Canadian Sponsored Plug-in Hybrids and Their Impact

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Outline

- Some plug-in hybrids; 1897 to 1983
- Four Canadian sponsored projects; 1984 to 1996
- Commercial vehicles
- Impact of the four projects
- Conclusions and recommendations
1905 first parallel hybrid patent
Plug-in Preamble

- 1897-1900 Series by Porsche
- 1905 Parallel by Pieper—motor coaxial with engine
- A number of US projects including GM XP-883?
- 1970 U of T parallel, 10 kWh
- 1976 Congress law mentions hybrids
- 1982 Charge depleting hybrids in report to Congress
- 1982 Blaineville Quebec, Marathon test charge depletion
Seen Birmingham 1982, described SAE 1983 by Lucas and by Victor Wouk at EVS 9 Toronto

Fig. 10 - Schematic of Lucas Chloride Hybrid; can be operated as a series or a parallel hybrid.
Four Projects

- 1988-1990 Gasoline/CNG hybrid minivans; Alcan, UQM, San Diego Gas and Electric
- 1995-1996 CNG hybrid delivery van: BCRI, NRCan, SCBC, BC Gas, SRC, Lordco and Hawker

UQM fame attracted Alcan e.g. 1984 LA Olympics hybrid for marathon (ABC)

After Elton Cairns
Aluminum-Air Hybrid at EVS 9 1988, system sales to Aisin-Seki and Nissan
1988-1990 Gasoline/CNG hybrid minivans; Alcan, UQM, San Diego Gas and Electric

Minivan described EVS 10

Four wheel motors; proposal to UK government 1988
Highway tested Kingston 1992, system sale to Renault

- Driven by two UQM SR218 60 kW traction motors. Natural gas fueled Chevrolet 4.3 liter V6 coupled to a third SR218 motor operating as a generator.
- 57.6 kWh capacity battery.
- From June to December 1995, tried by seven New York State transit operators
- Twelve seats
1995-1996 CNG hybrid delivery van: BCRI, NRCan, SCBC, BC Gas, SRC, Lordco and Hawker
Two Conventional Hybrids in Service for Comparison
### Vehicles in paper on SAE J277a “C” cycle

**Ford FC PHEV on “real cycle”**

<table>
<thead>
<tr>
<th>Hybrid Vehicle</th>
<th>Test Weight (kg)</th>
<th>Battery Weight (kg)</th>
<th>Fraction (%)</th>
<th>kWh</th>
<th>Wh/kg</th>
<th>E Range km*</th>
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</thead>
<tbody>
<tr>
<td>UQM Minivan</td>
<td>2,949</td>
<td>580</td>
<td>19.7</td>
<td>22</td>
<td>38</td>
<td>60</td>
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<tr>
<td>Orion II Bus</td>
<td>10,779</td>
<td>2,037</td>
<td>18.9</td>
<td>57.6</td>
<td>28</td>
<td>43</td>
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<tr>
<td>BOR G-van</td>
<td>3,300</td>
<td>580</td>
<td>17.6</td>
<td>16.4</td>
<td>28</td>
<td>40</td>
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<tr>
<td>Purolator</td>
<td>5,380</td>
<td>99</td>
<td>1.8</td>
<td>2.8</td>
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<td>4</td>
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<tr>
<td>Shuttle Bus</td>
<td>6,550</td>
<td>99</td>
<td>1.5</td>
<td>2.8</td>
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<td>3</td>
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<tr>
<td>FC PHEV</td>
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<td></td>
<td></td>
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<td></td>
<td>0.172 Wh/kg.km</td>
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<tr>
<td>Ford Edge</td>
<td>2,586</td>
<td>130</td>
<td>5.0</td>
<td>15.6</td>
<td>120</td>
<td>35</td>
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</tbody>
</table>

* 60% DOD
Courier Company Vehicles

Average Distance Traveled Per Vehicle Per Year

- Tractors: 185,878
- Straight Trucks: 48,200
- Step Vans: 36,598
- Cube Vans: 42,972
- Cargo Vans: 61,503
- Cars: 61,424

Overall Average Distance Traveled: 51,317 km

Source: Infobase Marketing 2000 Courier Fleet Study
Impact--Lessons from the aluminum-air work

- Fuel cell or engine, more efficient and reduced power density
- Number of cells reduced by using an efficient DC-DC inverter
- Started before the fuel cell came up to power
- Highway driving specifies the power of the prime mover
- Urban delivery is simpler hybrid target than passenger vehicle
- Battery returned to base fully charged on typical urban trips
Impact--California ZEV mandate helped by UQM vehicles

http://www.arb.ca.gov/msprog/zevprog/zevreview/panel_executive_summary.pdf
Conclusions and Recommendations

- Commercial “plug in” or “battery dominant” hybrid projects must be picked carefully. Explore utility trucks and emergency vehicles—1984 ABC vehicle a success----- EV can have grid benefits
- Support of metal-air, CNG and HEV helped changes outside Canada
- Canadian governments should continue to support and encourage both driveline and battery work
- PHEV may spin-off fuel savings from the lighter vehicle structures
- Engage the light structures industry which played a role in the 1980’s
- Communicate!