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

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Project Design

Labaratory Testing

Modeling and Simulation

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…
ReFUEL Test Cycle Selection

- 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
- 50 miles/day
- 100 miles/day
Preliminary Simulation Results

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

*NYCC drive cycle*

@ 40 miles/day of NYCC: Predicted FE and Battery Energy Relationship

- 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

OC Bus Drive Cycle
- 40 miles/day
- 42 to 82 kWh
- ~50% FE Improvement

NYCC Drive Cycle
- 40 miles/day
- 42 to 82 kWh
- ~38% FE Improvement
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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