

## **Anaerobic digestion of pulp and paper mill sludge: life cycle assessment of alternative uses of biogas**

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### **Abstract**

Biosludge is a solid waste of the pulp and paper industry, which is usually incinerated for energy recovery or landfilled. This study evaluates the energy balance and carbon footprint of using pulp and paper mill sludge in anaerobic digestion (AD) systems with alternative uses for the biogas, in different regions of the world, using Environmental Life Cycle Assessment (E-LCA). The digested residues from the AD are assumed to be used for biochar production, and subsequent incorporation into forest soils. Three scenarios based on alternative uses of biogas were investigated: (i) biogas for vehicle fuel in the transportation sector, (ii) biogas for heat and electricity in the power sector, and (iii) biogas for cooking in households. The E-LCA results demonstrate that both energy balance and greenhouse gas (GHG) emissions abatement of biosludge treatment in the AD systems significantly improve relative to the baseline scenario of incineration. The displacement of fossil fuel with biogas, and carbon stabilized in biochar contribute largely to the truncation of the energy and carbon footprints. Therefore, a combination of AD and pyrolysis technologies as a novel energy-biochar production system could offer an opportunity for sustainable management of pulp and paper mill sludge. Regarding biogas, the local or national infrastructure determines possible uses, and this aspect was shown to affect E-LCA results.

Keywords: Biochar, biogas, digested sludge, carbon footprint, energy balance, waste treatment