Spatially explicit life-cycle analysis of forest based bioenergy in California

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Abstract

Bioenergy production from wood has potential to reduce greenhouse gas (GHG) emissions from the transport sector by utilizing low-carbon alternatives to fossil energy feedstocks, reducing the risk of catastrophic wildfire and increasing the stability of forest carbon pools. We present a spatially explicit analysis of emissions from a likely future bioenergy production system in California. We find that forest residue utilization results in the displacement of 3.7 Tg CO_2e/year.

Introduction

The Low-Carbon Fuel Standard (LCFS), a component of the California Climate Change Bill(AB32) sets a target of 10% reduction in GHG emissions from transportation by 2020. The California Renewable Portfolio Standard (RPS) sets a target of +/- 1450 Mwe by 2010 and 33% of demand by 2020. Forest residues are energy-dense biomass produced as bi-products form commercial forestry or fire risk reduction activities. Forests are a significant carbon sink. In California and much of the Western US, however, they are increasingly susceptible to catastrophic wildfire as a result of changing climate. This paper presents preliminary results of an ongoing study to model GHG emissions from the use of forest-based biomass for electricity and biofuel production.

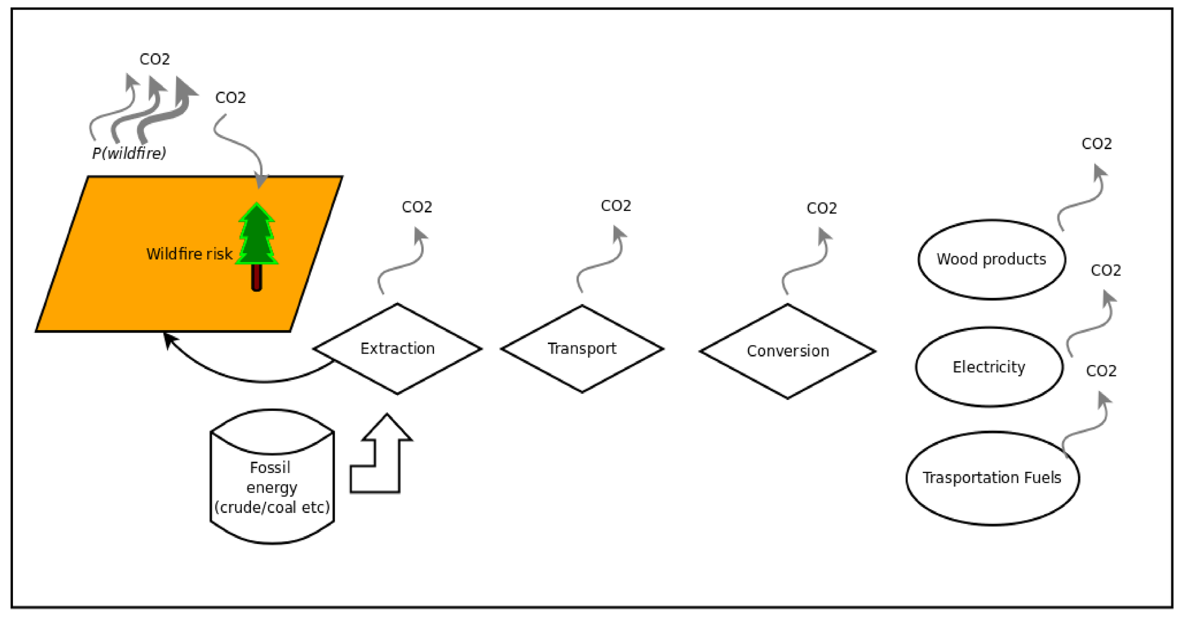

Figure 1: LCA Schematic.

Methods

A bioenergy System Model (BSM) was developed for California (Figure 2) (Tittmann, Parker, Hart, Jenkins 2010 *in review*). The model predicts the location, size, and type of bioenergy production facilities based on geographic distribution and procurement costs of feedstock for a market prices of $2.55/gge for biofuels. (Figure 3) We use the BSM to track emissions from harvest, transport and conversion of forest biomass using a geographic transport network. We use the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model to evaluate offset fossil emissions from the future bioenergy system

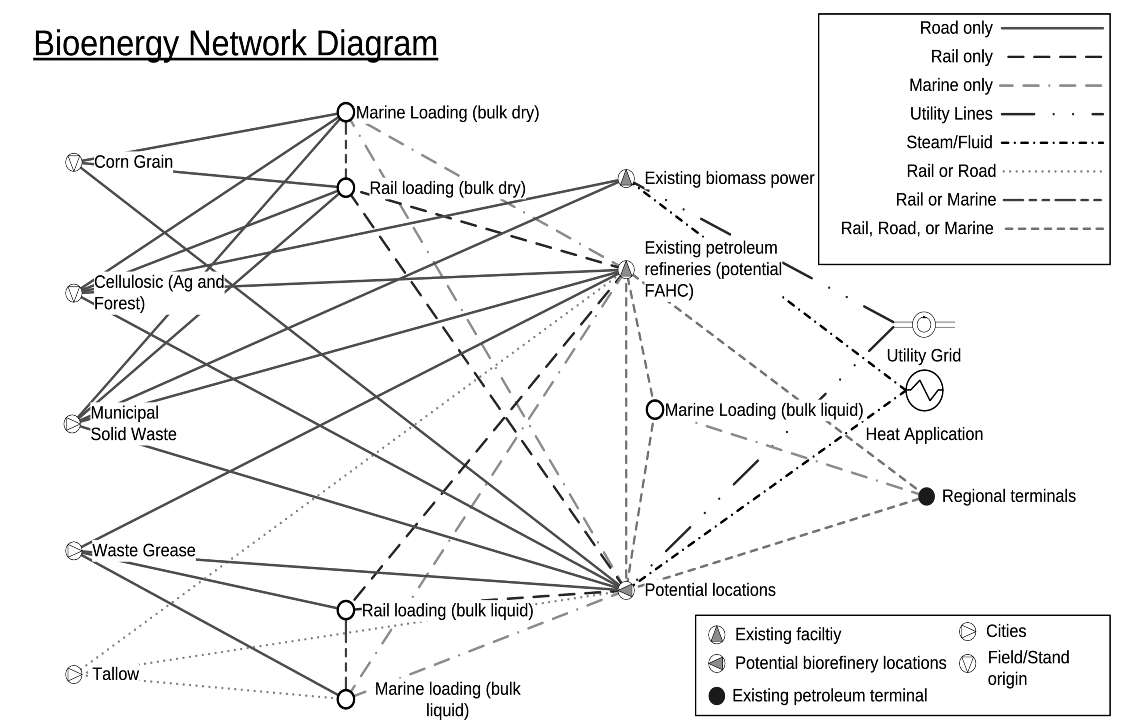

Figure 2: BSM network.

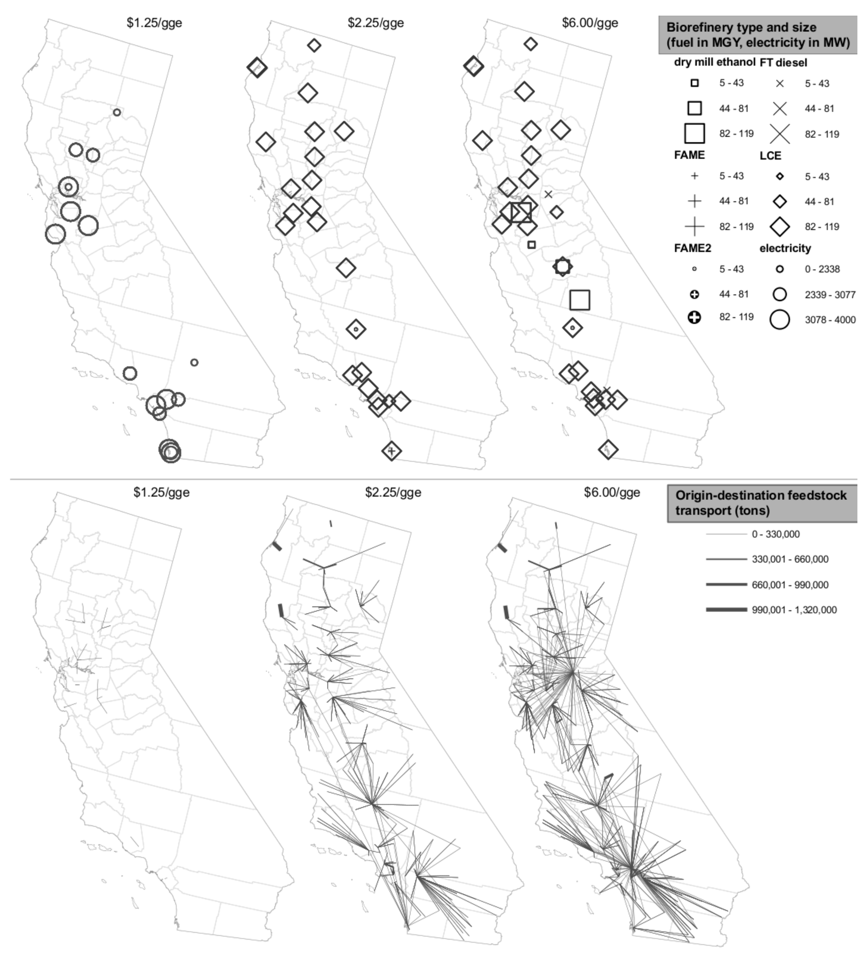

Figure 3: BSM output.

Figure 4: CA forest types.

Results

The results of the sting model indicate that 8 biorefineries are cited producing a total of 907 MGY of ethanol from all biomass feedstocks. Forest residue produces 335.4 MGY or 40% of the total volume. 23 electricity facilities are used at this price level producing 1602 Mwe from forest residues. In this scenario aggregate displacement of fossil energy sources results in a net reduction in annual greenhouse gas emissions by 3.67 Tg.

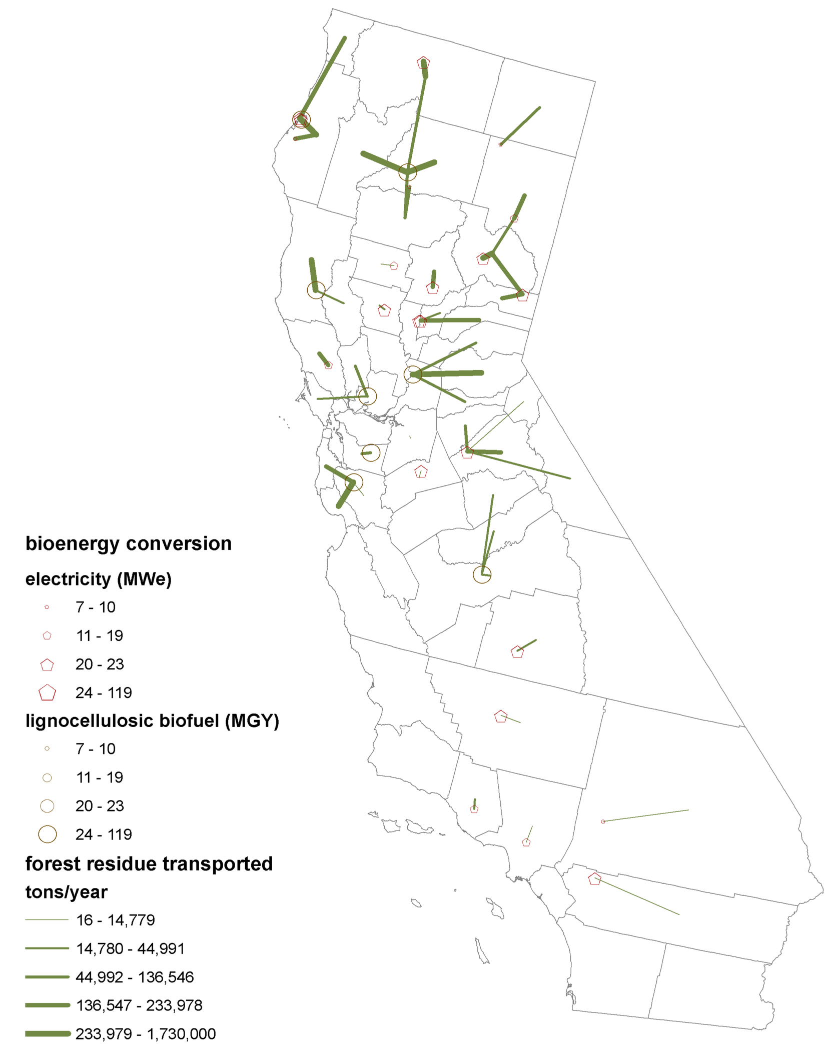

Figure 5: CA future forest bioenergy system.

	Production (MWe, MGY)	Emissions from production (Mg CO2e/y)	Displacement (Tg CO2e/y)
Electiricty	1602.24	0.11	-0.004
Biofuel (ethanol)	335.43	0.56	-3.67
Wildfire	n/a	n/a	25

Discussion

The use of forest residues in energy and fuel production results in significant reductions in GHG emissions from fossil fuels. Further climate benefits may be achieved from forest residue utilization if the silvicultural practices used to produce residue improve the stability of carbon remaining in forest pools. This can be achieved by managing forest for wildfire resistance.