Plug-in Hybrid Electric Vehicle
IPRO 356

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URL: www.isopomoto.com
IPRO 356/Isopomoto

Mission: To analyze the business opportunities for Plug-In Hybrid Electric Vehicles (PHEV) for the Grainger Power Electronics Lab and AllCell Technologies

Team Structure
- Technical and business divisions
- Collaboration with Illinois Institute of Technology
The Problem

1. Oil Prices:
   - Three fold increase in price, last five years
   - $2.4 billion, the avg. daily cost (U.S)
   - Cost will continue to increase

2. Finite resources:
   - Reserve estimated at 1 trillion barrels
   - 27.7 billion barrels produced in 2004
   - 33 billion bar/yr in 2010, expected

3. Environmental Pollution:
   - Global Climate Change
   - Ozone Depletion
   - Emissions and smog
Our Solution

HEV → PHEV Conversion Kits

- Advanced Technology
  - Externally charged battery

- Wide Application
  - Kit can convert any existing hybrid vehicle

- Value
  - Reduces oil consumption and emissions
Introduction to the PHEV

Battery Pack (Li-ion or NiMH)

PHEV Kit

To Wall

Conventional Hybrid

Source: 2006 EDrive Systems LLC.
HEV Market Potential

HEV Sales: 2000-2005

Cumulative sales of major auto-manufacturers like Toyota and Honda

- Owned by the ‘Hybrid Guru’
- Top selling certified hybrid dealer
Introduction to the Simulation Software (ADVISOR)

• Developed by the National Renewable Energy Laboratory
• Predicts the performance of a vehicle
• Flexibility in design:
  • Choose an engine type
  • Determine an optimal electric motor and a battery
  • Decide a control strategy
  • Select drive cycle and number of cycles
Plug-in Hybrid Escape Simulation Results

Fuel Economy (city)
- Twice as efficient

Emissions
- Cut emissions in half
## Component/Cost Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Cost per kit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery (Li-ion)</td>
<td>245V, 24Ah, 6kWh</td>
<td>10,000</td>
</tr>
<tr>
<td>Power Electronics System (AC/DC Converter)</td>
<td>AC Input Voltage 85 – 264 V AC</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>DC Output Voltage 2 – 48 V DC</td>
<td></td>
</tr>
<tr>
<td>Power Electronics System (DC/DC Converter)</td>
<td>DC Input Voltage 12 V DC</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>DC Output Voltage 350 V DC</td>
<td></td>
</tr>
<tr>
<td>Assembly Labor</td>
<td>$25/hr</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>20hrs per kit</td>
<td></td>
</tr>
<tr>
<td>Insulation / Packaging</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>Miscellaneous Components</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>12,000</strong></td>
</tr>
</tbody>
</table>
ISOPOMOTO - SWOT Analysis

Strengths
- Technical Knowledge
- Productive and committed team

Weaknesses
- Insufficient capital
- Lack of established customer base

Opportunities
- High gasoline prices
- Increased environment awareness

Threats
- Alternative fuels
Major Industry Trends

- The gradual decline of the big 3 (General Motors, Ford, DaimlerChrysler)
- Alternative fuels gain popularity
- Fuel efficiency becomes key selling element (CAFE standards)
  - 27.5 MPG for passenger cars
  - 20.7 MPG for light trucks

Source: Plunkett Research Ltd.
Fuel Efficiency becomes key selling element

Survey Results

- Fuel efficiency: 48.33%
- Maintenance, Repair, Quality, Reliability: 18.33%
- Safety: 15.83%
- Luxury, Features, Comfort, Smooth ride: 15.00%
- Cost, Resale value, Warranty, Economy: 13.33%
- Fast, Speed, Engine, Power, Performance: 10.83%
- Look, Style, Aesthetic, Design: 9.17%
Alternative Fuels

- Ethanol
- Diesel
- Hydrogen Fuel cells
- Bio-diesel
- Electricity – fully electric
- Natural Gas (compressed and liquid)

## ISOPOMOTO – Political, Economic, Social and Technological Analysis

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>IMPACT ON ISOPOMOTO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political</td>
<td></td>
</tr>
<tr>
<td>1. Federal safety regulations (high voltage)</td>
<td>Might delay acceptance</td>
</tr>
<tr>
<td>2. Current tax reduction is $2,000</td>
<td>Will encourage sales</td>
</tr>
<tr>
<td>Economic:</td>
<td></td>
</tr>
<tr>
<td>Illinois is transitioning to a competitive market structure for electricity beginning Jan 1, 2007</td>
<td>Less economic appeal</td>
</tr>
<tr>
<td>Social:</td>
<td></td>
</tr>
<tr>
<td>Trends (Health, Environment etc)</td>
<td>Will encourage sales</td>
</tr>
<tr>
<td>Technological:</td>
<td></td>
</tr>
<tr>
<td>Development of alternative fuels</td>
<td>May reduce sales</td>
</tr>
</tbody>
</table>
Barrier to Entry

Internal factors
- Large capital cost

External factors
- Federal regulation
- Dramatic change in fuel or electricity costs
Risk Analysis

- Internal risks
  - Financial risks
  - Logistical risks
  - Technical risks
    - What if it does not work?
- External risks
  - Legal risks
  - Competitive risks
## Primary Competitors

<table>
<thead>
<tr>
<th>Company</th>
<th>Background</th>
<th>Target Clients</th>
<th>Partnerships</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnergyCS</td>
<td>• First to introduce PHEV commercially</td>
<td>• Toyota</td>
<td>• UK company</td>
</tr>
<tr>
<td>(<a href="http://www.energycs.com">www.energycs.com</a>)</td>
<td>• 2007 target for direct consumer sales</td>
<td>• Ford</td>
<td>• Amberjac Projects Ltd</td>
</tr>
<tr>
<td>Hymotion</td>
<td>• Introduced for fleet use</td>
<td>• Honda</td>
<td>• Calcars</td>
</tr>
<tr>
<td>(<a href="http://www.hymotion.com">www.hymotion.com</a>)</td>
<td>• 2006 direct consumer sales</td>
<td>• Lexus</td>
<td>• Valence Technology</td>
</tr>
<tr>
<td></td>
<td>• Target price for kit is $9,500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Comparison to Primary Competitors

<table>
<thead>
<tr>
<th>Company</th>
<th>Price($)</th>
<th>Fuel Efficiency (city mpg)</th>
<th>Emission Efficiency (g/mile)</th>
<th>Battery type</th>
<th>Battery size (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isopomoto</td>
<td>12,000</td>
<td>124.3 (Toyota Prius) 76.3 (Ford Escape)</td>
<td>Zero Emission (City drive cycle 2.97)</td>
<td>lithium-ion with thermal management</td>
<td>6kWh</td>
</tr>
<tr>
<td>EnergyCS</td>
<td>Goal price : 12,000</td>
<td>112 (Toyota Prius)</td>
<td>Zero Emission</td>
<td>lithium-ion</td>
<td>9kWh</td>
</tr>
<tr>
<td>HyMotion</td>
<td>12,500</td>
<td>100 (Toyota Prius) 60 (Ford Escape)</td>
<td>Zero Emission</td>
<td>lithium-ion</td>
<td>L5 : 5kWh L12 : 12kWh</td>
</tr>
<tr>
<td></td>
<td>Goal Price: 9,500</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(emission efficiency is based on the city driving in 28mile/h)
Comparison to Primary Competitors

Isopomoto - 124.3 mpg
EnergyCS - 112 mpg
HyMotion - 100.6 mpg
Customer Analysis

Three Main Types of Customers have been identified

1. Direct Consumer
2. Fleets
3. Indirect Customer
   i. Partnership with a global auto company
   ii. Licensing to major auto manufacturers
Case Study: Chicago Transit Authority (CTA)

Second largest public transportation system in the U.S.

Over 1.6 million customers and 205,000 miles every weekday

Increase in fuel price generated $9.1 mil. additional operating cost

The Fleet in 2005
- Number of buses: 2033
- Distance covered: 74.8 million miles
- Fuel consumption: 24 million gallons
- Cost of fuel: 43 million dollars
# CTA: Cost Analysis / bus

Fuel saving in 2007 will be $17,127 per bus

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mileage</td>
<td>37,000 mi</td>
<td>37,000 mi</td>
<td>37,000 miles</td>
</tr>
<tr>
<td>(22,400 gas + 14,600 electric)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel efficiency</td>
<td>3.13 mpg</td>
<td>4.9 mpg</td>
<td>4.9 mpg</td>
</tr>
<tr>
<td>4 miles / kwh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel consumption</td>
<td>11,805 gal</td>
<td>7,551 gal</td>
<td>4571.4 gal</td>
</tr>
<tr>
<td>3650 kwh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of fuel</td>
<td>$2.41/gal</td>
<td>$2.41/gal</td>
<td>$2.41/gal</td>
</tr>
<tr>
<td>$80.0838 / kwh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tot_fuel cost</td>
<td>$28,450</td>
<td>$18,198</td>
<td>$11,323</td>
</tr>
<tr>
<td>($11,017 gas + $305 electric)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$10,252 saving  $6,895 saving
Cost Analysis

Start up costs
• Research and development costs
• Initial training of staff
• Facility and property costs
• Office equipment and furniture
• Legal fees

O&M Costs
• Wages and Benefits
• Parts and Shipping for kits
• Advertising
• Utilities
• Office Maintenance
Potential sources of cash include:

- Sales
- Fundraising and grants
- Investors
- Customers
Staffing

- Assembly and installation
  - Troubleshooting
  - Quality Control

- Executive Staff
  - Marketing Team

- Support Staff
  - Advisors
  - HR Manager
Partnership and Alliance

Strategic relationships

Partnership
- Illinois Institute of Technology
  - Pooling of resources

Alliance
- Honda Motorwerks
  - A stake in the partner company
  - Cross promotion and expansion of customer base
  - Preferential treatment and mutual referrals
The future of EnPRO 356/Isopomoto

- Complete the cost analysis
- Recyclable parts
- More robust power electronics
- More options for the end-user
  - Same day installations
  - Vehicle Delivery
  - Rental Arrangements
- Vehicle-to-grid integration (V2G)
Acknowledgements

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Thank You
Questions

www.isopomoto.com