

# Wood gasification: a comparative LCA of different supply scenarios alternatives

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**Keywords:** LCA, gasification, CHP, biomass, wood

## Introduction

The perspective of climate change, the increase of energy demand and the depletion of fossil sources of energy have driven a strong interest in the development of renewable energies such as the gasification of biomass.

Within the framework of the researches and the developments of Veolia Environnement (an environmental services specialized company) on new technologies for energy production, this technology has been chosen to answer some particular issues: combining heat and power (CHP) production, which saves primary energy compared to separated solutions, and optimizing the use of biomass. The researches on biomass are concentrated on two points: to diversify the supply and to make biomass being a competitive fuel, from an economic, technical and environmental perspective.

On the environmental point of view, the performances of wood gasification have been evaluated following the LCA rules in order to identify the key parameters influencing the environmental balance and bring some decision-supporting elements to develop this offer in energy. Three scenarios were compared for biomass supply.

The goal of the study is also to identify the advantages and drawbacks of cogeneration of electricity and heat from wood gasification as compared to a more classical gas cogeneration.

## Methodology

### Technical characteristics of the systems:

The three different supply scenarios which were evaluated are:

- wood from sawmill,
- from forest
- and from energy crops (poplar).

The CHP system has an annual production of 2 158 MWhe and 3 304 MWhth and a lifespan of 20 years. The energetic conversion of the biomass by the gasification system (gasifier, gas cleaning and motor) is the same in the three cases (Figure 1).

The natural gas CHP system is equivalent in power to the gasification system.

### LCA methodology and assumptions:

The data come from:

- a commercial gasification plant,
- Ecoinvent 2.0 LCA database
- and literature <sup>[1], [2]</sup>.

The impacts are evaluated with Impact 2002+ method <sup>[3]</sup> and SimaPro software.

The regional scale of the study is Western Europe.

The transport of biomass from its source to the gasification plant is considered to be 70 km.

The heat produced from the gasifier is partly self-consumed to dry the biomass before the energetic

conversion of wood.

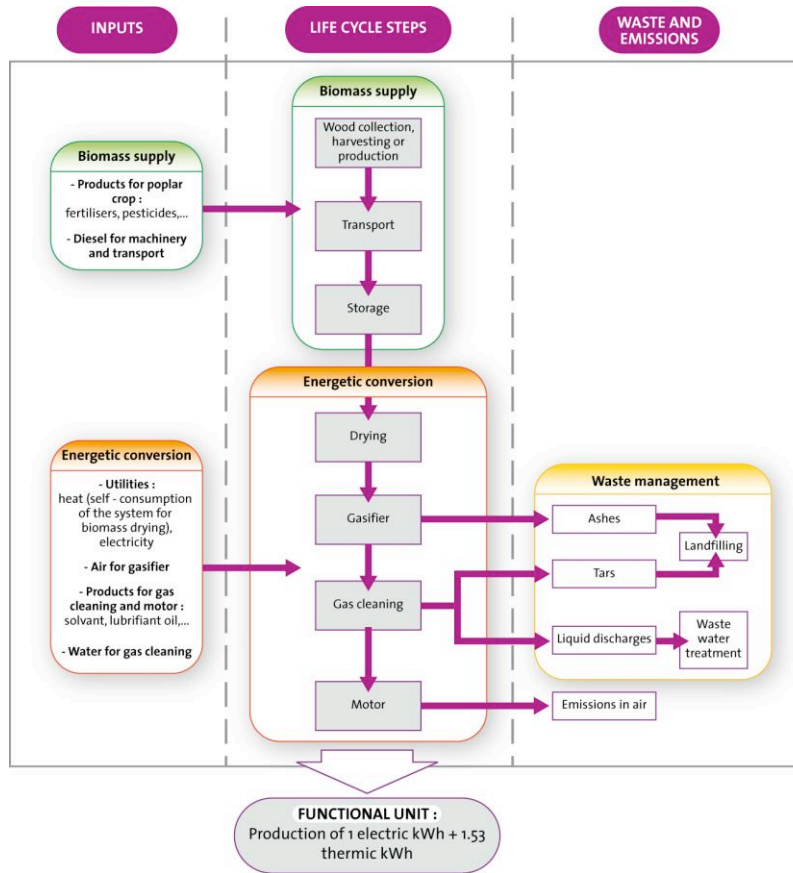


Figure 1: system boundaries for biomass gasification

### Results

The results of the LCA show that gasification of biomass has a better environmental balance than the natural gas-based cogeneration: it allows reducing greenhouse gases emissions and non-renewable energy consumption by up to 80% (Figure 2).

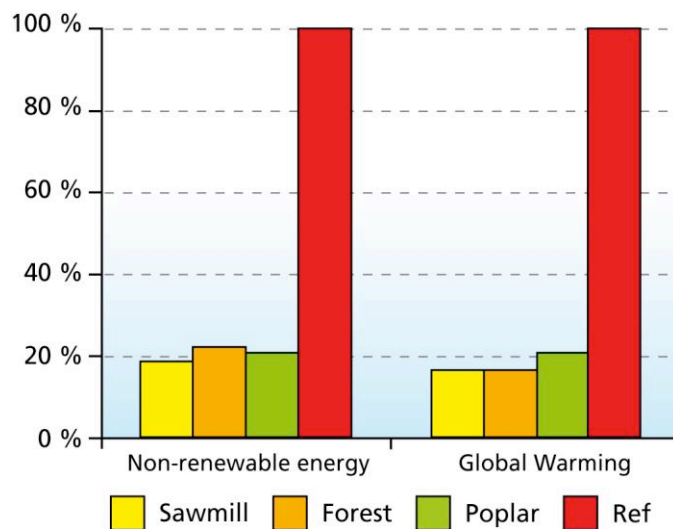
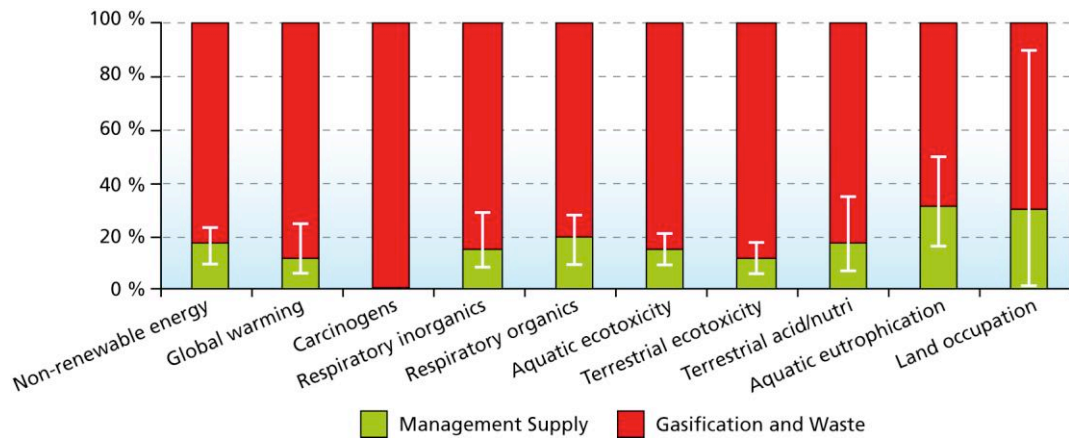


Figure 2: comparison between scenarios of gasification and natural gas cogeneration

During the whole life cycle of the gasification of biomass, the contribution to the environmental impacts of biomass supply is small (less than 17% on average) compared to the energetic conversion itself (Figure 3).



The gasifier is the less impacting step during the energetic conversion of biomass (Figure 4). The different contributions of the others steps are due to:

- the demand of energy (heat / electricity) for the drying phase of biomass;
- the solvent used for the gas cleaning (rape seed oil);
- the atmospheric emissions of the motor.

Figure 3: contribution of biomass supply on impacts

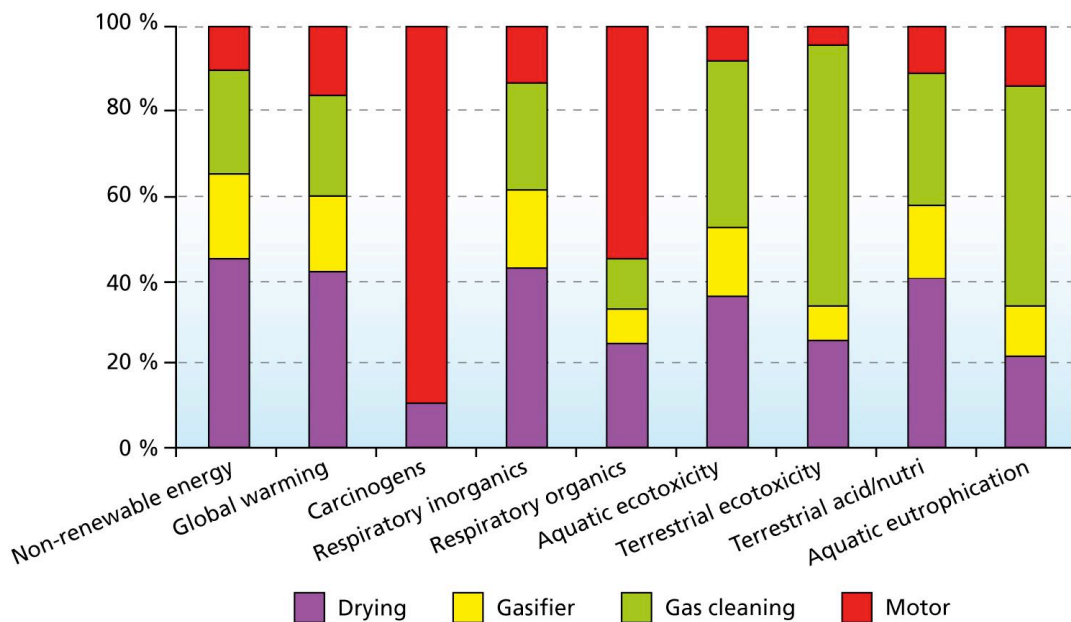


Figure 4: repartition of the contribution of the energetic conversion steps of biomass on the impacts

## Conclusions

Globally, the results show that choosing a supply of waste wood is environmentally better (with a priority for wood from sawmill, and wood from forest in a second time), than an energy crop. Furthermore, the question of the land use is less problematic in the cases of wood from sawmill or forest, but is sustainable only if the supply chain of biomass for production of energy doesn't enter in competition with the needs of these materials for the others economic sectors (like biomaterials).

LCA allows highlighting technical ways of improvement for the gasification process. Before the production of the syngas, the drying process of wood has a non negligible impact by consuming electricity and heat: in this way technical solutions to reduce the energetic needs of the dryer are therefore evaluated. Other improvement possibilities at stake are the reduction of emissions from the gas motor as well as the use of a more environmentally-friendly gas cleaning system (more efficient and consuming less solvent).

The study will help the industrial development of this technology, which can be sold in the future by Veolia, in the offers of services provided for sustainable cities and industries.

### **References**

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