MEVA ENERGY

A potential negative emissions technology – result from a life cycle assessment of a biomass gasification technology

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The paper aims to increase awareness about the environmental potential of biomass gasification technology, provided by Meva Energy, based on results from a life cycle assessment study of Meva Energy's technology.

Introduction

The manufacturing industry today accounts for large emissions of greenhouse gases and is heavily dependent on fossil energy resources. A change is needed to radically reduce the industry's climate impact and to reduce its dependence on fossil resources to reach the Fit for 55 packages, a set of EU policies aimed to reduce net greenhouse gas emissions by at least 55% by 2030. Consequently, EU has established binding targets, mandating a minimum of 42.5% renewable energy in the overall energy consumption by 2030. The Renewable Energy Directive is the legal framework for the development of clean energy across all sectors of the EU economy with an overall aim of increasing the share of renewables in EU.

Background

Meva Energy provides a gasification technology that can play an important role in the manufacturing industry's shift towards renewable energy production. This technology utilizes locally generated biogenic waste streams from the manufacturing industry, converting low-quality biomass into high-quality biosyngas. By adopting this approach, the industry can significantly reduce fossil greenhouse gas emissions.

With a vision of a fossil-free manufacturing industry, an awareness of our technology and our products' environmental performance are of utmost importance. The company has for long understood the role of the technology in mitigating climate change for the manufacturing industry. Initial climate emissions savings calculations have been carried out to understand the magnitude of the possibilities.

In 2024, together with two master students from Chalmers University of Technology, a life cycle assessment of Meva Energy's biomass gasification technology was conducted. The study contains a multifunctional process, with production of mainly biosyngas with biochar as a by-product.

The study has been a natural step for the company to go beyond the climate impact category and the greenhouse gas emissions calculations guidelines according to the Renewable Energy Directive (RED). In Sweden implemented and known as the Law on Sustainable criteria for biofuels, bioliquids and biomass fuels. Another reason is to look at the gasification technology as a multifunctional system, where biomass residues or waste is used to produce both biosyngas and biochar.

Biosyngas is utilized by the manufacturing industry for the renewable energy production for process heating, to replace fossil gas, or for production of power and heat, named as combined heat and power plant. Biochar, a porous material with a very large surface area and high carbon content, is today accepted by the EU Commission as a CDR technology and widely used for carbon sequestration when used e.g. as a soil amendment. Additionally, biochar can substitute fossil coal in various products and industrial processes, contributing to a reduction in fossil fuel dependency.

Bioenergy, the carbon cycle and biochar

A thermo-chemical gasification is a bioenergy production process where energy from biomass is converted into biosyngas. The potential of bioenergy is recognized for its carbon-neutral potential in relation to global warming. Since the carbon emissions from bioenergy are biogenic, these are part of the natural carbon cycle.

The natural carbon cycle starts with the removal of carbon from the atmosphere through photosynthesis and then released back to the atmosphere upon biomass decay. If instead energy is derived from biomass feedstock through gasification, a share of the feedstock is transformed into gases. When combusted, these products release biogenic carbon back into the atmosphere. During this thermo-chemical transformation a highly stable organic carbon fraction remains, called biochar.

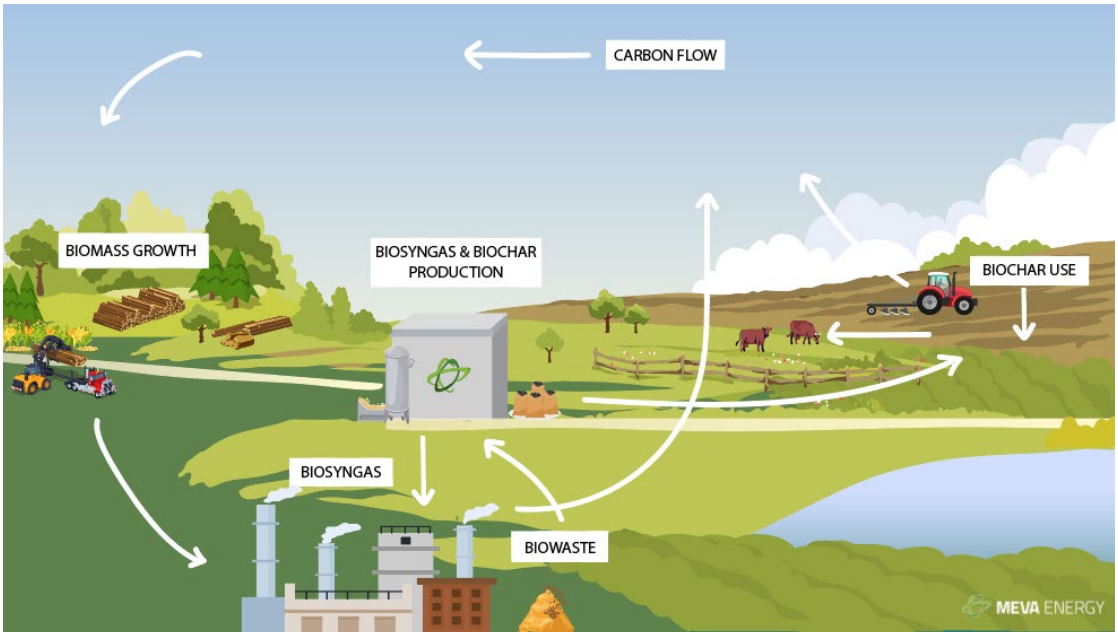

Figure 1. Illustration the carbon cycle of Meva Energy's products.

About the life cycle assessment study

Life cycle assessment, LCA, is a family of methods used to analyse, assess and understand a product's or a service's environmental performance throughout the entire life cycle. From raw material extraction, to production, use, to its end-of-life management. The result of an LCA is expressed in environmental impact categories of relevance for the study. The methods are scientifically based and globally accepted and used in various organisations to promote sustainability and to make informed decisions to reduce negative impact from products, services or activities.

This LCA study was conducted based on the ISO standards 14040/14044 from a cradle to grave perspective and gives an overview of the entire life cycle. The life cycle represents (i) the production of the plant components phase, (ii) the construction phase, (iii) the gasification phase, (iv) the use phase and (v) the end-of-life phase, see figure 2. A more detailed description of the system is described in the full LCA report.

The environmental performance is presented per functional unit, 1 kWh biosyngas. The study covers the most relevant impact categories that describe the potential impact of global warming, terrestrial acidification, freshwater eutrophication, land use and particulate matter. The LCA study was conducted using the Ecoinvent 3.10 cutoff database for background system data. Where data were available from suppliers, these has been reviewed and used. The inventory data for the foreground system were provided by Meva to represent Meva Energy's plant in Kisa, Sweden.

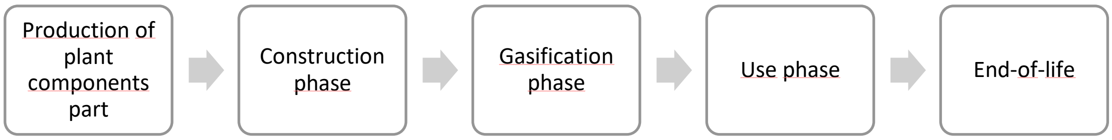

Figure 2. The gasification system divided into five sections.

Three allocation scenarios for the environmental burden were used in the study to understand how these methodological choices will affect the results. These considering mass allocation, energy allocation as well as one scenario where all environmental impact was allocated to the biosyngas production, and the carbon sequestration effect of the produced biochar was included.

Main results of the study

When the biochar sequestration effects are included, the gasification process gives rise to a negative emissions value, -6 g CO_2-eq/kWh. This means more carbon dioxide is removed from the atmosphere than is emitted. When only considering the impact allocated to the biosyngas, the process shows a climate impact of 22 to23 g CO2-eq/kWh, see table 1.

Table 1. The climate impact of the gasification plant for each allocation scenario.

	Mass allocation (1)	Energy allocation (2)	Carbon sequestration (3)
Climate change (g CO2eq/kWh)	23	22	-6

1) Climate impact allocated between biosyngas and biochar (by-product), based on mass. 2) Climate impact allocated between biosyngas and biochar (by-product), based on energy content. 3) All climate impact allocated to the biosyngas, including carbon.

The gasification phase and use phase are the primary contributors to all impact categories, while the production of plant components phase, construction phase and end-of-life phase were shown to have negligible impacts. For climate change, the biomass feedstock production (wood pellets) in the gasification phase gives rise to the largest impact, see figure 3. The impact assessment for all impact categories of the entire life cycle of the biosyngas is presented in the full LCA report.

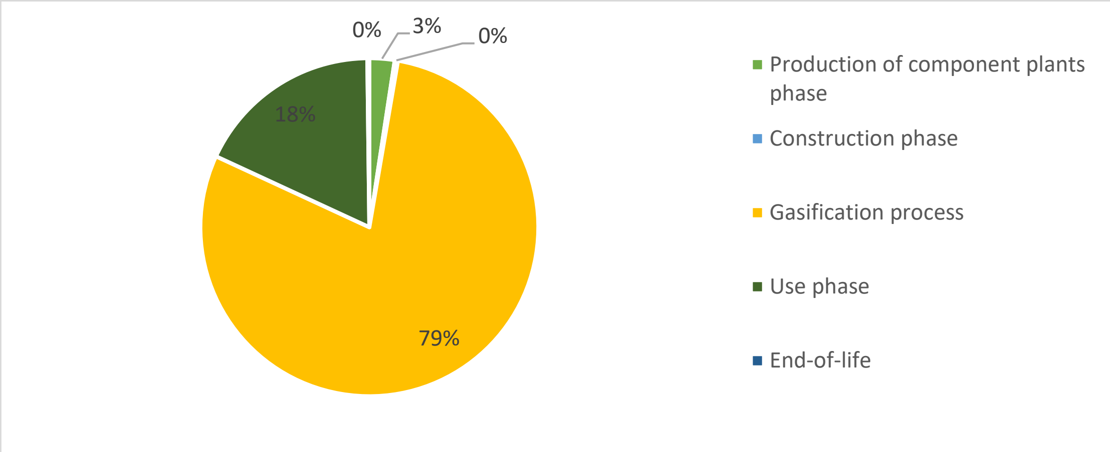

Figure 3. The diagram shows the climate impact for each life cycle phase.

Compared to the fossil alternative LPG (Liquid Petroleum Gas), Meva Energy's biomass gasification plant has a lower climate impact, see figure 4 where different sources of LPG have been used for the comparison.

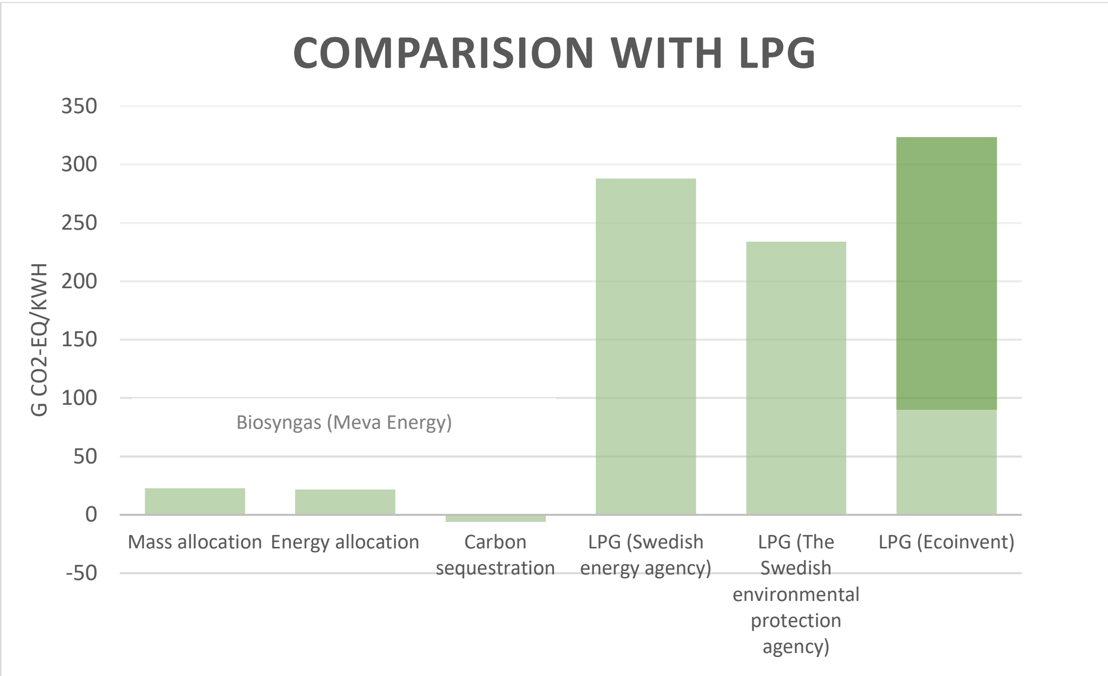

Figure 4. The three allocation scenarios of Meva Energy's biosyngas compared to fossil LPG (Hedbom, H and Lundh, P (2024).

The LCA report also presents a sensitivity analysis, where the sawdust was used to produce wood pellets were defined as a waste stream, as defined in the Renewable Energy Directive. This means that the emissions start first upon the collection of the sawdust. This resulted in significantly reduced environmental impact.

Conclusion

The findings of this study highlight that energy produced by Meva Energy's gasification technology can contribute to a positive climate impact, i.e. can constitute a net negative emissions technology if the application of the biochar constitutes as a permanent carbon removal. Additionally, the study demonstrates that the thermal energy generated through biomass gasification has significantly lower climate change impacts compared to the fossil alternative LPG.

References

The full LCA study by Hedbom, H and Lundh, P is available **here.**

Hedbom, H and Lundh, P (2024) Life cycle assessment of biosyngas from a multifunctional biomass gasification plant in Sweden. Department of Technology Management and Economics Chalmers University of Technology.

Acknowledgments

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