# Energy and Emission Benefits of Alternative Transportation Liquid Fuels Derived from Switchgrass: A Fuel Life Cycle Assessment

**May Wu, Ye Wu, and Michael Wang**
Center for Transportation Research, Argonne National Laboratory

In ***Biotechnology Progress***, Volume 22: 1012-1024 (2006)

## Abstract

We conducted a mobility chains — or well-to-wheels (WTW) — analysis to assess the energy and emission benefits of cellulosic biomass for the U.S. transportation sector in the years 2015 to 2030. We estimated the life-cycle energy consumption and emissions associated with biofuel production and use in light-duty vehicle (LDV) technologies by using the *G*reenhouse gases, *R*egulated *E*missions, and *E*nergy use in *T*ransportation (*GREET*) model. Analysis of biofuel production was based on ASPEN Plus™ model simulation of an advanced fermentation process to produce fuel ethanol/protein, a thermochemical process to produce Fischer-Tropsch diesel (FTD) and dimethyl ether (DME), and a combined heat and power plant to co-produce steam and electricity. Our study revealed that cellulosic biofuels as E85 (mixture of 85% ethanol and 15% gasoline by volume), FTD, and DME offer substantial savings in petroleum (66–93%) and fossil energy (65–88%) consumption on a per-mile basis. Decreased fossil fuel use translates to 82–87% reductions in greenhouse gas emissions across all unblended cellulosic biofuels. In urban areas, our study shows net reductions for almost all criteria pollutants with the exception of carbon monoxide (unchanged), for each of the biofuel production option examined. Conventional and hybrid electric vehicles, when fueled with E85, could reduce total sulfur oxide ($SO_x$) emissions to 39–43% of those generated by vehicles fueled with gasoline. By using bio-FTD and bio-DME in place of diesel, $SO_x$ emissions are reduced to 46–58% of those generated by diesel-fueled vehicles. Six different fuel production options were compared. This study strongly suggests that integrated heat and power co-generation by means of gas turbine combined cycle is a crucial factor in the energy savings and emission reductions.