Energy Intensive industries decarbonization circularity path: Steel, Glass and Cement industry success cases.

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Europe is striving to become the world's first climate-neutral continent by 2050 and reach a decarbonization rate of 80-95% (compared to 1990) by 2040. Energy-intensive industries (EIIs) are considered a notoriously 'hard to abate' sector and a critical asset for climate transition. The EIIs ecosystem includes a wide range of high-energy intensity sectors correspond to 24% of EU energy consumption and 16,5% of greenhouse gas (GHG)

Efficient industrial processes, re-usage of obtained materials and alternative raw materials proved to be a lucrative circular path

Overview

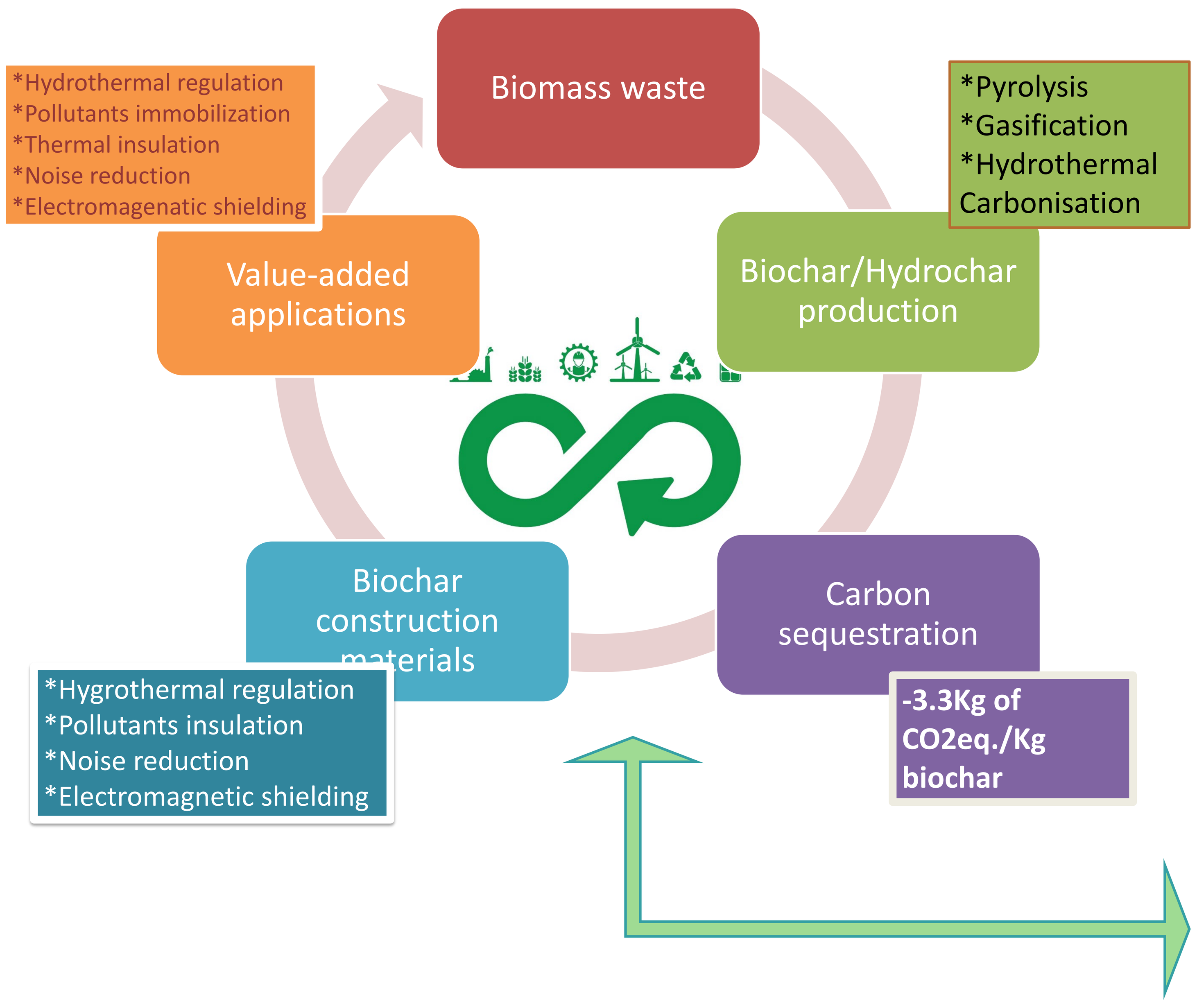
Steel, glass and cement industry stand out among EIIs in promoting circular economy concepts.

Cement manufacturing process is energy intensive, corresponding to 50-60% of the total production cost, is highly targeting in usage of alternative raw materials in order to maintain its sustainability amd can assess the impact of replacing petcoke with an alternative renewable fuel such as biomass Plus biochar use also improve cement final materials mechanical properties and carbon sequestration

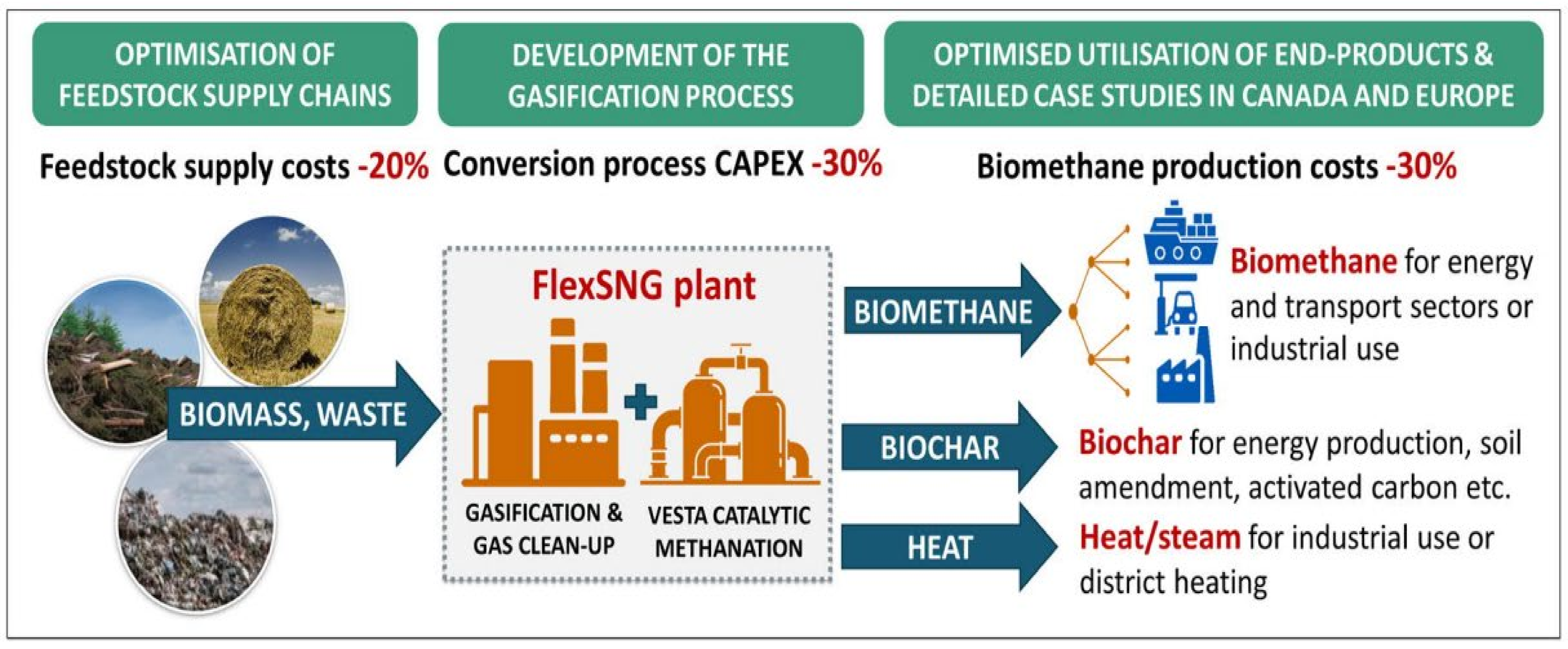
Steel industry improving resource efficiency and fostering sustainable development in Europe Steel is 100% recyclable therefore a fundamental part on the circular economy pathway. The integration of biochar into steel production represents a significant step towards more sustainable manufacturing practices.

Glass manufacturing industry innovates in effective adaptation of reuse and recycling strategies. The use of biochar as filler in glass fiber reinforced polymer composite showed higher stiffness and fire retardancy properties.

through circular biomass implementation



FlexSNG concept production of intermediate bioenergy carriers (biomethane and biochar) & heat.



	Function	Key characteristics	FlexSNG biochar
Energy	Fuel Storability Transportability	Heating value Hydrophobicity Energy density	XXX XXX XXX
Metallurgy	Coke Substitution	High heating value Very low volatile matter Plasticity thresholds	XX XX X
	Coal substitution	High heating value Very low volatile matter Particle sizes	XXX XX XX
Construction	Cement & Filler substitute	Particle sizes High surface area	XX XXX
Adsorption	Soil/water/air decontamination	High surface area Total pore volume Pore size	XX XX XX

Biomass industrial adaptation| Case studies

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Develop renewable or decarbonised energy by Biofuel co-firing implementation in furnaces
Considering an average consumption of 24000 t/y and a substitution percentage with biofuel of around 10%, would lead to a **CO_2 emission saving of 4,752 t CO_2/y**.

Heidelberg Materials

By 2030, Heidelberg Materials aims to reduce specific net CO_2 emissions to 400kg per ton. of cementitious material. [Compared with the base year 1990] corresponding to a reduction of almost 50% emissions, by
- Increased use of alternative fuels, including biomass, accounted for 26.4% of the company's entire energy consumption (in 2021)
- Substituting the CO_2 intensive clinker in cement by secondary cementitious materials with a significantly lower CO_2 footprint.

Torero Project ArcelorMittal

ArcelorMittal is building an industrial-scale demo plant that uses torrefaction process to turn waste wood into bio-coal (use of blast furnace). Two reactors at the Ghent facility will each generate 40,000 tonnes of bio-coal annually that can be used in the blast furnace as a substitute for coal. Construction of the €55 million project will be completed by 2025. The project is expected to reduce Ghent's annual CO_2 emissions by **225,000 t.** (operating at full capacity)

Milaki Cement Plant(MCP) is co-processing biomass, SRF and dried sewage sludge;

MCP managed to achieve a rapid increase of the use of biomass. In 2021, biomass amounted to 20 % of the total energy mix. The biomass investment at Milaki provides additional environmental benefits by reducing the total volume of waste materials that are landfilled. Allternative biomass fuels achieved redu-ction of CO_2 emissions by 70,000 tons/year. About **75,000 tons/year** of biomass – mostly prunings and other agricultural residues – can be valorised to promotion of circular economy principles and redu-cing the volume of waste that is landfilled Biomass co-processing at cement plants such as that in Milaki also offers an alternative, since the ash is effectively made inert within the cement.

Outline

Biofuels production and utilization has a complex background yet a broad impact on man on EIIs. Biomass conversion is suitable for energy production. In comparison with pure biomass, biochar had higher energy density, which is advantageous regarding handling and transportation of the fuel. Also, the biodegradation during the fuel storage is decreased due to the increased hydrophobicity of biochars which gives the material attractive characteristics for efficient use in EIIs

References

Re4Industry Project: D3.3 - Success cases of RE integration in EIIs
European Biochar Industry's (EBI) Materials Working Group report
FlexSNG project: D6.1 Report on biochar characterization
FlexSNG project : D7.2 Definition of the FlexSNG process configurations

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