how to clean instead of pollute ?

Friday 18 February

Summary :

- The energy problem
- The waste problem
- Sustainability thanks to biomass
- Gasification, Refining, Vitrification
- CHO-Power Morcenx
- CO_2 saving calculation

"Without major changes in how we produce and use energy, we face significant risks to our common energy security and the future of the environment " Nobuo Tanaka, director of the International Energy Agency (IEA) Ministerial Meeting on Clean Energy, Washington, July 19, 2010.

The Energy problem

Fossil fuels are still widely used in the world today and this can cause two main problems: their rarities will create geopolitical tensions in the world and high emissions of CO2 they generate contribute heavily to global warming. The availability of reserves is a major source of concern. At current rates of consumption, oil will be the first fossil fuel which we should dispense, there would be between forty and sixty years of reserves. Natural gas could, in turn, be exploited for another seventy years.

The growth solicits since the beginning of the industrial age an increasing demand for energy. According to the International Energy Agency (IEA), global energy demand could increase by more than 50% by 2030. It is estimated that by 2030 fossil fuels would still represent nearly 80% of our consumption. Fossil energy resources are limited and may not meet the growing needs of the population. However, they are sufficient for their burning triggers a dangerous climate disruption to the planet.

The IEA has estimated that without transition of fossil fuels to clean energy, emissions of carbon dioxide, considered responsible for global warming, will double by 2050.

The Waste problem

Besides the energy problem, population growth raises serious questions about the management of our wastes. The United Kingdom is one of the biggest European producers of waste with about 100 million tons from residential, commercial and industrial. Most of this waste still be directed to discharges. The government proposes a set of guidelines and measures to reduce waste. The British strategy (Waste Strategy for England 2007) is based on a hierarchy imposed in the possibilities of waste management, the Waste Hierarchy, with the main objective to minimize the use of landfills.

Sustainability thanks to biomass

In establishing the Brundtland Commission, in 1983 the United Nations General Assembly recognized that environmental problems were global in nature and determined that it was in the common interest of all nations to establish policies for sustainable development. In this commission sustainable development has been defined as the 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

A major shift energy is crucial for the sustainability of our planet.
This shift included the use of Renewable Energy in our production including biomass.

Biomass is defined as "all non-fossil organic matter of vegetable and animal products and its processing and degradation. The concept of biomass implies that the material is used for energy purposes. Biomass sources are divided into three categories: forestry, food processing and urban."

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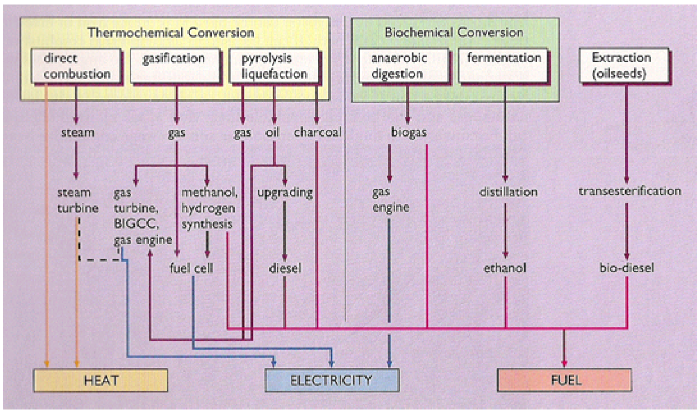
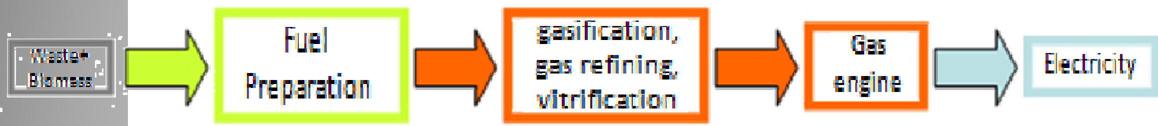


The use of biomass plays a key role in protecting the environment because it allows reuse the waste to avoid landfill costs and, consequently, contamination of soil and groundwater, while producing electricity or heat.

How to clean instead of pollute?

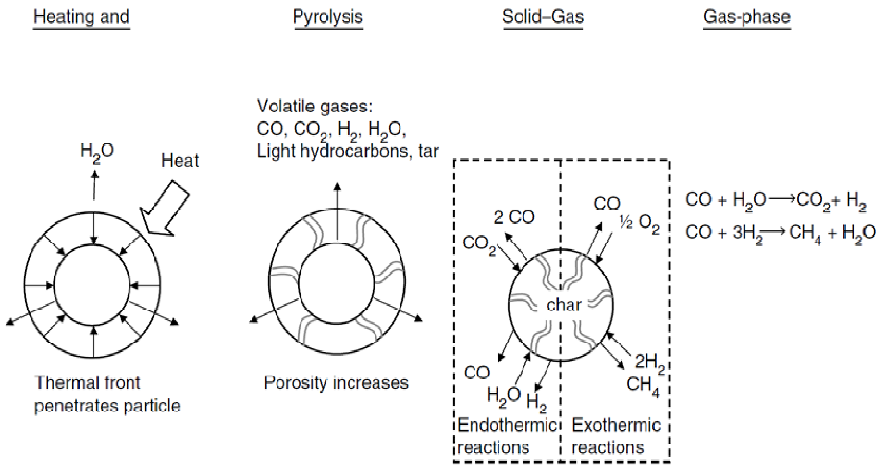
The transformation process, by gasification, of waste into a Syngas (synthesis gas) cleaned by refining plasma to feed a turbine or a gas engine generating electricity, all with an electrical efficiency from start to finish up to 40%. The electricity produced, net of the process' own consumption is then sold on the network at a fixed price per kWh.



The valuation principles used: Gasification, Refining, Vitrification.

Waste & Biomass pretreatment

The pretreatment step of waste is to begin by make a new sorting to remove non-usable materials (ferrous metals, inert materials). For homogeneity and ensure a speed high heat transfer in the gasifier, the waste is crushed. Finally, the waste should be dried so that can be pyrolysis.



Pyrolysis in gasification process

Pyrolysis is a process that occurs at low temperatures. Hemicellulose pyrolysis can start at temperatures between 150 ° and 300 ° C, the cellulose starts between 275 ° and 350 ° C and lignin between 250 ° and 500 ° C. The materials are overheated and release volatile compounds, leaving pores on the surface of the particle. These pores facilitate interactions with selected gases. This process will produce porous carbon residue called char.

Interactions between gases & solids

The interaction between the injected gases (usually oxygen, water vapor), the produced gases during the previous step and the char, causing endothermic and exothermic chemical reactions, that convert the solid carbonated in gas as H_2, CO and CH_4.

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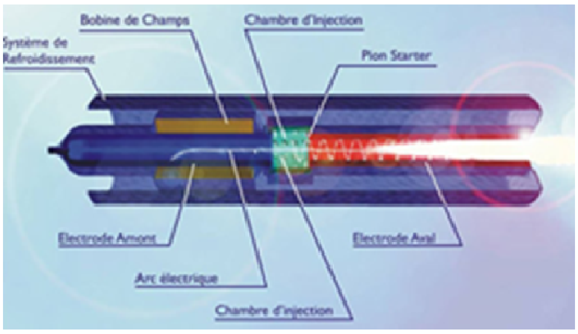
Endothermic reactions:
$C + CO_2 \leftrightarrow 2CO$ $\Delta H_R = 172{,}4$ MJ/kmol $C + H_2O \leftrightarrow H_2 + CO$ $\Delta H_R = 131{,}3$ MJ/kmol
Exothermic reactions:
$C + 1/2\ O_2 \leftrightarrow CO$ $\Delta H_R = -110{,}5$ MJ/ kmol
$C + 2H_2 \leftrightarrow CH_4$ $\Delta H_R = -74{,}8$ MJ/kmol
Exothermic reactions provide the energy necessary for endothermic reactions and drying.

Gases Interactions

After the conversion of solid to gas, other reactions take place between the gases:
$CO + H_2O \leftrightarrow CO_2 + H_2$ $\Delta H_R = -41{,}1$ MJ/kmol $CO + 3H_2 \leftrightarrow CH_4 + H_2O$ $\Delta H_R = -206{,}1$ MJ/kmol

Refining of synthesis gas by plasma torch

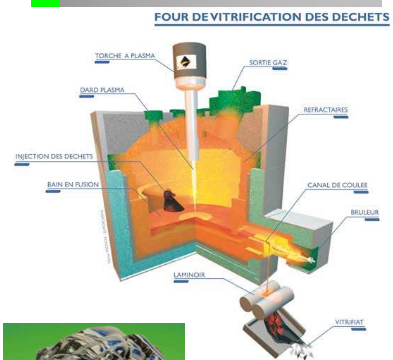


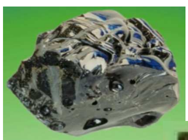
The raw synthesis gas is mainly composed of carbon monoxide and hydrogen, but it also contains tar that make it inappropriate for turbines or engines use. Refining allows a complete separation of tar in synthesis gas without the possibility of recombination and is involved in raising the gas calorific value.
Plasma torches considered are non-transferred arc. These torches could produce, from a standard gas, a plasma with high temperatures.
They are composed of two tubular electrodes, connected to a swirling gas injecting room. The torch can operate with all of the gases mixture (air, Ar, CO, helium, CO2, H2, N2, CH4, O2).

The firing of the arc is obtained by a short circuit. The temperature of the resulting plasma jet is about 4000 K while its mean enthalpy is in the top 5 MJ / kg air to 8 MJ / kg air. To increase the electrodes lifetime, a magnetic field controls the movement of the arc root of the upstream electrode while the gas injection controls the downstream electrode. The electrodes and the injection chamber are cooled by water in a closed circuit.

Advantages of non-transferred arc plasma technology :

- High thermal efficiency
- Flexibility in the choice of the the ionized gas
- Total independence for plasma generation between torch and furnace, and consequently operating conditions are facilitated
- Less evaporation due with the absence of hot spot
- Flexibility of operation: 25 to 100% power
- Manufacturing with safe equipment





Using process products :

The BioSynGas heat is recovered to fuel the gasification process and a steam turbine combined cycle. The gas has a calorific value of about 3.6 kWh / m³. The gas powers a motor or a gas turbine that produces electricity sold on the network. The heat of engines is recovered to generate steam and additional electricity. With this method the electrical efficiency from start to finish is 40%.

A part of inorganic (metals, minerals) do not turn into synthesis gas. The ash are then vitrified using a plasma torch. The ashes are made molten at 1400 ° C and cooling form an inert material and recoverable, the vitrified. Why is the vitrified glass? Because it is the most abundant solid compound in our waste, it eliminates the toxicity of heavy atoms due to its nature. The glass or silica, SiO2 is insoluble in water, so it traps the heavy metals contained in waste. We can reuse it later as gravel in concrete production, for example.

Location: Morcenx (40) - France

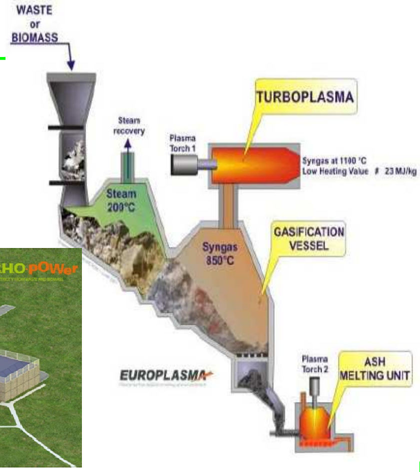
Energy output: 12 MW

Capacity: 150t/jour

Type of waste: Refuse sorting non-hazardous industrial waste and wood chips

Provenance: Landes and neighboring districts

Status: Under construction since 1 December 2010



All the electricity produced is sold to EDF. CHO-Power will deliver 90 000 MWh per year, enough to power about 50,000 citizens.

In total, funding for this project has mobilized 40 million. But the investment coast of a gasification center is generally lower than for an incineration center (0,8 M€/ MWthinput for gasification and 1,48 M€/ MWthinput for an incinerator) we can conclued that in choosing this technology 34 million€ has been economised.

ENVIRONMENTAL FOOTPRINT

The use of curbside refuse to waste recovery in the form of electricity rather than to landfill or incinerator disposal is a commitment to sustainable development.

FOOTPRINT GREENHOUSE

This principle offers a better carbon footprint than current solutions:
- Prevents the landfill of waste they have generated methane, greenhouse gas emissions 21 times more potent than CO2.
- Reduced transportation with facilities closer to urban centers and adapted to communities of rural municipalities.
- With energy-efficient, two times less CO2 emitted per kWh produced in a plant timber, CO2 from biomass to 60-85%.

SOCIAL FOOTPRINT

CHO-Power facilities create sustainable jobs, not relocated. This process does not preclude the practice of sorting / recycling and discourages waste. Fuel obtained after separation of recyclable materials and / or organic and used, it can achieve very high recovery rates. Acceptance government, which has invested heavily in the sort and does not wish to depart from this principle of waste recycling.

- More energy: 45% electrical efficiency gasifier while modern incinerators 23%.
- Less CO2: a gasifier generates 0.8 kg of CO2 per kWh of electricity produced against 1.7 kg for an incinerator.
- Low emissions: since there is no combustion, so little oxygen, there is a low production of acid oxides (NOx, SOx), and the combination with high temperature ensures that no Dioxin is created. The volume of gas emitted is very low.
- Plants compact size: the gasification furnaces do not require large volumes.
- Few transport: gasification plants can be near the cities, besides the places where waste is produced, saving transport costs and pollution.
- Few secondary products: limited emissions create limited reactive tailings for the treatment of fumes, non-organic wastes are processed in vitrified product that retains the pollutants in the glass matrix and can be reused as base material in civil engineering.

Calcul needs:

Located Morcenx (40-Landes) on land adjacent to Inertam site where waste come from, and at 30 km from the pellet production centre. 4 loads of 5 tones of pellet will bring the 20 tones of pellets which the gasifier needs every day.

Before, waste was sent to the incineration center of Messanges, 60 km away. 130 tones of waste will be treated, it was sent to Messanges in 26 loads of 5 tones.

The CO_2 emission of a load is 92 g/t/km.

CO_2 emission during the incineration is nearly the same than in a coal production, with 23% efficiency.

Gasification produce twice less gas than incineration and it is a syngas.

A gasifier generates 0.8 kg of CO2 per kWh of electricity produced against 1.7 kg for an incinerator.

CO_2 savings in Transport:

92*26*5*60 = 717.6 kg/day
92*4*5*30 = 55.2 kg/day
CO_2 savings = 662.4 kg/day

CO_2 savings in using:

P output = 12 MW, Efficiency = 0.23 so P input = 12 / 0.23 = 52.2 MW
W = 1 J/s à P input = 52.2*3600*24/1000 = 4 508 GJ/day
CO_2 emission during the incineration is nearly the same than in a coal production, we make the calculation with coal production.
GCV coal (dry) = 28.54 GJ/t so Mass Coal (dry) = 158 t/day
%Ash in Coal = 15.8%, %C in ash of Coal = 85.1% so Mass C=0.851*0.842*MassCoal
Mass C = 113 t/day
Every kg of C produces 3.67 kg of CO2
Mass CO_2 coal = 113*3.67 = 415 t/day
CO_2 emission of the gasifier = 0.8/1.7*CO_2 emission of the incinerator

CO_2 emission of the gasifier = 195 t/day

CO_2 savings = 220 t/day

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