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Pilot-Scale Evaluation of Hydrochar Utilization in Electric Arc Furnace Steelmaking: Results from the BioReSteel Project

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The BioReSteel project, funded by the European Union's Research Fund for Coal and Steel (EU RFCS), has successfully carried out a pilot-scale electric arc furnace (EAF) campaign at Swerim in December 2025, aiming to validate the use of biomass-derived carbon materials as partial substitutes for fossil carbon in electric steelmaking. The campaign evaluated a range of hydrochar-based materials, including pristine and pyrolyzed hydrochar in pellet form, fine fractions, and hydrochar-iron oxide agglomerates, produced from low-grade wet biomass residues.

The pilot trials were designed to assess hydrochar performance under realistic EAF operating conditions and across key process stages, including melting, feeding, and refining. The materials were tested for multiple metallurgical functions relevant to EAF operation, such as carburization of the steel melt, reduction reactions, and slag foaming behavior, and were benchmarked against conventional fossil carbon materials. The experimental program generated a comprehensive dataset on process stability, material behavior, and operational compatibility.

Hydrochar production and upgrading were developed within an integrated value-chain approach, combining biomass valorization, quality optimization through controlled pyrolysis and phosphorus reduction, and adaptation to existing EAF charging and injection practices. Particular emphasis was placed on ensuring that the renewable carbon carriers could be applied without major modifications to current industrial equipment or operating procedures.

The results from the pilot campaign demonstrate the technical feasibility of hydrochar as a renewable carbon carrier in EAF steelmaking, showing stable process performance and promising functionality across the investigated applications. The outcomes provide a robust basis for the ongoing and forthcoming industrial-scale trials within the BioReSteel project and contribute to the development of low-carbon and circular solutions for electric steel production. This work supports the broader transition of the European steel industry toward reduced fossil carbon dependency, improved resource efficiency, and lower CO_2 emissions.

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