Motivation
Biofuels have received legislative support in California’s Low-Carbon Fuel Standard and the Federal Energy Independence and Security Act, in part, on the basis of expected reductions in greenhouse gas emissions. Although legislation acknowledges uncertainty and variation in input parameters in the LCI calculations, no quantitative methodology to deal with the uncertainty is prescribed. This is troublesome for two reasons: first, using only single values disregards the ranges and uncertainty in data used to generate a point estimate (such as a mean value), and second, new fuel life cycles (such as of butanol) can only be predicted, not measured.

In addition to these concerns, claims of increased energy security through increased biofuel use are not entirely convincing because of natural variability in bio-feedstock supply due to climatic/meteorological variability and the presumption that bio-feedstocks will be rain fed so as not to increase burdens on freshwater supplies.

Approach
Emissions work uses Monte Carlo simulation to estimate life-cycle emissions distributions from ethanol and butanol from corn or switchgrass. Data for input distributions are drawn primarily from previous literature studies and U.S. government databases.

Feedstock yield variability is examined using switchgrass as a case study. A crop yield model predicts yield under historic meteorological data to illustrate potential inter-annual variability. Various strategies, including irrigation and strategic planting locations are investigated to see how variability can be mitigated.

Preliminary Results and Discussion
Life-cycle emissions for each feedstock and fuel pairing modeled distributions span an order of magnitude or more, and each feedstock-fuel pathway show some probability of greater emissions than a distribution for gasoline.

Incorporating uncertainty in the decision making process can illuminate the risks of policy failure (i.e., increased emissions), and a calculated risk of failure due to uncertainty can be used to inform more appropriate reduction targets in future biofuel policies.

Preliminary results regarding feedstock supply may only be partially subdued by irrigation during times of water scarcity, and price stability is only partially mitigated as a result.

Financial Support
Funding for this work is by the center for Climate and Energy Decision Making (SES-0949710), through a cooperative agreement between the National Science Foundation and Carnegie Mellon University.

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