



ELECTRIC ENERGY PRODUCTION, VAPOUR, HOT GASES AND HIGH TEMPERATURE HEAT PLANTS BASED ON BIOMASS GASIFICATION

- ✓ *Reduction of 35% to 65% of the energy bill*
- ✓ *100% CO₂ free emissions*
- ✓ *Totally automated plants*
- ✓ *High flexibility of operation*
- ✓ *Use of any type of biomass with the possibility of combining a wide range of solid fuels and industrial by-products of an organic nature*

Sectors:

- | | |
|---------------------------------|--------------------------------|
| ✓ Chemistry sector | ✓ Pharmaceutical sector |
| ✓ Paper sector | ✓ Textile sector |
| ✓ Agro-industrial sector | ✓ Ceramic industry |
| ✓ Energy sector | ✓ Meat Flours |

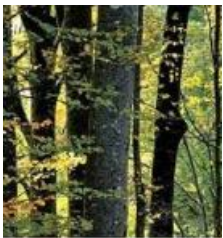
GASIFICATION FOR ELECTRICAL AND / OR THERMAL USES

KERN S & D is an engineering and consulting firm specializing in the design, construction, management and operation of renewable energy projects, with special attention to the Electrical and Thermal Generation facilities from Biomass.

We are endorsed by the experience in this sector, the professionalism and the quality with which we execute each of our projects.

The most important asset of **KERN S & D** is its human team, formed mostly by Industrial Engineers who have accumulated extensive experience in the Industrial Sector and in the Renewable Energy Sector, which guarantee success in each of the phases of the process.

KERN S & D puts at your service the integral management of the project in the form of "turnkey": initial feasibility study of the project, management of the processing, permits and licenses, basic and detailed engineering, construction of the facility, operation and maintenance.



¿What is Biomass?

It is all organic matter susceptible of energetic use.

More broadly, we can say that it is an energetic vector that, in the short term, can be basic in our society, both from the energetic and environmental point of view, and for the socioeconomic development of rural areas.

We find products or waste from agricultural, livestock, forestry or industrial activities. Even by-products from the related industries, both agri-food and logging (orujillo, sawdust, shavings, barks ...).



Energy use of biomass

Biomass is a source of renewable energy and is used with energy, either electricity generation, heat production or the production of fuels (biofuels).

Biomass technologies can be classified into three groups: combustion, pyrolysis or gasification.

Advantages of using biomass

Environment:

- Neutral environmental balance
- Forestry operation
- Fire and erosion prevention

Economic partner:

- Generation of employment (direct and indirect) in the area
- Reduced external dependence on fossil fuel supply
- New business opportunities in the area
- Use of a natural resource in the area



Forest Biomass

- *Forest masses. Biomass generated by forest systems through sustainable forest management.*
- *Residues and by-products that the wood industry generates as a result of its own activity.*

Energy crops for biomass

They are implanted and exploited crops with the sole objective of producing transformable biomass in fuel for thermal or electric generation.

Energy crops should collaborate in an important way to the agricultural diversification, providing possibilities and creating complementary markets, without supposing a great change of the customs of the farmer.

- *It is a fuel with exclusive energy destination, without competition with other markets.*
- *Greater productivity per surface than forest biomass, requiring the contracting of a smaller area to obtain the required biomass.*
- *Responsiveness of farmers to establish long-term contracts, as it entails additional income.*
- *Suppose a new source of biomass supply, in addition to forest biomass.*

The most commonly used are: pine, poplars, eucalyptus, willows, acacias, conifers...

Gasification supports all types of biomass from very different origins:

- *Forest sliver (pine, eucalyptus, oak, oak, beech ...)*
- *By-products of sawmill (coastal, shale, sawdust ...)*
- *Recovered wood*
- *Agricultural by-products (pruning, peeling ...)*
- *Bark and branches*
- *And in general, any type of solid organic-based fuel.*

...



Other Gasifiable Biomass

- *Sewage sludge*
- *Olive pomace*
- *Recovery wood*
- *Meat industry waste (flour ...)*
- *Any organic based solids*



BIOMASS GASIFICATION

ELECTRICAL ENERGY PRODUCTION

Gasification consists of a high temperature thermochemical process in which the solid fuel in the presence of a limited amount of oxidizing agent is converted into a gaseous fuel. This gaseous fuel, called Syngas, can be used in a wide variety of applications, such as internal combustion engines, direct gas in furnaces and dryers, or thermal applications such as steam or thermal oil generation, taking advantage of advances in gas technologies.

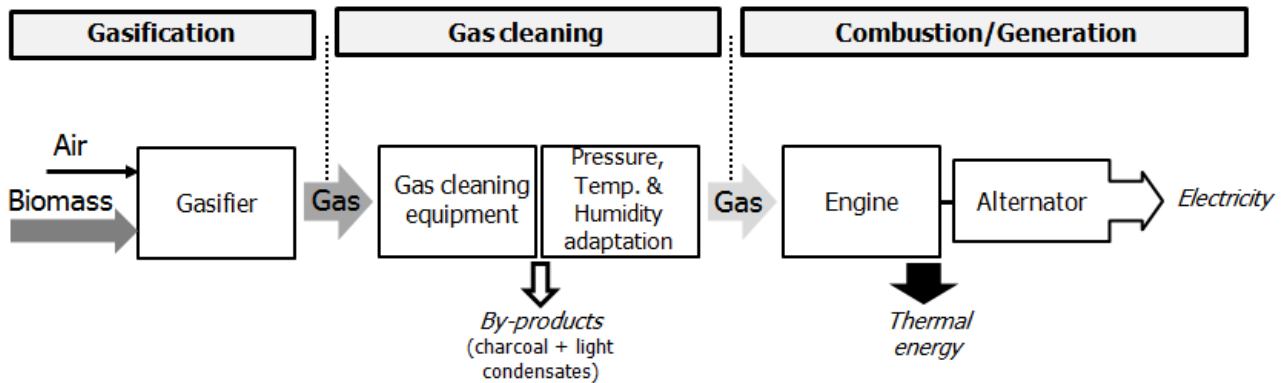


Diagram of the biomass gasification process

One of the fundamental advantages of Gasification is that the **energy performance** of an installation does not vary much with its size, so from small powers this technology is an efficient alternative. Thus, **in gasification plants of small installed capacity, the electrical performance is higher than 27%**. Meanwhile, in installations based on a turbine boiler system, both the electrical performance and the investment ratio, are greatly affected by the size of the facility.

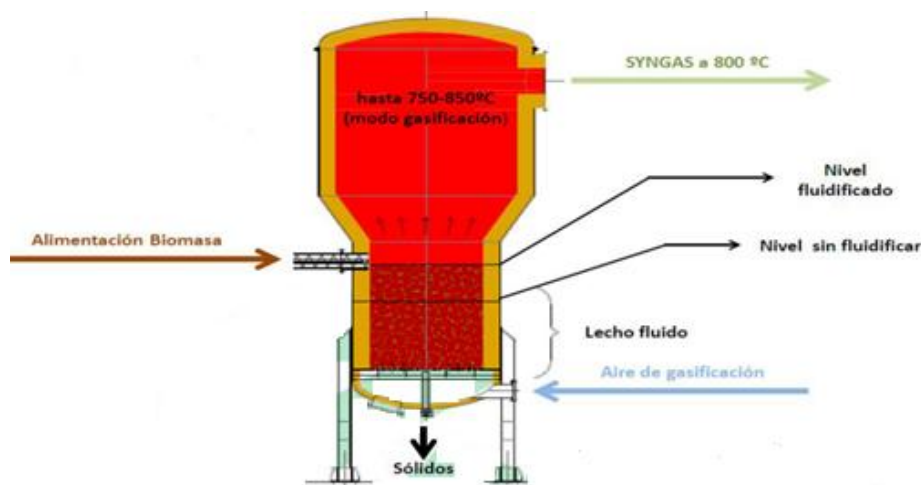


Diagram of operation inside the gasifier

The result of these gasification processes is the transformation of the biomass into a fuel gas of low calorific value, called Syngas.

The calorific value is around 1,500 kcal / Nm³ (between 12% and 16% of the Natural Gas PIP).

The approximate composition (% in dry volume) is:

Compound	Vol %
Hydrogen (H ₂)	10-14
Monoxide (CO)	13-17
Methane (CH ₄)	3-6
Propane (C ₃ H ₈)	<0,5
Ethane (C ₂ H ₆)	<0,5
Ethylene (C ₂ H ₄)	1-2
Carbon dioxide (CO ₂)	15-17
Nitrogen (N ₂)	45-50

The gas generated, Syngas, allows to be used in different applications:

Electricity generation

- Internal combustion engine
- Turbine

Thermal Applications

- Drying
- Steam
- Hot water
- Thermal oil
- Ovens

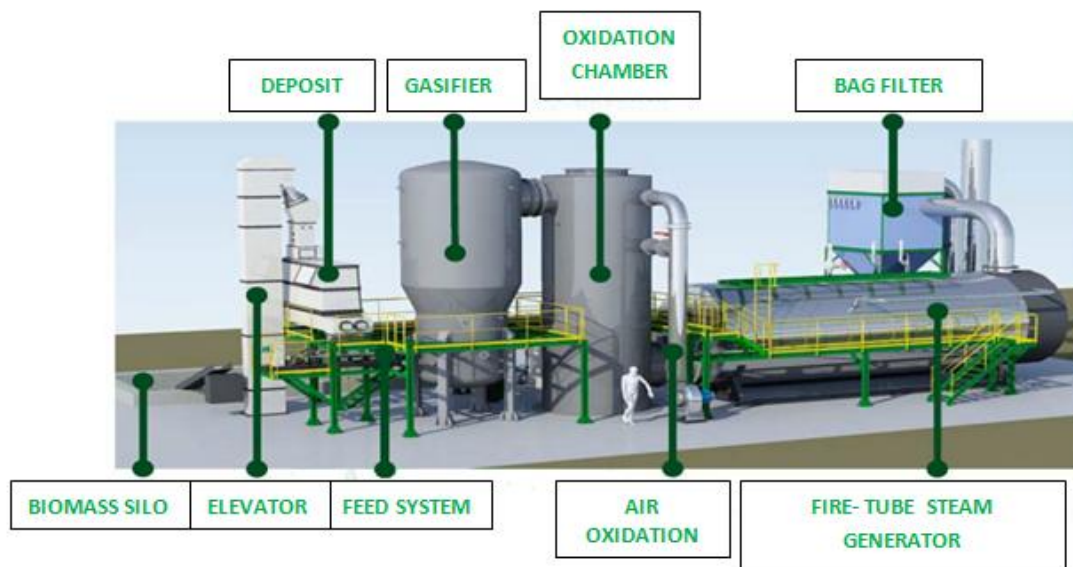


GENERATION OF STEAM

The Steam plus System is a complete steam generation solution from biomass with numerous advantages compared to conventional biomass boiler solutions.



Diagram of the biomass gasification process



ADVANTAGES:

- It allows the generation of steam or thermal fluids at elevated temperature from 400 ° C to 550 ° C and in a stable way.
- It is compatible with the use of existing equipment (oxidation chambers, recovery boilers ...).
- Generates minimum pollutant emissions.
- Homogeneity in the Syngas generation.
- Versatility in the use of different biomasses and in different conditions (humidity, granulometry).
- Easy process operation (temperature control and inlet air regulation in the reactor).
- Compact and modular system.
- Modulation continues from 30% to 100% of the power of the gasifier.
- Minimum generation of slag biobiocharts", as a consequence of high working temperatures, always below the melting temperature of the ashes.
- Minimum generation of "Tars" light tar, as a consequence of high working temperatures.



CHARACTERISTICS INDUSTRIAL PLANT

Rated Electrical Power of the Plant: 2MWe

Rated thermal power of the plant: 7,25 MWt

Availability of the plant: 7,500 hours / year

Biomass consumption: 13,500 tonnes / year

Production of briquettes: 8,500 tons / year



KERN S & D has **Bubbling Fluid Bed Gasification technology** and experience in the design and construction of production of thermal and electrical energy from biomass.

The production in the industrial plant is totally automated optimizing the space and the energy consumed, obtaining important reductions of costs and impacts with the environment.

CLEAN ENERGY: ZERO CO2 EMISSIONS

- Plants use the sun to grow.
- Organic matter in plants stores solar energy in the form of carbon, through photosynthesis.
- The CO₂ that is emitted in its combustion or energy use, closes the carbon cycle, with a neutral balance, since all the emitted CO₂, came initially from the air and is returned to the air.



THERMAL USE

The heat generated in the gasification process and in the combustion engines is used to dry the biomass that feeds the gasification plant and the briquette production plant.



Installation of briquette production



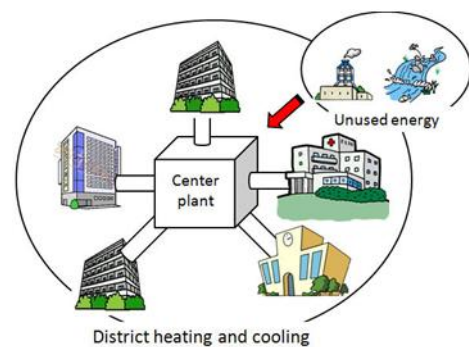
Briquettes



Drying of biomass chips

Possibility of using the **thermal energy generated** for many applications, such as:

- Biomass drying for the production of pellets, briquettes, chips, ...
- District heating (urban network of heat and cold).
- Industrial processes.
- Steam generation.
- Drying processes.
- ...



STEAM PLUS SYSTEM

PROFITABILITY AND COMPETITIVENESS

The following is a typical case of a system powered by Natural Gas compared to the Steam Plus system fed with forest biomass.

Production of gas at the place of consumption, in a clean way and from renewable energy sources.

CLASSICAL METHOD

Power	10 Ton/hour
Hours year	7.500 hour/year
Average steam production	6.000 kg/hour
Gas	Gas Natural
Thermal demand	33,5 GWth
Natural Gas Price	0,036 €/kwh
Annual accounts with natural gas	1.206.000 €

STEAM PLUS METHOD

Power	10 Ton/hour
Hours per year	7.500 hours/year
Average steam production	6.000 kg/hour
Gas	Wood
Forest biomass price	50 €/Tn
Forest biomass PCI	3.200 kcal/kg
Humidity forest biomass	< 25%
Annual biomass consumption	10.000 Tn/year
Annual biomass cost	500.000 €



TYPE OF PLANTS

- *Biomass plants for electricity generation: with ranges from 1 MWe to 5 MWe.*
- *Biomass plants will pay thermal generation: with ranges of 2.7 MWth to 18 MWth.*

** For smaller powers, each particular case will be studied.*

BENEFITS

- *Generation of direct and indirect employment in the area*
- *Benefits in rural areas*
- *Reduction of 35% to 65% of the energy bill*
- *Possibility of using any type of biomass*
- *100% CO2-free*



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