Presentation

Centre Albert La Borschette

Bruxelles

10-13 June 2008

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The Article 14 of the Directive 2000/76/EC of the European Parliament and the Council establishes that :

"*the Commission shall submit a report to the European Parliament and the Council before 31 December 2008 based on experience of the application of this directive, in particular for new plants (...) the report shall be based on* ***the development of the state of technology*** *and shall be accompanied by proposals for revision of the related provisions for this directive*".

According to this Article we present some observations in order to (i) show clearly the differences between biomass incineration or low temperature gasification and an IPGCC facility and (ii) obtain a more adequate and precise requirements on the legislation.

IPGCC PROCESS

- The IPGCC Process is a high temperature gasification process (4000-5000ºC).
- Molecular Dissociation:
  - Organic compounds in the feedstock (waste) are broken down to their elements which ultimately form stable molecules of CO, H_2 and H_2O (SynGas).
- Sub-stoichiometric conditions:
  - combustion is not possible
  - the formation of SVOC, dioxins, furans and VOCs is avoided. (no precursors, no free O_2)
- IPGCC process is 100% environmentally safe the products are
  - H_2-rich fuel
  - inert glassy slag
  - toxic fumes or hazardous ashes are not created.

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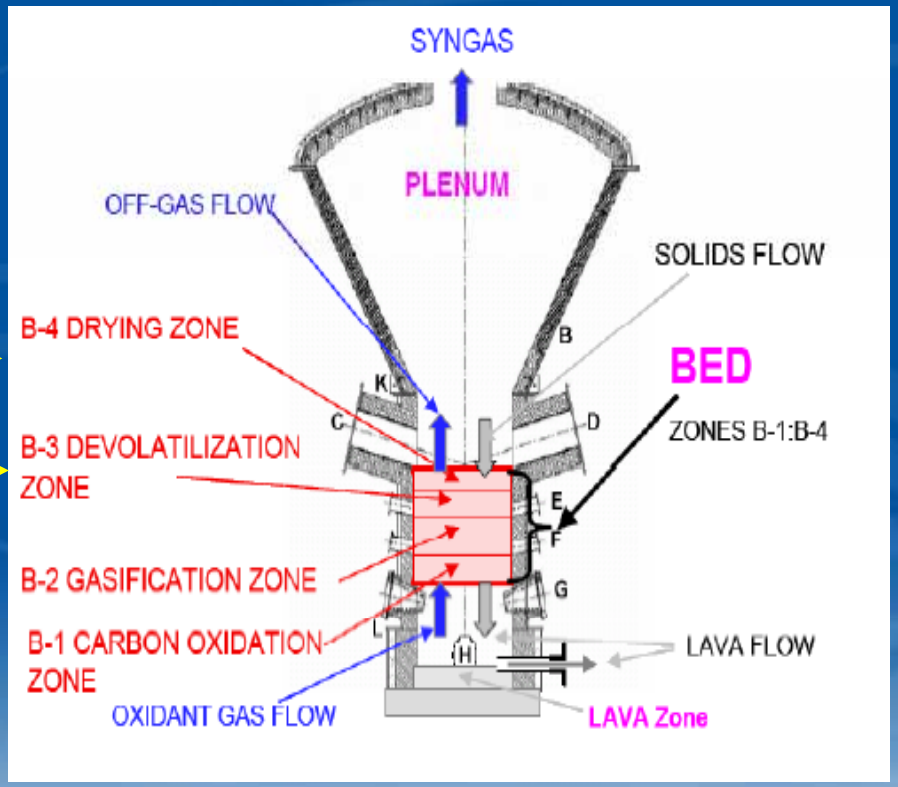
PLASMA GASIFICATION

C30 H 48 O 19 N 0..5 S 0.05

C 44H 37 N 0.86

Cx Hy x >17; y = 2x



SYNGAS

$H_2 + CO + CO_2 + N_2 + H_2O + HCl + H_2S$

≥ 80 –90 %

MOLECULAR DISOCIATION

T ≥ 2000 ºC

REDUCTIVE ATMOSPHERE

SUB-STOCHIOMETRIC CONDITIONS

CO_2

PARTIAL OXIDATION

NOx

REFORMATION

SURFACE VELOCITY

GLASSY SLAG INERTE

COMERCIAL PURPOSES

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Waste Incineration Directive (W.I.D.)

FLUE GAS COMPOSITION

N_2 67-70%	NOx	Particulate
CO_2 8-11%	SOx	VOC
O_2 6-7%	HCl	
H_2O 12-15 %	SVOC	

Volume flow

Incineration vs Gasification

7:1

SYNGAS AVERAGE COMPOSITION

H_2 40-45 %	HCl <0.7 %
CO 40-45 %	H_2S <0.3 %
CO_2 2-5 %	H_2O 2-5%
N_2 2-5%	

~~NO_X SO_X SVOC Dioxins Furans~~

STEAM → ~ → 25% max. Eff.

CLEANING → EXHAUST

CLEANING

~ → 42-50% max. Eff.

ELECTRICITY

FT → NAPHTA, BIODIESEL

METHANOL

H_2

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ELECTRICITY

SYNGAS

NATURAL GAS REPLACEMENT

METHANOL

FISHER TROPSCH

BIODIESEL/ KEROSENO

3 R: REDEFINING AND QUESTIONING

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ART. 1 & 2

"Objetives: the aim of this directive is to prevent as far as practicable negative effects on the environment in particular pollution by emissions into air, soil, surface water and groundwater and the resulting risk to human health from the ***incineration and co-incineration of waste****.*

*Scope: "****Incineration and co-incineration plants****"*

From the start (Articles 1 and 2) the Waste Incineration Directive (WID) should not be applicable to gasification:

Plasma gasification is not the same as conventional incineration or low temperature gasification and should be considered separately from a legislation point of view.

ART. 3

"(...) this includes the incineration by oxidation of waste as well as other thermal treatment processes such a Pyrolysis, gasification or plasma processes in so far as the substances resulting for the treatment ***are subsequently incinerated****".*

The main substances resulting from plasma gasification is a fuel gas, which may or may not be combusted in a power generator unit. SynGas produced may be the building block of wide arrange of products (FT Fuels, methanol, H_2, electricity). Only one of the potential applications of SynGas involves combustion: gas turbine for power production. In any case is not incinerated.

ART. 3

“ The concept of Plant covers the site and the entire incineration plant including all incineration lines, waste reception, storage, on site pretreatment facilities, waste-fuel and air supply systems, boiler, facilities for treatment exhaust gases, on-site facilities for treatment or storage of residues and waste water, stack, devices and systems for controlling incineration operations, recording and monitoring incineration conditions.”

But: SynGas is a gaseous H_2-rich fuel and uses Gas turbine (in CC) for recovering the chemical value of SynGas, which is neither mentioned or considered.

ART. 4

“ the heat generated during the incineration and co-incineration process is recovered as far as practicable e.g. through combined heat power, the generating of process steam or district heating.”

This point should be adapted because Plasma Gasification’s main energy recovery form is a gaseous fuel (SynGas). Energy in SynGas is recovered (90% Chemical Energy and 10% Sensible Heat) in two ways: the chemical energy for production of fuels or electricity and the sensible heat for production of steam.

ART. 6

The conditions laid down in Article 6 (*"Operating conditions"*) are not applicable for an IPGCC process:

- High gasification temperatures (>2000 ºC) no need for auxiliary burners
- No ashes
- No combustion chamber
- No combustion air
- Fischer Tropsch : main product liquid bio fuels

Different conditions should be set forth in a new directive as IPGCC clearly does not fit within referred Article 6.

ART. 7&8

SynGas is a gaseous hydrogen-rich fuel which is conditioned before the gas turbine, and in no circumstances should be considered as “exhaust gas”.

Exhaust gas from an IPGCC plant comes from the gas turbine not from the gasification process. This gas turbine exhaust does not require cleaning, therefore Articles 7 and 8 regarding air emission limit values and water discharges from the cleaning of exhaust gases does not apply well to an IPGCC plant.

ART. 11

Article 11 “Measurement requirements” should be modified to be able to regulate the specific and different from traditional incineration facilities pollutants emissions of an IPGCC plant.

Ex: *“ (...) continuous measurements of the following process operation parameters: (..), concentration of Oxygen content of the exhaust gas”* .

The exhaust gas in an IPGCC is the gas exhausted from the turbine. **The SynGas contains no O_2**

Also continuous measurement of **HCl, total dust etc**. as regarded in Article 11 has no sense for the SynGas. The SynGas is cleaned and conditioned before entering the gas turbine and the gas turbine exhaust already complies with WID emission limits without the need for cleaning.

RECOMENDATIONS

1. The types of plants excluded for the Scope of the Directive should be widened to (i) include certain exclusions for Plasma gasification for the production of SynGas and (ii) to consider the Algae as another type of biomass.

2. In order to incentivate energy efficiency, emission limits should be linked to power production. To do so, there should be limits in terms of

$$\frac{\text{Quantity of Pollutant}}{\text{amount of energy}} \quad \text{[Kg/MWh],}$$

which is the same method as the US EPA currently applies

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RECOMENDATIONS (II)

3. Include Algae within definition of biomass

a) Algae gasification for production of electricity

- Closed Carbon loop : CO_2 zero emission

b) Algae gasification for production of bio-fuels (Fischer Tropsch)

- System becomes a CO_2 sink

EXAMPLES

1. Case of Poland

   Due to discrepancies between *organic* and *fermentable*, energy from landfill biogas is considered 100% renewable, while energy obtained from syngas is only considered 42% renewable. Syngas is produced from the organic matter only (inorganics do not contribute to syngas formation), and therefore energy from syngas should also be considered 100% renewable.

2. Case of Italy

   Categories for emission limitis include (i) biomass combustion, (ii) combustion of gaseous fuels and (iii) gas turbines in CC. An IPGCC plant might in theory fit within several of these categories at the same time. There is no clear class for plasma gasification.

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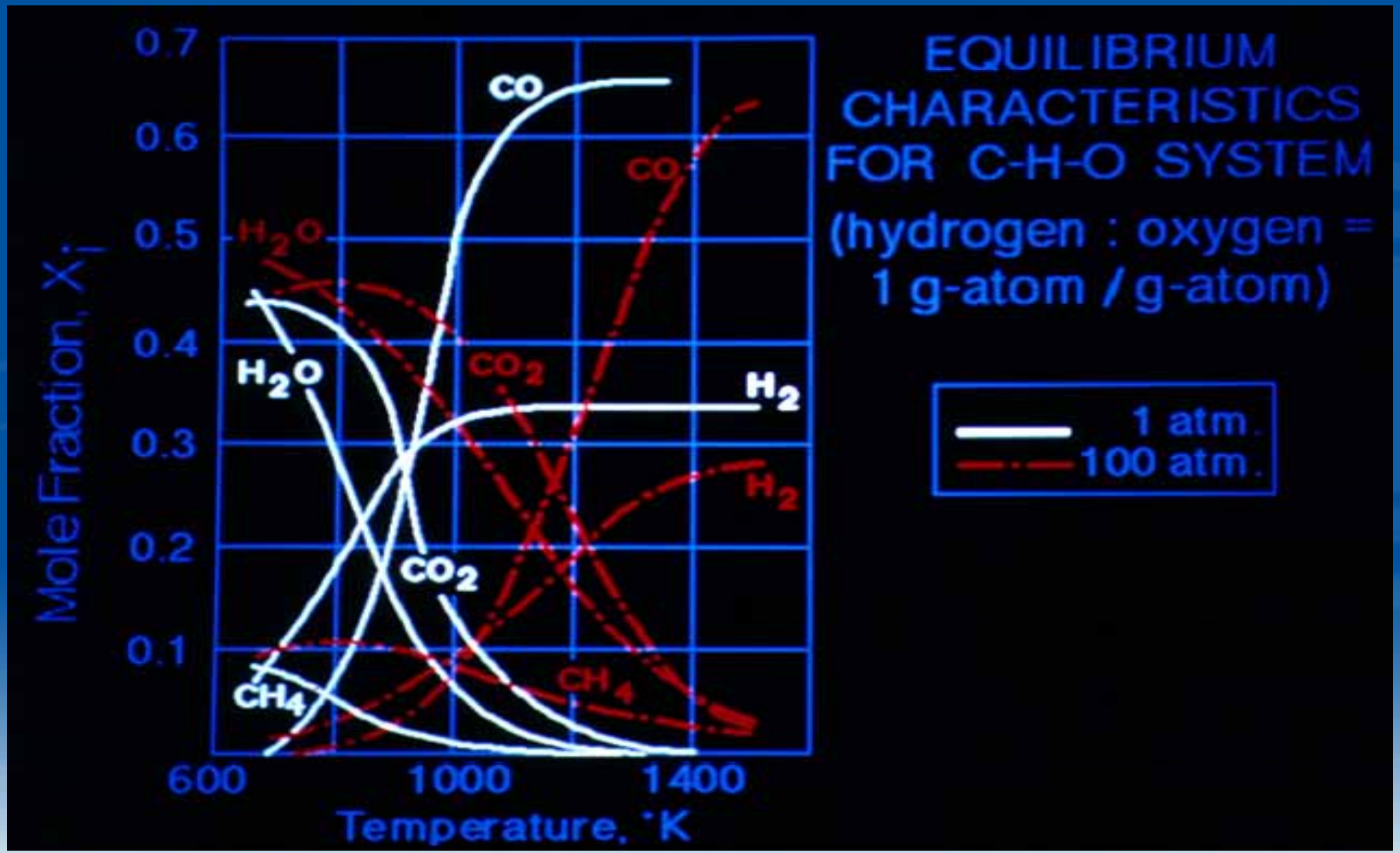
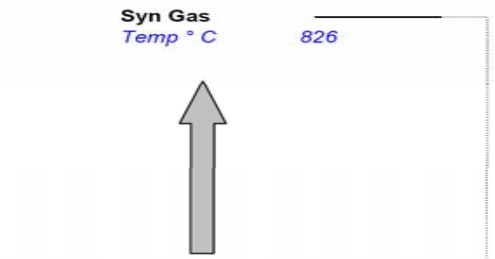
END


EQUILIBRIUM CHARACTERISTICS FOR C-H-O SYSTEM
(hydrogen : oxygen = 1 g-atom / g-atom)
1 atm.
100 atm.
Mole Fraction, X_i
0.7
0.6
0.5
0.4
0.3
0.2
0.1
600
1000
1400
Temperature, °K
CO
H_2O
CO_2
H_2
CH_4

KOCEALI PROJECT (IW) JANUARY 2008

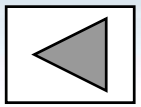
	Feedstock Composition (Wt %)
Inert	7.06
H	8.14
C	63.20
S	0.58
N	0.58
Cl	2.79
O	6.88
H2O	10.77
TOTAL	100.00



Syn Gas Composition (gas only)		
Consituent	Weight %	Volume %
CO	79.37%	47.54%
CO_2	0.56%	0.22%
H_2	4.91%	40.88%
N_2	7.42%	4.44%
H_2S	0.34%	0.17%
H_2O	0.22%	0.19%
CH_4	5.55%	5.80%
HCl	1.63%	0.75%
Total	100.00%	99.99%
	kcal/kg	MJ/kg
HHV	4317	18.06
LHV	3988	16.69

	Power Input MW	Mass Input kg/hr
Feedstock	120.9	14580
Flux (CaO)		540
Coke	6.1	729
Enriched O2	0.0	7200
Temp ° C		93.00%
		25
Water Steam	0.0	2520
Temp ° C		100
Thermal Plasma Power	4.0	1800
Temp ° C		25
Total	**131.0**	**27,369**

	Mass Output kg/hr	Power Output MW	
		10.9	SynGas Sensible
	25,735	119.3	SynGas Chemical
		0.3	Process Losses
Temp° C			
995	1,634	0.5	Slag sensible
	27,369	**131.0**	**Total**



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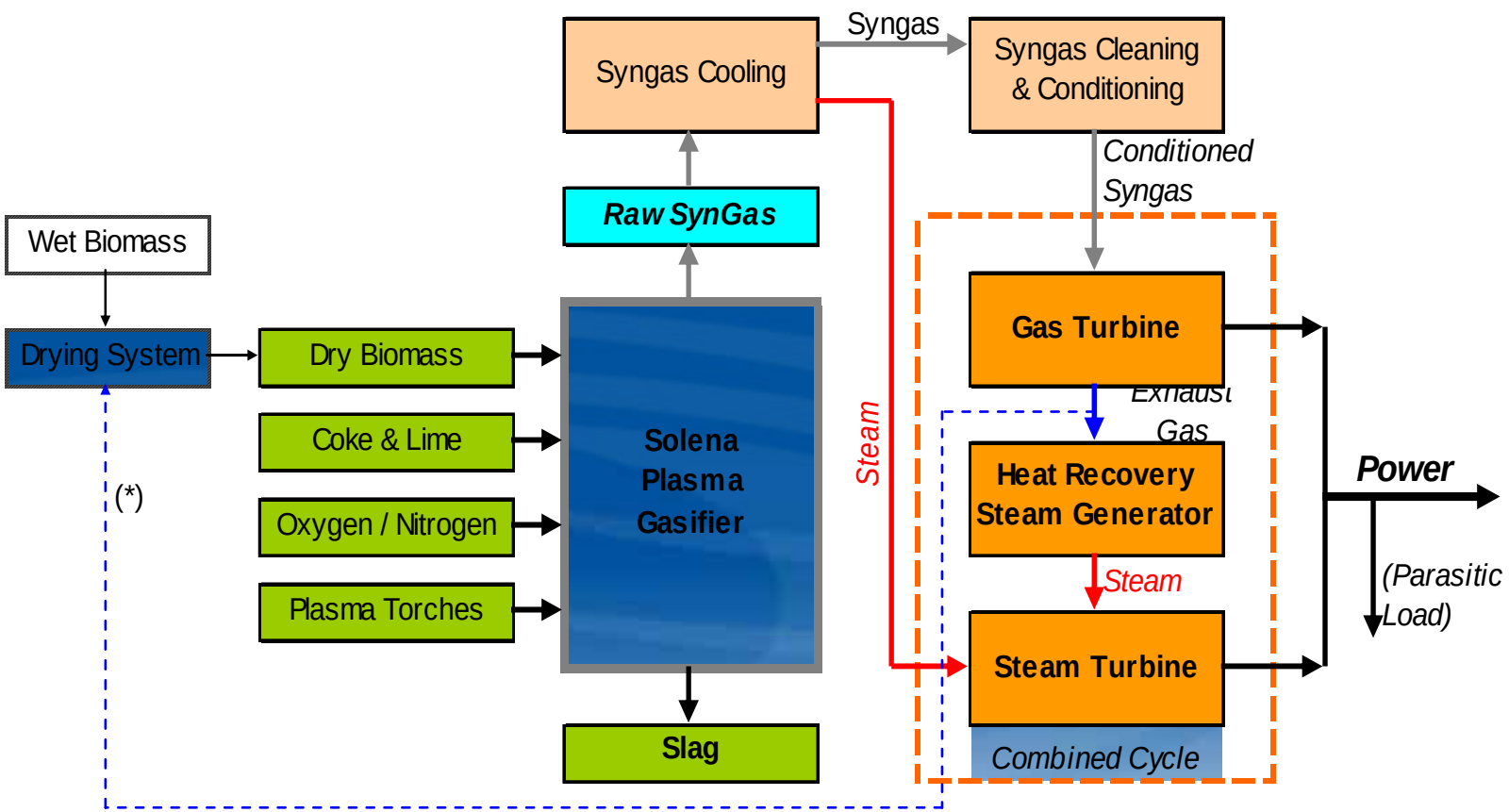
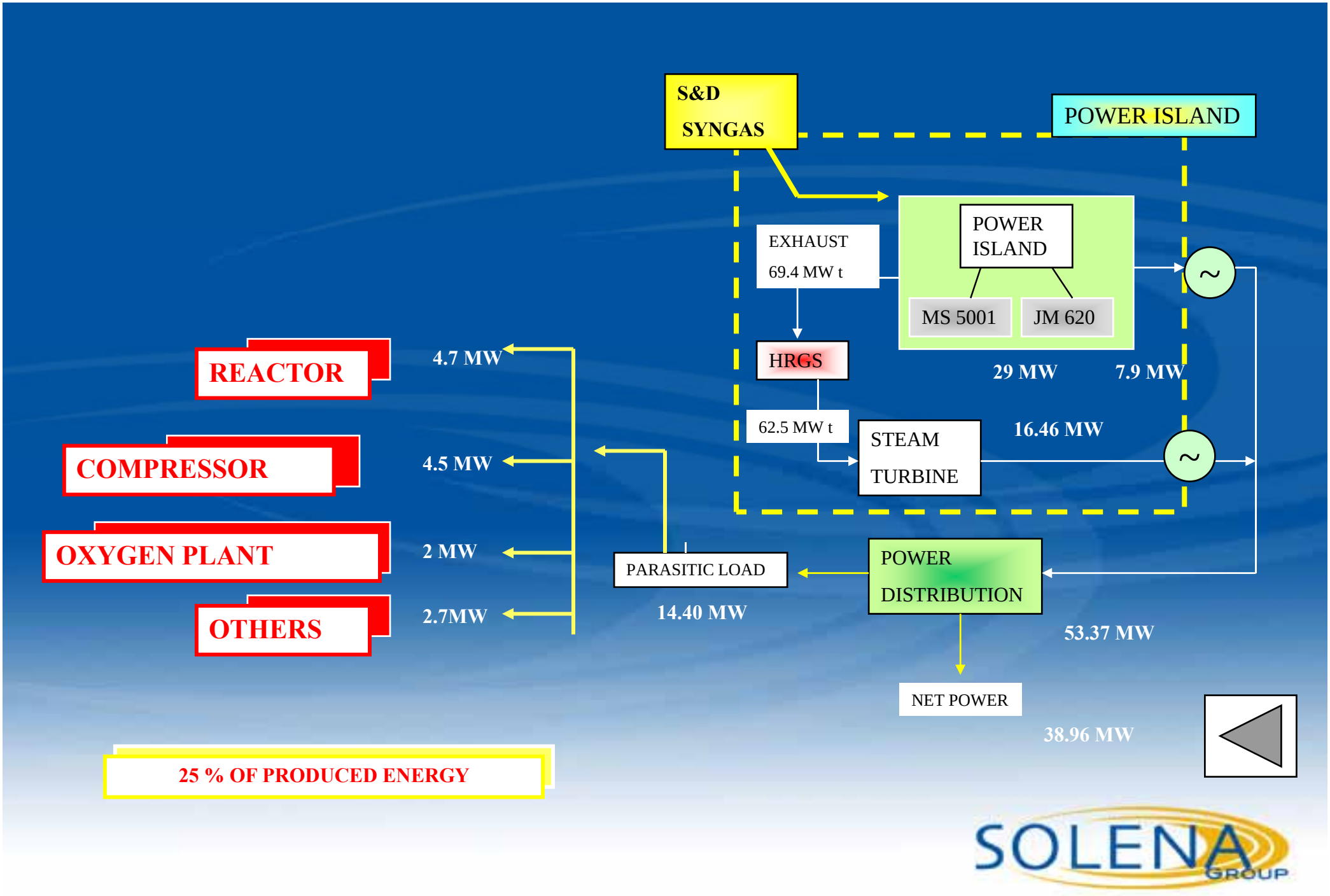
IPGCC CONCEPT DIAGRAM



(*) When required, a side stream of the GT exhaust can provide the thermal energy for the drying system. Alternatively, an external co-generation unit can provide the necessary heat.


S&D
SYNGAS
POWER ISLAND
EXHAUST
69.4 MW t
POWER
ISLAND
MS 5001
JM 620
HRGS
29 MW
7.9 MW
62.5 MW t
STEAM
TURBINE
16.46 MW
REACTOR
4.7 MW
COMPRESSOR
4.5 MW
OXYGEN PLANT
2 MW
OTHERS
2.7MW
PARASITIC LOAD
14.40 MW
POWER
DISTRIBUTION
53.37 MW
NET POWER
38.96 MW
25 % OF PRODUCED ENERGY
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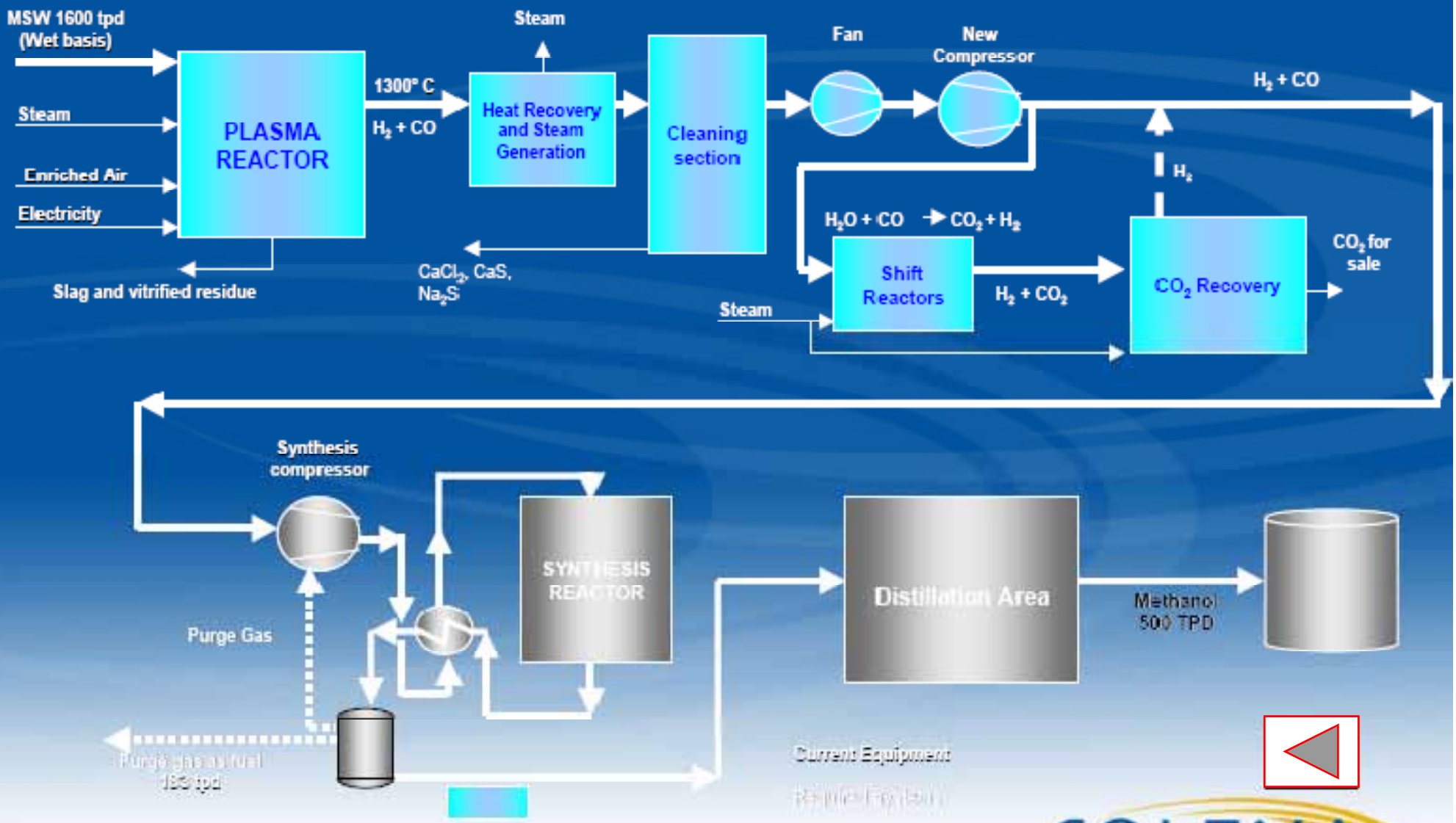
PLASMA TECHNOLOGY INTEGRATION CONCEPT WITH METHANOL PRODUCTION



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CALIFORNIA PROJECT

PLASMA GASIFICATION REACTOR

SYNGAS CONDITIONING

steam

To steam turbine

FT Synthesis Off gas

H2 REM

To steam turbine

GAS TURBINE

HRGS

FISHER TROPSCH SYNTHESIS

Tail gas

Steam from FT Synthesis

CRUDES

STEAM TURBINE

PRODUCTS UPGRADE

Jet Fuel JP 8
1080 barrels/ day

Naphta
780barrels/ day

Steam from Solena Plant

Parasitic Loads

Net Power: 19 MW

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