

Research and development activities on bioenergy at ENEA's Research Center in Southern Italy

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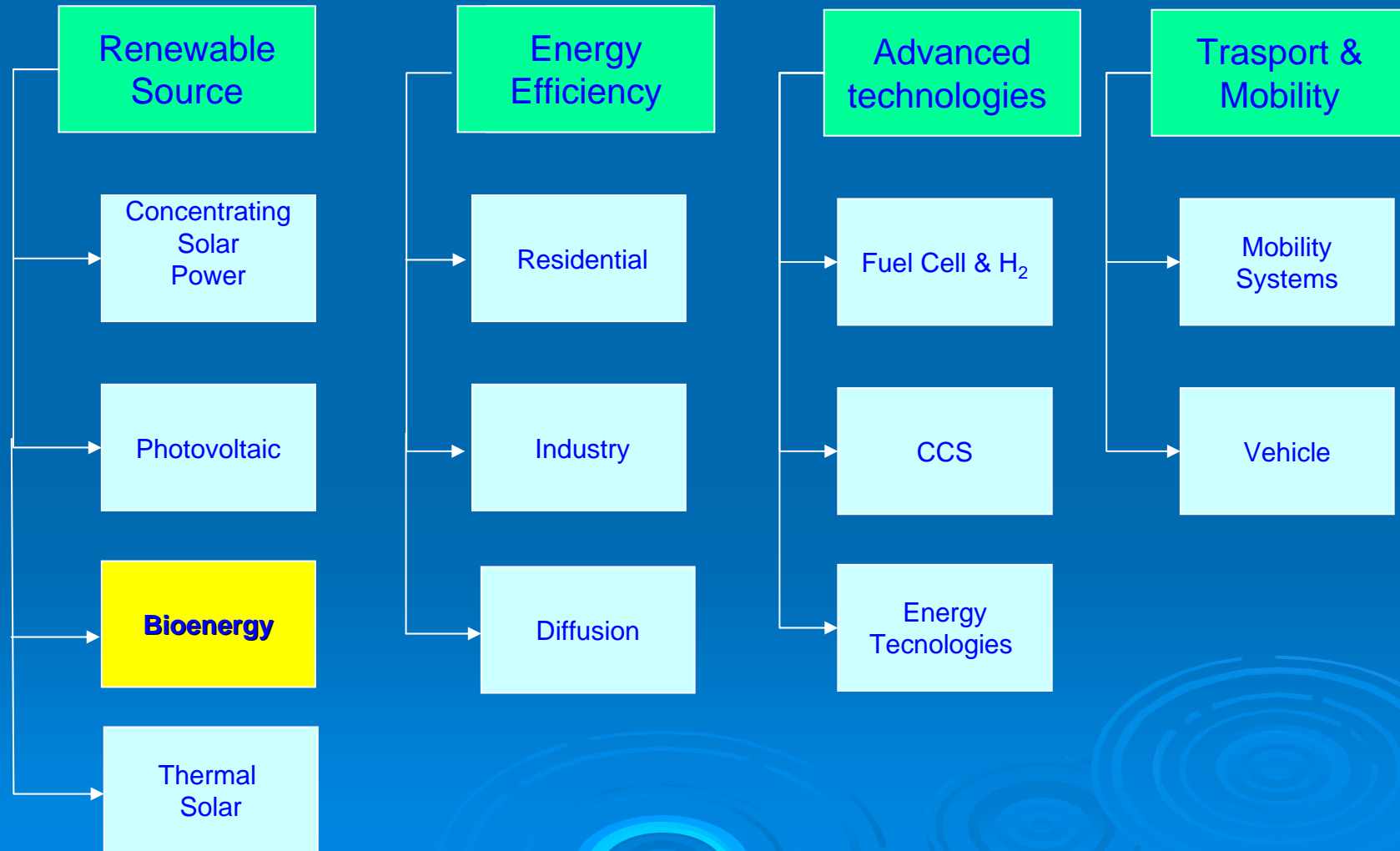
ENEA's role in Italy

- ENEA has a specific mission in applied research activities, technology transfer and dissemination of innovation in the field of renewables
- The Research Centre "La Trisaia" (in the south of Italy) can boast complete platforms for the thermal treatment of wastes and biomass, comprising a number of bench scale, pilot scale and demonstrative scale plants.

ENEA'S RESEARCH CENTERS



ENEA's ENERGY DEPARTMENT



ENEA's activities on BIOENERGY

Bioethanol

Biodiesel

Production of gaseous fuels by means of *GASIFICATION*

- Biomass conversion in liquid fuel (ethanol) by **STEAM-EXPLOSION** pre-treatment, enzymatic hydrolysis and fermentation
- Fractionation of steam treated biomass in cellulose, hemicellulose and lignin to obtain products of industrial interest

Development of innovative plant technologies and implementation of effective process configurations:

- *Fixed bed reactor*
- *Steam gasification in fluidised bed reactor*
- *Gasification with oxygen to obtain hydrogen rich gas*

risaia
Projects

FISR
(fluidized bed)
500 kW+

Hydrosyn
(fluidized bed)
1000 kWth

Tecnoparco
(fixed bed, updraft)
150 kWth

Penguin
Fixed bed
up draft
1000 kWth

Fixed Bed (downdraft)
SOCOGES;
ICQ
80 kW+

Gas Cleaning Systems

Ceramic Filters

Scrubber

Biodiesel & coalescet filters

Scrubber

Electrostatic Precipitator

Scrubber + filters

End Use

Fuel Cell

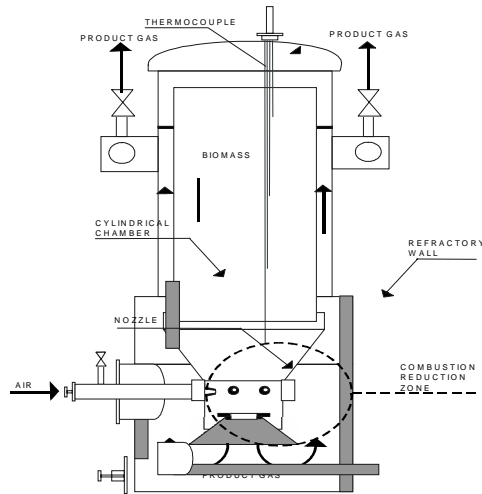
Gas Turbine

Methanol

Hydrogen

IC Engine

The downdraft fixed bed gasifiers



Power Production - Small Scale Plant

- Gasifier: DownDraft Fixed Bed
- Biomass: Lignocellulosic Residues (oak, olive, almond shells, etc)
- Gasification Agent: air
- Coupled to an Internal Combustion Engine
- Electrical Power: 30 kWe
- LHV: 1100-1200 kcal/Nmc

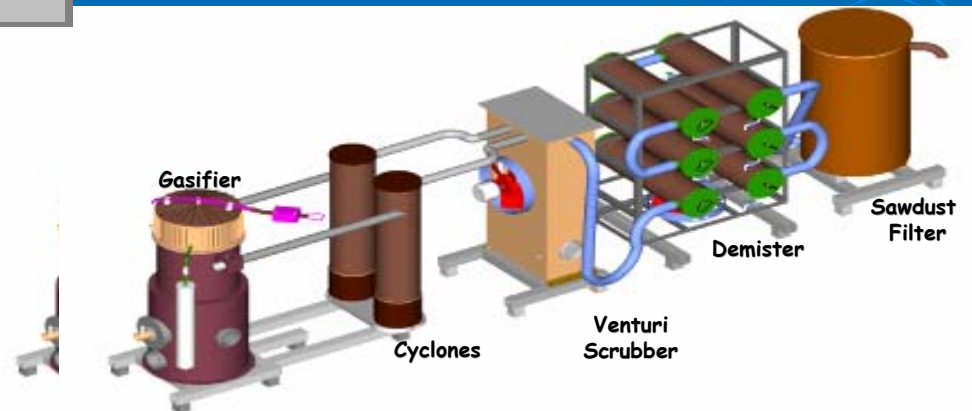
Downstream Gas Cleaning via Physical Methods:
Cyclones & Scrubber.

Operating Conditions

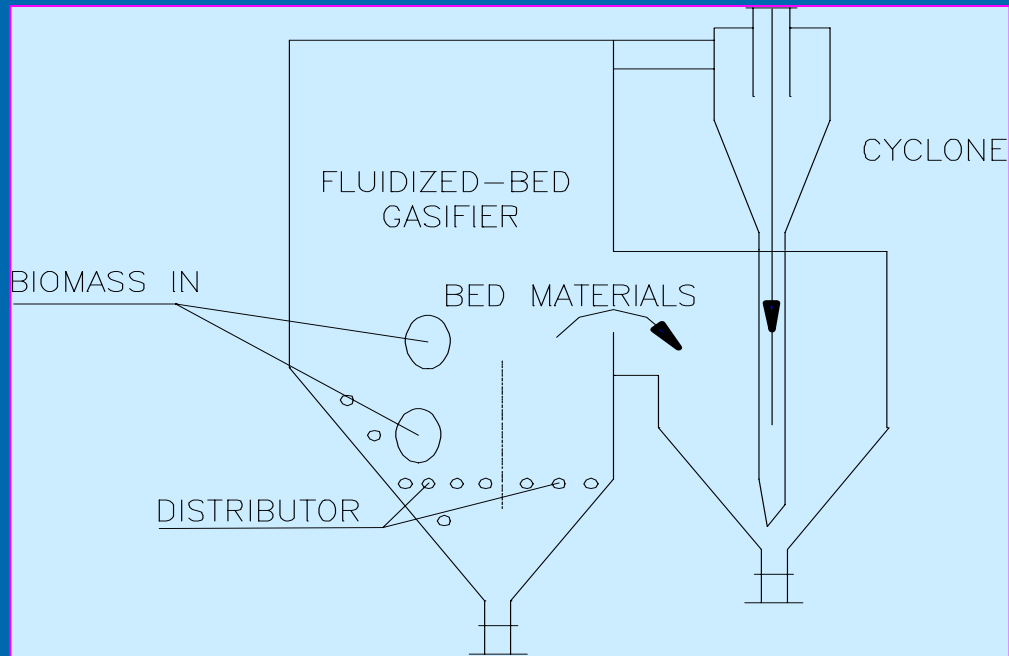
- Feeding: 50-100 kg
- Moisture: 10-20%
- Air Flow: 11-13 Nm³/h

Product Gas Composition

- H₂ : 10÷16%
- O₂ : 1÷ 2%
- N₂ : 40÷54%
- CH₄ : 1÷3%
- CO : 15÷25%
- Other (CO₂, H₂O): 15÷20%



The 1MW_{th} Bubbling Fluidised Bed Reactor: the 'China' Project



Gasifier developed in collaboration with University of L'Aquila.



Trisaia

Characteristics

- Feedstock: wood chips, Rice husks;
- Moisture: 10-20 %
- Feeding: 280 Kg/h
- Gasification medium: Air
- Flow rate: 500 Nm³/h
- Operating Pressure: 1.0 bar
- End Use: IC Engine
- Electric Power: 160 kWe.

Producer Gas

- | | |
|-----------------------------------------------|-------------------------------|
| ➤ CO: 15-19 % vol | H ₂ : 5-10 % vol |
| ➤ CO ₂ : 16-18 % vol | CH ₄ : 1.5-7 % vol |
| ➤ C ₂ H ₆ : 0-0.5 % vol | |

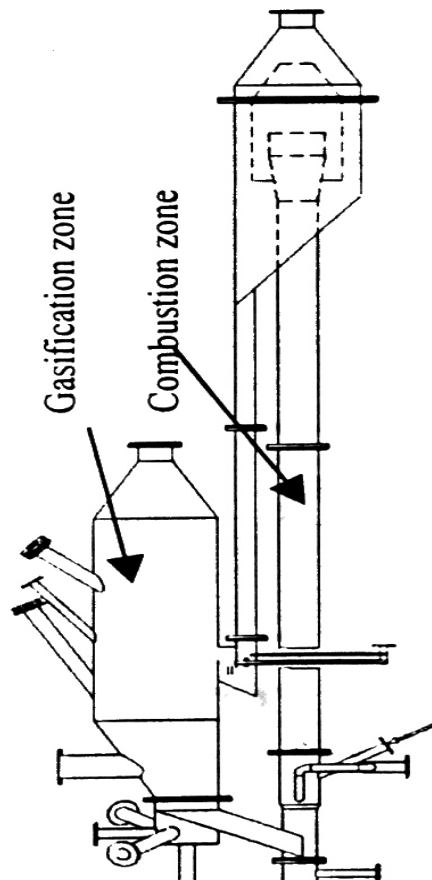
From 'China' Project to 'Hydrosyn'

Objective: Development of a low environmental impact Technology for gaseous fuel production, H₂-Rich Gas, and combustion for low environmental energy production.

Main Changes Design: Air → O₂/Steam; Compact Design.

Final Goal: H₂ → 30-40 %

The Circulating Fluidised Bed Reactor (the 'Joule' Project)



H2 Production

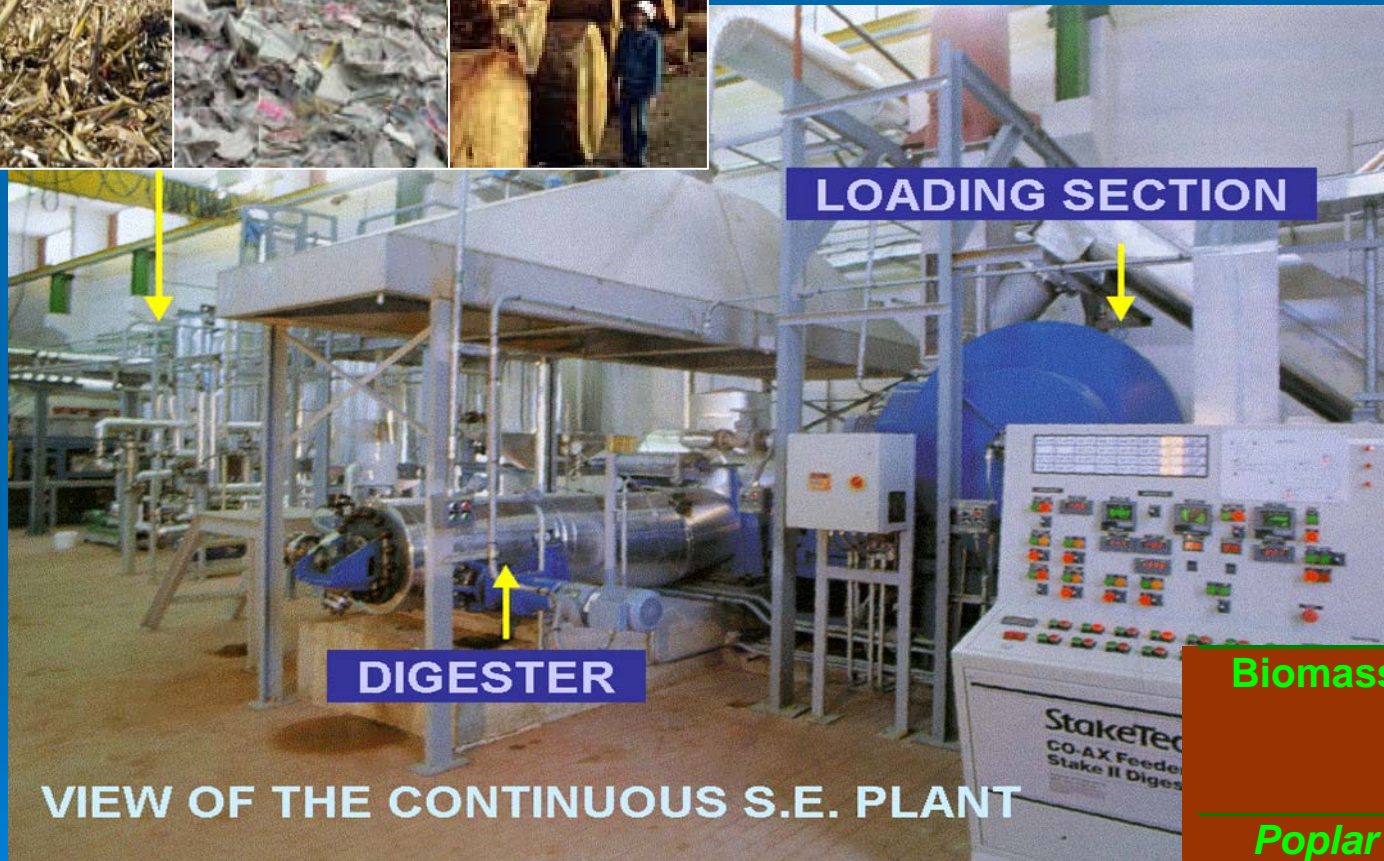
- Gasifier: Fast Internally Circulating Fluidised Bed (FICFB)
- Biomass: Lignocellulosic Residues (Almod Shell, Staw, Wood Chips)
- Moisture: 10 – 20 %
- Feeding: 120 Kg/h
- Gasification Agent: Steam
- Thermal Power: 550 kWth
- LHV= 10 – 12 MJ/Nm³
- Max Gas Flow: 350 Nm³/h
- Coupling to a Molten Carbonate Fuel Cell (125 Kwe).

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Tech

	Gasifier Exit
T [°C]	830
P [bar]	< 1
Gas	% vol
H2	38.2
CO	21.9
CO2	25.7
CH4	9.6

Second-generation bioethanol process development



VIEW OF THE CONTINUOUS S.E. PLANT

Biomass	Ethanol (L/ton)	Ethanol cost (Euro/L)
<i>Poplar</i>	346	0.39
<i>Straw</i>	273	0.429
<i>Magazines</i>	398	0.259