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PHEV parcel delivery truck model - development and preliminary results

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PHEV Parcel Delivery Truck Model – Development and Preliminary Results

Hybrid Truck Users Forum

October 28, 2009
Atlanta, Georgia

Robb Barnitt
NREL

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NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.
Project Design

Laboratory Testing

Modeling and Simulation

Validation

Calibration

Stakeholders

In-use Evaluation
Route Visualization

- Latitude/longitude/speed data filtered, visualized using Google Earth to more completely understand vehicle usage
- Key considerations:
  - Screen out off-days
  - Day-to-day consistency
  - Route “zone” exclusivity

POC - Industry

EMT/SPQ - LA
Drive Cycle Analysis

• Drive cycle comparisons based on average speed and stops/mile lack resolution and precision
• NREL performed comparative analysis of all 62 days of data over 55 drive cycle characteristics

- Average driving speed
- Average cycle speed
- 0 mph time
- Average stop duration
- Stop time bins
- Idle time

Robust Drive Cycle Characterization

- Aerodynamic speed
- Characteristic acceleration
- STDEV of speed
- Max., average, % time accelerations
- Max., average, % time decelerations
- and many more…
HTUF4 and NYCC represent “boundary cycles”
OC Bus cycle most closely matches Custom POC data
# Preliminary FE (ReFUEL)

<table>
<thead>
<tr>
<th>Drive Cycle</th>
<th>gHEV FE (mpg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTUF4</td>
<td>10.5</td>
</tr>
<tr>
<td>Orange County Bus</td>
<td>8.6</td>
</tr>
<tr>
<td>NYCC</td>
<td>6.8</td>
</tr>
</tbody>
</table>
Parcel Delivery Model Development

Propulsion
- Engine
- ESS, motors

Glider
- Frontal area, $C_d$
- Mass
- Axle weight fractions
- Wheels, tires

Auxiliary Loads
- Mechanical
- Electrical

Gearing
- Transmission gear ratios
- Final drive ratio

Control Strategy
Preliminary Simulation Results

- 60 kW is plenty for vehicle and route
- Daily distance traveled matters!

NYCC drive cycle

Graph showing fuel economy vs. battery capacity for different power levels and daily distances.
Preliminary Simulation Results

- Duty cycle matters!
- Daily distance traveled matters!
Preliminary Simulation Results

- Daily distance traveled matters!
- Diminishing returns: larger battery capacity with dVMT
Preliminary Simulation Results

- Duty cycle and dVMT influence capacity decision
- dVMT and lifetime mileage drive ROI
Key Points

- GPS-based route logging, when properly analyzed, allows for effective comparison of existing standard drive cycles and real-world data based drive cycles.
  - Allows for selection of relevant drive cycles for chassis dyno test programs and vehicle simulations, and better matching of vehicle groups in field evaluations.

- Validated vehicle platform model allows for more precise exploration of design-performance tradeoffs.

- Knowledge of drive cycle, daily miles traveled is critical in assessing PHEV battery trade-offs.
  - Increased capacity for improved daily fuel economy.
  - Diminishing returns with daily distance traveled.
  - Vehicle lifetime mileage also drives ROI.
Future Work

1. Vocational and route power and energy requirements
   - Traction
   - Work site
2. AER and blended CD strategies
3. Engine usage changes and emissions impacts
4. Economics
5. Next two platforms.....
Thanks to:

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