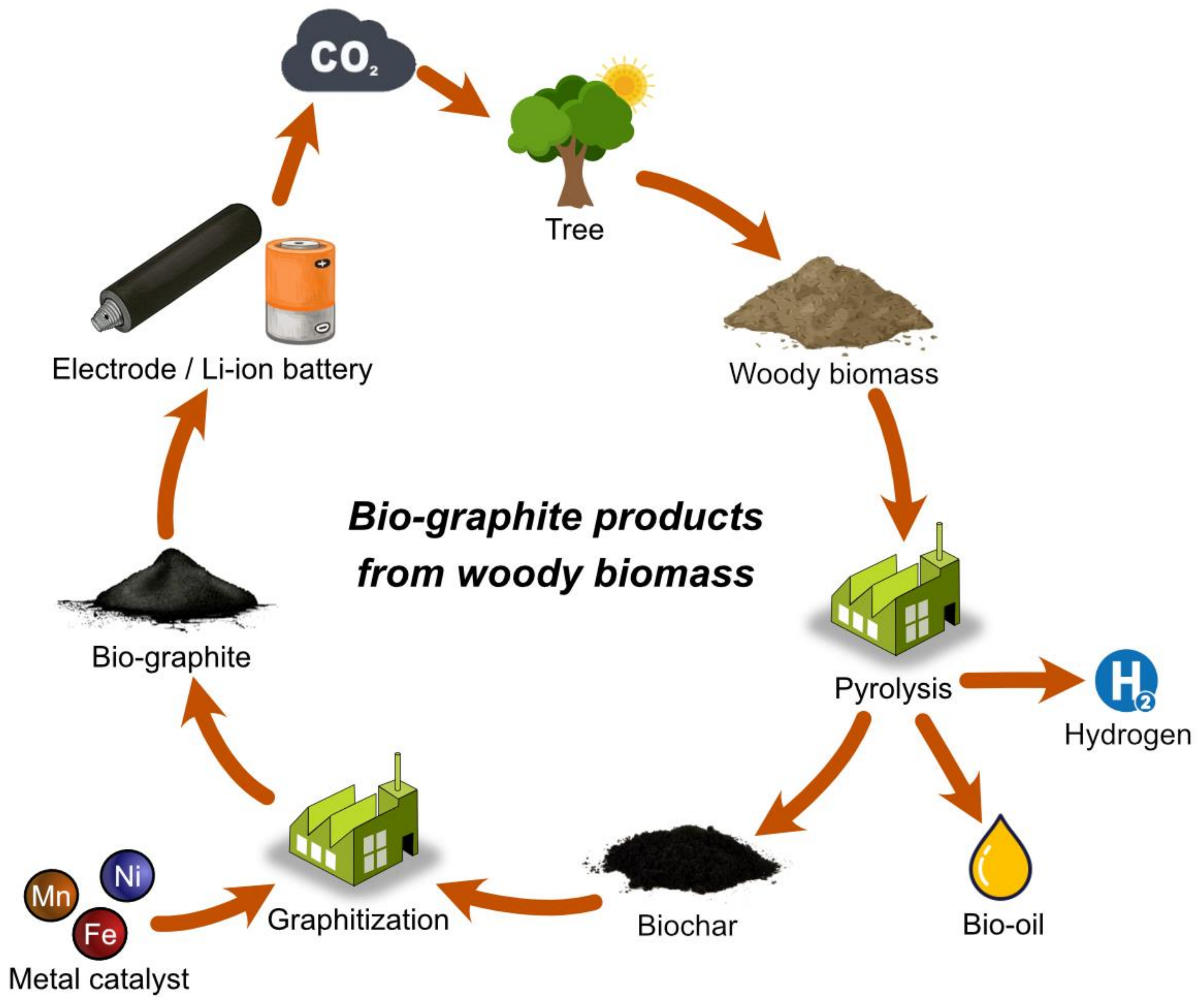

Catalytic graphitization of woody biomass, from feedstock to final bio-graphite products

Graphite, one of the most thermodynamically stable allotropes of carbon, is widely applied in different industrial areas, for example, anode material in lithium-ion batteries (LIBs) and electrode material in metallurgy. Currently, commercial graphite is either produced from artificial synthesis or obtained from natural deposits. However, both production methods have certain drawbacks. To artificially synthesize graphite, an energy-intensive process (∼3000 °C) is being used to transform amorphous carbon (coal or pitch) to graphite materials, accompanied by large-scale non-combustion greenhouse gas (GHG) emissions. For natural graphite, mining and purifying processes result in devastating environmental impacts on the soil, water, and air because of the large-scale use of HF.

The Bio+ project **Fossil Free Graphite** investigates a novel and environmentally friendly route to transform renewable raw materials into high-quality graphite as the anode material in LIBs and electrode materials in electric arc furnaces (EAFs) for the metallurgy industry. In the project, woody biomass is chosen as feedstock for graphite production because of its abundance in Sweden. Moreover, a hybrid metal catalyst is used to accelerate graphitization and lower graphitization temperature, achieving less energy consumption and GHG emissions during production.

The preliminary characterization results show that synthetic graphite (bio-graphite) with a high graphitization degree was successfully produced from woody biomass materials through three-phase catalytic graphitization at 1300 °C. The bio-graphite material has extremely low resistivity (2.01 μΩ·m), and exhibited the best electrochemical performance in the half-cell test (with a reversible capacity of 295 mAh/g at 30 mA/h charging rate). Moreover, our priliminary simulation results show that the catalytic graphitization process has a much lower GHG emission (0.93 ton CO2/ ton graphite) than natural graphite (13.283 ton CO2/ tong graphite [1]) and traditional artificial graphite production processes (17.467 ton CO2/ tong graphite [2]). These results indicate that the bio-graphite, prepared in the environmentally friendly process with hybrid metal as a catalyst, is a competitive and promising material for LIBs and EAF.

[1] Engels, Philipp, et al. "Life cycle assessment of natural graphite production for lithium-ion battery anodes based on industrial primary data." Journal of Cleaner Production 336 (2022): 130474.
[2] Surovtseva, Daria, et al. "Toward a life cycle inventory for graphite production." Journal of Industrial Ecology (2022).