MODERN TECHNOLOGIES FOR ENERGY AND MATERIAL RECOVERY FROM WASTE

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Who We Are

- Central Europe Engineering & Investment (CEEI) offers the state-of-the-art technologies and solutions through the partnership with leading industry companies in following areas

- Nuclear
  - Construction of storage facilities for spent nuclear fuel and low radioactive wastes
- Energy & Renewables
  - Waste to Energy
  - Hydrothermal Carbonization
  - Fuel Cells - High efficient chemical production of electricity
  - Biomethane – biogas upgrading to natural gas quality
- Locations – Czech Republic, Slovakia, Ukraine and USA

What we do in Waste sector

- Hydrothermal Carbonization technology for processing of organic wastes and biomass into solid biofuel – biocoal.

  - in cooperation with company AVA-CO2, Switzerland

- Plasma-assisted gasification technology for processing of wide range of waste streams into energy, hydrogen and biofuels

  - in cooperation with Westighouse Plasma Corporation, USA

HYDROTHERMAL CARBONIZATION

FOR

ORGANIC WASTES

Hydrothermal Carbonisation

- Highly efficient thermo-chemical technology for biomass and organic waste conversion to solid biofuel – the biocoal, for:
  - Energy production
    - electricity and heat
  - Industrial applications
    - iron and steel, cement, tires, plastics, pharmaceuticals…
  - Waste heat supplies available
- Process invented in 1913 by German professor Friedrich Bergius,
  - Nobel Prize Laureate for Chemistry in 1931
- Applicable for a wide variety of biomass
  - Wet, mixed and low quality biomass and organic waste streams
- Significant reduction of CO_2 emissions
  - HTC technology offers a carbon neutral footprint and has the potential to become the main tool for capturing CO_2 from biomass

Suitable Biomass

- Ideal for biomass with a high cellulose, hemicellulose and protein content but a low content of lignin, such as:
  - Sewage sludge from WWTP
  - Organic MSW
  - Agriculture wastes
    - manure, straw, husks, stalks….
  - Beverage and food industry wastes
    - beer, spirits, fruit, vegetable….
  - Residues from ethanol and sugar production
  - Grass and leaves
  - Food waste
  - and many more…
- Not competing with food production

Biocoal features

Benefits and features of HTC coal

- CO_2–neutral source of energy
- High biomass energy conversion to biocoal
- High calorific value up to 32 MJ/kg
  - Depending on the used feedstock
  - Production of coal with defined calorific value
- High incineration efficiency with low NOx emissions
  - Very low content of sulfur and heavy metals
- Compared to other solid biofuels (e.g. wood pellets)
  - Lower volume for storing
  - No degradation
  - Simple transportation
  - High energy density

Biocoal Characteristics

Heating value

- Heating value of the produced biocoal depends on the utilized biomass. Examples of LHV for biocoal produced from various types of biomass:
  - Sewage sludge – approx 15 MJ/kg
  - Grass and manure – approx 25 MJ/kg
  - Ethanol wet cake – approx 32 MJ/kg
- HTC process allows production of biocoal with tailored heating value

biocoal composition

- Chemical composition of the produced bio-coal depends the biomass used

Shape and dimension options for biocoal

- Produced biocoal has the form of dust powder
- Based on customer request, production facility can be equipped with product confection device for any shape and size – pellets, briquettes

Biocoal Characteristics

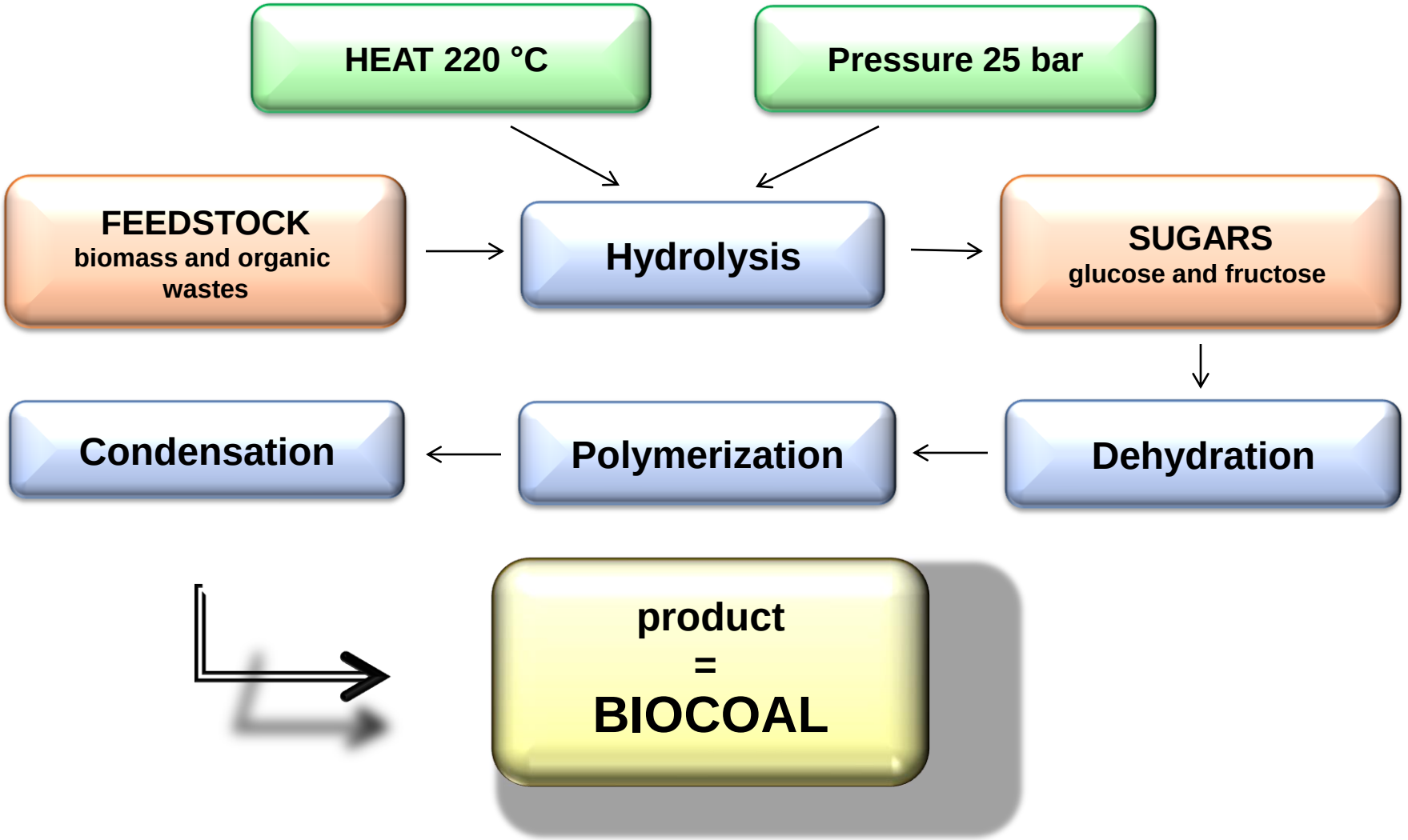
Conditions of biocoal handling, storage and shipping

- No special requirements for handling, storage and shipping of biocoal
- Generally, the methods for fossil coal are applicable for biocoal
- Production equipment can include storage silo with automatic dispensing device leading directly to the boiler or used for loading to road trucks or railway wagons
- Biocoal is hydrophobic, so does not adsorb water or moisture

Biocoal production equipment:

- Equipment manufactured
  - in accordance with ISO and DIN norms & standards
  - holds Declaration of Compliance “CE marking”
  - pressure vessels in accordance to PED

Carbonization chemistry



Test and Demonstration plants

Our partner company AVA-CO2 has a test plant and commercial demonstration facility in Karlsruhe (Germany)

More than 100 varieties of biomass and organic waste have been successfully tested for biocoal production

<u>Test plant</u>

- Operation since 2009
- 3 off 350 liters reactors

<u>Commercial Demonstration Facility</u>

- Operating since 2010
- 15,000 liters reactor vessel
- Industrial plant size

References

EuroSolid, Relzow, Germany

- Mixed organic waste and reed processing
- 8,000 tons/year feedstock
- Operation from Sep-2012

Two additional projects under construction in Germany

- Operation during spring 2014
- Capacity 60,000 tons/year of mixed biomass
  - sewage sludge, organic MSW, AD digestate, grass and leaves

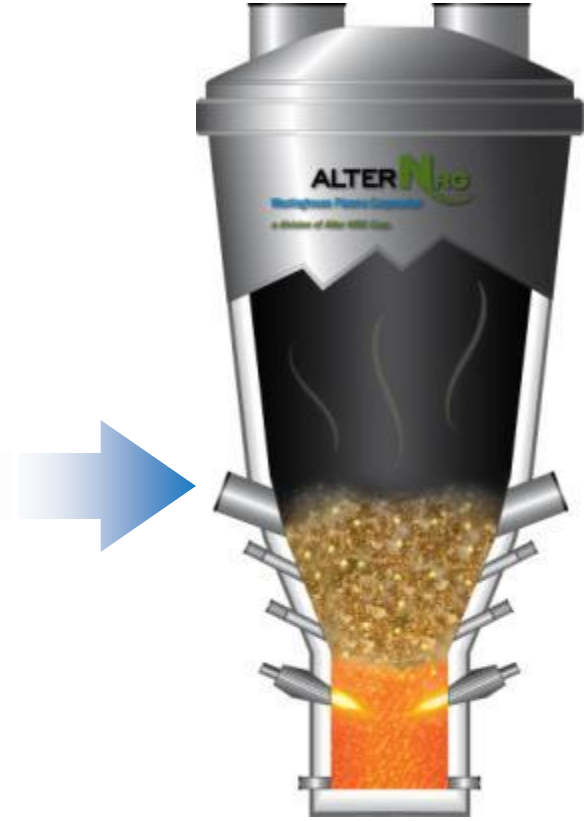
PLASMA-ASSISTED GASIFICATION

FOR

WASTE TO ENERGY

What is plasma?

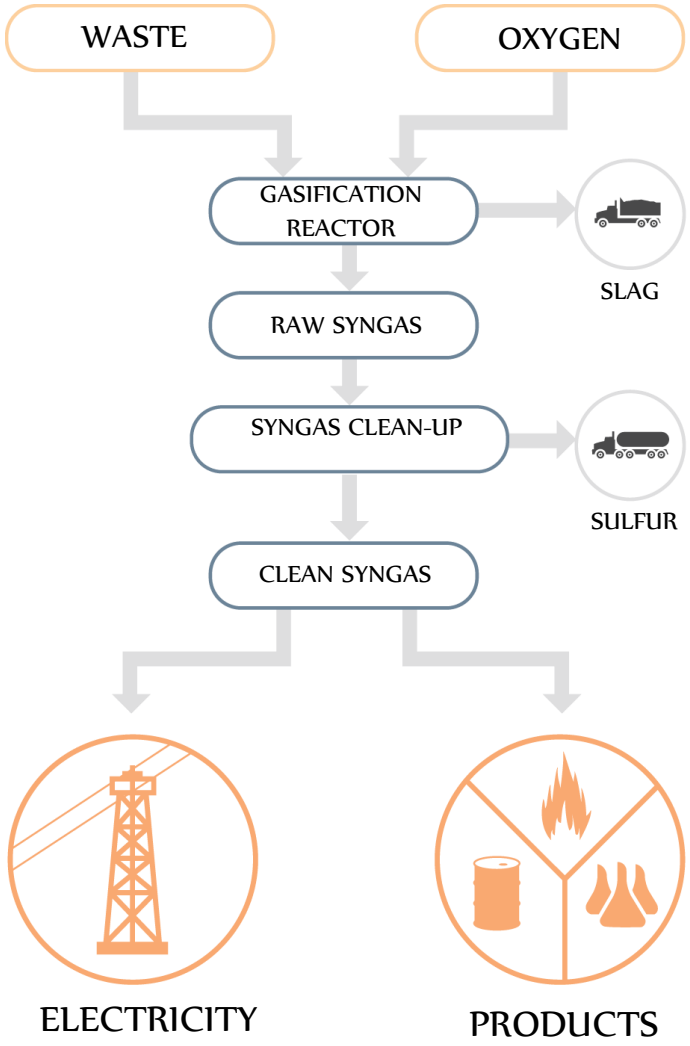
- Plasma is highly ionized or electrically charged gas
- An example in nature is lightning - capable of producing temperatures exceeding 7,000°C
- An ionized gas is one where the atoms of the gas have lost one or more electrons and has become electrically charged



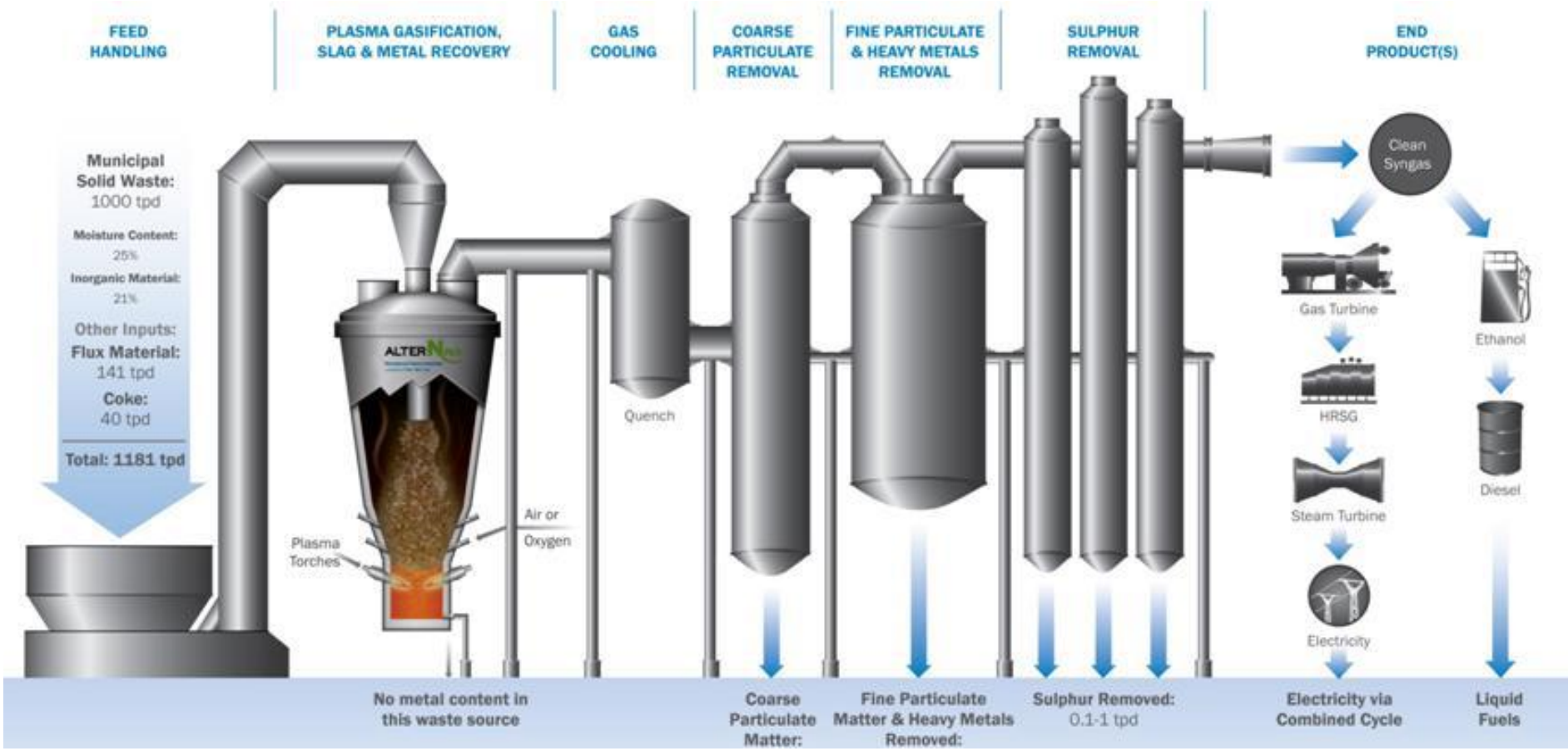
Plasma torch systems create the intense heat inside plasma gasifier

What is gasification?

- Gasification is a proven manufacturing process that converts hydrocarbons such as waste, coal, petroleum coke and biomass to a synthesis gas (syngas), which can be further processed to produce electricity, heat, chemicals, fertilizers, liquid fuels and hydrogen
- **Gasification is not incineration**
- Gasification is a partial oxidation (reaction) process which produces syngas comprised primarily of hydrogen (H2) and carbon monoxide (CO). It is not a complete oxidation (combustion) process, which produces primarily thermal energy (heat) and solid waste, criteria air pollutants (NOx and SO2), and carbon dioxide (CO2).



Technology overview



Feedstock options

Our technology can process and produce energy from following feedstocks

- Waste stream
  - Municipal Solid Waste (MSW)
  - Industrial Waste
  - Hazardous and Toxic Waste
  - Hospital Waste
- Sewage Sludge from Waste Water Treatment Plants
- Used Tires
- Old Environmental Burdens
- Biomass
- Low energy coal
- Combination of above

Product output

Plasma gasification technology offers unique end product selection:

- Electricity – engines, steam turbine, combined cycle, fuel cells
- Steam or hot water
- Cogeneration
- Substitute Natural Gas (SNG) - methanation
- Hydrogen – Water Gas Shift
- Liquid Fuels – F-T synthesis
- Chemicals and Fertilizers

By- products – slag, sulphur and metals

Westinghouse Plasma Corporation

WESTINGHOUSE PLASMA TECHNOLOGY MILESTONES

1983
PLASMA FIRED CUPOLA APPLICATION

General Motors; Defiance, Ohio - commissioned in 1987
Demo – 50 tpd

2002
WORLD'S 1ST COMMERCIAL SCALE PLASMA GASIFIER

Mihama Mikata, Japan - operational in 2002

2011
ENERGY FROM WASTE FACILITY

Teeside, UK –1000 tpd MSW to combined cycle power Under construction, 2014 commissioning date
Intention to build 5 facilities

1995
INCINERATOR ASH VITRIFICATION

Kinuura, Japan - commissioned in 1995

2009
SECOND GENERATION ETHANOL FACILITY

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

2012
BIOMASS FACILITY

Kaidi, China – operational Q4 2012

1999
PLASMA GASIFICATION OF MUNICIPAL SOLID WASTE (MSW)

Hitachi Metals; Yoshi, Japan - commissioned in 1999

2008
WORLD'S LARGEST PLASMA HAZARDOUS WASTE FACILITY

Pune, India – operational in 2009

2012
DEMONSTRATION PLANT INTEGRATED WITH EXISTING INCINERATOR

Shanghai, China – operational in 2013

2012
MARC-3 TORCHES

Guanchuan, China – delivery Q1, 2013

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, 200 tpd

Thank you

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