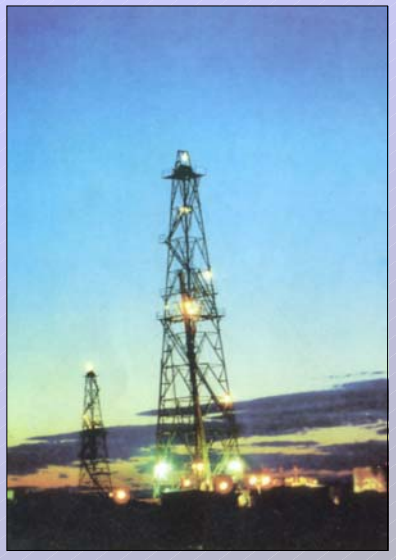
Integration of Bioenergy with Petrochemical Complex



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with the support of ETA-Renewable Energies

Bioenergy for Crude-Oil Refining

Potential bioenergy Contribution to supply the energy inputs for refining

- Heat (steam)
- Electricity
- Hydrogen

Large amount of energy input is needed (Process =80%)

- 0.4 MTOE/y (Refinery capacity = 2 MTOE/y)
- 2 MTOE/y (Refinery capacity = 10 MTOE/y)

Most promising Biomass Resource: → **BIO-PELLETS**

- cost similar to Natural Gas (~ 200$/TOE)
- easily handled, transported, stored

Amount of Biopellets needed per year

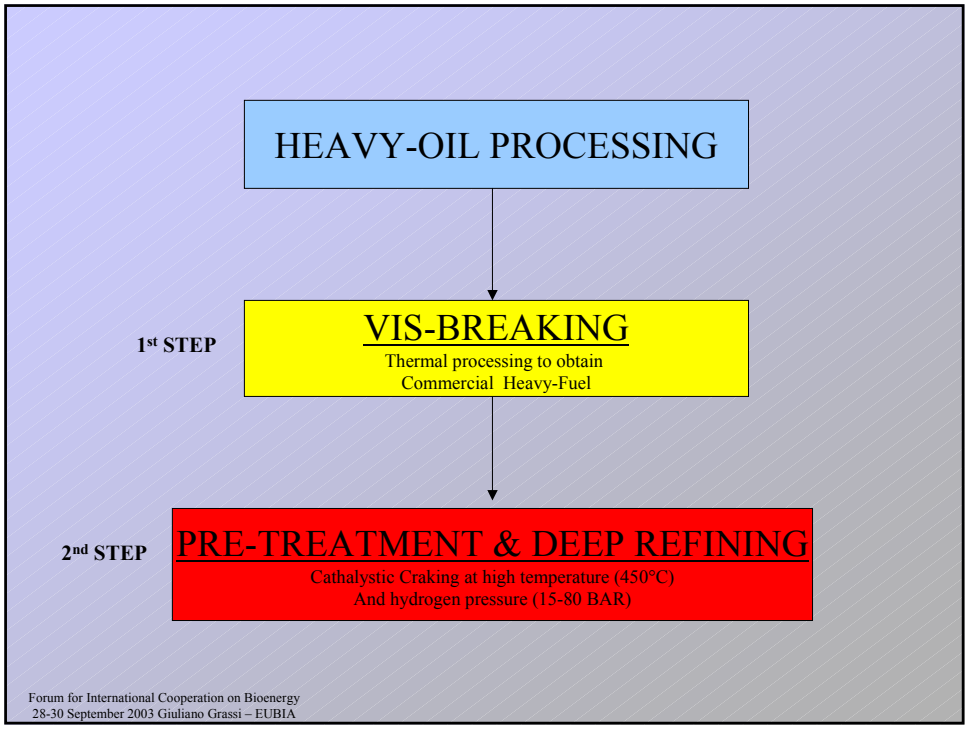
- 0.85 mio t/y (Refinery capacity = 2 MTOE/y)
- 4.2 mio t/y (Refinery capacity = 10 MTOE/y)

Major Benefits deriving from the use of Bioenergy for Crude-oil Refining

- **Benefits for the oil-importing Country balance of payment, due to the substitution of valuable $ imported hydrocarbons with local competitive biomass energy resources valued in local currency.**

- **The substitution an utilization of 20% renewable biomass energy resources decrease, of 20% the CO_2 emission into the atmosphere**

- **The production and supply of biopellets to the refinery generates many diversified jobs and supplementary income for rural population (rural development impact)**



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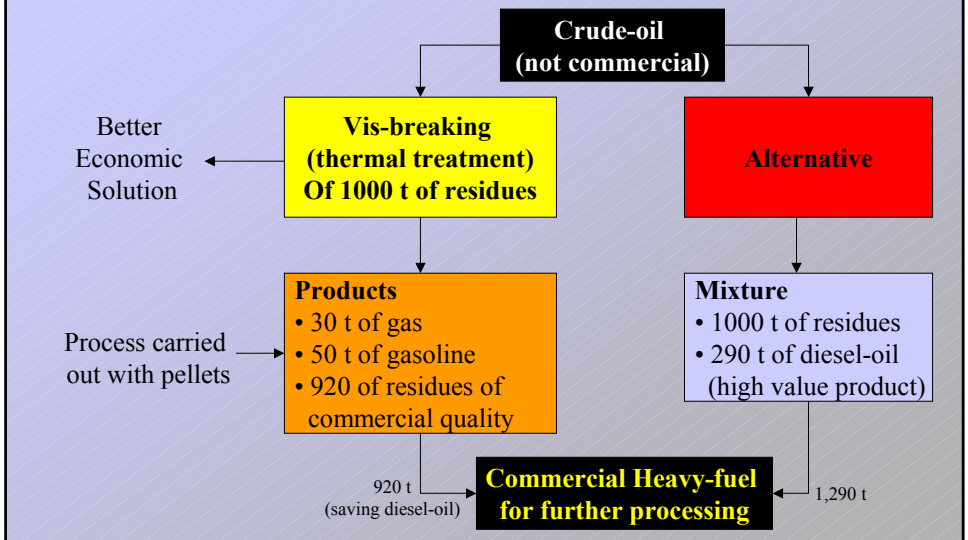
1° Process of heavy crude-oil
VIS-BREAKING



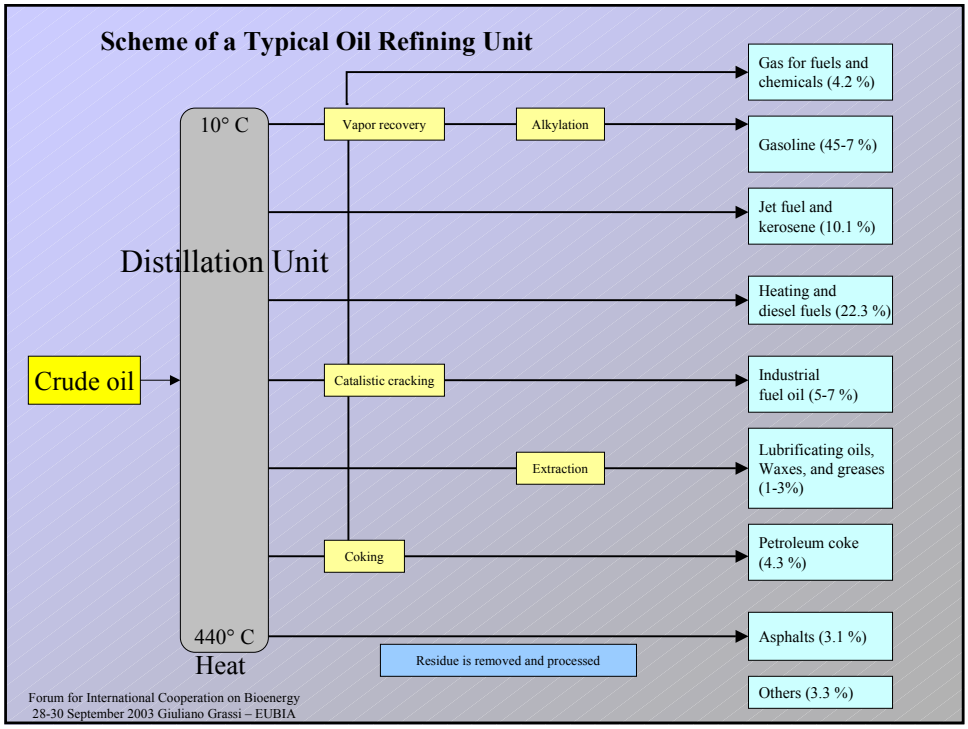
OIL REFINING

Basic refining process of heavy oil into light oil and the conversion of distillation residues, consists of cracking the molecules to increase the hydrogen content and to decrease the carbon content of the derived products with expenses of energy (endotermic process)

OIL REFINING	H_2 CONTENT (wt)
Heavy – oil	11%
Medium – oil	12%
Gasoline	14%
(Methane)	(25%)

Main ingredients for refining processes:

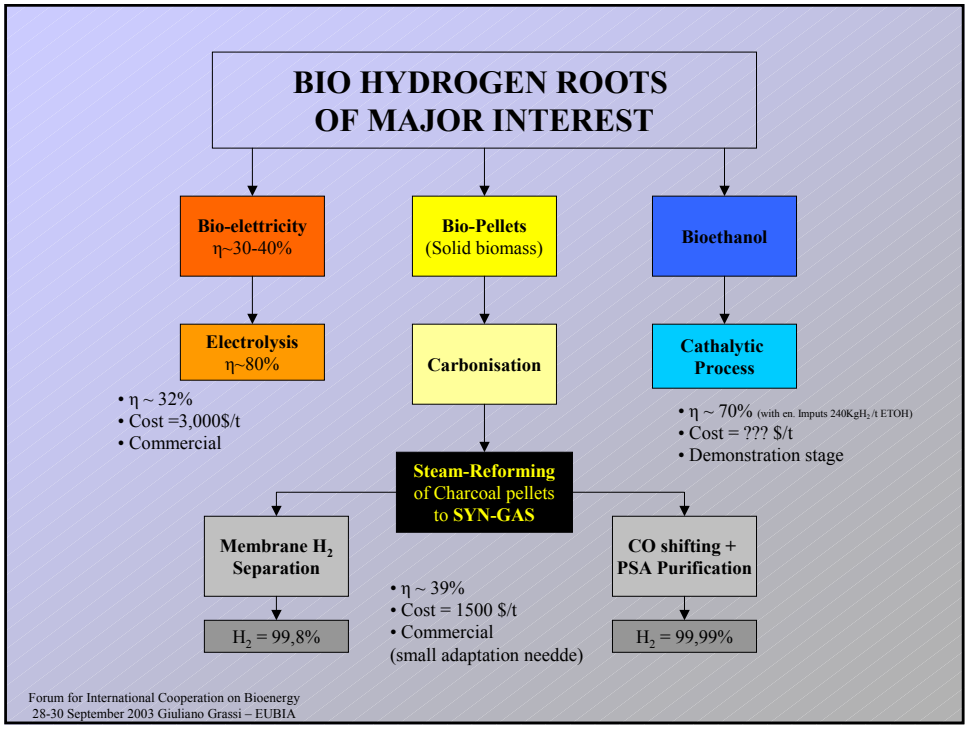
Temperature	Pressure	Hydrogen	Catalyst



Typical final refined products

Products	(Classical Refining) Vis-breaking plus Cathalytic Craking	(Deep Refining) Cathalytic Craking plus Fluid Coking
Gas/GPL	~ 6%	~ 8,4%
Gasoline	~ 23%	~ 28%
Distillate	~ 42%	~ 52%
Heavy Fuel	~ 22%	~ 5%
Fuel burn in the refinery	~ 7%	~ 7%

Large Amount of hydrogen must be added in the process to obtain valuable products


BIO HYDROGEN ROOTS OF MAJOR INTEREST
Bio-elettricity η~30-40%
Bio-Pellets (Solid biomass)
Bioethanol
Electrolysis η~80%
Carbonisation
Cathalytic Process
• η ~ 32%
• Cost =3,000$/t
• Commercial
• η ~ 70% (with en. Imputs 240KgH2/t ETOH)
• Cost = ??? $/t
• Demonstration stage
Steam-Reforming of Charcoal pellets to SYN-GAS
Membrane H2 Separation
CO shifting + PSA Purification
H2 = 99,8%
H2 = 99,99%
• η ~ 39%
• Cost = 1500 $/t
• Commercial
(small adaptation needde)
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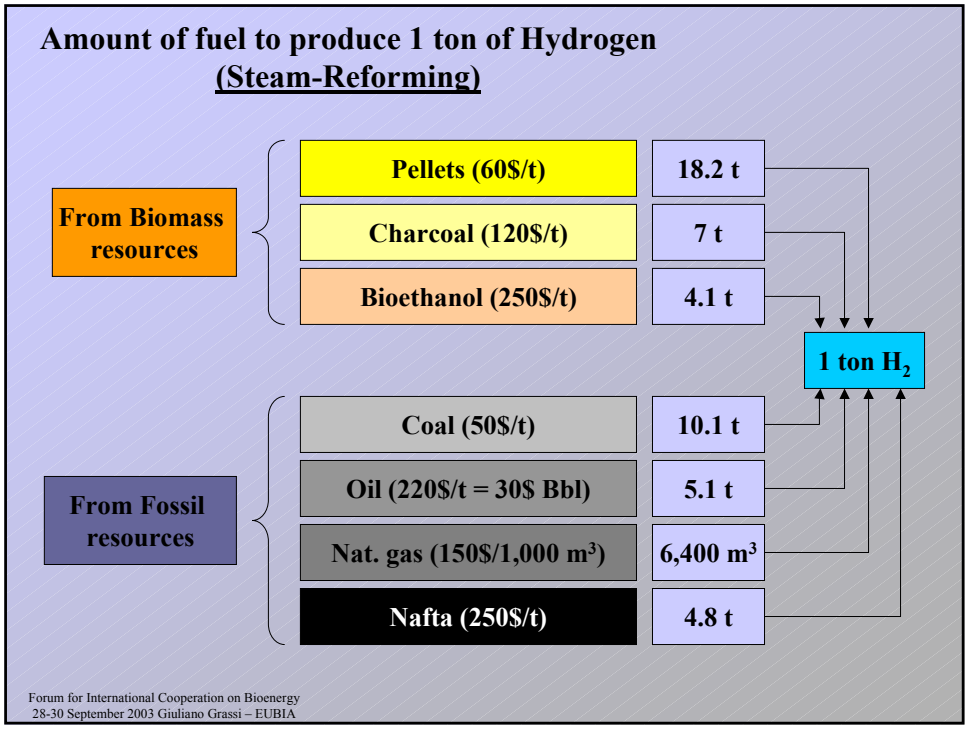
Amount of fuel to produce 1 ton of Hydrogen
(Steam-Reforming)
From Biomass resources
Pellets (60$/t)
18.2 t
Charcoal (120$/t)
7 t
Bioethanol (250$/t)
4.1 t
1 ton H2
From Fossil resources
Coal (50$/t)
10.1 t
Oil (220$/t = 30$ Bbl)
5.1 t
Nat. gas (150$/1,000 m3)
6,400 m3
Nafta (250$/t)
4.8 t
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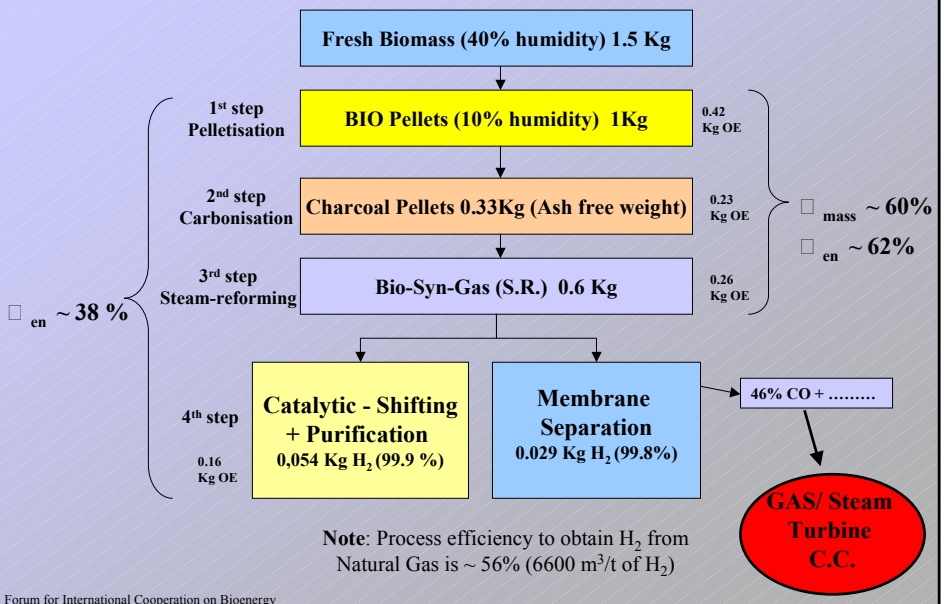
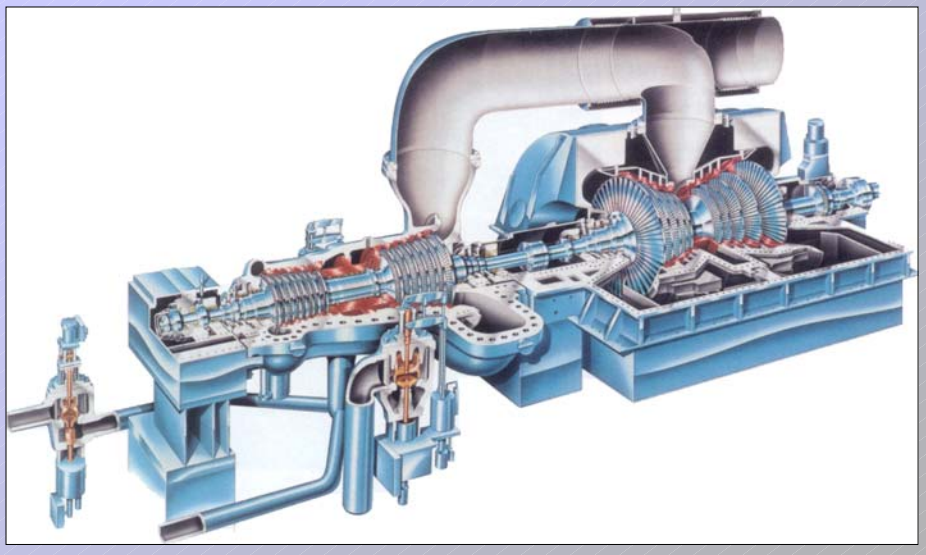
MOST ATTRACTIVE BIOHYDROGEN PRODUCTION FRO BIO-PELLETS



Note: Process efficiency to obtain H_2 from Natural Gas is ~ 56% (6600 m^3/t of H_2)



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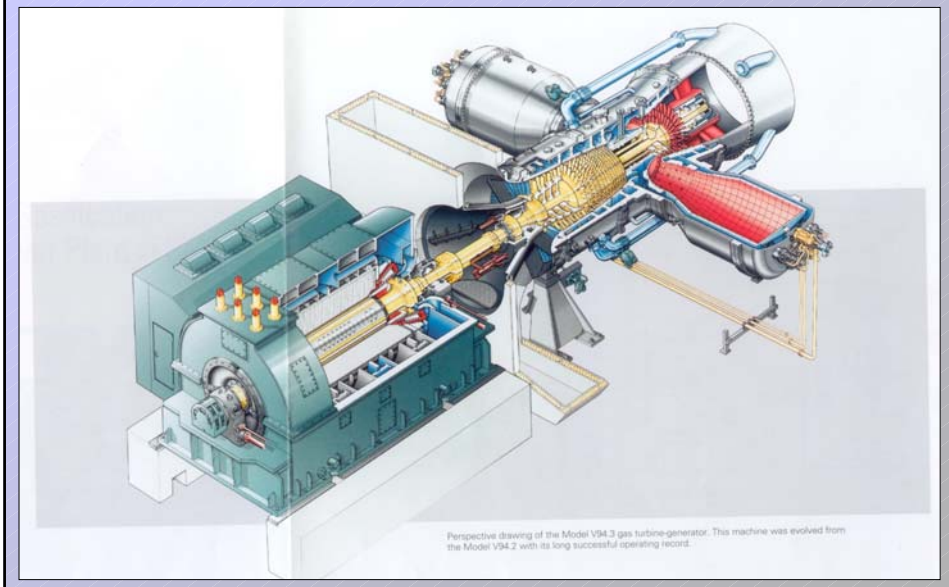
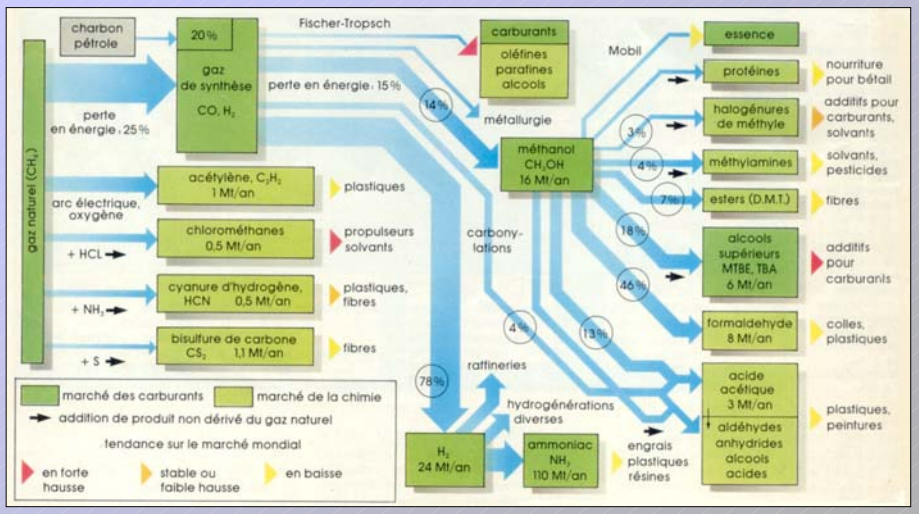
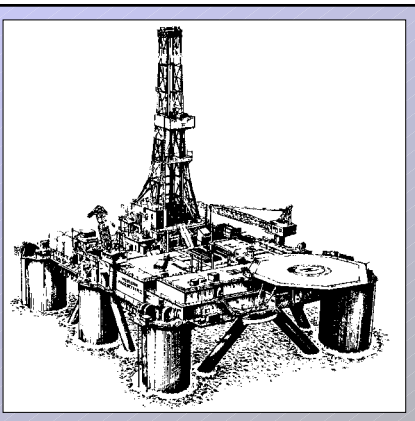
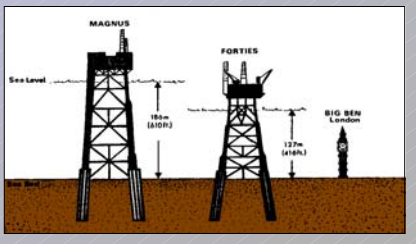


Perspective drawing of the Model V94.3 gas turbine-generator. This machine was evolved from the Model V94.2 with its long successful operating record.







Proposed Process for the small Maoming Refinery (1)

2 MIO t/y Very Heavy Fuel (not commercial)

Thermal treatment of VIS - Breaking ← Biomass Inputs

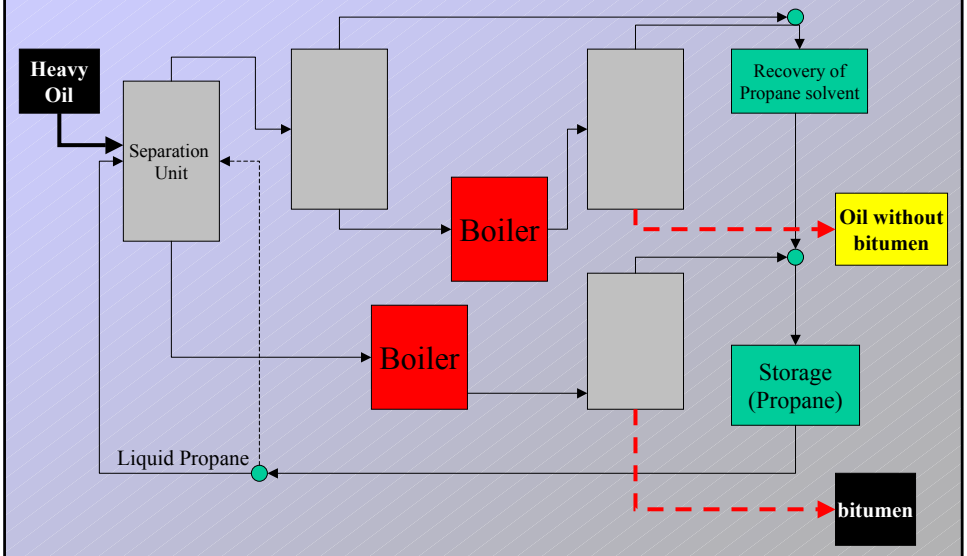
- 60.000 t/y gas
- 100.000 t/y gasoline
- **1,840,000 t/y of Heavy Fuel but of commercial quality**

1,840,000 t/y of Heavy Fuel but of commercial quality → **First Refining Process of de-asphalting**

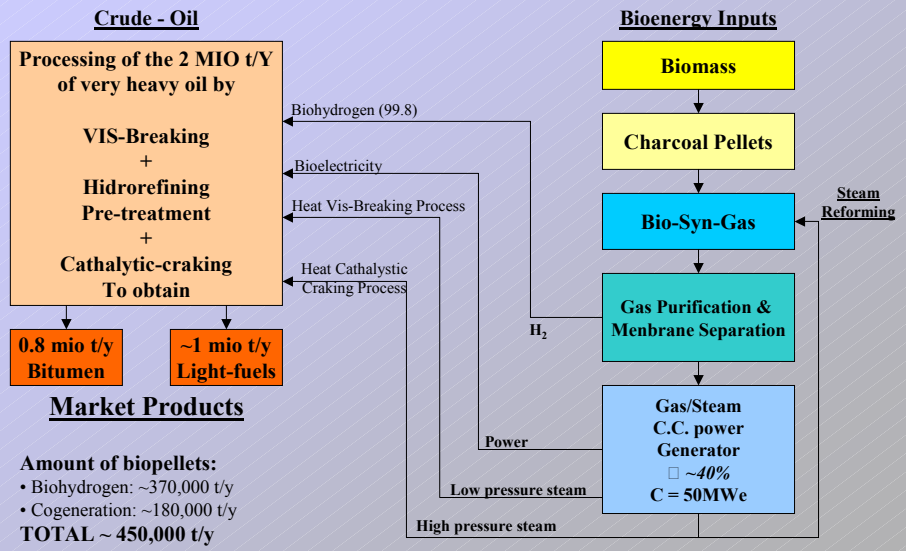
- Bitumen ~ 0.8 MIO t/y
- **First Refining Process of de-asphalting**
- Biomass Inputs → **Hydrorefining Pre - Pretreatment**
- **Deep – Refining (decarbonication & Hydrogenation)**
- **Market Products** → ~ 1 MIO t/y of Light Fuel

Proposed Process for the small Maoming Refinery (2)

Scheme



Concept of Integration of Bioenergy in the small new Maoning Oil-Refining



Economics
(Preliminary extimation)

Investments

Biohydrogen 20,000 t/y x 3300$/t	= 66 MIO $
C.C. Generator 50,000 kW x 700$/kW	= 35 MIO $
Refining 260 $ x 3300$/tail y	= 520 MIO $

Total = 621 mio $

Income

Light fuels	~ 270 MIO $/y
Bitumen	~ 40 MIO $/y
Bioelectricity (30MWe surplus)	~ 12 MIO $/y

Total ~322 mio $/y

Annual Expenses

Very heavy fuel	~ 100 MIO $/y
Biopellets	~ 45 MIO $/y
Financial	~ 50 MIO $/y
OUM (3%)	~ 20 MIO $/y

Total ~215 mio $/y

Balance (322-215) = 107 mio $Y
R.O.I.(107/621): ~18%