Supporting Online Material for

Greater Transportation Energy and GHG Offsets from Bioelectricity Than Ethanol

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Tables S1 to S13
References
Greater transportation energy and GHG offsets from bioelectricity than ethanol
Campbell, J.E.¹,², Lobell D.B.³, and Field C.B.⁴

Transportation Energy:

Table S1. Gross transportation output of the bioenergy fuel cycle for ethanol and bioelectricitya.

<table>
<thead>
<tr>
<th></th>
<th>Corn (kg ha⁻¹ y⁻¹)</th>
<th>Switchgrass (kg ha⁻¹ y⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest Mass</td>
<td>8,746</td>
<td>13,450</td>
</tr>
<tr>
<td>Harvest Energy</td>
<td>157,427</td>
<td>242,101</td>
</tr>
<tr>
<td>Ethanol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross Ethanol</td>
<td>73,424</td>
<td>108,855</td>
</tr>
<tr>
<td>Gross Gasoline</td>
<td>2,335</td>
<td>3,462</td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross Electricity</td>
<td>52,140</td>
<td>80,184</td>
</tr>
<tr>
<td>Gross Electricity</td>
<td>14,483</td>
<td>22,273</td>
</tr>
</tbody>
</table>

aAll values based on EBAMM data¹ unless indicated otherwise.
bHeat contents are 31.45 MJ l⁻¹ for gasoline and 18 MJ l⁻¹ for biomass¹. For both ethanol and bioelectricity, the corn cases use only the kernels and the switchgrass case uses the total harvested biomass. The relatively small distribution energy costs (1.7% of throughput for cellulosic case) were not included².
cBased on thermal efficiency of 32% for biomass boiler², 92% transmission efficiency² and 90% electric vehicle battery charging efficiency².

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⁴Department of Global Ecology, Carnegie Institution of Washington, Stanford, CA, 94305.
Table S2. EBAMM fuel cycle inputs for ethanol and bioelectricity pathways.\(^a\)

<table>
<thead>
<tr>
<th></th>
<th>Corn</th>
<th>Switchgrass</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ethanol:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Primary Coal Inputs (MJ ha(^{-1}) y(^{-1}))</td>
<td>29,513</td>
<td>-3,595</td>
</tr>
<tr>
<td>Net Primary NG Inputs (MJ ha(^{-1}) y(^{-1}))</td>
<td>19,774</td>
<td>1,001</td>
</tr>
<tr>
<td>Net Nuclear and Renewables Inputs (MJ ha(^{-1}) y(^{-1}))</td>
<td>1,951</td>
<td>63</td>
</tr>
<tr>
<td>Total Net Electricity Inputs (kWh ha(^{-1}) y(^{-1}))(^b)</td>
<td>4,310</td>
<td>-158</td>
</tr>
<tr>
<td>Net Primary Petroleum Inputs (MJ ha(^{-1}) y(^{-1}))</td>
<td>2,727</td>
<td>7,145</td>
</tr>
<tr>
<td>Net Gasoline Equivalent Inputs (l ha(^{-1}) y(^{-1}))(^c)</td>
<td>78</td>
<td>204</td>
</tr>
<tr>
<td><strong>Bioelectricity:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Primary Coal Inputs (MJ ha(^{-1}) y(^{-1}))</td>
<td>724</td>
<td>763</td>
</tr>
<tr>
<td>Net Primary NG Inputs (MJ ha(^{-1}) y(^{-1}))</td>
<td>582</td>
<td>2,136</td>
</tr>
<tr>
<td>Net Nuclear and Renewables Inputs (MJ ha(^{-1}) y(^{-1}))</td>
<td>1,589</td>
<td>383</td>
</tr>
<tr>
<td>Total Net Electricity Inputs (kWh ha(^{-1}) y(^{-1}))(^b)</td>
<td>441</td>
<td>327</td>
</tr>
<tr>
<td>Net Primary Petroleum Inputs (MJ ha(^{-1}) y(^{-1}))</td>
<td>2,727</td>
<td>7,297</td>
</tr>
<tr>
<td>Net Gasoline Equivalent Inputs (l ha(^{-1}) y(^{-1}))(^c)</td>
<td>78</td>
<td>209</td>
</tr>
</tbody>
</table>

\(^a\)All values based on EBAMM data\(^1\) unless indicated otherwise. Inputs account for agriculture and biomass energy conversion steps of the fuel cycle. Energy conversion step excludes capital equipment and water related energy costs because EBAMM included data for biorefineries but not for electricity plants. These exclusions are expected to be small relative to other larger fuel cycle and vehicle cycle consumption for ethanol\(^1\) and bioelectricity\(^4\) pathways.

\(^b\)For use in net transportation analysis, the net electricity inputs are calculated at potential point-of-use (field-to-tank) based on thermal efficiency conversions (34% coal and 42% natural gas\(^2\)), 92% transmission efficiency\(^2\), and 90% electric vehicle battery charging efficiency\(^3\).

\(^c\)For use in net transportation analysis, liquid fuels inputs calculated at potential point-of-use (field-to-tank) based on petroleum to gasoline conversion efficiency of 90%\(^1\).

Table S3. Input energy for vehicle cycle (vehicle material recovery and production, component fabrication, assembly, and disposal/recycling) of battery electric vehicles (BEV) and internal combustion vehicles (ICV).

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Primary Energy(^a)</th>
<th>Energy ICV(^b)</th>
<th>Energy BEV(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>0.146 MJ km(^{-1})</td>
<td>1.21*10(^{-5}) kWh km(^{-1})</td>
<td>2.00*10(^{-5}) kWh km(^{-1})</td>
</tr>
<tr>
<td>Natural gas</td>
<td>0.159 MJ km(^{-1})</td>
<td>1.62*10(^{-5}) kWh km(^{-1})</td>
<td>2.68*10(^{-5}) kWh km(^{-1})</td>
</tr>
<tr>
<td>Petroleum</td>
<td>0.083 MJ km(^{-1})</td>
<td>2.36*10(^{-3}) l km(^{-1})</td>
<td>3.90*10(^{-3}) l km(^{-1})</td>
</tr>
<tr>
<td>Other</td>
<td>0.027 MJ km(^{-1})</td>
<td>7.01*10(^{-5}) kWh km(^{-1})</td>
<td>1.16*10(^{-5}) kWh km(^{-1})</td>
</tr>
</tbody>
</table>

\(^a\)GREET 2.7 vehicle cycle energy for ICV scaled by the vehicle lifetime of 257,440 km (160,000 miles)\(^3\).

\(^b\)Energy at point of vehicle. Conversion of coal and natural gas to electricity accounts for thermal efficiency (34% coal and 42% gas\(^2\)), 92% transmission efficiency\(^2\) and 90% electric vehicle battery charging efficiency\(^3\). Other energy source assumed to be primarily electricity and includes accounting of battery charging efficiency.

\(^c\)Vehicle cycle for BEV is 1.65 times ICV primarily due to the battery and battery replacement during the vehicle lifetime\(^6,7\).

\(^d\)Petroleum energy is given as energy in petroleum for primary energy and as energy in gasoline for ICV and BEV energy (gasoline conversion efficiency is 90% and gasoline heating value is 31.45 MJ l\(^{-1}\)).
Table S4. EPA vehicle efficiency data\(^a\) for battery electric vehicles (BEV) and internal combustion vehicles (ICV).

<table>
<thead>
<tr>
<th>Make</th>
<th>Engine</th>
<th>Efficiency (city/highway)(^b)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kWh 100km(^{-1})</td>
<td>100km(^{-2})</td>
<td>km MJ(^{-1})</td>
</tr>
<tr>
<td>Small Car</td>
<td>BEV</td>
<td>20/25</td>
<td>1.4/1.1</td>
</tr>
<tr>
<td>Small Car</td>
<td>ICV</td>
<td>-</td>
<td>0.5/0.6</td>
</tr>
<tr>
<td>Midsize Car</td>
<td>BEV</td>
<td>18/16</td>
<td>1.5/1.7</td>
</tr>
<tr>
<td>Midsize Car</td>
<td>ICV</td>
<td>-</td>
<td>0.3/0.4</td>
</tr>
<tr>
<td>Small SUV</td>
<td>BEV</td>
<td>17/21</td>
<td>1.7/1.3</td>
</tr>
<tr>
<td>Small SUV</td>
<td>ICV</td>
<td>-</td>
<td>0.3/0.4</td>
</tr>
<tr>
<td>Fullsize SUV</td>
<td>BEV</td>
<td>34/45</td>
<td>0.8/0.6</td>
</tr>
<tr>
<td>Fullsize SUV</td>
<td>ICV</td>
<td>-</td>
<td>0.2/0.3</td>
</tr>
</tbody>
</table>

\(^a\)EPA recently updated efficiency ratings for all vehicles years to reflect more realistic driving conditions.\(^6\)

Improved efficiency for ethanol relative to gasoline is small relative to differences between BEV and ICV efficiency.\(^b\)

\(^b\)Energy efficiency (mi MJ\(^{-1}\)) calculated based on gasoline LHV of 31.45 MJ l\(^{-1}\).

Table S5. Gross transportation for ethanol and bioelectricity (km ha\(^{-1}\) y\(^{-1}\)).

<table>
<thead>
<tr>
<th>Make</th>
<th>Ethanol City</th>
<th>Bioelectricity City</th>
<th>Ethanol Highway</th>
<th>Bioelectricity Highway</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Corn:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Car</td>
<td>35,750</td>
<td>58,295</td>
<td>41,709</td>
<td>45,499</td>
</tr>
<tr>
<td>Midsize Car</td>
<td>20,854</td>
<td>64,326</td>
<td>27,806</td>
<td>71,748</td>
</tr>
<tr>
<td>Small SUV</td>
<td>24,827</td>
<td>69,091</td>
<td>30,785</td>
<td>54,866</td>
</tr>
<tr>
<td>Fullsize SUV</td>
<td>14,896</td>
<td>34,545</td>
<td>19,861</td>
<td>25,909</td>
</tr>
<tr>
<td><strong>Switchgrass:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Car</td>
<td>53,002</td>
<td>89,650</td>
<td>61,835</td>
<td>69,971</td>
</tr>
<tr>
<td>Midsize Car</td>
<td>30,918</td>
<td>98,924</td>
<td>41,223</td>
<td>110,338</td>
</tr>
<tr>
<td>Small SUV</td>
<td>36,807</td>
<td>106,252</td>
<td>45,640</td>
<td>84,376</td>
</tr>
<tr>
<td>Fullsize SUV</td>
<td>22,084</td>
<td>53,126</td>
<td>29,445</td>
<td>39,844</td>
</tr>
</tbody>
</table>
Table S6. Transportation for ethanol and bioelectricity accounting for fuel cycle energy (km ha\(^{-1}\) y\(^{-1}\))\(^a\).

<table>
<thead>
<tr>
<th></th>
<th>Ethanol-City</th>
<th>Bioelectricity-City</th>
<th>Ethanol-Highway</th>
<th>Bioelectricity-Highway</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corn:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Car</td>
<td>12,870</td>
<td>55,062</td>
<td>23,389</td>
<td>42,514</td>
</tr>
<tr>
<td>Midsize Car</td>
<td>61,380</td>
<td>187</td>
<td>68,310</td>
<td></td>
</tr>
<tr>
<td>Small SUV</td>
<td>65,846</td>
<td>9,346</td>
<td>51,919</td>
<td></td>
</tr>
<tr>
<td>Fullsize SUV</td>
<td>1,548</td>
<td>9,559</td>
<td>24,339</td>
<td></td>
</tr>
<tr>
<td><strong>Switchgrass:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Car</td>
<td>50,663</td>
<td>85,089</td>
<td>58,801</td>
<td>65,176</td>
</tr>
<tr>
<td>Midsize Car</td>
<td>29,966</td>
<td>95,555</td>
<td>39,764</td>
<td>106,174</td>
</tr>
<tr>
<td>Small SUV</td>
<td>35,572</td>
<td>102,416</td>
<td>43,690</td>
<td>80,340</td>
</tr>
<tr>
<td>Fullsize SUV</td>
<td>21,249</td>
<td>50,986</td>
<td>28,058</td>
<td>37,462</td>
</tr>
</tbody>
</table>

\(^a\)Fuel cycle accounts for energy inputs and co-products. Petroleum inputs are accounted as transportation costs using ICV efficiencies while coal, natural gas, and electricity inputs are accounted as transportation costs using BEV efficiencies. Negative distances occur if the distance that could be traveled with fuel cycle inputs (petroleum via ICV and electricity, coal and natural gas via BEV) is greater than the distance traveled with the gross ethanol output.

Table S7. Net transportation for ethanol and bioelectricity accounting for fuel cycle and vehicle cycle energy (km ha\(^{-1}\) y\(^{-1}\))\(^a\).

<table>
<thead>
<tr>
<th></th>
<th>Ethanol-City</th>
<th>Bioelectricity-City</th>
<th>Ethanol-Highway</th>
<th>Bioelectricity-Highway</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corn:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Car</td>
<td>10,231</td>
<td>36,450</td>
<td>19,318</td>
<td>30,315</td>
</tr>
<tr>
<td>Midsize Car</td>
<td>40,393</td>
<td>7,570</td>
<td>41,743</td>
<td></td>
</tr>
<tr>
<td>Small SUV</td>
<td>41,399</td>
<td>7,570</td>
<td>35,648</td>
<td></td>
</tr>
<tr>
<td>Fullsize SUV</td>
<td>1,369</td>
<td>8,648</td>
<td>20,516</td>
<td></td>
</tr>
<tr>
<td><strong>Switchgrass:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Car</td>
<td>40,276</td>
<td>56,328</td>
<td>48,566</td>
<td>46,475</td>
</tr>
<tr>
<td>Midsize Car</td>
<td>23,751</td>
<td>62,882</td>
<td>30,385</td>
<td>64,881</td>
</tr>
<tr>
<td>Small SUV</td>
<td>27,562</td>
<td>64,391</td>
<td>35,385</td>
<td>55,163</td>
</tr>
<tr>
<td>Fullsize SUV</td>
<td>18,799</td>
<td>41,299</td>
<td>25,382</td>
<td>31,578</td>
</tr>
</tbody>
</table>

\(^a\)Vehicle cycle inputs are the product of the fuel cycle distance (Table S6), the per mile vehicle cycle energy input (Table S3), and the vehicle efficiencies (Table S4). Net transportation is not calculated for cases in which the fuel cycle distance (Table S6) is negative.
Table S8. Hybridization efficiency improvement (Conventional : Hybrid) from reported EPA fuel economies8.

<table>
<thead>
<tr>
<th>City</th>
<th>Highway</th>
<th>Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.60</td>
<td>1.25</td>
<td>Honda Civic Hybrid 4 cyl, 1.3 L, Automatic (variable gear ratios), HEV, Regular</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Honda Civic 4 cyl, 1.8 L, Automatic 5-sp, Regular</td>
</tr>
<tr>
<td>1.52</td>
<td>1.06</td>
<td>Nissan Altima Hybrid 4 cyl, 2.5 L, Automatic (variable gear ratios), HEV, Regular</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nissan Altima 4 cyl, 2.5 L, Automatic (variable gear ratios), Regular</td>
</tr>
<tr>
<td>1.89</td>
<td>1.19</td>
<td>Ford Escape Hybrid FWD 4 cyl, 2.5 L, Automatic (variable gear ratios), Regular</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ford Escape FWD 6 cyl, 3 L, Automatic 6-sp, Regular</td>
</tr>
<tr>
<td>1.75</td>
<td>1.16</td>
<td>GMC Yukon 1500 Hybrid 2WD 8 cyl, 6 L, Automatic (variable gear ratios), Regular</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GMC Yukon 1500 2WD 8 cyl, 6.2 L, Automatic 6-sp, Gasoline or E85</td>
</tr>
</tbody>
</table>

Table S9. Net transportation for ethanol and bioelectricity with hybrid efficiencies for the ICV’s and IGCC efficiency for electricity production (mi ha⁻¹ y⁻¹)a.

<table>
<thead>
<tr>
<th>Ethanol-City</th>
<th>Bioelectricity-City</th>
<th>Ethanol-Highway</th>
<th>Bioelectricity-Highway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Car</td>
<td>25,985</td>
<td>43,043</td>
<td>27,290</td>
</tr>
<tr>
<td>Midsize Car</td>
<td>5,272</td>
<td>49,208</td>
<td>1,464</td>
</tr>
<tr>
<td>Small SUV</td>
<td>14,769</td>
<td>48,634</td>
<td>12,114</td>
</tr>
<tr>
<td>Fullsize SUV</td>
<td>10,783</td>
<td>32,442</td>
<td>11,350</td>
</tr>
<tr>
<td>Switchgrass:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Car</td>
<td>62,316</td>
<td>65,941</td>
<td>59,806</td>
</tr>
<tr>
<td>Midsize Car</td>
<td>35,285</td>
<td>76,153</td>
<td>32,220</td>
</tr>
<tr>
<td>Small SUV</td>
<td>49,934</td>
<td>74,979</td>
<td>41,763</td>
</tr>
<tr>
<td>Fullsize SUV</td>
<td>32,171</td>
<td>49,938</td>
<td>29,237</td>
</tr>
</tbody>
</table>

a IGCC efficiency of 40%2 and hybridization efficiency improvements in Table S8.
Table S10. GHG reductions by offsetting gasoline use with gross output from ethanol and bioelectricity pathways (Mg CO$_2$e ha$^{-1}$ y$^{-1}$)$^{a}$.

<table>
<thead>
<tr>
<th></th>
<th>Ethanol-City</th>
<th>Bioelectricity-City</th>
<th>Ethanol-Highway</th>
<th>Bioelectricity-Highway</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corn:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Car</td>
<td>6.9</td>
<td>11.3</td>
<td>6.9</td>
<td>7.5</td>
</tr>
<tr>
<td>Midsize Car</td>
<td>6.9</td>
<td>21.3</td>
<td>6.9</td>
<td>17.9</td>
</tr>
<tr>
<td>Small SUV</td>
<td>6.9</td>
<td>19.3</td>
<td>6.9</td>
<td>12.3</td>
</tr>
<tr>
<td>Fullsize SUV</td>
<td>6.9</td>
<td>16.0</td>
<td>6.9</td>
<td>9.0</td>
</tr>
<tr>
<td><strong>Switchgrass:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Car</td>
<td>10.2</td>
<td>17.4</td>
<td>10.2</td>
<td>11.6</td>
</tr>
<tr>
<td>Midsize Car</td>
<td>10.2</td>
<td>32.8</td>
<td>10.2</td>
<td>27.5</td>
</tr>
<tr>
<td>Small SUV</td>
<td>10.2</td>
<td>29.6</td>
<td>10.2</td>
<td>19.0</td>
</tr>
<tr>
<td>Fullsize SUV</td>
<td>10.2</td>
<td>24.7</td>
<td>10.2</td>
<td>13.9</td>
</tr>
</tbody>
</table>

$^{a}$Based on gasoline offset with a life cycle emission rate of 94.0 g CO$_2$e/MJ gasoline.

Table S11. GHG emissions due to fuel cycle processes (Mg CO$_2$e ha$^{-1}$ y$^{-1}$).

<table>
<thead>
<tr>
<th></th>
<th>Ethanol</th>
<th>Bioelectricity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corn</td>
<td>Switch</td>
</tr>
<tr>
<td>Agriculture</td>
<td>2.70</td>
<td>0.97</td>
</tr>
<tr>
<td>Energy Conversion$^a$</td>
<td>4.33</td>
<td>0.03</td>
</tr>
<tr>
<td>Feedstock Trans.</td>
<td>0.17</td>
<td>0.26</td>
</tr>
<tr>
<td>Ag Co-Products</td>
<td>-1.82</td>
<td></td>
</tr>
<tr>
<td>Refinery Co-Products</td>
<td></td>
<td>-0.54</td>
</tr>
<tr>
<td>Distribution$^b$</td>
<td>0.10</td>
<td>0.15</td>
</tr>
</tbody>
</table>

$^a$Energy conversion step excludes capital equipment and water related energy costs because EBAMM included data for biorefineries but not for electricity power plants. These exclusions are expected to be small relative to other larger fuel cycle and vehicle cycle consumption for ethanol and bioelectricity pathways.

$^b$Ethanol distribution inputs are based on emissions rate of 1.4 g CO$_2$e MJ$^{-1}$.

Table S12. Fuel cycle GHG offsets (gross gasoline offsets - net fuel cycle emissions) (Mg CO$_2$e ha$^{-1}$ y$^{-1}$).

<table>
<thead>
<tr>
<th></th>
<th>Ethanol-City</th>
<th>Bioelectricity-City</th>
<th>Ethanol-Highway</th>
<th>Bioelectricity-Highway</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Corn:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small Car</td>
<td>1.4</td>
<td>8.4</td>
<td>1.4</td>
<td>4.7</td>
</tr>
<tr>
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<td>1.4</td>
<td>18.5</td>
<td>1.4</td>
<td>15.0</td>
</tr>
<tr>
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<td>16.4</td>
<td>1.4</td>
<td>9.5</td>
</tr>
<tr>
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<td>13.2</td>
<td>1.4</td>
<td>6.2</td>
</tr>
<tr>
<td><strong>Switchgrass:</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Small Car</td>
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<td>9.4</td>
<td>10.4</td>
</tr>
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<td>26.2</td>
</tr>
<tr>
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<td>9.4</td>
<td>12.6</td>
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Table S13. Total GHG reductions (gross offset - fuel cycle - vehicle cycle) (Mg CO₂e ha⁻¹ y⁻¹)ᵃ.

<table>
<thead>
<tr>
<th></th>
<th>Ethanol-City</th>
<th>Bioelectricity-City</th>
<th>Ethanol-Highway</th>
<th>Bioelectricity-Highway</th>
</tr>
</thead>
<tbody>
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<td></td>
</tr>
<tr>
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<td>0.7</td>
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<td>1.4</td>
<td>11.5</td>
<td></td>
</tr>
<tr>
<td>Small SUV</td>
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<td>6.8</td>
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<tr>
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<td>11.5</td>
<td>1.1</td>
<td>4.9</td>
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</tr>
<tr>
<td>Fullsize SUV</td>
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<td>20.9</td>
<td>8.5</td>
<td>10.7</td>
</tr>
</tbody>
</table>

ᵃVehicle cycle inputs are the product of the fuel cycle distance (Table S6) and the GREET vehicle cycle emissions² rate 13.1 Mg CO₂e lifetime⁻¹. BEV’s are assumed to have an emissions rate that is 1.65 times the ICV rate. Net transportation is not calculated for cases in which the fuel cycle distance (Table S6) is negative.

References