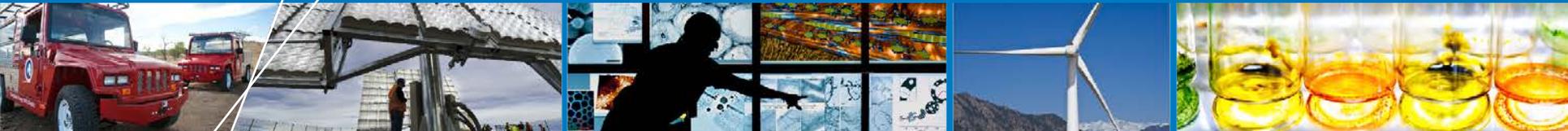


Using Data-Focused Tools to Assess Lower Vehicle Energy Use



NTEA Green Truck Summit

Kevin Walkowicz

March 5, 2013

NREL/PR-5400-58031

Background

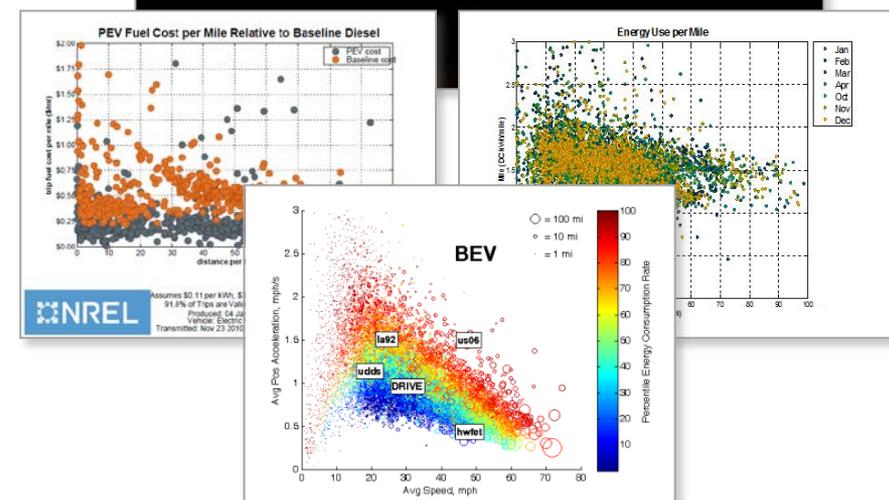
Project Startup: Evaluating Coca-Cola's Class 8 Hybrid-Electric Delivery Trucks
Although the largest trucks - Class 8, with a gross vehicle weight rating (GVWR) above 33,000 lb.-make up only 1% of

Advanced Technology Vehicles in Service
Advanced Vehicle Testing Activity
FreedomCAR

King County Metro Transit
DIESEL HYBRID ELECTRIC BUSES

NYCT Diesel Hybrid-Electric Buses
Final Results

Results: Evaluating Express Hybrid-Electric Trucks



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

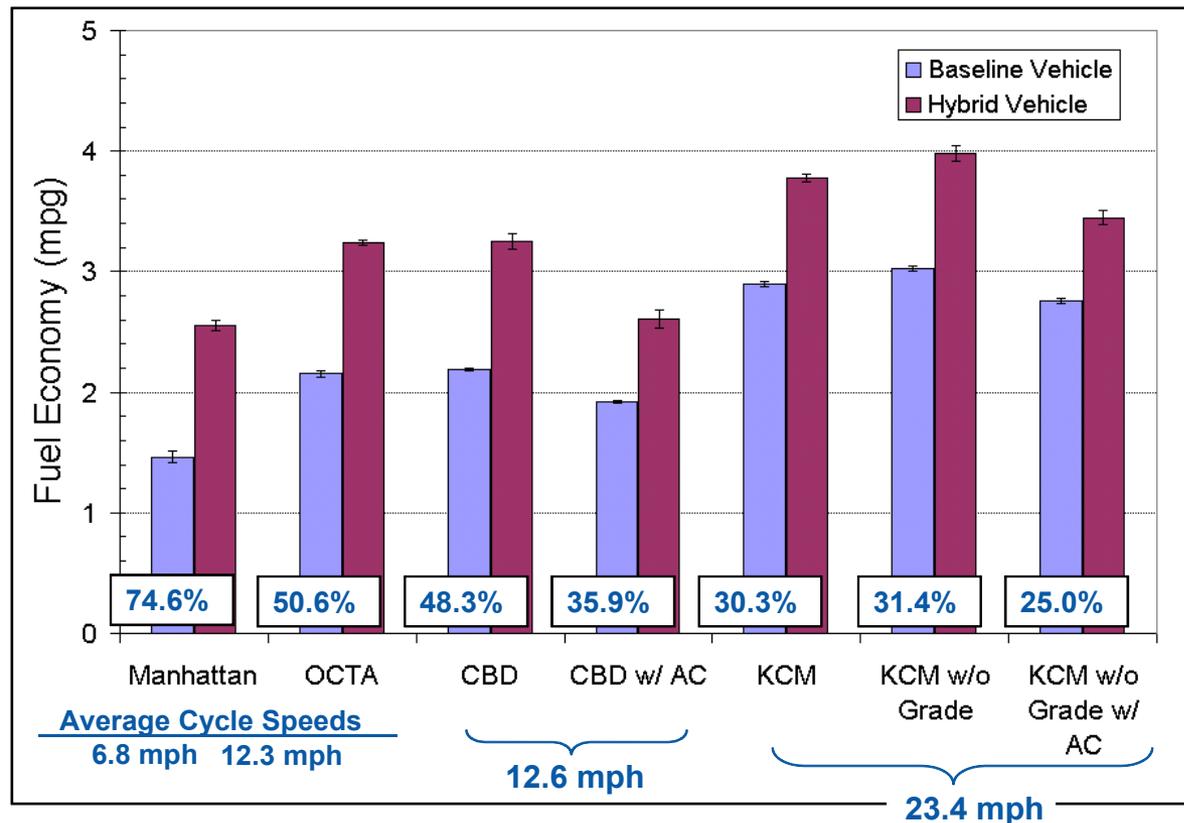


3. Validate in Laboratory

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

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

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

ABOUT NREL | ENERGY ANALYSIS | SCIENCE & TECHNOLOGY | TECHNOLOGY TRANSFER | APPLYING TECHNOLOGIES | ENERGY SYSTEMS INTEGRATION

Advanced Vehicles & Fuels Research

Fleet Test & Evaluation

1 Fleet Test and Evaluation Home

Fleet DNA: Vehicle Drive Cycle Analysis

Fleet DNA helps vehicle manufacturers and fleet managers understand the broad operational range for many of today's commercial vehicles. This tool offers access to vehicle fleet data summaries and visualizations similar to "real-world" "genetics" for medium- and heavy-duty commercial fleet vehicles operating within a variety of vocations.

Contribute Data

To contribute your fleet data anonymously to help other fleets analyze and improve their drive cycle metrics, contact [Kevin Walkowitz](mailto:Kevin.Walkowitz@nrel.gov), 903-275-4492.

Learn about the data in the [Fleet DNA Data Dictionary](#).

Analyze Data

Use these tools to analyze and sort transportation data:

- FASTsim
- DRIVE

Urban Delivery Vans

Fleet DNA has data for 350 urban delivery vans operating in 3 regions in the United States.

- Composite Data
- Data Summary and Visualizations

Related Studies

Learn more about the drive cycle metrics of urban delivery vans through these studies:

- First Study Name
- Second Study Name
- Third Study Name

Vehicle Categories: Delivery Vans, Urban Delivery Vans, School Buses, Transit Buses, Bucket Trucks, Telecommunications Vehicles, Refuse Trucks, Class 8 Trucks.

Phase 2: Sortable Data Sets

REPORTING | ADD DATA

CLASS | VOCATION | FUEL TYPE | REGION | DIVISION

VOCATION	PROVIDERS	VEHICLES	DAYS	LEGEND
Urban Delivery	5	22	397	
Telecom	2	50	68	
School Bus	4	55	75	
Urban Delivery	1	35	425	
Urban Delivery	1	35	425	

PERCENT OF TOTAL

TRIP FREQUENCY

HOURLY OF DAY | HOURLY OF WEEK

GRAPH TYPE: SCATTER | BAR | 2D | 3D

AXIS TYPE: zero_seconds, total_average_speed, total_average_speed

UPDATE

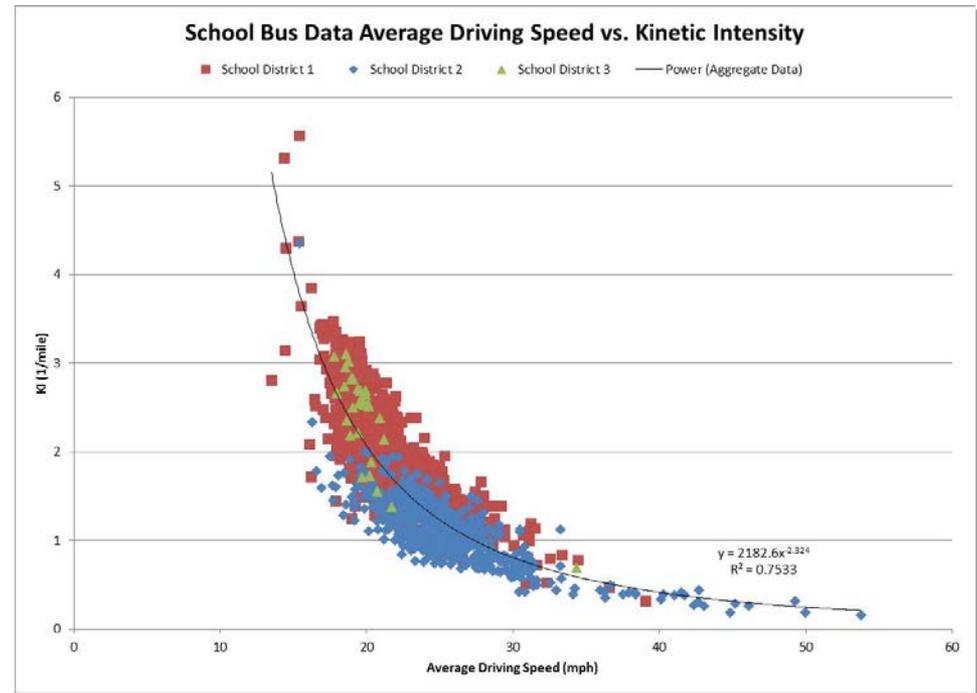
VOCATION	VEHICLE	TRIPS	DAYS	AVG SPEED
Urban Delivery	1	18	7	15
Urban Delivery	2	15	6	12
Urban Delivery	3	6	2	24
Urban Delivery	4	19	14	26
Urban Delivery	5	22	17	17
Telecom	6	10	4	33
Telecom	7	15	9	55
Telecom	8	36	18	47
Telecom	9	35	20	46

Users can custom sort and graph:

- Class
- Vocation
- Fuel type (or drivetrain)
- Region (4)
- Sub-region (based on census map)

Fleet DNA Benefits

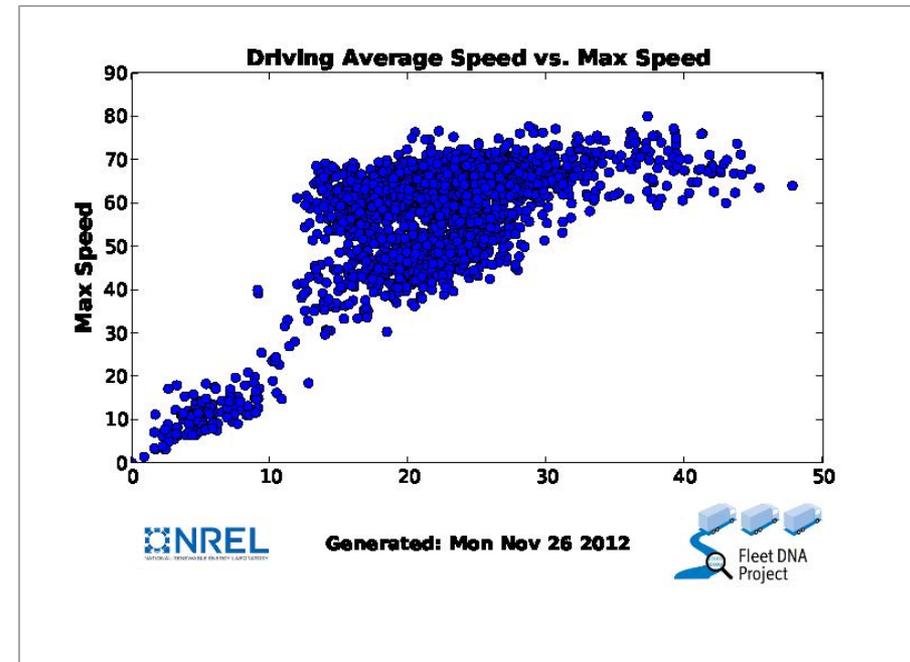
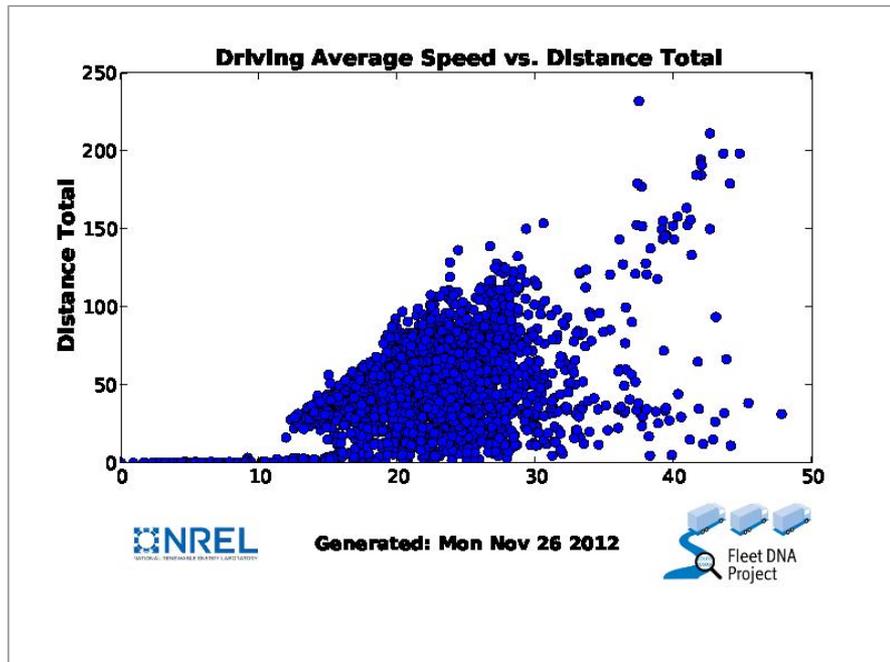
- OEMs
 - Better understanding of customer-use profiles
- Fleets
 - Determine maximum ROI from investment
- Funding agencies
 - Optimize impact of financial incentive offers
- Researchers
 - Data source for modeling and simulation



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:

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

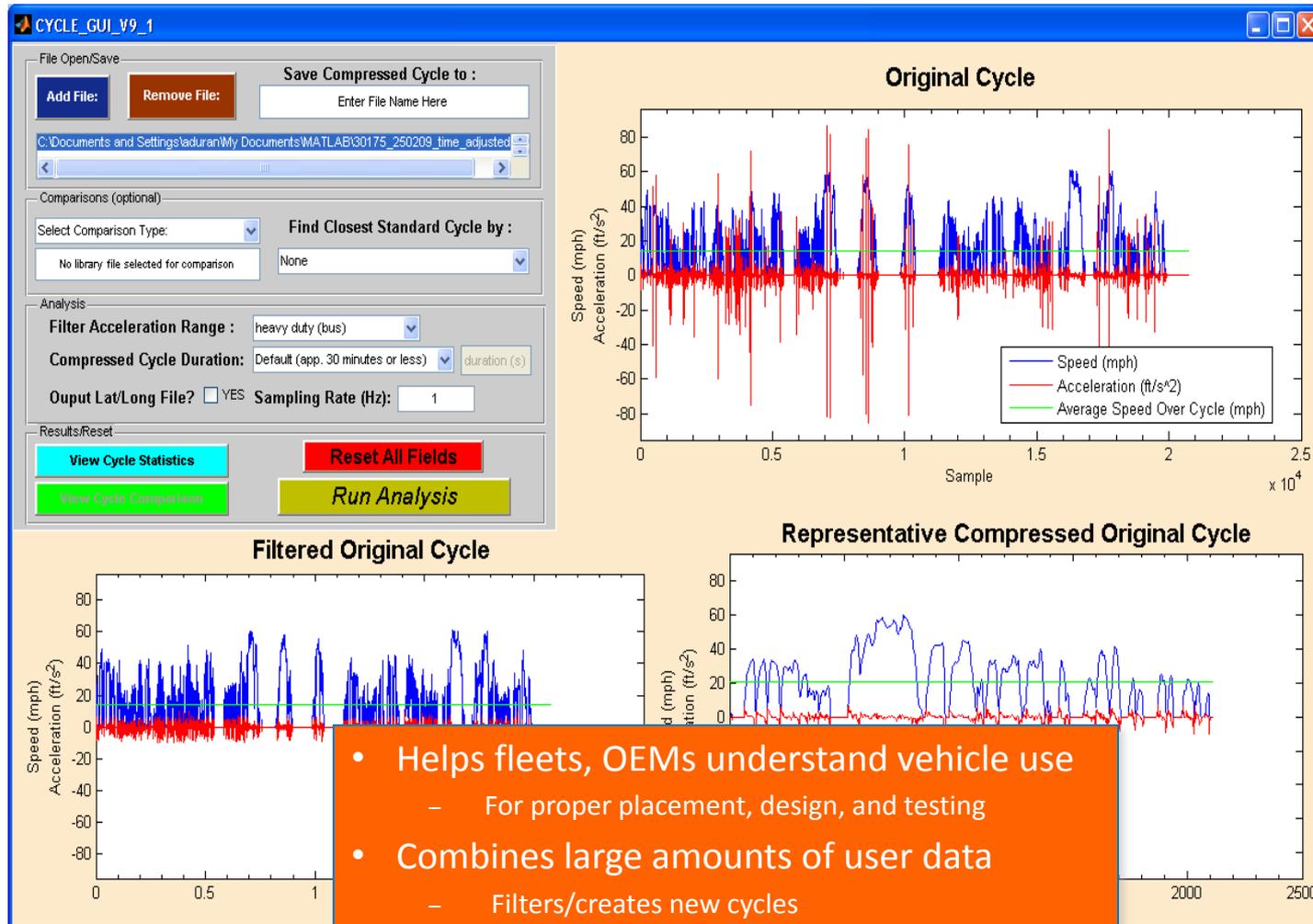
- Data may vary by application/situation
- Other data can be useful
 - Torque demands, ambient temp, gear, etc.

Hardware Requirements

- NREL hardware
 - CAN/analog data loggers gather basic drive cycle data + additional if desired
 - TSI 747 Pro (GPS-only units)
- Other options
 - Use existing telematics
 - Leverage existing large-scale, long-term tracking efforts



Data Analysis: Drive-Cycle Data

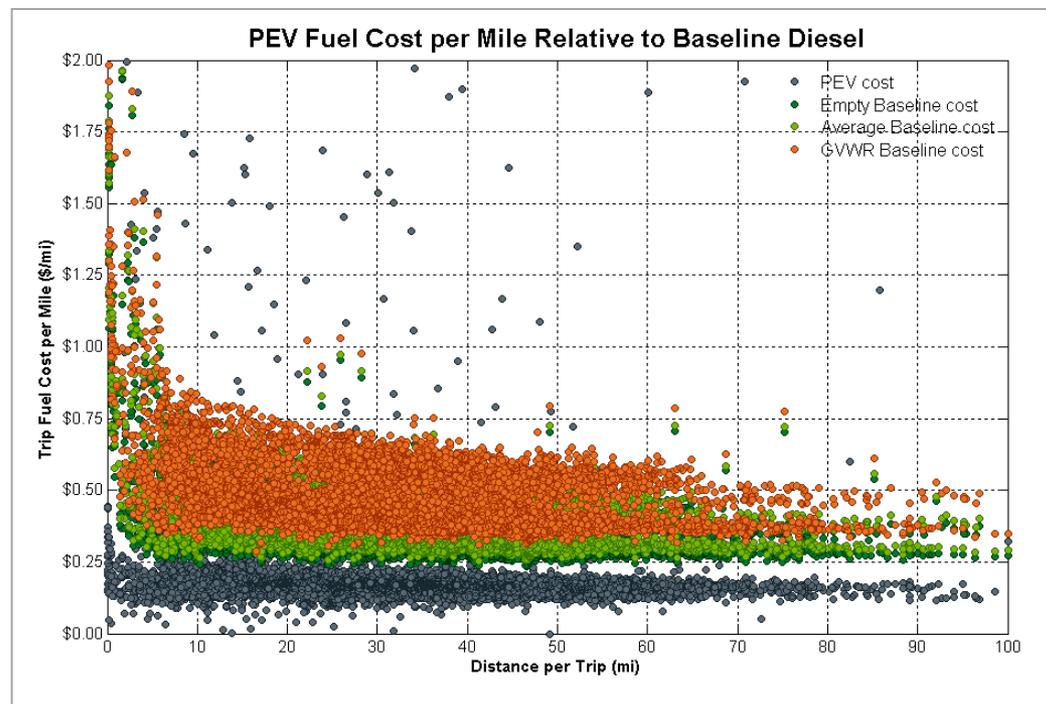


- Helps fleets, OEMs understand vehicle use
 - For proper placement, design, and testing
- Combines large amounts of user data
 - Filters/creates new cycles
- Quickly processes/analyzes data
- Integrates with Fleet DNA for public use

Image credit: NREL

Data Analysis: Simulation

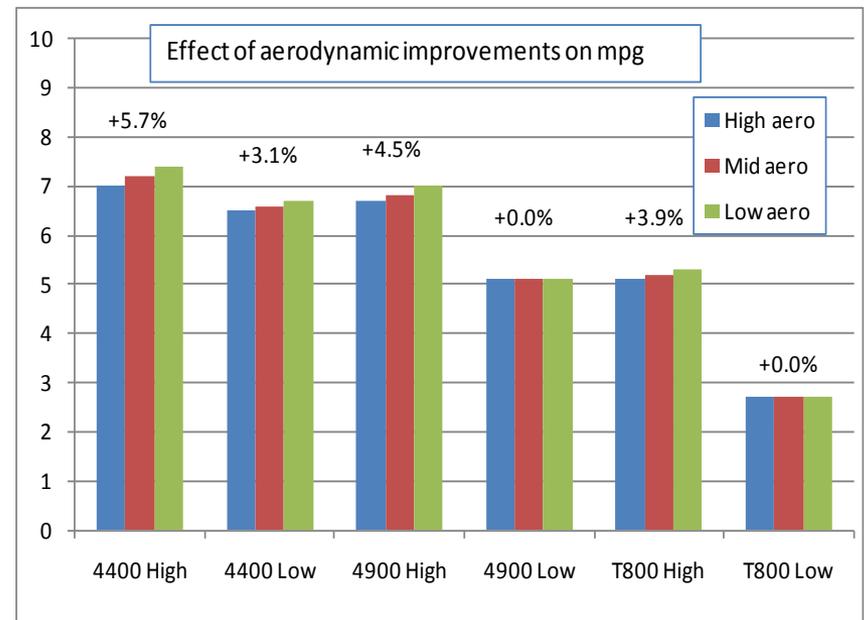
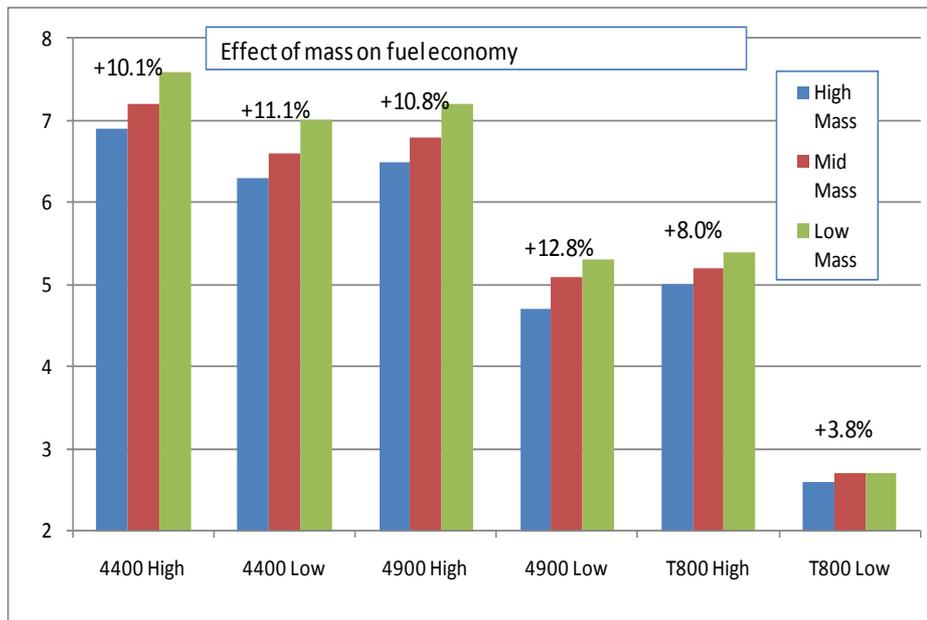
- FASTSim
 - Vehicle modeling tool
 - Well suited for large data sweeps
 - Short run time in accessible Excel environment
 - Validated performance outputs
 - Fuel economy
 - Cost results



For Example: Fleet DNA and GTA

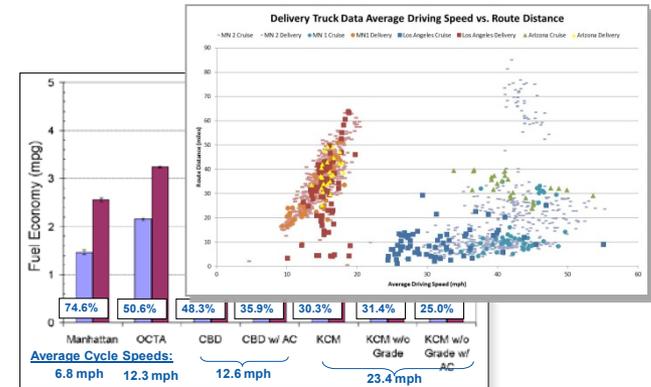
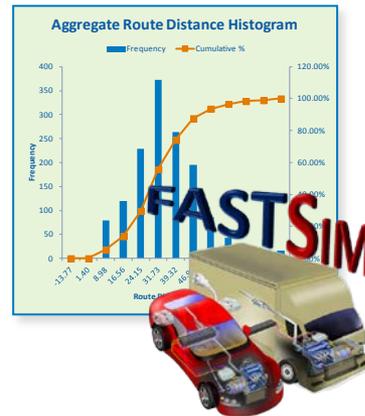
Three Steps

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...

Result: Calculated Decision Making

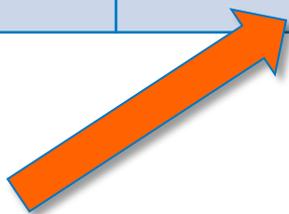


- Provides **fleets, OEMs, and researchers** with refined data and analysis of need-specific options
- Creates/maintains **accessible database** for public use
- Recommends drive cycles
- Identifies **most appropriate technologies** for observed drive-cycle data

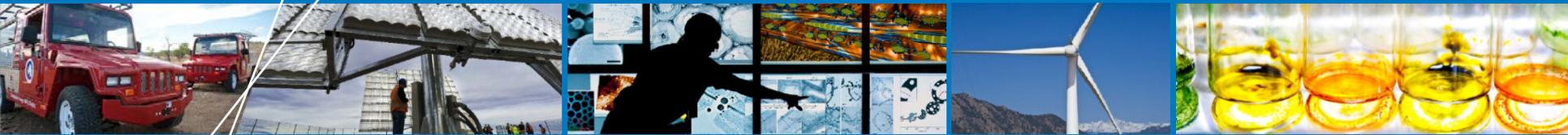
Interested in Participating?

Preliminary Fleet DNA Participants	
• Calstart	• SCAQMD
• CARB	• ORNL
• DOE	• Zonar
• NTEA/GTA	• Many other fleets
• Many other OEMs	

**Add your
name here.**



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



Thank you!

Kevin Walkowicz

Fleet Testing and Evaluation Team Lead

National Renewable Energy Laboratory

Golden, Colorado

kevin.walkowicz@nrel.gov