

SUCCESS CASES ON THE USE OF BIOMASS FOR THE DECARBONISATION OF THE CEMENT, STEEL AND GLASS INDUSTRY

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ABSTRACT: The EU is committed to its ambitious decarbonization goals to be achieved in 2050 and Energy Intensive Industries (EII) represent almost one third of the final energy consumption, therefore has a significant role in realizing these targets. In order to ensure the successful decarbonization of the EIIs, a long-term vision and strategy is required to stay competitive while contributing to the emission reduction targets. H2020 project RE4Industry is aiming to ensure a smooth transition in EIIs while they implement renewable energy solutions. RE4Industry is looking into economically and technically feasible retrofit and renewable solutions for the EIIs in short (2030) and long term (2050) and together designing action plans for industrial decarbonization with the ultimate goal of transforming the European Union's industrial sector into a thriving market for renewable energy. Different renewable electricity and heat sources are being looked into within the project and analysed to best provide the different needs of the EIIs to be and biomass will play a vital role in decarbonizing not only traditional combustion systems but also as a source of biofuels. Biomethane and green hydrogen are considered essential, as biomethane enables a seamless transition from fossil-based natural gas to renewable gas [1].

Keywords: biomass, CO2 emission, industry, project, renewable energies technology

1. BIOMASS AS A RENEWABLE SOLUTION

Solid biomass has been recognized as a crucial source of energy for Europe's shift towards renewable sources. It dominates as the primary raw material (accounting for 91%) in the production of bioheat [2]. To convert biomass into usable energy, various conversion methods are required, which can be broadly classified into three main pathways: thermochemical, physicochemical, and biochemical. Thermochemical conversion processes encompass technologies that enable the production of renewable heat.

Table I provides an overview of suitable renewable energy solutions for Energy Intensive Industries. The colors represent different levels of application: green indicates sectors that already extensively utilize the

technology (with potential for expansion), orange denotes high potential, yellow signifies medium potential, red indicates limited or no significant application foreseen, and gray represents possible application but no main route or wide-scale implementation.

According to **Table I**, biomass solutions are already widely applied or show high potential in several EIIs. The cement and paper industries, in particular, have embraced these solutions with numerous examples worldwide. Additionally, the lime industry has creatively utilized biomass, such as olive seed residues and various agricultural residues, in Mediterranean countries like Spain, Italy, and Greece. Furthermore, biomass applications in the steel and glass industries exist and will be further discussed in the subsequent section.

Table I: Suitable RE combination options for Energy Intensive Industries [3]

Sector	Renewable power for process electrification		Renewable heat and its sources				CCUS technologies	
	Heat and mechanical	Electrochem. processes (excluding H ₂)	Biomass combustion (and biofuels feedstock)	Other RE (Geotherm. & Conc. solar)	Green H ₂ (electrolysis/gasification)	Biomethane (anaerobic digestion)	Carbon Capture and Storage	Carbon Capture and Utilisation
Steel	Green	Yellow	Gray	Orange	Orange	Orange	Orange	Orange
Chemicals	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange
Fertilizers	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange
Cement	Yellow	Red	Green	Yellow	Gray	Yellow	Orange	Orange
Lime	Gray	Red	Orange	Yellow	Gray	Orange	Orange	Orange
Refining	Yellow	Red	Orange	Orange	Orange	Orange	Orange	Orange
Ceramics	Orange	Red	Gray	Orange	Yellow	Orange	Red	Gray
Paper	Yellow	Red	Green	Yellow	Red	Orange	Red	Red
Glass	Orange	Red	Orange	Green	Gray	Orange	Red	Red
Non-Fe metals	Green	Green	Orange	Orange	Orange	Orange	Orange	Orange
Alloys	Green	Green	Orange	Orange	Yellow	Orange	Orange	Orange

2. SUCCESSFUL USE OF BIOMASS FOR THE DECARBONISATION OF THE INDUSTRY

Within the project work, various success cases which are the flagship companies that adapted renewable energy

technologies are detected and a report and a factsheet on the success cases have been prepared. The examples from the successful adaptation of the biomass solutions adaptations by cement, steel and glass industry are given in the subchapter below:

2.1 ArcelorMittal Ghent steel plant

ArcelorMittal Belgium has been chosen as a success case in the RE4Industry Project due to its significant endeavors in reducing CO₂ emissions through the utilization of Renewable Energy Sources (RES) and implementing Carbon Capture and Utilisation (CCU) technologies in their primary production operations.

In order to meet their target of reducing CO₂ emission by 3.9 Mt/y by 2030, ArcelorMittal plans to establish a direct reduced iron (DRI) plant and electric arc furnace (EAF) facility with a capacity of 2.5 million tons at their Ghent site. These facilities will work in conjunction with the advanced waste wood and plastic-fired blast furnace at Ghent, known as the Horizon 2020 Torero project. Furthermore, the Carbalyst/ Steelanol project aims to promote Carbon Capture and Utilisation (CCU) by converting biologically captured waste gases from blast furnaces into bioethanol. This bioethanol can be utilized as a chemical feedstock or blended into liquid fuel. Both of these projects are expected to be operational by 2022.

ArcelorMittal Belgium and Dow Benelux have conducted experiments using a new experimental facility situated on ArcelorMittal's premises in Gent. The purpose of this pilot plant is to extract carbon dioxide (CO₂) and carbon monoxide (CO) from the hot flue gases generated during steel production. This initiative is expected to result in a significant reduction of 3 million tons of CO₂ emissions annually, as compared to the levels recorded in 2018. Additionally, it allows for the establishment of synergies within ArcelorMittal Belgium's strategy towards achieving net-zero carbon emissions by 2050 [4].

2.2 Biomass co-processing in the cement industry / The Milaki Cement Plant of HERACLES Holcim

Cement manufacturing is an energy-intensive process that requires high-temperature heating of raw materials. In Europe, where the cement industry is advanced and employs state-of-the-art technology, around 3,300 MJ of thermal energy is needed to produce one ton of clinker. Consequently, fuel costs for generating this thermal energy represent a significant expense in cement production.

In 2020, HERACLES, a leading cement manufacturer in Greece and a member of the Holcim Group, implemented an innovative project at its Milaki Cement Plant on the island of Evia. This project involved the co-processing of biomass as an alternative fuel source in cement production. HERACLES aims to reduce its environmental impact by substituting fossil fuels with alternative fuels, such as biomass, which not only reduces the company's carbon footprint but also enhances the competitiveness of its products.

The company has set strategic goals for energy and climate, including a reduction in total gross CO₂ emissions (Scope 1) to 1,522 kt CO₂ by 2030, compared to the 2,103 kt emitted in 2019. Additionally, HERACLES aims to increase the substitution of fossil fuels with alternative fuels to 50% by 2023. The gradual introduction of alternative fuels began in 2013, with licensing procedures initiated in 2009. In 2020, HERACLES utilized 130,000 tons of alternative fuels for thermal energy production, accounting for 27.7% of the total fuel energy input. This resulted in approximately 85,000 tons of CO₂ emissions saved and a 7% reduction in the company's overall CO₂ emissions.

To achieve these goals, HERACLES invested a total of 2 million EUR to replace solid fossil fuels, such as

petcoke, with alternative biomass fuels. This substitution is expected to lead to a yearly reduction of 70,000 tons of CO₂ emissions.

This investment allows for the utilization of approximately 75,000 tons of biomass annually, predominantly consisting of prunings and other agricultural residues. By doing so, it promotes the principles of a circular economy and effectively reduces the amount of waste that would otherwise be sent to landfills [5].

2.3 Biofuel co-firing implementation in furnaces of glass industry Verallia Spain S.A (Zaragoza)

The glass manufacturing industry is highly energy-intensive, requiring the heating of raw materials to extreme temperatures (around 1600°C) for melting, shaping, coating, and annealing glass products such as containers, fibers, and flat slides. In 2020, Verallia Spain S.A., a prominent glass manufacturer, made the decision to introduce innovative processes at its Zaragoza facilities to enhance corporate decarbonization strategies.

Verallia recognizes the significance of using biofuels as co-firing fuels in their furnaces as a means to replace non-renewable liquid fuels. At their Zaragoza plant in Spain, one of their furnaces is already operating with a blend of biofuel and natural gas (10% biofuel by weight). Replacing natural gas with biofuels, such as biomethane, has the potential to render this combustion process CO₂ neutral.

The Verallia Group is committed to adopting policies that prioritize renewable energy solutions, with a particular emphasis on biofuels. They also aim to explore alternative transportation methods, such as rail, to reduce their reliance on road transport.

In line with their objectives, Verallia currently utilizes rapeseed biofuel in the Champagne region, resulting in a 60% reduction in CO₂ emissions from transport in the area. This switch to biofuel also leads to an 80% decrease in fine particle emissions compared to diesel usage. With an average monthly consumption of 2000 tons and a biofuel substitution rate of approximately 10%, the resulting CO₂ emission reduction would amount to 395.6 tons per month [6].

3. CONCLUSION

In conclusion, biomass solutions play an important role in the decarbonization of energy-intensive industries. Especially when sourced locally and sustainably, biomass not only helps decrease industries' CO₂ emissions but also ensures a secure and clean energy supply. The RE4Industry project, in addition to preparing action plans for the energy-intensive industry and exploring various renewable energy solutions, also showcases different subsectors that have successfully implemented biomass solutions. Thus, the project aims to make these exemplary cases more visible, thereby encouraging and mobilizing other industries on their path towards a green transition.

4. REFERENCES

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