Life-Cycle Energy Use and Greenhouse Gas Emission Implications of Brazilian Sugarcane Ethanol Simulated with the GREET Model

Michael Wang*, May Wu, Hong Huo and Jiahong Liu

Center for Transportation Research, Argonne National Laboratory,
9700 South Cass Avenue, Argonne, IL 60439, USA.

*Contact author: Tel: +1 (630) 252 2819 Fax: +1 (630) 252 3443
Email: mqwang@anl.gov

In *International Sugar Journal 2008*, Vol. 110, No. 1317

ABSTRACT

By using data available in the open literature, we expanded the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model developed by Argonne National Laboratory to include Brazilian-grown sugarcane ethanol. With the expanded GREET model, we examined the well-to-wheels (WTW) energy use and greenhouse gas (GHG) emissions of sugarcane-derived ethanol produced in Brazil and used to fuel light-duty vehicles in the United States. Results for sugarcane ethanol were compared with those for petroleum gasoline. The sugarcane-to-ethanol pathway evaluated in the GREET model comprises fertilizer production, sugarcane farming, sugarcane transportation, and sugarcane ethanol production in Brazil; ethanol transportation to U.S. ports and then to U.S. refueling stations; and ethanol use in vehicles. Our analysis shows that sugarcane ethanol can reduce GHG emissions by 78% and fossil energy use by 97%, relative to petroleum gasoline. The large reductions can be attributed to use of bagasse in sugarcane mills, among other factors. To address the uncertainties involved in key input parameters, we developed and examined several sensitivity cases to test the effect of key parameters on WTW results for sugarcane ethanol. Of the total GHG emissions associated with sugarcane ethanol, the five major contributors are open-field burning of sugarcane tops and leaves, N_2O emissions from sugarcane fields, fertilizer production, sugarcane mill operation, and sugarcane farming. Brazil is going to phase out open-field burning in the future. This action will certainly help further reduce GHG emissions of sugarcane farming, together with reductions in emissions of criteria pollutants such as No_x and particulate matter with diameters smaller than 10 microns. The eventual elimination of open-field burning in sugarcane plantations will result in additional GHG emission reductions by sugarcane ethanol of up to 9 percentage points.

Keywords: greenhouse gases, life-cycle analysis, sugarcane ethanol, well-to-wheels analysis