Assessment of a novel alder biorefinery concept to meet demands of economic feasibility, energy production and long term environmental sustainability

A biorefinery concept based on alder tree plantations on degenerated soil is developed to comply with indicators of economic feasibility, fossil fuel depletion concerns, and long term sustainability issues. The potential performance of feedstock and biorefinery has been assessed through a literature study and by using a method developed during the study for first hand assessment and comparison of biorefinery system characteristics. The management of an average alder plantation in a 6-year coppicing system was found to fixate atmospheric nitrogen to the soil in yearly rates between 50 and 200 kg ha\(^{-1}\) and produce a 6-year total dry biomass quantity around 33 Mg ha\(^{-1}\) plus yearly leaf production. This production could facilitate a biorefinery to serve society with production of energy related and value added products to substitute the use of fossil fuels while at the same time replenishing degenerated soils. Integrating a biomass handling system, an LTCFB gasifier, a diarylheptanoids production chain, an anaerobic digestion facility, a slow pyrolysis unit, gas upgrading and various system integration units, the biorefinery could obtain the following production characteristics accounted on a yearly basis: Total system Energy Return on energy Invested 2.0, total system Exergy Return on exergy Invested 1.5, Net Energy Output 78 GJ ha\(^{-1}\), Net Exergy Output 50 GJ ha\(^{-1}\), Net carbon sequestration (as CO\(_2\) equivalents) 0.80 Mg ha\(^{-1}\), Total product value 2030 V ha\(^{-1}\) and Net Dry Matter Removal of approximately 90%.

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