Environmental and Grid Ramifications of PHEV-20, 30 & 60 Vehicles in California

Kreider & Associates, LLC
Boulder, CO
27 April, 2006

How people get to work

<table>
<thead>
<tr>
<th>Mode</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car, truck, or van -- drove alone</td>
<td>10,432,462</td>
<td>71.8</td>
</tr>
<tr>
<td>Car, truck, or van -- carpooled</td>
<td>2,113,313</td>
<td>14.5</td>
</tr>
<tr>
<td>Public transportation (including taxicab)</td>
<td>736,037</td>
<td>5.1</td>
</tr>
<tr>
<td>Walked</td>
<td>414,581</td>
<td>2.9</td>
</tr>
<tr>
<td>Other means</td>
<td>271,893</td>
<td>1.9</td>
</tr>
<tr>
<td>Worked at home</td>
<td>557,036</td>
<td>3.8</td>
</tr>
</tbody>
</table>
Different vehicles considered

- **PHEV-20**
  - Maximum electric driving range of 20 miles
  - About 150 pounds of Li-ion batteries
  - Normal charging at 1 kW and 120 VAC

- **PHEV-30**
  - Maximum electric driving range of 30 miles
  - About 220 pounds of Li-ion batteries
  - Normal charging at 1 kW and 120 VAC

- **PHEV-60**
  - Maximum electric driving range of 60 miles
  - Several hundred pounds of NiMH batteries
  - Rapid charging at 4 kW and 240 VAC

---

**PHEV vehicles sold in CA**

![Graph showing annual and cumulative sales of PHEV vehicles in California over 20 years after commercial introduction. The graph includes a peak around 15 years after introduction, with annual sales in the thousands and cumulative sales in millions. The 20-year limit of analysis is indicated.]
Going to work

Increased load on grid

Values shown are hourly increased grid loads due to PHEV-20
Increased load on grid

Values shown are hourly increased grid loads due to PHEV-30

Increased load on grid

Values shown are hourly increased grid loads due to PHEV-60
Increase of residential loads

Example electric loads for large, all-electric house in San Francisco on warm June afternoon with evening PHEV-20 charging

Increase of residential loads

Example electric loads for large, all-electric house in San Francisco on warm June afternoon with evening PHEV-30 charging
Increase of residential loads

Example electric loads for large, all-electric house in San Francisco on warm June afternoon with evening PHEV-60 charging

Total emissions

PHEV-20