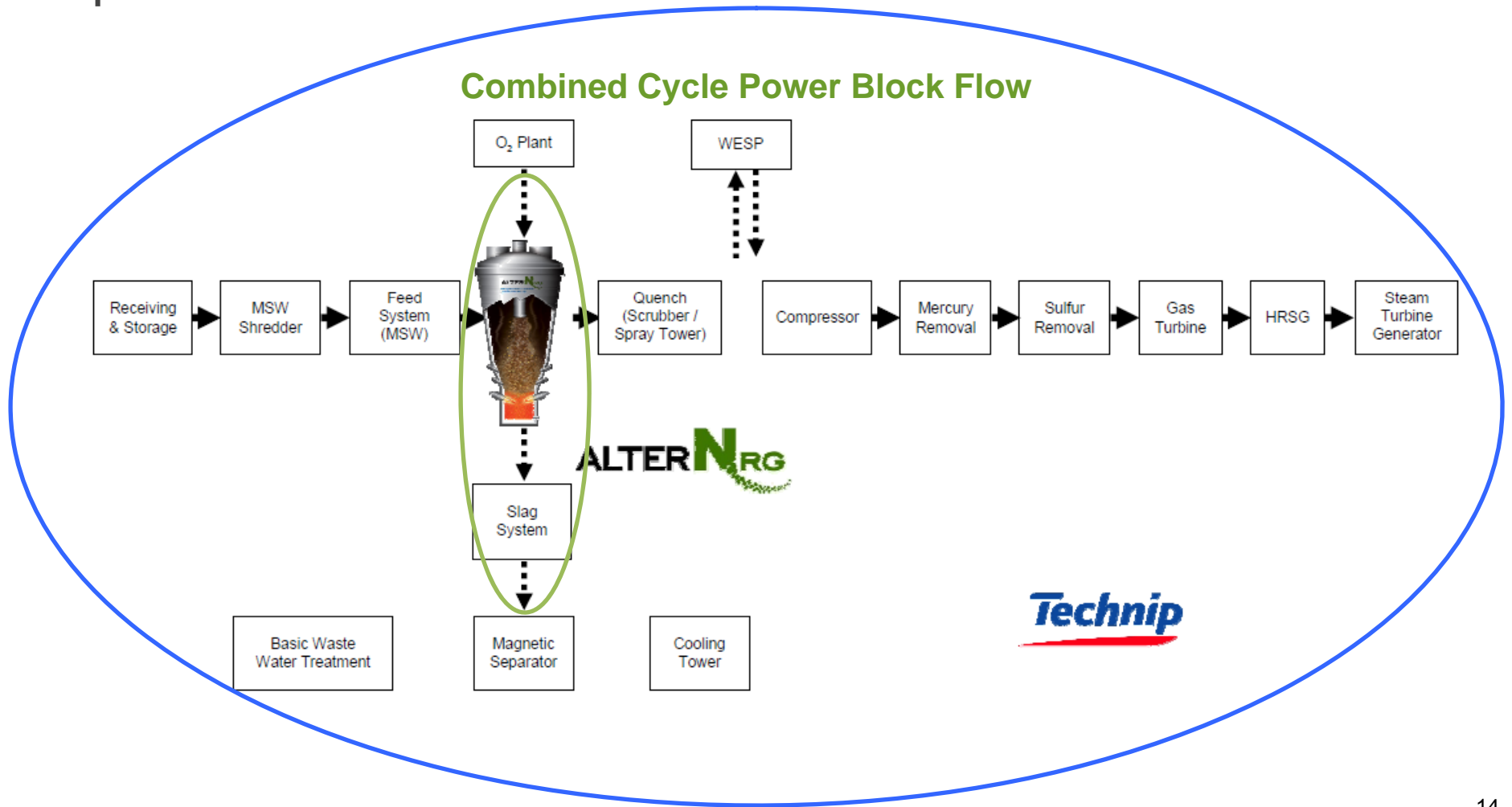
- Reduced Operating Cost
  - Alternative bed material in some cases only 30% of the cost of a metallurgical coke bed
- Reduced Capital Cost
  - Reduced by up to 30% for the Alter NRG scope from original cost estimates
- Improved Efficiency
  - Example-Torch developments for improved performance
  - Optimize overall torch power usage
- Improved Operability



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# ALTER NRG EXPERTISE IS GASIFICATION

We have strategic partners who will integrate our technology into a turnkey, balance of plant solution

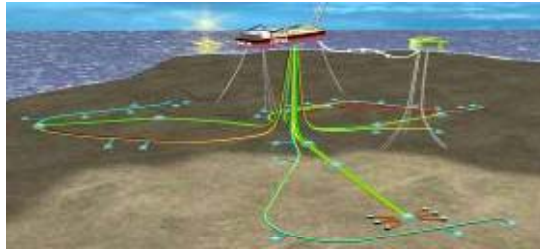


*Technip*

&

BALANCE OF PLANT DESIGN

# TECHNIP: BUSINESS SEGMENTS



## SUBSEA

- ▶ Design, manufacture and supply of deepwater flexible and rigid pipelines, umbilicals, and riser systems
- ▶ Subsea construction and pipeline installation services
- ▶ Five state-of-the-art flexible pipe and umbilical manufacturing plants
- ▶ Five spoolbases for reeled pipeline assembly
- ▶ A constantly evolving fleet strategically deployed in the world's major offshore markets



## OFFSHORE

- ▶ Engineering and fabrication of fixed platforms for shallow waters (TPG 500, Unideck®)
- ▶ Engineering and fabrication of floating platforms for deep waters (Spar, semi-submersible platforms, FPSO)
- ▶ Leadership in floatover technology
- ▶ Two construction yards



## ONSHORE

EPC Execution of:

- ▶ Gas Treatment and Processing
- ▶ Gas Liquefaction (LNG)
- ▶ Gas-To Liquid (GTL)
- ▶ Refining, hydrogen and sulphur units
- ▶ Onshore pipelines
- ▶ Petrochemicals (ethylene, aromatics, olefins, polymers, fertilizers)
- ▶ Renewables: Biofuels, Waste to Energy, Solar, Geothermal
- ▶ Metals and Mining

**2009 Revenues: \$ 9 billion, Backlog : \$ 10.5 billion**

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**Technip**

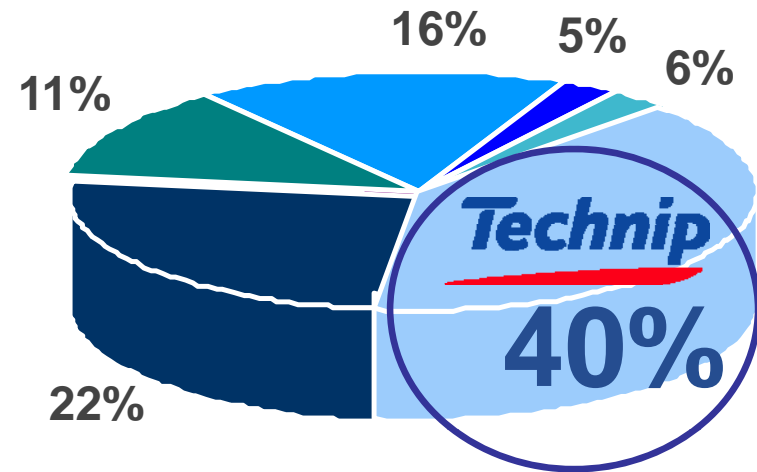
**ALTER NRG**



Westinghouse Plasma Corporation  
a division of Alter NRG Corp.

# TECHNIP'S LEADERSHIP IN HYDROGEN/SYNGAS

**World No.1**



- Customized solutions
- Single-source responsibility
- State-of-the-Art designs
- Large reference base
- Exclusive world wide alliance with APCI in Hydrogen

## TECHNIP'S ROLE: BALANCE OF PLANT DESIGN

**Collaboration agreement in place with Alter NRG to be their Preferred EPC partner for North America, Middle East, Europe**

- Technip brings expertise in Syngas handling, cleaning & emissions abatement
  - Integrate the gasification island with the syngas clean-up and balance of plant
- Design gas clean up section (removal of metals, ammonia, sulfur, mercury, HCN etc.)
  - Design Power Island, Utilities and Offsites
  - Provide overall Project Management, Detailed Engineering, Procurement, Construction solutions, Start-up and Commissioning services

# KEY CONSIDERATIONS IN DESIGN OF WASTE TO ENERGY UNITS

- Determine the mix of feedstock to be used and their specifications
  - e.g. MSW, Tires, CDW, ASR, Biomass, etc
- Establish emission limits to be met
- Establish optimal plant configuration for the site
  - Gasifier design
  - Gas clean up- establish sequence of unit operations
  - Select steam/power generation equipment
- Determine sparing philosophy based on plant availability requirements

# PLASMA GASIFICATION & BALANCE OF PLANT CONFIGURATION OPTIONS

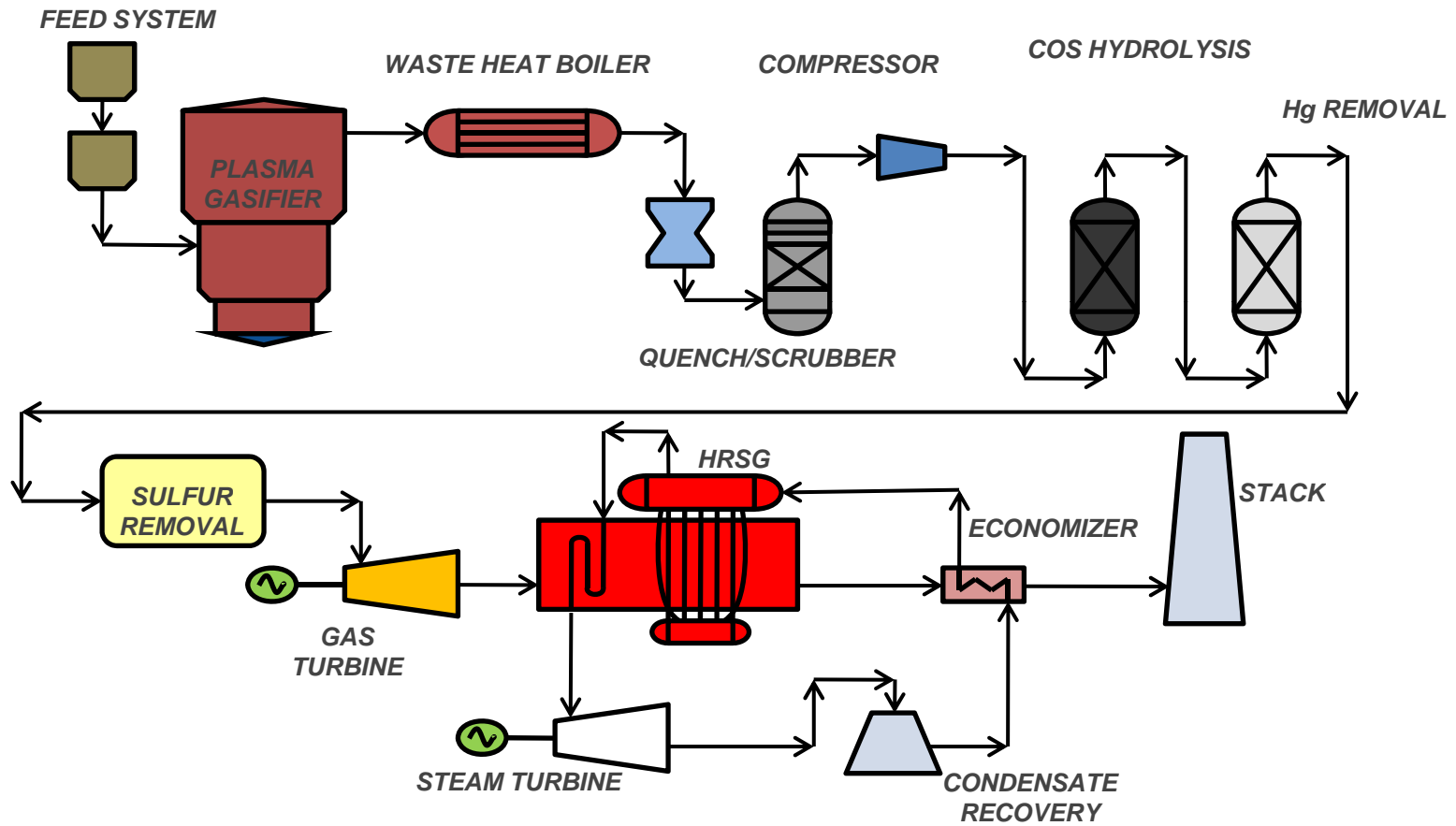
Various plant configurations can be considered as follows:

- Gasifier configurations
  - Air blown gasifier
  - Oxygen blown gasifier
- Balance of plant configurations
  - Pre-combustion syngas clean up
  - Post-combustion flue gas clean up
  - Boiler + STG for power production
  - Gas Turbine - simple cycle or combined cycle for power production
  - Liquid fuels or chemicals production

# ADVANTAGES/DISADVANTAGES - OPTIONS OF PLANT CONFIGURATION

Air Blown	Oxygen blown
No Oxygen plant	Syngas suitable for boiler/steam turbine cycle and combined cycle power generation system
Good for direct firing in a boiler with post combustion clean up	Higher MW per ton of MSW
Higher volume of syngas due to presence of N <sub>2</sub>	Lower volume of syngas, smaller equipment

# PRE-COMBUSTION GAS CLEAN-UP + COMBINED CYCLE POWER PLANT - TYPICAL



# A CASE STUDY ON TARGET EMISSIONS- PLASMA GASIFICATION OF MSW/TIRES TO PRODUCE POWER

Pollutants	Emission Limits, 7% v (dry) O <sub>2</sub> , 24 MW Project
NOX	150 ppmvd,
CO	50 ppmvd
SO2	30 ppmvd
VOC	N/A
HCl	25 ppmvd or 95% reduction
PM/PM10	20 mg/dscm
Pb	140 microg/dscm
Hg	50 microg/dscm
Cd	10 microg/dscm
Dioxins/Furans	13 microg/dscm
VE	10%- 6 minute average
NH3 slip	2 ppmvd

**Note: Units can be designed to site specific regulatory limit.**

Case study results shown in the table

## BREAKDOWN OF TOTAL INSTALLED COST - CASE STUDY

- Basis of estimate:
  - 185TPD Hazardous/Industrial waste - combination of multiple feed streams
  - >10MW power generation- combined cycle,
  - Oxygen blown gasifier
  - ROI > 25% as result of high value feed
  - Should not be directly scaled

Plant Section	% of TIC
Waste handling/storage/buildings	Excluded
Gasification island + Oxygen unit	32 %
Syngas clean up	28 %
Power generation	40 %
<b>TOTAL</b>	<b>\$ 100 -120 million</b>

# SUMMARY

- Alter NRG's Plasma Gasification creates Hydrogen and Carbon Monoxide: an energy rich gas stream "building block"
- Alter NRG's Plasma Gasification is commercially proven, economically viable technology. It is environmentally sustainable; reducing carbon footprint & emissions
- Alter NRG's Plasma Gasification system can handle multiple complex waste streams with the flexibility of producing a range of energy solutions
- Technip's expertise in EPC work for syngas handling/conditioning and power generation enables complete waste-to-energy solutions to be offered to clients
- The collaboration agreement between Alter NRG and Technip USA have the following benefits:
  - Technip USA is providing the optimal design for the balance of plant
  - Technip USA is the preferred EPCM for the complete balance of plant
  - Alter NRG and Technip jointly provide industry standard performance guarantees on a project by project basis

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