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The Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) is a public body of the Ministry of Economic Development. The agency's main research issues are:

- Energy efficiency;
- Renewable energy sources;
- Nuclear energy;
- Climate and the environment;
- Health and safety;
- New technologies;
- Electric system research.

ENEA scientific research and technological development activities are carried out at nine research centres and five laboratories, and offers a wide range of expertise (the agency has 2,600 employees).

The **Technical Unit of the Trisaia Research Centre** carries out industrial research and experimental developments in bioenergy. It also supports the industrial system and public administration in the use of these renewable energy sources. The Technical Unit performs:

- Sustainable production of biomass.
- Establishment and maintenance of databases related to the availability of biomass in Italy.
- Development and demonstration of processes for the conversion of biomass into liquid biofuels and bioproducts.
- Development and demonstration of processes for biomass thermoconversion for heat and electricity, syngas and synthetic biofuels.
- Applied research for conversion of oils derived from unconventional sources into biodiesel.

BRISK activities

ENEA's involvement in the BRISK project includes research and networking activities. In particular, thermal conversion of hydrolytic lignin, a byproduct of second generation ethanol is covered. ENEA will test the gasification and combustion of lignin obtained from enzymatic hydrolysis and fermentation of herbaceous crops

Figure 1: Hydrogen from waste. In this plant 5 kg/h of plastics can be gasified through a bubbling bed fluidized with mixtures of oxygen, water steam and air. The gas produced is then cleaned and catalytically upgraded into a hydrogen rich stream.
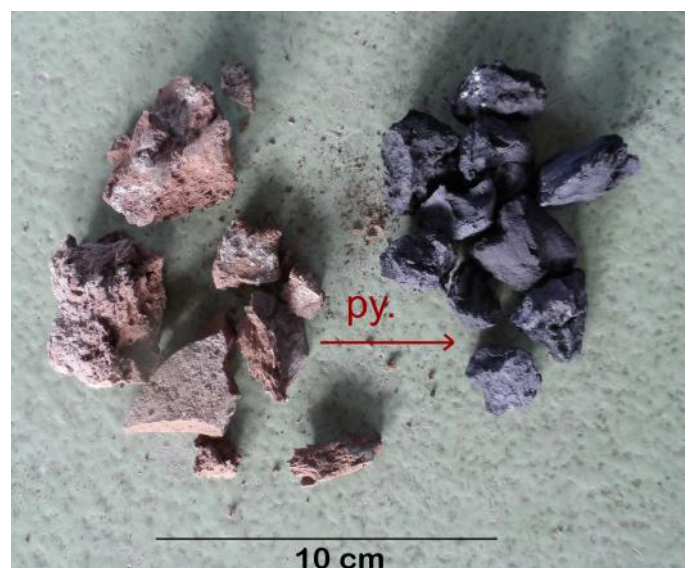

Figure 2: Pieces of lignin obtained as a residue of the bioconversion of straw (hydrolytic lignin), and then pyrolyzed in a fixed bed.

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Figure 3: ENEA's Trisaia Research Centre – biomass gasification plants. Scales from 10-1000 kW$_{th}$ are available; fixed bed (down and updraft) and fluidized bed (bubbling and recirculating) technologies are tested.

at its facilities, some of which are available for BRISK Transnational Access, as follows:

Circulating Fluidized Bed Gasifier, (JOULE)
The biomass gasification pilot plant, consists of a dual fluidized bed technology with a thermal power of 500 kWth. This technology enables a synthesis gas to be obtained with a limited content of nitrogen and a high content of hydrogen (up to 40%). The lower heating value (LHV) of the gas is around 12-14 MJ/Nm³.

The gasification system consists of two reactors, one for steam gasification and the other for combustion, respectively fluidized with super-heated steam and pre-heated air. The gasification plant is equipped with a section for hot cleaning of the gas produced, consisting of a unit for the removal of acid compounds, mainly H_2S and HCl, and two consecutive units designed to capture the particulate.

Updraft Fixed Bed Gasifier, (PRAGA)
PRAGA is a fully equipped gasification plant based on a 200 kWth updraft gasifier which was installed in June 2010 to test the co-gasification of biomass and sorted municipal solid waste (MSW). The nominal input of the gasifier is 30-40 kg/h of feed with a maximum plastic content of 15%.

The plant is operated slightly above atmospheric conditions and uses a mixture of air and steam as

Figure 4: ENEA's facility for fixed bed gasification and gas cleaning (ground and first floor), and syngas upgrading (second floor).

a gasification medium. The gas cleaning section is composed of a biodiesel scrubber and a series of coalescer filters. Most of the organic and inorganic compounds (tars, HCl, etc.) are removed from the gas by organic scrubbing and the coalescer filters capture the oil drops. After cleaning, the syngas is conveyed to the hydrogen enrichment section.

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Figure 5: The section for hydrogen enrichment: water gas shift reactor (WGS) - pictured to the left. CO_2 adsorption system based on MEA - pictured right.
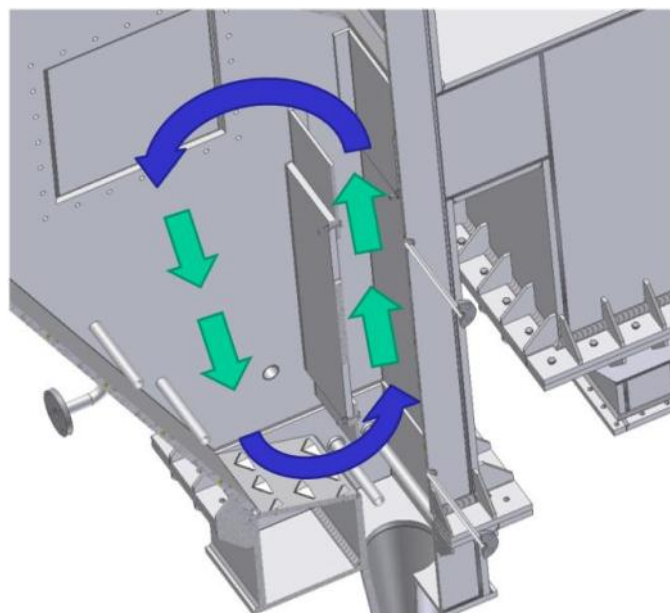

Figure 6: The internal recirculation of the fluid bed allows the achievement of a higher conversion of char and low tar content in the gas produced - by improving the contact between the sand of the bed and the biomass particles.

Hydrogen enrichment modules (HENRI)

HENRI is the hydrogen enrichment section connected to the 200 kWth gasification plant to sample 20 Nm^3/h of the gas from the clean-up line. At the exit from the two coalescer filters, the syngas is conveyed to the shift conversion reactor and CO_2 removal to generate a hydrogen rich syngas. The gas is mixed with superheated steam and heated to 300°C by an electric heater. This mixture is sent to the water gas shift reactor (WGS) where the hydrogen content is enriched by a catalytic reaction with Pt–CexOy. CO_2 is separated by absorption with MEA.

Internal circulating fluid bed gasifier, (HYDROSYN)

The plant has a thermal input of 10 kWth and is based on an internal circulating fluidized bed gasifier which is injected with steam and oxygen. The syngas is conveyed to a cleaning section composed of two cyclones, a ceramic filter, scrubber and a heat exchanger.

Different types of biomass can be fed to the gasifier and different parameters can be investigated. The bed can be loaded with sorbents, reactants, catalyst for *in situ* neutralization and upgrading.

AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE

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