Using Data-Focused Tools to Assess Lower Vehicle Energy Use

NTEA Green Truck Summit

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March 5, 2013
Buy it. Then try it.
Evaluations of newly deployed technology are useful but can be backward-looking

Try it before you buy it. Simulate!
Evaluations can also be forward-looking, but good data is needed for accurate assessment
Refined Data to Make Informed Decisions

Data in...

- Drive-Cycle/Duty-Cycle Data
  - Speed
  - Acceleration
  - Grade
  - Miles, hours driven
  - Power take off, auxiliary loads
- Operating-Condition Data
  - Temperature, humidity
  - Payload

Information out...

- Vocational Analysis
  - Route, fleet averages
- Situational Modeling and Simulation
  - Sensitivity studies
  - Placement optimization
  - Expected performance
- Online Resources
  - Clean Cities
    cleancities.energy.gov
  - Alternative Fuels Data Center
    afdc.energy.gov
An Approach to Assess New Technology

1. Collect in-Use Data
   - Acquire field data
   - Process data
     - DRIVE™
     - Fleet Analysis Tool
   - Compile and summarize
     - Fleet DNA

2. Analyze and Simulate
   - Utilize user-specific field data
   - Vehicle simulation
     - FASTSim
     - Autonomie
   - Benefit analysis
     - Best technology for specific application

3. Validate in Laboratory
   - Validate field data in a controlled setting
   - Quantify emissions and fuel consumption
   - Explore limits, assess changes to system

Photo credit: NREL/PIX 22742
Effects of Variable Duty Cycle

1. Fuel economy variation
2. Component life variation
3. Life cycle costs, payback
4. Placement of vehicles for maximum ROI

Understanding duty cycle = Understanding the right technology for application
Fleet DNA

Online vocational database of vehicle-use information

**Phase 1: Presorted Data Sets**

- **Fleet DNA: Vehicle Drive Cycle Analysis**
  - Fleet DNA helps vehicle manufacturers and fleet managers understand the broad operational range of today’s commercial vehicles. This tool offers access to vehicle fleet data summaries and visualizations similar to real-world “genetic” fingerprint of medium- and heavy-duty commercial fleet vehicles operating within a variety of vocations.
  - Click on the vehicle types to access comparative data, summaries, and visualizations. You can also download the full summary and visualizations.
- **Urban Delivery Vans**
  - Delivery Vans
  - Urban Delivery Vans
  - Service Buses
  - Transit Buses
  - Bucket Trucks
  - Telecommunications Vehicles
  - Refuse Trucks
  - Class B & C Trucks

**Phase 2: Sortable Data Sets**

- **Contribute Data**
  - To contribute your fleet data anonymously to help other fleet analysts and improve their drive cycle metrics, contact Tom Philo at TPhilo@nrel.gov.
  - Learn more about the data in the Fleet DNA Case Study.

- **Analyze Data**
  - User interface leads to analysis and sort/transportation filters.
  - FASTSim DRIVE

**Users can custom sort and graph:**
- **Class**
- **Vocation**
- **Fuel type (or drivetrain)**
- **Region (4)**
- **Sub-region (based on census map)**
Fleet DNA Benefits

• OEMs
  – Better understanding of customer-use profiles

• Fleets
  – Determine maximum ROI from investment

• Funding agencies
  – Optimize impact of financial incentive offers

• Researchers
  – Data source for modeling and simulation

Fleet DNA features:
• Aggregated and anonymous data
  – Fleets are not identified
• 20-plus high-value metrics
• Data products for each vocation
• Data for industry drive-cycle development
Fleet DNA Example Data Output: Phase I

- Data products that visualize and calculate vehicle use patterns
- Visualizations that show data variability
- Data analysis enables calculated decision making
Fleet DNA Data Sets

• Class 4-6 Delivery Vans
  Parcel, food, uniform
• Class 3-4 Light Aerials
  Telecom service
• Class 5-6 Aerial
  Utilities
• Class 3 Service Vans
  Telecom
• Class 8 Tractor Trailers
  Beverage delivery
• Class 6 Box Trucks
  In-city delivery
• EV MD Delivery Vans
  Multiple uses

• Class 8 OTR Tractor Trailers
• Transit Buses
• Shuttle Buses
  Airport, specialty
• Refuse Trucks
  Multiple types
• Tow Trucks

• Class 8 OTR Tractor Trailers
• Transit Buses
• Shuttle Buses
• Refuse Trucks
• Tow Trucks
• High PTO Use Work Trucks

DOE’s Data Priorities:
• National fuel consumption
• Payback/ROI success
• Scalable or transferable technology
### Required Data

Typical data required for inclusion into Fleet DNA:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency</th>
<th>Source</th>
<th>Required</th>
<th>Desired</th>
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<tbody>
<tr>
<td>Time</td>
<td>1 hz</td>
<td>CAN / J1939</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>1 hz</td>
<td>CAN / J1940</td>
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<td></td>
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<tr>
<td>Vehicle ID</td>
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<td>CAN / J1941</td>
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<td></td>
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<tr>
<td>Vehicle Speed (MPH)</td>
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<td>CAN / J1942</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Engine Speed (RPM)</td>
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<td>CAN / J1943</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Engine Mode (on/off)</td>
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<td>CAN / J1944</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Instantaneous Fuel Usage (gram)</td>
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<td>CAN / J1945</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Cumulative Fuel Usage (litre)</td>
<td>1 hz</td>
<td>CAN / J1946</td>
<td>x</td>
<td></td>
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<tr>
<td>PTO Engage (y or n) if applicable</td>
<td>1 hz</td>
<td>CAN / J1947</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>PTO % (if applicable)</td>
<td>1 hz</td>
<td>CAN / J1948</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Elevation</td>
<td>1 hz</td>
<td>CAN / J1949</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>GPS Latitude</td>
<td>1 hz</td>
<td>GPS</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>GPS Longitude</td>
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<td>x</td>
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<tr>
<td>GPS HDOP</td>
<td>1 hz</td>
<td>GPS</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

- Data may vary by application/situation
- Other data can be useful
  - Torque demands, ambient temp, gear, etc.
Hardware Requirements

• NREL hardware
  – CAN/analog data loggers gather basic drive cycle data + additional if desired
  – TSI 747 Pro (GPS-only units)

• Other options
  o Use existing telematics
  o Leverage existing large-scale, long-term tracking efforts
Data Analysis: Drive-Cycle Data

- Helps fleets, OEMs understand vehicle use
  - For proper placement, design, and testing
- Combines large amounts of user data
  - Filters/creates new cycles
- Quickly processes/analyzes data
- Integrates with Fleet DNA for public use

Image credit: NREL
Data Analysis: Simulation

• FASTSim
  – Vehicle modeling tool
  – Well suited for large data sweeps
  – Short run time in accessible Excel environment
  – Validated performance outputs
    ▪ Fuel economy
    ▪ Cost results
For Example: Fleet DNA and GTA

Three Steps

1. GTA identifies/recruits interested fleet/technology for analysis
2. Fleet DNA provides drive-cycle analysis to fleet
3. Fleet DNA performs simulation of vocational data set to **assess benefits** of technology for specific usage patterns

**Fleet DNA analyzes** aerodynamic improvement, rolling resistance, engine sizing, mass reduction, driving behavior, idle reduction, alternative fuels, and more...
• Provides **fleets, OEMs, and researchers** with refined data and analysis of need-specific options
• Creates/maintains **accessible database** for public use
• Recommends drive cycles
• Identifies **most appropriate technologies** for observed drive-cycle data
## Interested in Participating?

### Preliminary Fleet DNA Participants

<table>
<thead>
<tr>
<th>• Calstart</th>
<th>• SCAQMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>• CARB</td>
<td>• ORNL</td>
</tr>
<tr>
<td>• DOE</td>
<td>• Zonar</td>
</tr>
<tr>
<td>• NTEA/GTA</td>
<td>• Many other fleets</td>
</tr>
<tr>
<td>• Many other OEMs</td>
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</tr>
</tbody>
</table>

**Add your name here.**

Stop by the Clean Cities booth (3605) this week, or email kevin.walkowicz@nrel.gov
Thank you!
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