Wind Energy

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Mean 80-m Wind Speed in North America

## Global Renewable Energy Resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Max Potential (TW)</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind over land &gt; 6.9 m/s (TW)</td>
<td>72</td>
<td>47</td>
</tr>
<tr>
<td>Solar over land (TW)</td>
<td>1700</td>
<td>340</td>
</tr>
<tr>
<td>Geothermal (TW)</td>
<td>160</td>
<td>0.15</td>
</tr>
<tr>
<td>Hydroelectric (TW)</td>
<td>1.9</td>
<td>&lt;1.9</td>
</tr>
<tr>
<td>Wave+tidal (TW)</td>
<td>3.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Global electric power demand (TW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global overall power demand (TW)</td>
<td></td>
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</tr>
</tbody>
</table>
Matching Hourly Electricity Demand in 2020 With 80% Renewables

Hoste et al. (2007)
Aggregate Wind Power (MW) From 81% of Spain’s Grid Versus Time of Day, Oct. 26, 2005
Number of 5 MW Wind Turbines in 7-8.5 m/s winds to Eliminate All U.S. CO$_2$ 2005

- Coal electricity (121-185)
- Natural gas electricity (53-81)
- Oil electricity (3-5)
- Other (139-230)
- Onroad vehicles (battery) (73-144)

Total (2005) 389-645
Percent Change in U.S. CO₂ From Converting to BEVs, HFCVs, or E85

- Wind-BEV: -32.5 to -32.7
- Wind-HFCV: -31.9 to -32.6
- CSP-BEV: -32.4 to -32.6
- PV-BEV: -31.0 to -32.3
- Geo-BEV: -31.1 to -32.3
- Tidal-BEV: -31.3 to -32.0
- Wave-BEV: -31.1 to -31.9
- Hydro-BEV: -30.9 to -31.7
- Nuc-BEV: -28.0 to -31.4
- CCS-BEV: -17.7 to -26.4

- Corn-E85: +0.78 to +30.4
- Cel-E85: -16.4 to +16.4
Low/High U.S. Air Pollution Deaths For 2020 BEVs, HFCVs, E85, Gasoline

2020 U.S. Vehicle Exhaust+Lifecycle+Nuc Deaths/Year

- Nuc-BEV 640-2170-27,540
- CCS-BEV 2880-6900
- Corn-E85 15,000-15,935
- Cel-E85 15,000-16,310
- Gasoline 15,000

Wind-BEV 20-100
Wind-HFCV 80-380
CSP-BEV 80-140
PV-BEV 190-790
Geo-BEV 150-740
Tidal-BEV 320-660
Wave-BEV 390-750
Hydro-BEV 450-860
Corn-E85 15,000-15,935
Cel-E85 15,000-16,310
Gasoline 15,000

0 5000 10000 15000 20000 25000 30000 35000
Area to Power 100% of U.S. Onroad Vehicles

- **Cellulosic E85**: 4.7-35.4% (low-industry est. high-data)
- **Corn E85**: 9.8-17.6%
- **Solar PV-BEV**: 0.077-0.18%
- **Wind-BEV Footprint**: 1-2.8 km²
- **Wind-BEV turbine spacing**: 0.35-0.7%

Map: www.fotw.net
Water Consumed to Run U.S. Vehicles

U.S. water demand = 150,000 Ggal/yr
Overall Scores/Rankings (Lowest is Best)

Overall Score of Technology Combination

Recommended

Not recommended

More at www.stanford.edu/group/efmh/jacobson/revsolglobwarmairpol.htm