FRONTSH1P CSS1: a Circular Systemic Solution for the valorisation of wood packaging waste

V. Benedetti[1], F. Patuzzi[1], M. Baratieri[1]

[1]Faculty of Science and Technology, Free University of Bolzano, Bolzano, 39100, Italy
Keywords: wood packaging waste, circular economy, gasification, char, CO_2 capture
Presenting author email: vittoria.benedetti@unibz.it

Introduction

Valorisation of wood packaging waste through a circular systemic solution (CSS) is one of the objectives of the H2020 – Green Deal project *FRONTSH1P: A FRONTrunner approach transition to a circular & resilient future: deployment of systemic solutions with the support of local clusters and the development of regional community-based innovation schemes.*

By the development and demonstration of four different CSSs, FRONTSH1P aims at ensuring a green and just transition of the Polish Łódzkie Region towards decarbonization and territorial regeneration addressing the current challenges and needs of the Region, transforming them into opportunities for economic growth, social inclusion, decarbonisation, improvement of the quality of life for citizens, reconnection between the urban and rural context.

In particular, this work presents *CSS1 - A circular approach to wood packaging waste*. The specific objectives of CSS1 are: 1) Creation of a new value chain based on wood packaging waste valorisation, involving the whole community and implementing the circular economy approach (refurbishing, reusing, recycling, energy recovery); 2) Coupling of biomass gasification for renewable heat generation and post-combustion capture of CO_2 towards carbon negative emissions; 3) Exploitation of gasification char as pigment/filler in the plastic industry or as additive for compost; 4) Exploitation of CO_2 as foaming agent in the plastic industry.

The technological core of CSS1 is a biomass gasifier which acts as a polygenerative system. Indeed, the gasifier is not only designed for energy purposes, but also for the production of valuable goods such as char and CO_2 (Figure 1).

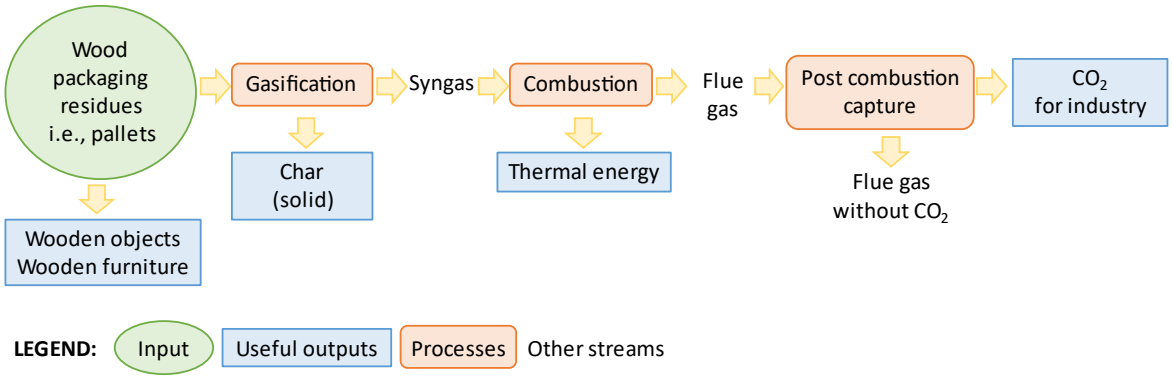

Figure 1. Valorisation of wood packaging waste through CSS1, a circular systemic solution developed in the FRONTSH1P project.

This approach allows biomass gasification to be considered as a zero-waste process providing both renewable energy and bio-based products. Therefore, gasification technology could be beneficial for preserving resources, minimizing waste and eventually fostering the transition from a linear to a circular economy

Material and methods

At first, wood packaging waste is sorted according to its quality. High quality wood (40% of the wood packaging residues collected) will be reused, refurbished, and recycled for the production of wooden goods. Low quality wood and wooden residues (60%) will be gasified to produce heat through gas combustion, and char. For this purpose, an updraught direct-current commercial gasifier (40 kg/h) with stationary fluidised bed will be used (Patuzzi et al. 2021).

Syngas combustion characteristics will be evaluated connecting the gasifier to an existing industrial-scale natural gas boiler, flue gases will be treated, and CO_2 captured by means of a compact post combustion capture (PCC) unit operating with appropriate solvents such as alkaline salts or amines. Char, the solid residue of the

gasification process, will be tested as compost and used as pigment/filler for polymers (Benedetti et al. 2020), while CO_2 will be further exploited as foaming agent in the plastic industry.

Results and discussion

Wood coming from packaging (e.g., disused pallets) is usually discarded after use due to defects or small damages. The valorisation of this type of wood could generate a flux of recovered material up to 4,500 t/y providing new jobs opportunities and opening up a potential new market. Ideally, considering the Polish Łódzkie Region as benchmark, this would result in 180,000 new pieces of furniture per year, more than 1,500 new jobs created along the whole value chain in the Region, 3,240 MWh/y of renewable thermal energy production, 270 t/y of char produced, 3,250 t/y of CO_2 captured and used, and > 80% direct greenhouse gas (GHG) reduction in heating residential and industrial applications.

Conclusions

The application of a circular approach for the valorisation of wood packaging residues not only allows for the minimization of waste and all the issues related to its management, the preservation of resources and the reduction of GHG emissions, but also for the production of low impact products such as wooden goods (e.g. furniture), renewable heat, char to be used as compost or as pigment/filler in the plastic industry, and CO_2. Moreover, citizens could play an active role in each stage of the valorisation chain, increasing their awareness on sustainability and circular economy, and indirectly benefitting from the environmental advantages that the CSS will bring.

References

Benedetti, V., M. Scatto, M. Baratieri, and P. Riello. 2020. "Valorization of Biomass Gasification Char as Filler in Polymers and Comparison with Carbon Black." *Waste and Biomass Valorization*. https://doi.org/10.1007/s12649-020-01243-7.

Patuzzi, Francesco, Daniele Basso, Stergios Vakalis, Daniele Antolini, Stefano Piazzi, Vittoria Benedetti, Eleonora Cordioli, and Marco Baratieri. 2021. "State-of-the-Art of Small-Scale Biomass Gasification Systems: An Extensive and Unique Monitoring Review." *Energy* 223: 120039. https://doi.org/10.1016/j.energy.2021.120039.

Acknowledgements

FRONTSH1P project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 101037031.