

## Innovative gasification plant for renewable energy micro-generation and biochar production

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### Introduction

Gasification is a thermo chemical conversion process in which a biomass or other different organic matrices are partially oxidized by heating at high temperatures (1.200°C) in a gas (syngas) and biochar [1].

The syngas, a mix of carbon monoxide and dioxide, hydrogen, methane and nitrogen, is used to power a diesel-cycle endothermic engine in order to produce electricity and heat or, alternatively, as fuel for multiple uses.

Gasification creates a fine-grained, highly porous charcoal that may significantly vary in its chemical and physical properties depending on the process typology and starting material.

### Results and Discussions

The AGT researchers have developed a fixed-bed, down-draft, open core, innovative gasifier, which allows to obtain – through low-oxygen combustion – syngas and biochar from organic matrices of different origin.

The presence in the syngas of not combustible particles, as CO<sub>2</sub> and N<sub>2</sub>, gives the mixture a low heating value:  $\approx 5 \text{ MJ/Nm}^3$ .

The gasifier, which has 300 kW nominal electric capability (micro-generation), mainly uses biomass deriving from agricultural feedstock and its by-products.

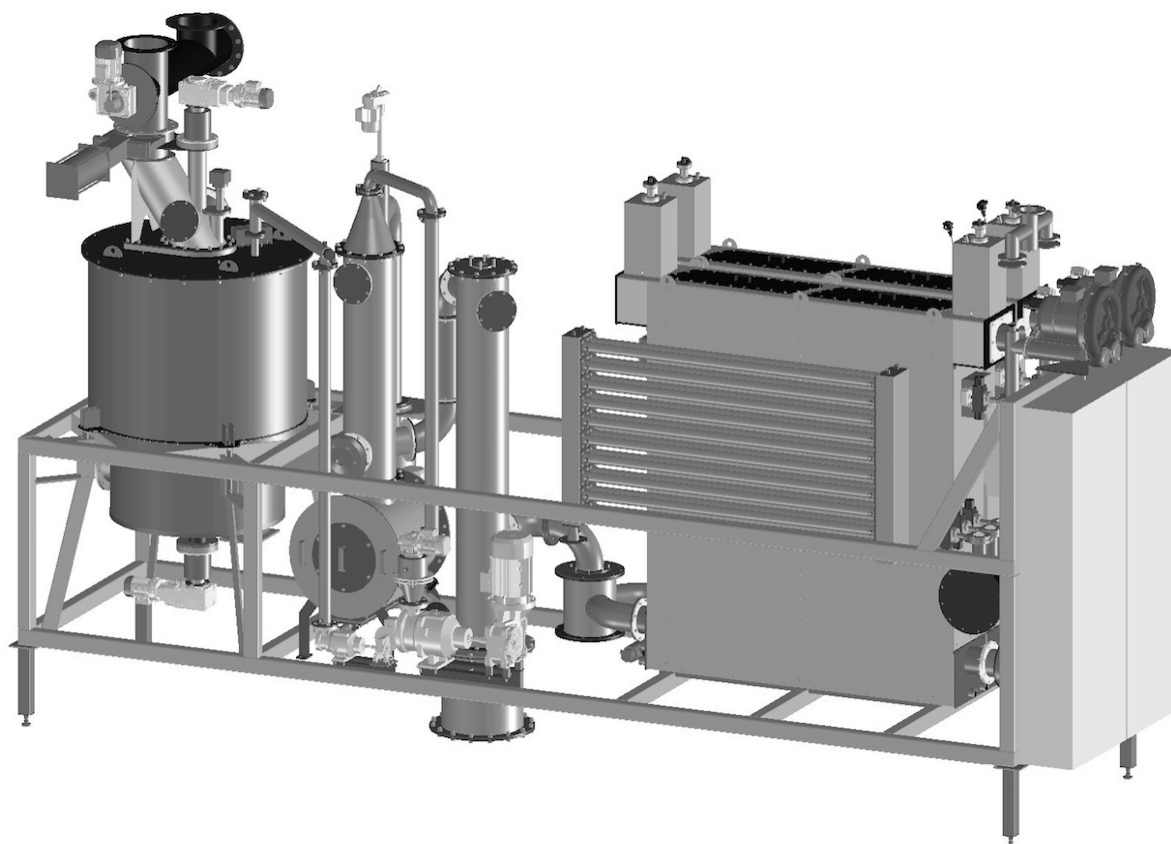


Figure 1. AGT gasifier drawing

The plant is presented in a groundbreaking and efficient way, unique both for the extreme compactness of the gasifier (little more than 10 m<sup>2</sup>), the gas cleaning system (by electrostatic filters), the flexibility in the employment of different biomasses and the easiness of management.

Considering woody biomasses, the electric performance is 1 kWh<sub>e</sub> kg<sup>-1</sup> dry matter.

**Table 1.** Gasification plant main technical parameters\*

Parameters	Values
Biomass typology	Wood
Biomass requirement	300 kg <sub>(d.m.)</sub> h <sup>-1</sup>
Electric rated power	300 kW
Thermal rated power	1.000 kW
Syngas flow	600 Nm <sup>3</sup> h <sup>-1</sup>
Syngas LHV	5 MJ Nm <sup>-3</sup>
Syngas starting temperature	700°C
Syngas final temperature	50°C
Biochar production	10% w/w <sub>(d.m.)</sub>

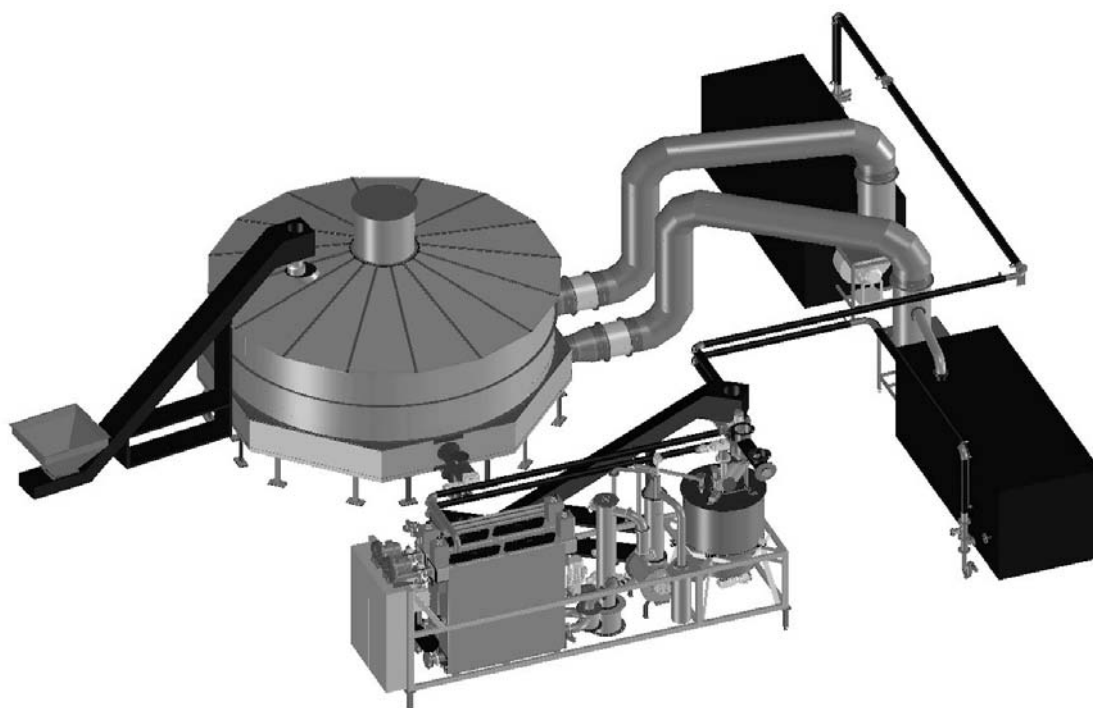
\*Considering woody biomasses

The plant in standard configuration is made up of a gasifier, a drying kiln/feeding hopper and two or three generators; additional accessories are added in order to reach the full automation of the system.

The plant does not generate emissions: TAR, obtained from syngas cleaning, is carried back to the gasifier reactor and quickly eliminated; engines exhaust gas is cleaned in a catalytic converter and then sent to the dryer for biomass conditioning, where it is further bio-filtered; no draining is generated.

The gasification process creates a fine-grained, highly porous pollutant-free charcoal that may significantly vary in its chemical and physical properties depending on starting material.

The system generally produces a quantity of biochar comprised between five and ten percent of starting material (d.m.), depending on biomass typology and characteristics.



**Figure 2.** AGT gasification plant lay-out (gasifier, drying kiln/feeding hopper, generators)

### Conclusions

The plant puts forward as a candidate in offering a profitable environmental solution: bioenergy may contribute to securing a supply of green energy, biochar can be an important tool to increase agricultural productivity and to stock carbon in the soil.

The plant, thanks to its applications (energy and biochar), can be also considered an opportunity of development for degraded and poor marginal lands in low-income countries.

<sup>1</sup> Dumbleton, F. 1997. *Biomass conversion technologies: an overview*, *Aspects of Applied Biology*, 49: Biomass and Energy Crops, 341-34.