Empirical evidence for the potential climate benefits of decarbonizing light vehicle transport in the U.S. with bioenergy from purpose-grown biomass with and without BECCS

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Abstract

Climate mitigation scenarios limiting global temperature increases to 1.5 °C rely on decarbonizing vehicle transport with bioenergy production plus carbon capture and storage
(BECCS), but climate impacts for producing different bioenergy feedstocks have not been
directly compared experimentally nor for ethanol vs. electric light-duty vehicles. A field
experiment at two Midwest U.S. sites on contrasting soils revealed that feedstock yields of
seven potential bioenergy cropping systems varied substantially within sites but little
between. Bioenergy produced per hectare reflected yields: miscanthus > poplar > switchgrass
> native grasses ≈ maize stover (residue) > restored prairie ≈ early successional. Greenhouse
gas emission intensities for ethanol vehicles ranged from 20 to -179 g CO$_2$e MJ$^{-1}$: maize
stover >> miscanthus ≈ switchgrass ≈ native grasses ≈ poplar > early successional ≥ restored
prairie; direct climate benefits ranged from ~80% (stover) – 290% (restored prairie)
reductions in CO$_2$e compared to petroleum, and were similar for electric vehicles. With CCS,
reductions in emission intensities ranged from 204% (stover) – 416% (restored prairie) for
ethanol vehicles, and from 329 – 558% for electric vehicles, declining 27% and 15%,
respectively, once soil carbon equilibrates within several decades of establishment.
Extrapolation based on expected U.S. transportation energy use suggests that, once CCS
potential is maximized with CO$_2$ pipeline infrastructure, negative emissions from bioenergy
with CCS for light-duty electric vehicles could capture >900 Tg CO$_2$e yr$^{-1}$ in the U.S. In the
future, as other renewable electricity sources become more important, electricity production
from biomass would offset less fossil-fuel electricity, and the advantage of electric over
ethanol vehicles would decrease proportionately.

**Methods**

Data collected as described in materials and methods.

**Usage Notes**

See the readme file for a description of data in "dataset_gelfand_es&t.xlsx". The file
"calculations_gelfand_es&t.xlsx" shows the assumptions, calculations, and extrapolations of
these data and their location in the paper and supplemental information.

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**References**

This dataset is supplement to [http://dx.doi.org/10.1021/acs.est.9b07019](http://dx.doi.org/10.1021/acs.est.9b07019)

**Keywords**

soils, Carbon capture and storage, Bioethanol, Fossil fuels, biomass

**Files**

3 files for this dataset

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