Life-cycle Assessment of Biomass for Energy Production

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Wood Fuel Use in the Wood Products Industry

• About 50% of wood product manufacturing energy is provided by wood fuel.
• Government policy continues to push the industry away from the use of wood fuel.
• Yet there are significant environmental and economic advantages to using wood fuel.
LCI and LCA offer means to demonstrate environmental and economic value of wood fuel.

- Other issues that can be addressed by the data include:
  - Sustainability
  - Carbon credits, cap and trade, taxes
  - Green material certification
  - Green material purchasing practices
  - Green building standards
CORRIM has a LCI Database for Wood Fuels and their Use
LCI Data for Wood Products

Oxygen

Forest Resource

- CO2 to growing trees

Fuel for harvesting logs

Fuel for log transportation

Veneer, LVL, etc. Manufacturing

Lumber Manufacturing

Plywood Manufacturing

Shaving, sawdust, ply trim, veneer clippings, chips, etc.

Wood, fuel, electricity, resin, wax and water

Fuel for transportation

Wood, fuel, electricity, resin, wax and water

Fuel for transportation

Wood, fuel, electricity, resin, water, etc.

Cabinets, furniture, etc. Manufacturing

Particleboard or MDF Manufacturing

Fuel for transportation

Emissions to air, water, and land

Landfill

Reuse, Recycle, or for Fuel
LCI Data for Wood Products

Emissions to air, water, and land

Oxygen

CO2 to growing trees

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Wood, fuel, electricity, resin, wax, wood and water

Particleboard or MDF Manufacturing

Cabinets, furniture, etc. Manufacturing

Wood, fuel, electricity, resin, water, etc.

Landfill

Reuse, Recycle, or for Fuel
## Fuel Sources in Ground to Produce Wood Products

<table>
<thead>
<tr>
<th></th>
<th>Glulam</th>
<th>Lumber</th>
<th>LVL</th>
<th>Plywood</th>
<th>OSB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MJ/m³</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td>532</td>
<td>224</td>
<td>528</td>
<td>404</td>
<td>1,270</td>
</tr>
<tr>
<td>Crude oil</td>
<td>725</td>
<td>349</td>
<td>759</td>
<td>621</td>
<td>1,883</td>
</tr>
<tr>
<td>Natural gas</td>
<td>1,985</td>
<td>863</td>
<td>1,858</td>
<td>827</td>
<td>3,809</td>
</tr>
<tr>
<td>Uranium</td>
<td>437</td>
<td>21</td>
<td>39</td>
<td>30</td>
<td>114</td>
</tr>
<tr>
<td>Biomass</td>
<td>2,301</td>
<td>2,034</td>
<td>1,973</td>
<td>2,187</td>
<td>3,951</td>
</tr>
<tr>
<td>Hydropower</td>
<td>199</td>
<td>102</td>
<td>252</td>
<td>176</td>
<td>98</td>
</tr>
<tr>
<td>Electricity other</td>
<td>7</td>
<td>6</td>
<td>13</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6,185</td>
<td>3,599</td>
<td>5,421</td>
<td>4,254</td>
<td>11,145</td>
</tr>
</tbody>
</table>

Note: CORRIM Phase I LCI data average of PNW and SE regions.
LCI Database of Wood Fuel Processing and Use

Forest

Lumber Manufacturing
Plywood Manufacturing
OSB Manufacturing
Glulam Manufacturing
I-joist Manufacturing
MDF Manufacturing
Particleboard Mfng.

Biomass Fuels
Slash, bark, hogged, sawdust, shavings, trim, chips, etc.

Boiler, fuel cells, and co-generation
Feedstock

Landfill
## LCI of Fuel Use in Industrial Boilers

Comparing Wood, Natural Gas, and Oil

<table>
<thead>
<tr>
<th>Raw materials</th>
<th>Wood fired kg/GJ</th>
<th>Natural gas fired kg/GJ</th>
<th>Fuel oil fired kg/GJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal in ground</td>
<td>0.0076</td>
<td>0.2254</td>
<td>0.4021</td>
</tr>
<tr>
<td>Natural gas, in ground</td>
<td>0.0755</td>
<td>24.2</td>
<td>1.6393</td>
</tr>
<tr>
<td>Crude Oil, in ground</td>
<td>0.3406</td>
<td>0.2922</td>
<td>23.6</td>
</tr>
<tr>
<td>Uranium, in ground</td>
<td>0.0000011</td>
<td>0.0000009</td>
<td>0.0000016</td>
</tr>
<tr>
<td>Wood and wood waste</td>
<td>48.1</td>
<td>0.0096</td>
<td>0.0169</td>
</tr>
<tr>
<td>Sources</td>
<td>Wood fired kg/GJ</td>
<td>Natural gas fired kg/GJ</td>
<td>Fuel oil fired kg/GJ</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------------------</td>
<td>-------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Emissions to air</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon dioxide, biogenic</td>
<td>100</td>
<td>0.0117</td>
<td>0.0189</td>
</tr>
<tr>
<td>Carbon dioxide, fossil</td>
<td>0.0000</td>
<td>56</td>
<td>77</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>0.6544</td>
<td>0.1210</td>
<td>0.0351</td>
</tr>
<tr>
<td>Methane</td>
<td>0.0000</td>
<td>0.1601</td>
<td>0.0127</td>
</tr>
<tr>
<td>Particulates, &lt; 10 um</td>
<td>0.0081</td>
<td>0.0039</td>
<td>0.0046</td>
</tr>
<tr>
<td>Particulates, unspecified</td>
<td>0.0001</td>
<td>0.0016</td>
<td>0.0051</td>
</tr>
<tr>
<td>NMVOC</td>
<td>0.0000</td>
<td>0.2252</td>
<td>0.1559</td>
</tr>
<tr>
<td>Nitrogen oxides</td>
<td>0.0889</td>
<td>0.1795</td>
<td>0.1004</td>
</tr>
<tr>
<td>Sulfur oxides</td>
<td>0.0042</td>
<td>0.8536</td>
<td>0.1695</td>
</tr>
</tbody>
</table>
Global Warming Potential Index
(carbon dioxide equivalence)

GWPI = CO$_2$ kg + (CH$_4$ kg x 23) + (N$_2$O kg x 296)
Global Warming Potential Index  
(carbon dioxide equivalence)

<table>
<thead>
<tr>
<th>Boiler fuel</th>
<th>GWPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>0</td>
</tr>
<tr>
<td>Natural gas</td>
<td>59</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>78</td>
</tr>
</tbody>
</table>
**PERFORMANCE ASSESSMENT**

- CO2
- CH4
- N2O

- Global Warming
- Acidification
- Eutrophication
- Fossil Fuel Depletion
- Indoor Air Quality
- Water Use
- Smog
- Ozone Depletion
- Human Health

**Environmental Performance Score**

**Overall Score**

**Economic Performance Score**

- Initial Cost
- Future Cost

Source: NIST
Summary

• Environmental benefits to use of wood fuel to generate energy.
• CORRIM has a LCI database for generation of wood fuel from forest and manufacturing facilities.
• CORRIM has a LCI database for wood feedstock.
• Life-cycle assessment of wood fuels can demonstrate their favorable environmental performance in comparison to other fuels.