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INDUSTRY 4.0 READY

TO WHOM IT MAY CONCERN
JANUARY 2024

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ENVIROMENTAL BENEFITS OF PLASMA GASIFICATION TECHNOLOGY

- The PL ET Ltd 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

NO LANDFILL VERY LOW EMISSIONS DURING THE PROCESS

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ZERO WASTE SCENARIO

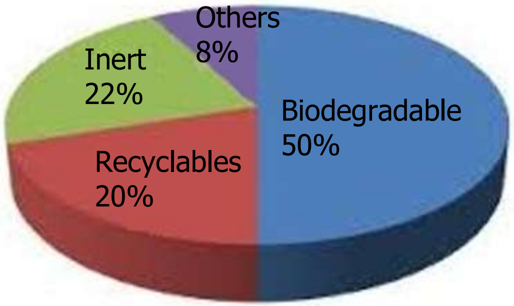
Example for a typical 256 TPD

40.000 m²

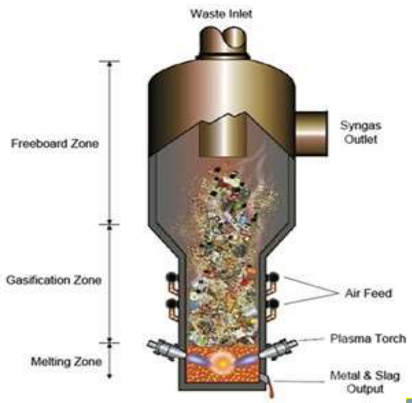
Soil pollution
Air pollution
Water pollution
Methane emissions

Hazardous landfill

Example of composition of MSW



ZEROWASTE



Plasma Gasifier

Only 10.000 m²

NO LANDFILL

Power produced is 600 KWh/ Ton

NO air pollution

Vitrified slag – 12,5 tons/day

For construction of roads, bridge, etc…

DIOXIN AND FURANS

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

- Dioxins & Furans form between 400-800°C, in our system the temperature of the syngas when it exits the gasifier is ~1,000-1,200ºC, it is immediately quenched to temperatures below 400ºC
- 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

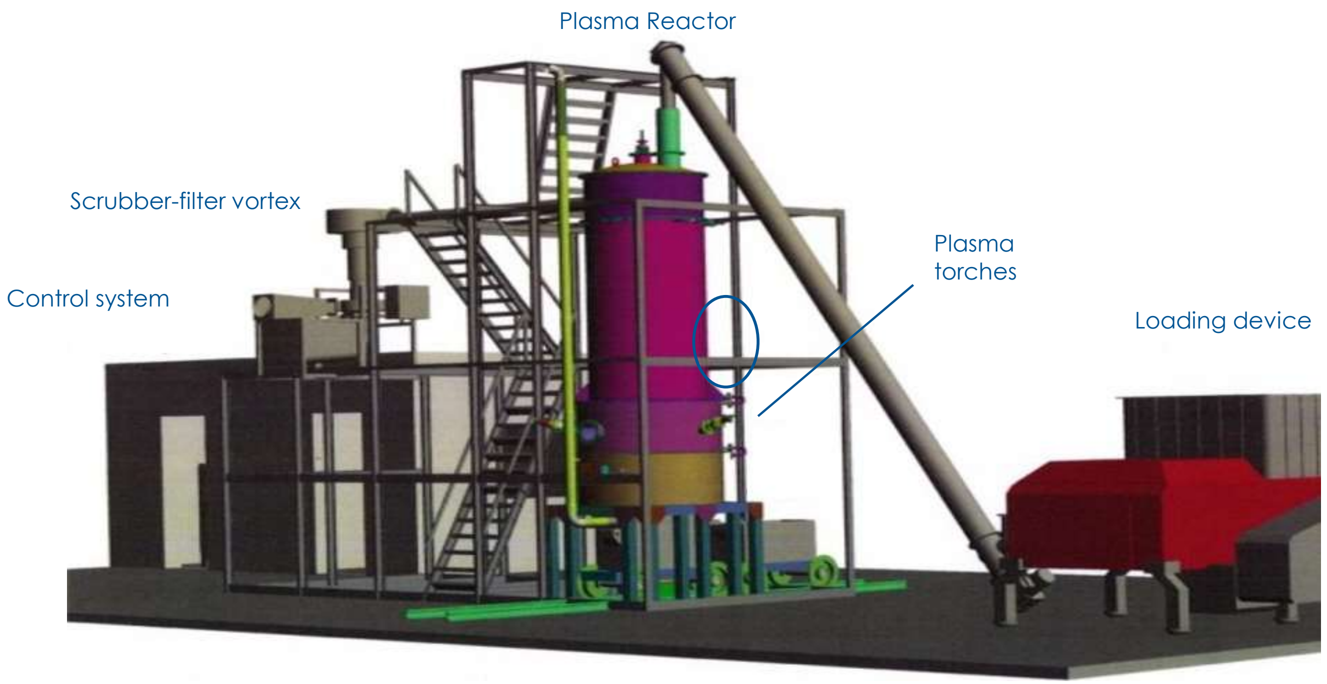
MIHAMA-MIKATA VITRIFIED SLAG

- 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

PLASMA GASIFICATION TECHNOLOGY

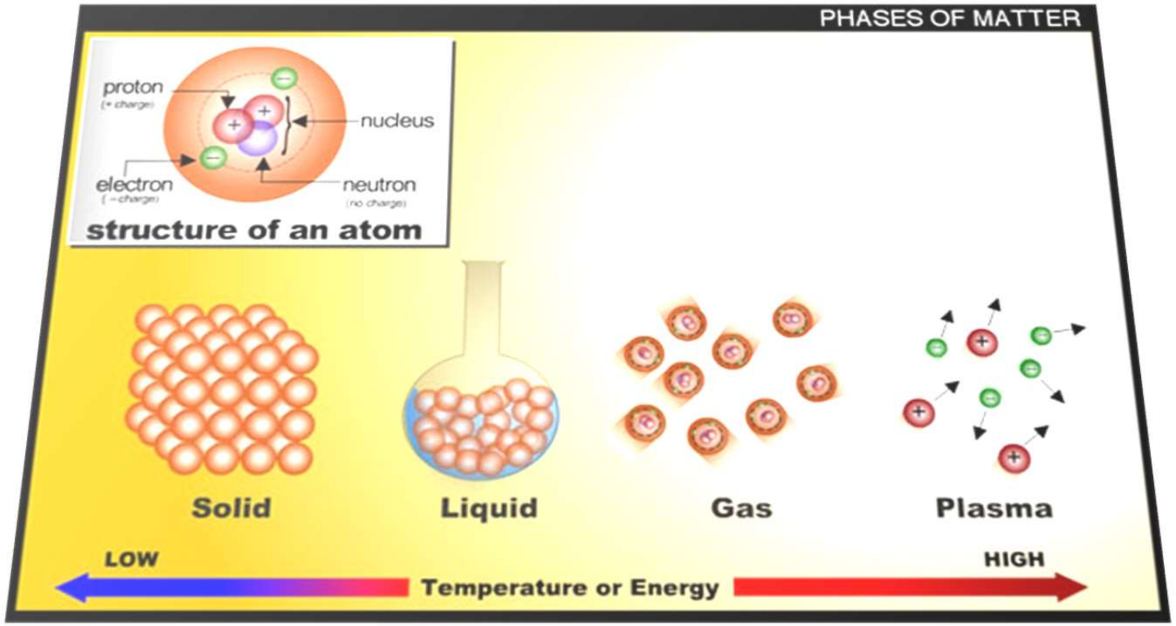


Origin of Plasma

- Plasma is a fourth state of matter
- Discovered by British physicist Sir William Crookes in 1879
- Heating a gas at very high temperature lead to ionization of atoms and turn it into plasma.
- Natural plasma can be seen in lightning, sun star, comet, etc..
- Firstly used by metal industry in 1800 in metallurgical, and in 1900 chemical industry to made acetylene from natural gas
- Plasma technology was used by NASA in 1960 and from this time become popular

WHAT IS PLASMA ?

Plasma Gasification process is a drastic **non-incineration thermal process,** which uses extremely high temperatures in an oxygen-starved environment to completely decompose input waste material into very simple molecules.



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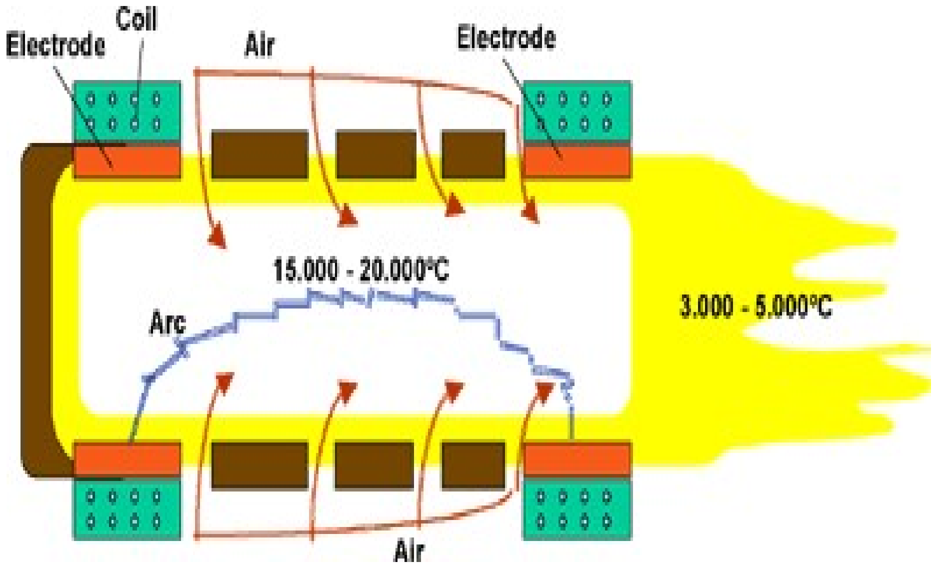
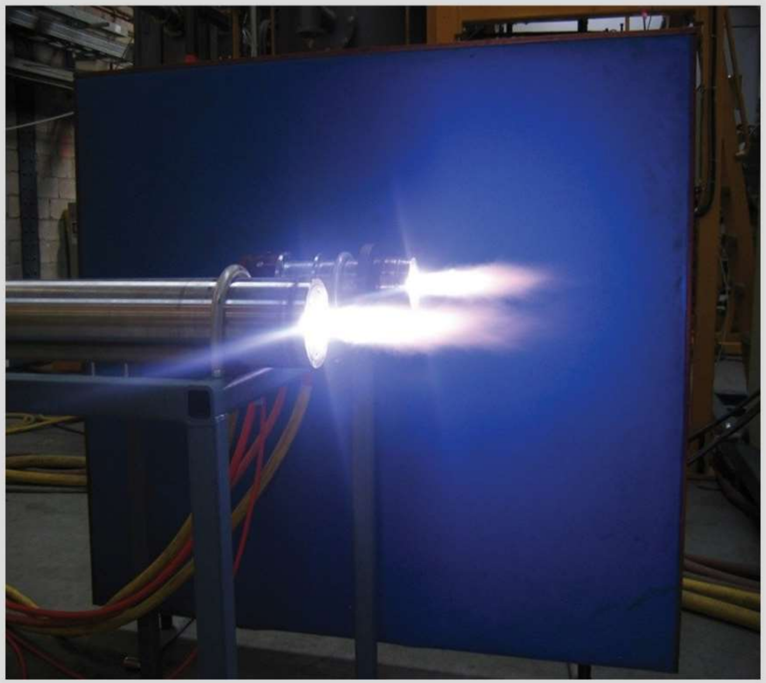
AIR PLASMA TORCH

The Plasma Torch is at the heart of our plasma waste processing and waste-to-energy technologies





Plasma is an ionized, conductive gas at a temperature till 5 000 °C, which arises when a stream of the carrier gas (air enriched with 93 % oxygen) is passed through an arc discharge.

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PLASMA GASIFICATION vs INCINERATION

Plasma Gasification	Incineration
1.Absence of oxygen	1.Includes oxygen
2.Results in gas which can be used to produce energy	2.The energy will be converted in heat
3.Residue is an inert glass-like slag	3.Residue is ash which is considered a hazardous waste
4.Residue amounts from around 6% to 15% of original solids volume	4.Residue can be as much as 30% of original solids volume
5.Extremely low levels of emissions	5.High level of emissions of GHG and other pollutants

VITRIFICATION OF MSW

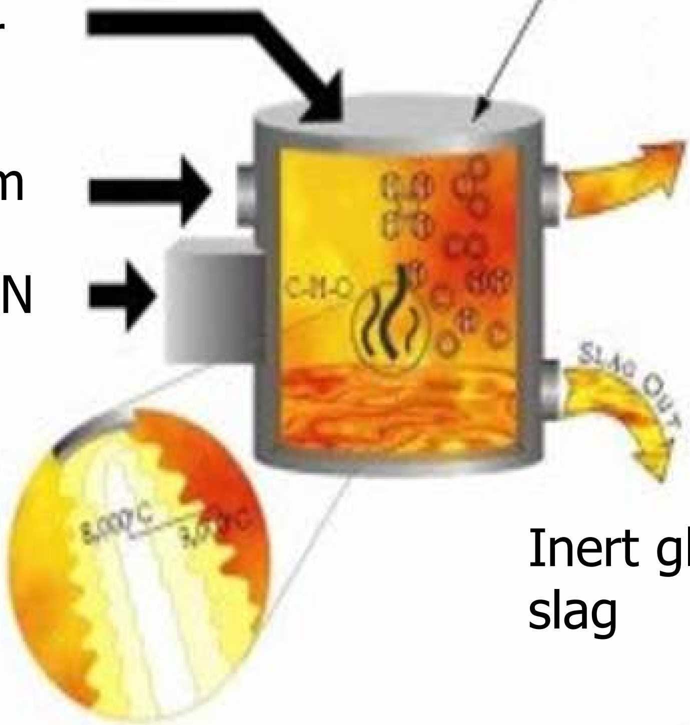
(Municipal Solid Waste)

Plasma arc generator

Steam

Solid Waste IN

Plasma gas profile



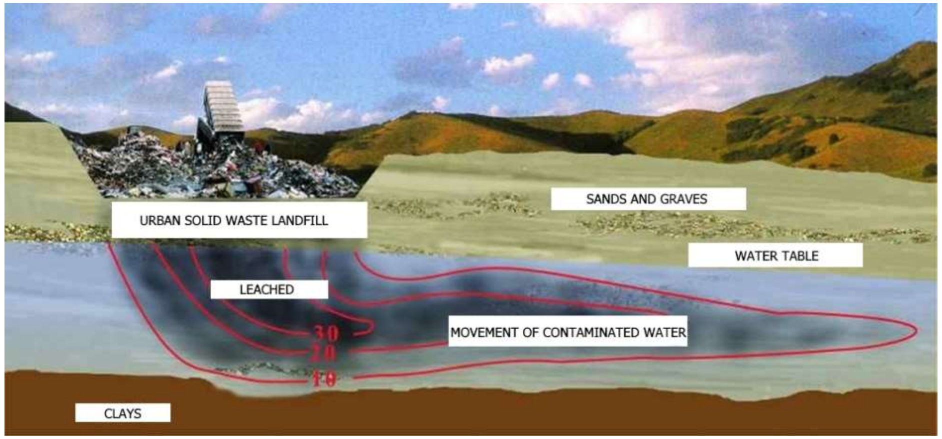
Refractory lined converter

Product gas out 800-1000 °C
H_2, N_2, O_2, CO, CO_2, CH_4

Inert glass-like slag

THE LEACHED

One of the great problems generated by landfills is the liquids that flow through the deposited waste and that ooze from them or are contained in, we call them leachates. Leachate is a liquid that percolates through deposited solid waste and extracts dissolved or suspended solid materials from them. The leachate is formed by the mixture of rainwater infiltrated into the reservoir and other products and compounds from the waste degradation processes.



The leachates produced in our daily warehouse will be collected and sent to the plasma reactor through a pump.

WASTES HANDLED BY

This process is responsible for working all types of waste, including hazardous


Auto Shredder residue


Paints


Oil waste


Appliances


Medical waste


Landfill waste


Chemicals & Industrial waste


Tires


Styrofoam

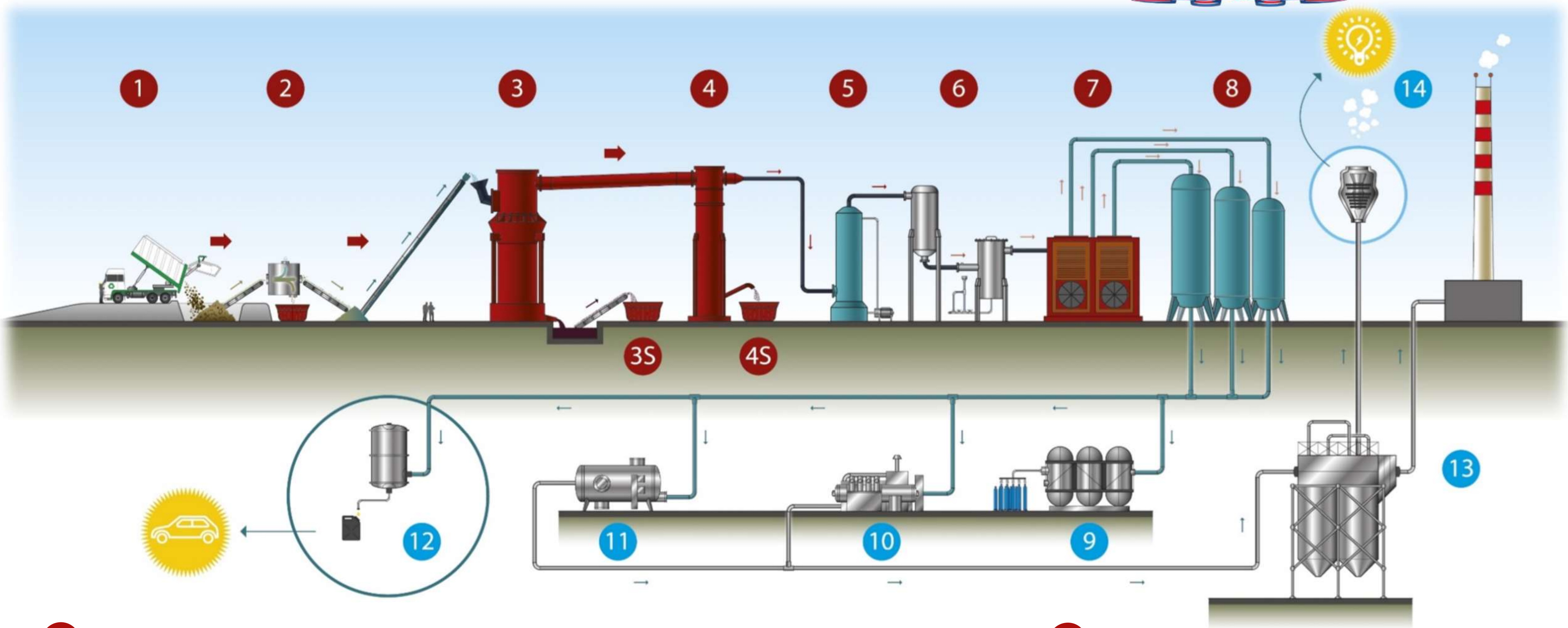

Coal fines


Old furniture


All kinds of plastics


Industrial sludge


Oil water & contaminated soil



1 Reception of Raw Material

The garbage trucks will fill the tank which will have the size of at least the daily consumption of the plant, this to constantly feed the plant. The deposit will have a recovery of leachates that will be processed inside the reactor

2 Raw material treatment

To convert waste into energy, first, it is necessary to select the raw material by removing as much material as possible that does not contain energy (for example, rubble, metals and glass). After this classification, the raw material is crushed, and then it is going to dry to get as much water as possible.

3 Plasma Gasification

Inside the reactor, the raw material is subjected to temperatures of 1250-1500 °C and comes into direct contact with the plasma discharge that has a temperature of 3000-5000 °C. Synthesis gas and slag are thus formed

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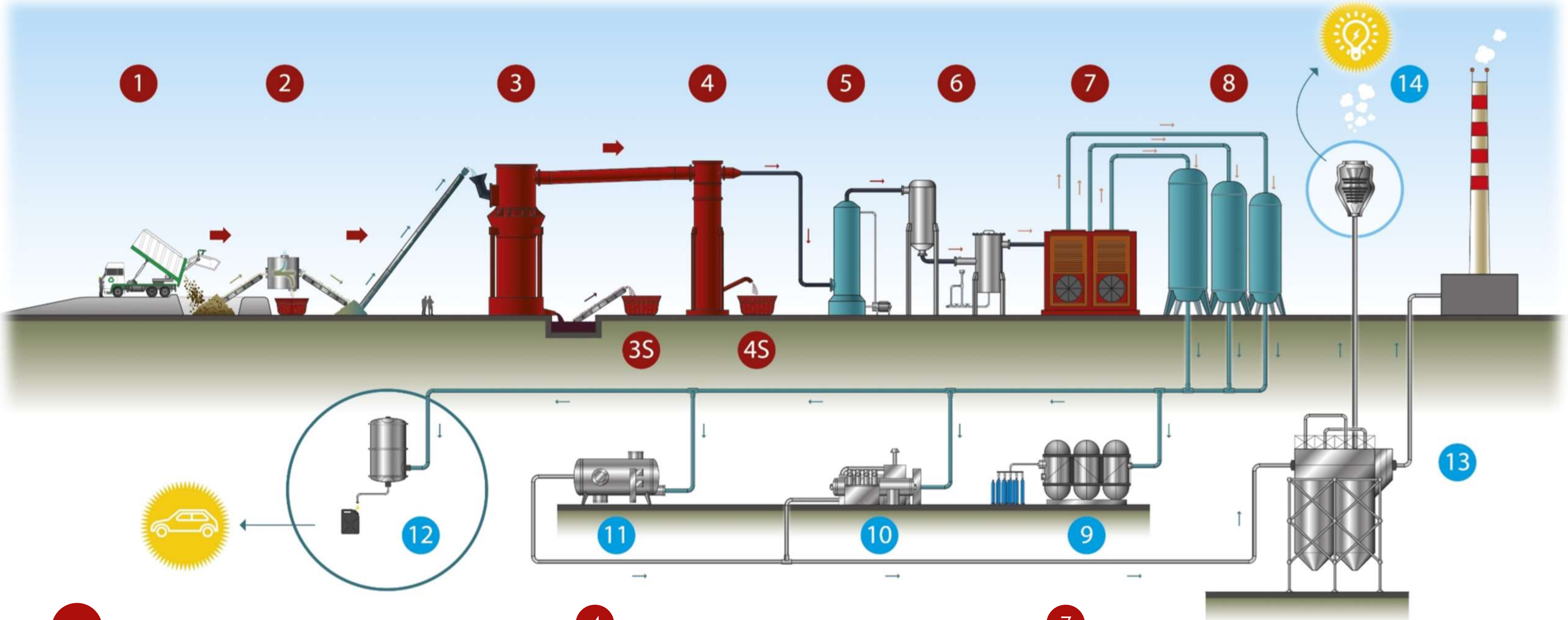

3s

4s

SLAG

The parts of the waste introduced into the Plasma gasifier that are not going to be gasified, melt and end up in the bottom of the reactor in a vitrified and inert form, that is, not dangerous for the environment.

4

5

6

Syngas cooling and purification

Before purification, the syngas is cooled to a temperature of approximately 200 °C. Purification removes acid gases (HCl, H_2S), solid contaminants, and excess of moisture.

7

Compressors

By compressing the Syngas to store it in the tanks ready for the following process. There will also be a dehumidification unit

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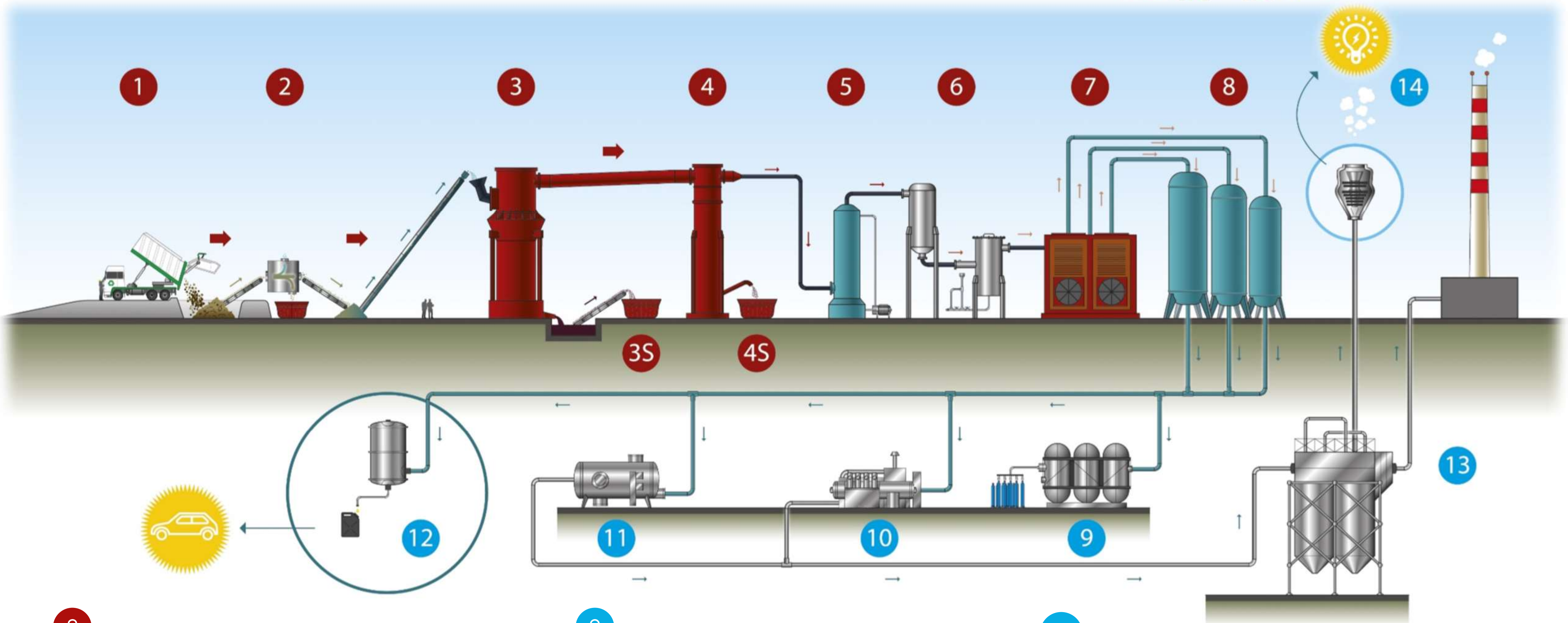


8

Storage tank

Here the produced gas is accumulated before end use. They also serve to absorb irregular gas production and keep the supply constant for later uses. The amount of gas produced will be proportional to the type of waste that enters

9

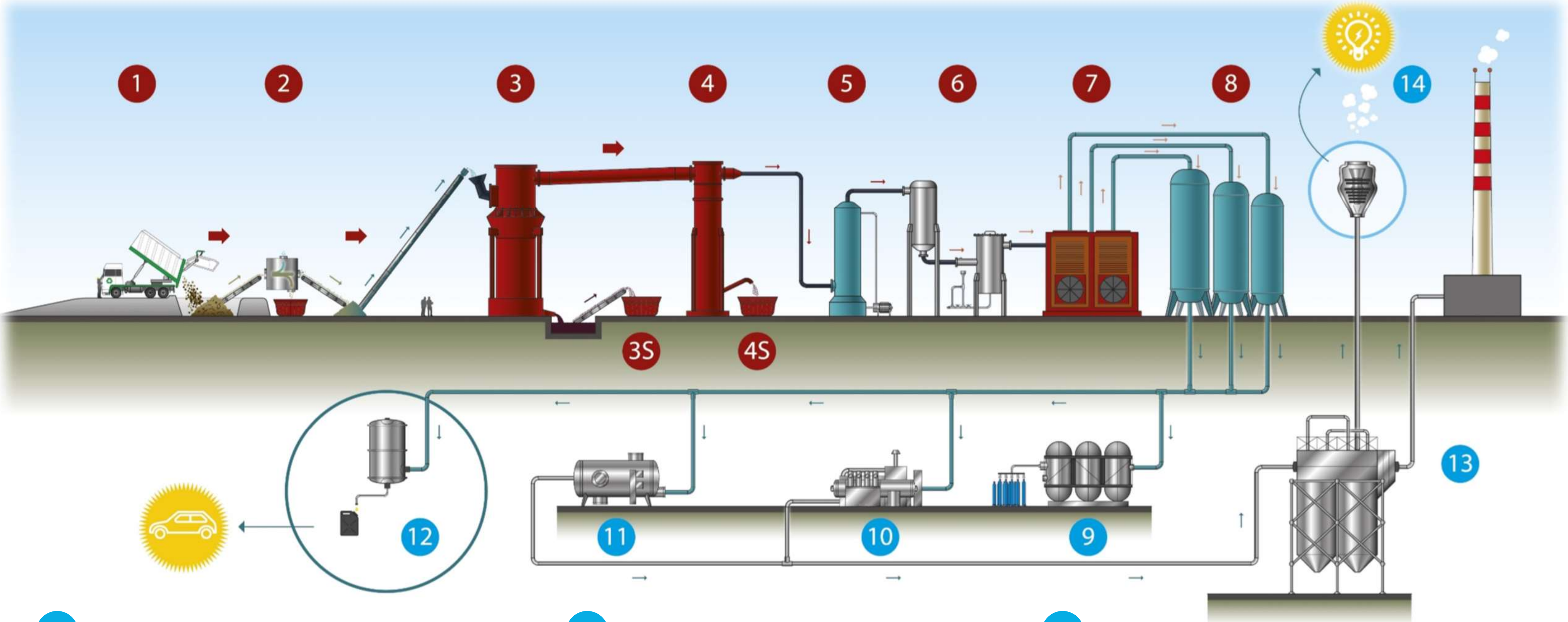
Hydrogen separation

Syngas can be a source to produce hydrogen for various uses, including as an alternative fuel, in the hydrogenation industry, in the production of ammonia, etc.

10

Endothermic motor

Syngas is used to generate heat and electricity in a cogeneration unit. Electricity production takes place through an internal combustion engine and an alternator that uses gas directly as fuel.



11

Steam turbine

Syngas is used in a steam generator to power a turbine to generate electricity. The steam that comes out of the turbine is used to generate other electricity.

12

Synthetic fuel production

Syngas can be used as a feedstock to produce biofuels

13

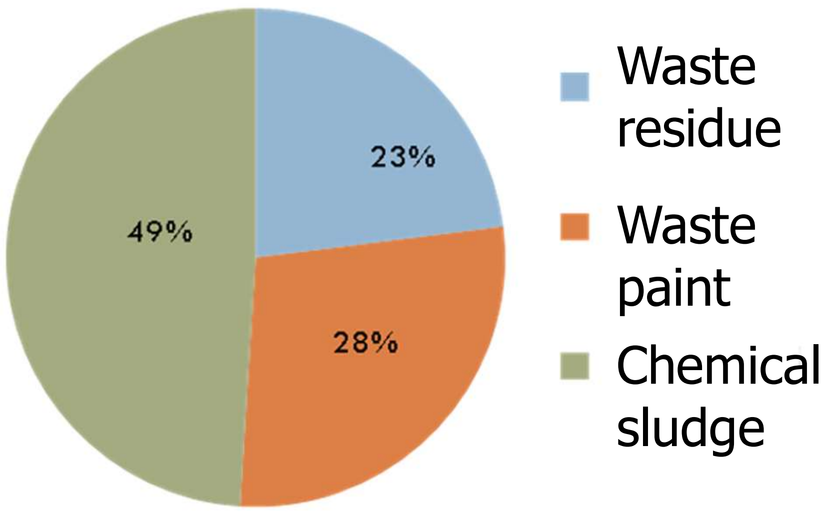
14

Economizer

Recovery of the remaining energy in the process fluids used, thus optimizing electricity production

TRIAL WITH HAZARDOUS WASTE

Composition



Parameters	Results
Feed rate	1 TPD (42 kg/hr)
Mode	Continuous
Input power/hr	10 KW
Output power/hr	52 KW
Net power output/hr	42 KW
Syngas produced	51 m^3/hr
Slag produced	100 kg

Power output = 1 MW/ton

TRIAL WITH BIOMEDICAL WASTE

Parameters	Results
Feed rate	1 TPD (42 kg/hr)
Mode	Continuous
Input power/hr	20 KW
Output power/hr	80 KW
Net power output/hr	68 KW
Syngas produced	87 m^3/hr
Slag produced	80 kg

Power output = 1.6 MW/ton

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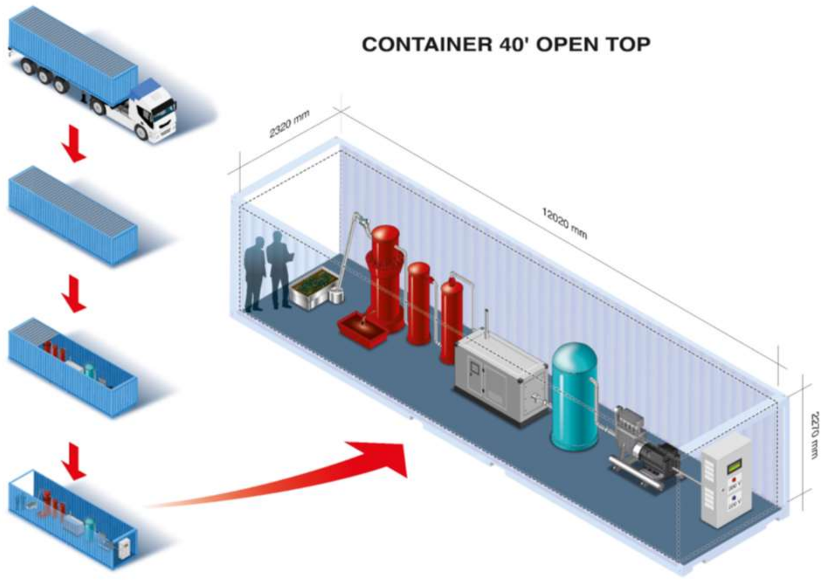
Container system to process Hospital waste
Model : CTE 5 to 12

Hospital waste will be placed directly in a hopper without removing it from its protective bag or carton, and will be automatically ground, into the reactor. Thanks to the temperature in the reactor (from 3500 to 6000 degrees centigrade), the waste is automatically sterilized.
The Syngas produced will be filtered and sent to an endothermic engine with alternator to produce electricity.
The slag THE REACTION RESIDUE, about 4-8% of the waste introduced) are inert and reusable in the construction of buildings and roads.
No operator comes into contact with infected waste during processing.

NB. In larger machines some components are placed in other containers (total n. 2 Containers)



TRIAL WITH BIOMEDICAL WASTE

Parameters	Results	
	MIN	MAX
Feed rate MIN	2,5 TPD (100 kg/hr)	12 TPD (500 kg/hr)
Mode	Continuous	Continuous
Input power/hr	50 KW	240 KW
Output power/hr	200 KW	960 KW
Net power output/hr	150 KW	720 KW
Syngas produced	200 m3/h	960 m3/h
Slag produced	Max 8%	Max 8%

WARNING: PERFORMANCE ARE INDICATIVE AND DEPEND ON THE REAL COMPOSITION OF THE WASTE

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TRIAL WITH OIL SLUDGE

Parameters	Results
Feed rate	1 TPD (42 kg/hr)
Mode	Continuous
Input power/hr	32 KW
Output power/hr	125 KW
Net power output/hr	93 KW
Syngas produced	126 m^3/hr
Slag produced	63 kg

Power output = 2.2 MW/ton

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TRIAL WITH TIRES

Parameters	Results
Feed rate	1 TPD (42 kg/hr)
Mode	Continuous
Input power/hr	20 KW
Output power/hr	98 KW
Net power output/hr	78 KW
Syngas produced	97 m^3/hr
Slag produced	120 kg

Power output = 1.8 MW/ton

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TRIAL WITH PLASTICS

Parameters	Results
Feed rate	1 TPD (42 kg/hr)
Mode	Continuous
Input power/hr	30 KW
Output power/hr	120 KW
Net power output/hr	90 KW
Syngas produced	118 m^3/hr
Slag produced	60 kg

Power output = 2.1 MW/ton

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INDUSTRY 4.0 READY

TRIAL WITH MSW (20% MOISTURE)

Parameters	Results
Feed rate	1 TPD (42 kg/hr)
Mode	Continuous
Input power/hr	35 KW
Output power/hr	66 KW
Net power output/hr	31 KW
Syngas produced	65 m^3/hr
Slag produced	130 kg

Power output= 0.6/0.7 MW/ton

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ANALYSIS OF FLY ASH

Plasma power=1000 Kwh/ton
Volume reduction : 11:1

Parameters	TCLP Results		
Feed rate	1 TPD (42 kg/hr)		
Mode	Continuous		
Heavy metals in ppm	Fly ash	Slag	Limit
Cd	143	0.021	0.3
Cu	3640	0.332	3
Zn	2869	0.431	-
As	0.334	0.032	1.5
Se	1.33	0.022	-
Pb	11.19	1.198	3.0
Cr	1.17	0.004	1.5
Density, kg/m^3	320	2770	
Feed/slag output in kg	1000	600	

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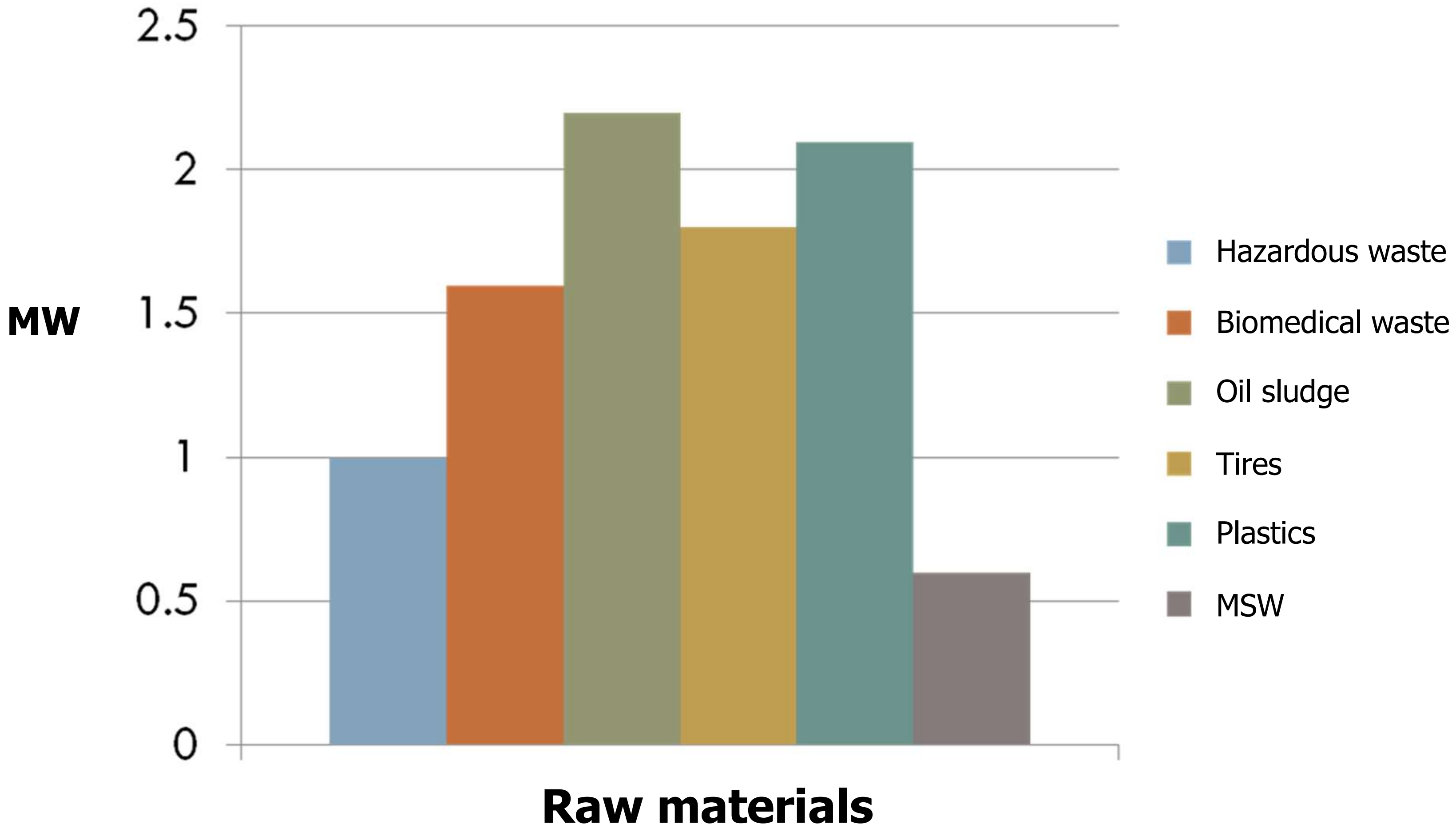
YIELD FOR DIFFERENT FEED TYPES



ZERO WASTE SCENARIO

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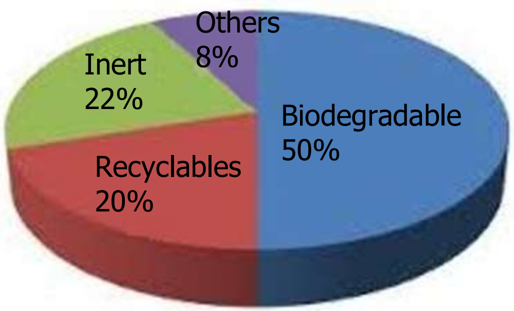
For a typical 25 TPD

5.000 m²

Soil pollution
Air pollution
Water pollution
Methane emissions

Example of composition of MSW



Incinerator

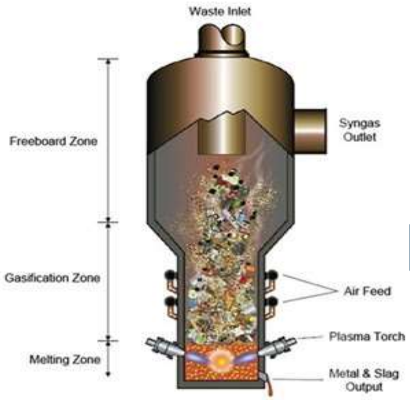
Power produced is 500 KWh

Air pollution (Dioxins + Furans)

Ash - 7.5 ton/day hazardous

Hazardous landfill

ZEROWASTE



Plasma Gasifier

Power produced is 600 KWh

NO air pollution

Vitrified slag – 2,5 tons/day

For construction of roads, bridge, etc…

JUST 1000 m² area required for 25 TPD

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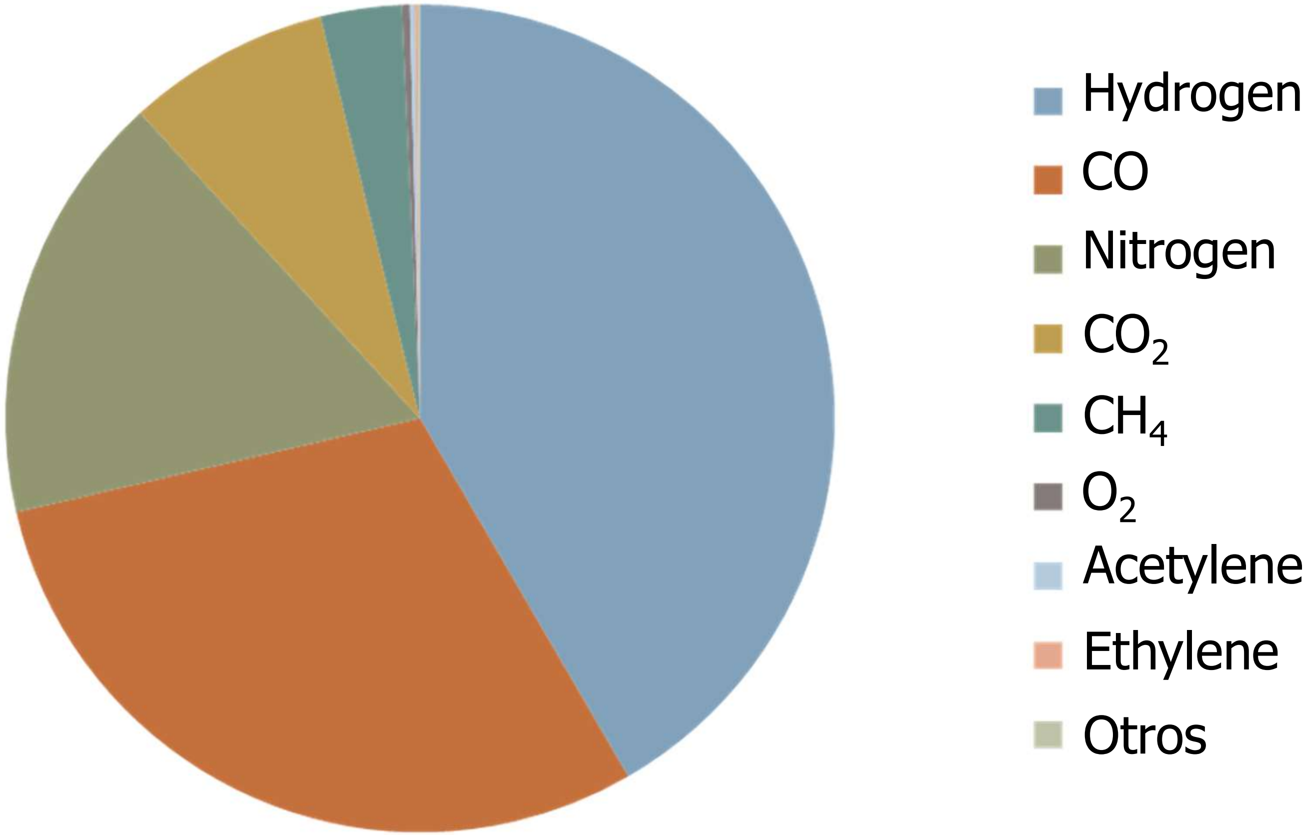
TYPICAL SINGAS COMPOSITION

Hydrogen	44%
CO	42%
Nitrogen	2%
CO_2	8%
CH_4	3.20%
O_2	0.30%
Acetylene	0.20%
Ethylene	0.10%
Otros	0.10%

Composition



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EMISSIONS

Parameters	Units	US EPA standards	EPA standards	Plasma emissions
Nox	ppmvd	150	250	**35-40**
PM	mg/dscm	20-24	34	**<5**
SO_2	ppmvd	30	55	**<2**
HCl	ppmvd	25	15	**<10**
CO	ppmvd	100	40	**<20**
Hg	µg/dscm	50-80	55	**<2**
PCDD/ PCDF	ng/dscm	13-30	25	**0**

FROM MUNICIPAL SOLID WASTE, COAL ASH AND SLAG FOR SECONDARY USE:

Possible use of residual products:

Coarse aggregate

Asphalt

Bridges

Roads

Concrete

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Fine aggregate

construction products

Oil spill clean-up

Tiles

Insulation

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VITRIFIED SLAG TCLP

Metal	Allowed concentration (mg/l)	Concentration (mg/l)
Arsenic	5.0	<0.1
Barium	100.0	<0.5
Cadmium	1.0	<0.02
Chromium	5.0	<0.2
Lead	5.0	<0.2
Mercury	0.2	<0.01
Selenium	1.0	<0.1
Silver	5.0	<0.5

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WHAT ARE THE ADVANTAGES ?

- Gasification technology that works at atmospheric pressure, elevated temperature for a better transformation into gas
- Feeding capacity with **any types of waste, solid, liquid, gas** (non-radioactive) and bio fuels
- Compact and modular, a feature that allows it, unlike traditional incinerators, to work from 30% to 100% of their nominal power, thus guaranteeing the operator the possibility of easily eliminating seasonal variations in the waste flow.
- Non-polluting and environmentally safe
- High recovery of clean renewable energy such as electricity
- Excellent ROI (Return on Investment) ratio
- Consolidated technology
- Ready for circular economy
- Low start-up and shutdown time
- Low GHG emissions

Plasma-steam gasification	Plasma	Pyrolysis	Incineration
Total decomposition (2000°C)	✓ (3000-5000°C)	Decomposition at 90% (800°C)	Decomposition at 70% (1000°C)
Combustion type	Indirecta	Indirect	Direct
Absence of resins and furans	✓	Presence of resins and furans	Massive presence of resins and furans
Ash absence	✓	10% ash	30% toxic ash
Any type of waste	✓	X	X
No need to sort waste	✓	X	X
Exhaust gas emissions	Low	Medium	Elevated
Unaffected by the moisture content of the waste.	✓	X	X
Sublimation	✓	X	X
Modularity	✓	X	X
Construction time	12-15 meses	12-15 meses	5 años
Waste	Obsidian	-	Ashes
Plant size	Small	Medium	Big
Plant waste products	100% recyclable inert material	-	Dangerous ash to be disposed of in landfills
Emissions			
NOx	<36 ppmvd		<110-205 ppmvd
SO_2	<1.05 ppmvd		<26-29 ppmvd
Hg	<1.4 µg/dscm		<28-80 µg/dscm

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OUR STANDARD MODELS

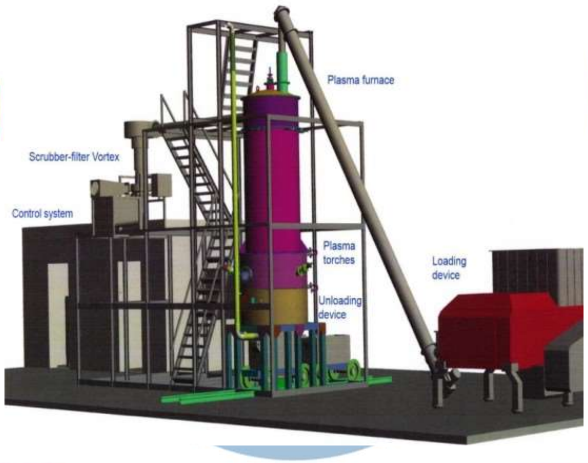
2 TPD

5 TPD

75 TPD

250 TPD

500 TPD



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QUALIFICATIONS

International Union of Professional Engineers

The Society of Professional Engineers Ltd - UK

CERTIFICATE OF QUALIFICATION PROFESSIONAL ENGINEER

CERTIFICATE OF QUALIFICATION PROFESSIONAL ENGINEER - GERMANY

Thanks for your attention

"Finding it's a beginning, staying together is a progress, working together is a success"

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