Energy and greenhouse gas intensity of electricity generation from perennial crops on agricultural land

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Abstract

Energy and climate change are two crucial issues of the EU's political and economic agenda. Bioelectricity from short rotation coppices (SRC) has the potential to contribute to energy security and mitigate climate change. Carbon losses due to land conversion may nullify the greenhouse gas (GHG) benefits of bioelectricity. However, this aspect has been ignored in many recent studies. We combined atmosphere-ecosystem flux measurements, soil sampling and a life cycle analysis approach to quantify the full GHG emissions (CO_2, N_2O, CH_4), full energy balance and land requirement of an operational bioenergy plantation (18 ha) in Flanders, Belgium We found that N_2O and CH_4 fluxes reduced the potential sink strength of perennial crops during the first two years of the culture, but that the net GHG balance was a considerable sink thereafter. The net energy ratio of the bioelectricity systems was ranged from 1.3 to 1.7 indicating an energy benefit. Total GHG emissions related to the production of bioelectricity ranged from 182 to 233 $gCO_2\ kWh^{-1}$. Land conversion contributed about 80% of the total GHG emissions in the bioelectricity generation system. Overall, the GHG emissions of bioelectricity from our SRC plantation were 2 to 3 times lower compared to those of the European grid mix electricity. Our results are of direct relevance to bioenergy industries, researchers, policy makers and NGOs seeking for further sustainability objectives in bioenergy production.

Keywords: Land use change, GHG emissions, life cycle assessment, short rotation coppice

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