Comparing alternative uses of scarce biomass energy resources using the AMIGA model

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Abstract

Biomass as an energy feedstock can be converted to liquid transportation fuels or electricity through several different technological pathways, including direct and cellulosic fermentation processes for ethanol, gasification/digestion processes leading to liquid fuels and/or electricity, and direct combustion for thermal-electricity generation. Currently, most U.S. biomass energy proposals suggest converting biomass into ethanol for use as a transportation fuel in order to reap the benefits of reducing dependence on petroleum imports, increasing the use of renewable fuels for improved environmental performance within the transportation sector, and providing new revenues to rural farming communities. Biomass use has also been proposed as a carbon mitigation strategy for the electricity sector by displacing coal-based carbon emissions with a carbon-neutral resource. Several agriculture sector economic models have generated U.S. biomass feedstock forecasts and, despite each being slightly different, all concur that not enough biomass exists to displace fossil fuel use in either the transportation or the electricity sectors. As future plug-hybrid-electric technologies become available, a blended transportation and electricity market will emerge. In this scenario, biomass energy can advance national security and renewable portfolio goals using different technology pathways representing an array of benefit and cost options. In light of this, an evaluation of biomass energy opportunity cost in both the electricity and transportation energy sectors can help identify a maximum co-benefit pathway for biomass energy infrastructure. This paper presents a methodology for modeling tradeoffs between alternative uses of scarce biomass energy resources using AMIGA, a dynamic, computable general equilibrium model.

The presented methodology consists of three biomass-to-energy industry modules: corn-ethanol industry, cellulosic-ethanol industry, and co-firing biomass with coal in existing U.S. coal-fired power plants. Each has been developed such that a dynamic estimation of techno-economic performance allows simultaneous opportunity cost comparisons with traditional fossil energy resources and technologies in both the transportation and electricity generation sector components currently available in the AMIGA model. This paper presents the three biomass-to-energy module structures, policy components and tradeoff algorithms capturing some of the political climate of biomass energy, and a brief example of alternative scenarios. Future biomass-to-energy industry modules are suggested for further research.

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AMIGA model searches for economically efficient technological configurations to achieve environmental and energy security goals. As such, the flexibility of biomass energy utilization to produce ethanol and electricity is combined with existing AMIGA technology models for petroleum product refinement fuels slate and coal and petcoke gasification to produce multiple products, such as Fischer-Tropsch liquid fuels, hydrogen, electric power, and others.

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