



NREL Transportation and Vehicles: Fleet DNA & Commercial Vehicle Technologies

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NREL Transportation and Vehicle RD&D Activities

Advanced Combustion / Fuels

*Advanced Petroleum and Biofuels
Combustion / Emissions Measurement
Vehicle and Engine Testing*

Advanced Power Electronics and Electric Motors

*Thermal Management
Advanced Heat Transfer
Thermal Stress and Reliability*

Advanced Energy Storage

*Thermal Characterization / Management
Life/Abuse Testing and Modeling
Computer Aided Engineering
Electrode Material Development*

Commercial Vehicle Technologies

*Technology Field Testing & Analysis
Big Data Collection, Storage & Analysis
Vehicle Systems Modeling
Super Truck and 21st Century Truck
Vehicle Thermal Management*

Hydrogen and Fuel Cells

*Fuel Cell Electric Vehicles
Fuel Cell Buses
Fueling Infrastructure
Hydrogen Systems and
Components
Safety, Codes and Standards*

Mobility Systems

*Connected and Autonomous Vehicles
Vehicle Systems Modeling
Technology Adoption
Cost of Ownership Modeling
SMART Cities Columbus*

Regulatory Support

*EPAct Compliance
Data & Policy Analysis
Technical Integration
Fleet Assistance*

Infrastructure and Impacts Analysis

*Vehicle-to-Grid Integration
Integration with Renewables
Charging Equipment & Controls
Fueling Stations & Equipment*

Vehicle Deployment / Clean Cities

*Guidance & Information for Fleet Decision
Makers and Policy Makers
Technical Assistance
Online Data, Tools, Analysis*



Medium- and Heavy- Vehicle Field Testing and Evaluations

Evaluate the performance of alternative fuels and advanced technologies in medium- and heavy-duty fleet vehicles - in partnership with commercial and government fleets and industry groups vehicles.

Collect, analyze and publicly report data:

- Drive cycle and system duty cycle analysis
- Operating cost/mile
- In-use fuel economy
- Chassis Dynamometer emissions and fuel economy
- Scheduled and unscheduled maintenance
- Warranty issues
- Reliability (% availability, MBRC)
- Implementation issues/barriers
- Subsystem performance data & metrics (ESS, engine, after-treatment, hybrid/EV drive focus)

Data stored in FleetDNA for security and limited public accessibility

Frequent interactions and briefings with stakeholders – fleets, technology providers, researchers, and government agencies

Fleets

UPS, FedEx, Coke, Frito-Lay, Foothill Transit, PG&E, Long Beach Transit, Miami-Dade, Verizon, Walmart, Waste Management...

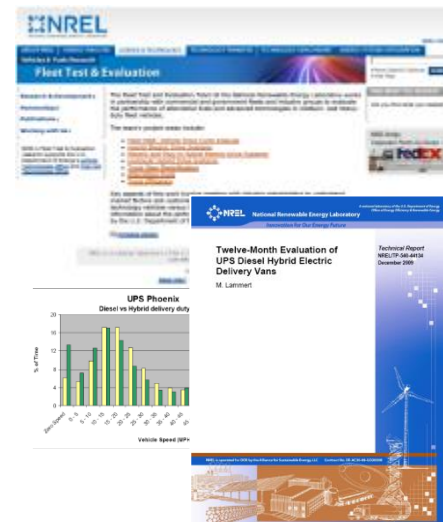
+

Vehicle & Equip
Mfg's

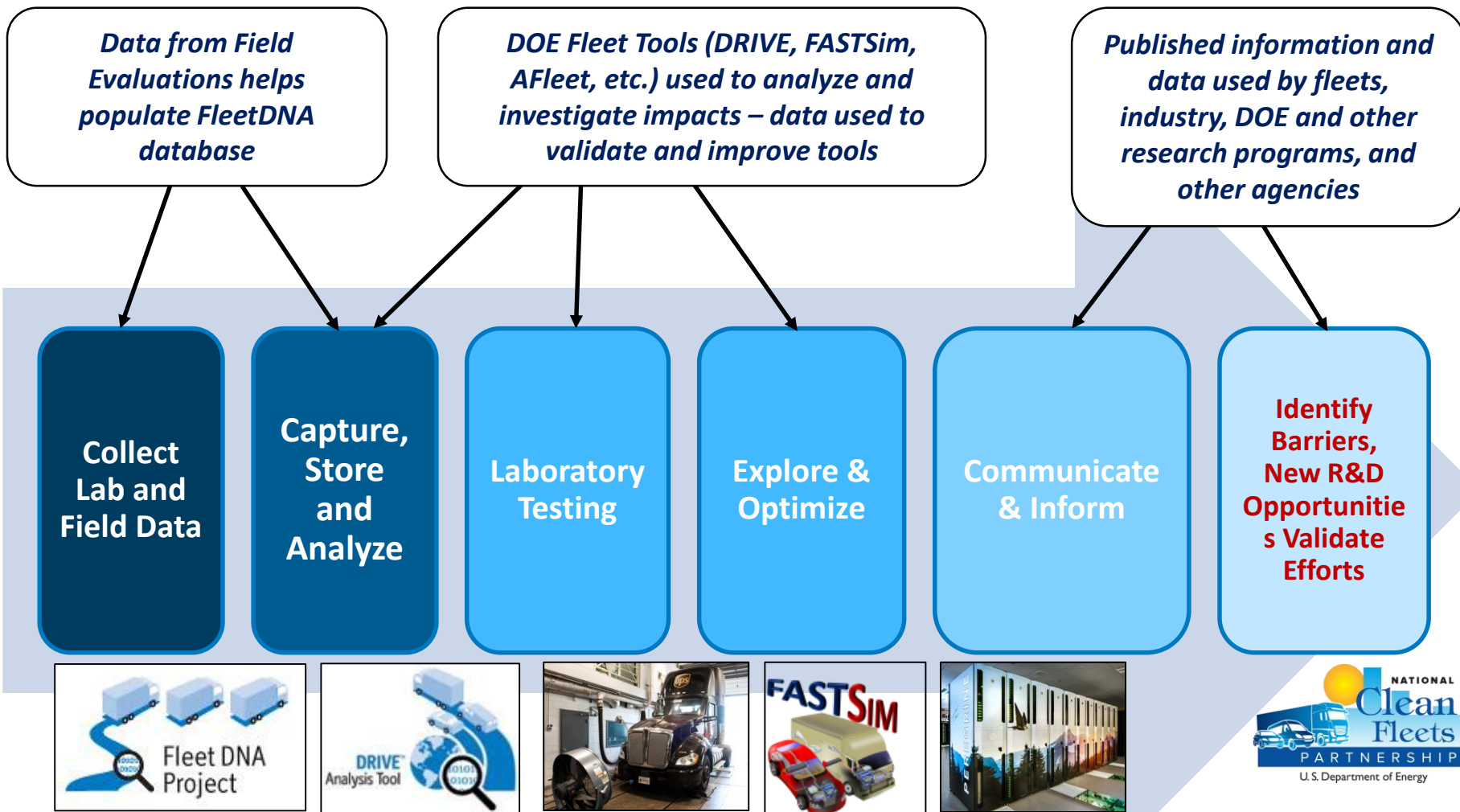
Proterra, BYD, Odyne, Parker-Hannifin, Cummins, Volvo, Peterbilt, Smith EV, Eaton, Allison, BAE, EDI, Altec, Navistar, PACCAR, Oshkosh, ...

||

Useful
Data,
Analysis
and
Published
Reports



NREL Field Data, Testing, & Analysis Tools



Partnership with Fleets and Technology Providers = Relevant Results & Optimized Solutions for Real World Applications



Bringing Fleet Data to Life – Fleet DNA

Objectives:

- Capture and quantify drive cycle and technology variation for the multitude of medium- and heavy-duty vocations
- Provide a common data storage warehouse for medium- and heavy-duty vehicle data across DOE activities and labs – www.nrel.gov/fleetsdna
- Integrate existing DOE tools, models, and analyses to provide data driven decision making capabilities

For Government : Provide in-use data for standard drive cycle development, R&D, tech targets, and rule making

For OEMs: Real-world usage datasets provide concrete examples of customer use profiles

For Fleets: Vocational datasets help illustrate how to maximize return on technology investments

For Funding Agencies: Reveal ways to optimize impact of financial incentive offers

For Researchers: Provides a data source for modeling and simulation

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Transportation Research

4 Transportation Research Home

Capabilities

Projects

- Deployment
- Electric Vehicle Grid Integration
- Energy Storage
- Fleet Test & Evaluation
 - Hybrid Electric Vehicles
 - Electric & Plug-In Hybrid Vehicles
 - Hydraulic Hybrid Vehicles
 - Alternative Fuel Vehicles
- Vehicle Operating Data
 - Truck Platooning
 - Truck Stop Electrification
 - Publications
 - Fuels Performance
 - Power Electronics & Electric Machines
 - Sustainable Mobility Systems Analysis & Integration
 - Vehicle Thermal Management

Success Stories

Facilities

Working with Us

Publications

Data & Tools

News

Fleet DNA: Commercial Fleet Vehicle Operating Data

The Fleet DNA clearinghouse of commercial fleet vehicle operating data helps vehicle manufacturers and developers optimize vehicle designs and helps fleet managers choose advanced technologies for their fleets. This online tool provides data summaries and visualizations similar to real-world "genetics" for medium- and heavy-duty commercial fleet vehicles operating in a variety of vocations.

Contribute Data
Learn how to [contribute to Fleet DNA](#) anonymously to help other fleets analyze and improve their drive cycle metrics.

Data by Vehicle Category
View and download data, charts, and reports by vehicle category.

 Delivery Vans	 Delivery Trucks	 School Buses	 Transit Buses
 Bucket Trucks	 Service Vans	 Tractors	 Refuse Trucks

Composite Data for All Categories
View charts with data for all the vehicle categories above or download the [composite data for all vehicles](#). Fleet DNA has 4,705 days of driving data from 486 vehicles operating in the United States.

 Daily Average Driving Speed and Kinetic Intensity for All Vehicle Categories	 Daily Stops per Mile Distribution for All Vehicle Categories	 Average Acceleration and Number of Stops for All Vehicle Categories
 Average Acceleration and Driving Speed for All Vehicle Categories	 Daily Stops Per Mile and Kinetic Intensity for All Vehicle Categories	 Daily Stops Per Mile and Average Driving Speed for All Vehicle Categories
 Daily Operating Distance Distribution for All Vehicle Categories	 Maximum Driving Speed Distribution for All Vehicle Categories	 Daily Average Driving Speed Distribution for All Vehicle Categories
 Daily Total Number of Stops and Operating Time for All Vehicle Categories	 Daily Total Number of Stops and Distance Traveled for All Vehicle Categories	 Daily Average Driving Speed and Distance Traveled for All Vehicle Categories

www.nrel.gov/fleetsdna

NREL / SCAQMD Port Drayage Projects

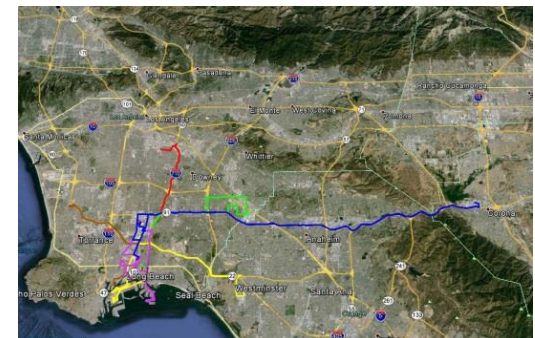
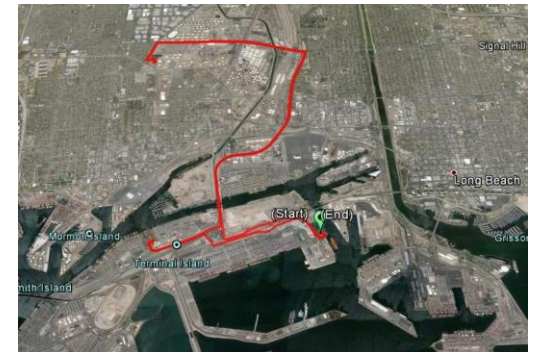
Zero Emissions Cargo Transport (ZECT)

- Objectives
 - Develop and demonstrate zero emission drayage truck technologies in real world cargo transport operations – Port of LA/Long Beach
 - Measure and analyze vehicle performance (NREL)
 - Accelerate the deployment of zero emission technologies in port drayage operations
- Includes Heavy-duty EV, Fuel Cell range extenders, and CNG hybrids



SCAQMD - NREL FleetDNA Roadmap

- Objectives – *apply NREL FleetDNA approach to:*
 - match powertrains and advanced technology with observed duty cycles of medium- and heavy-duty trucks.
 - enable intelligent deployment of advanced technology to maximize fuel economy and emissions reductions in the South Coast air basin
 - Currently collecting vehicle duty-cycle data on **port drayage**, transfer trucks, and delivery vehicles



NREL Baseline Data Collection - Port Drayage

- Instrumented 32 Class 8 Tractors
- 588 vehicle days of 1Hz GPS and vehicle CAN data
- Multiple OEMs
 - Navistar, Volvo, Mack, Freightliner, Peterbilt & Sterling
 - 2 CNG vehicles (not included in fuel analysis)
- Mixture of automatic, automated and manual transmissions



Port Drayage Example

- **71,243 Miles**
- **557 Operating Days**
- **30 Unique Vehicles**
- **3 Operating Companies**
- **Port of Long Beach & Port of Los Angeles**

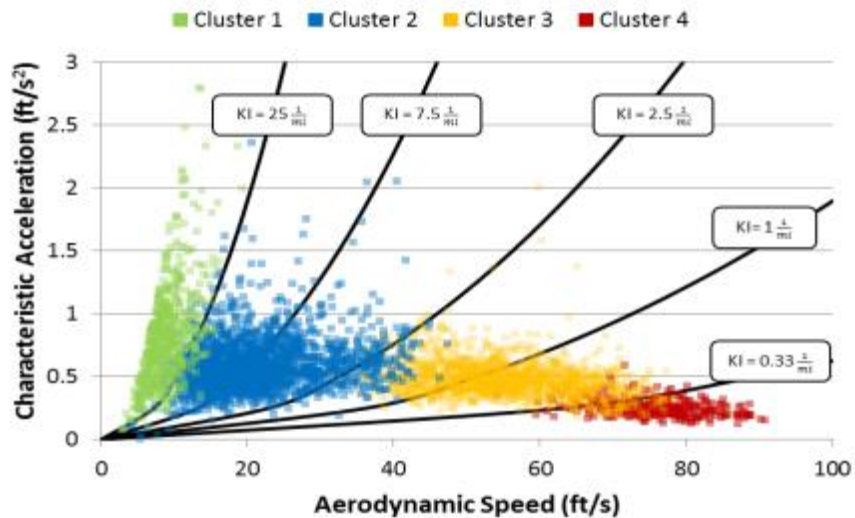


Vocation	Operator	Locations	Weeks	Vehicles	Operating Days
Port Drayage	TTSI	Compton, CA	16	2	166
	Container Freight (California Cartage)	Long Beach, CA	4	14	180
	Dependable Highway Express	Wilmington, CA	4	14	211

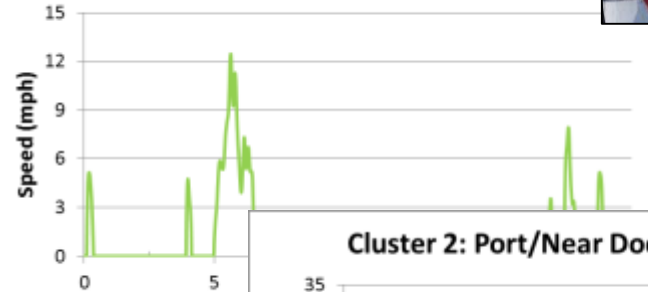
NREL Drive Cycle Analysis - Clustering



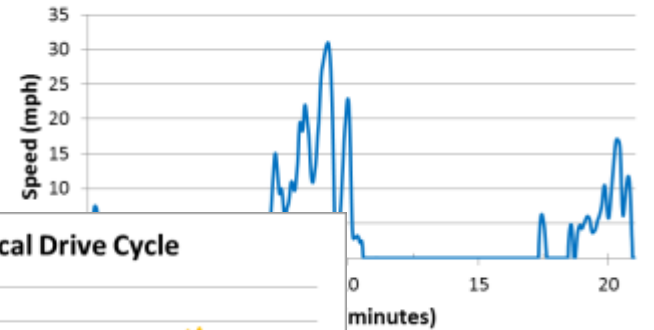
Characteristic Acceleration vs Aerodynamic Speed



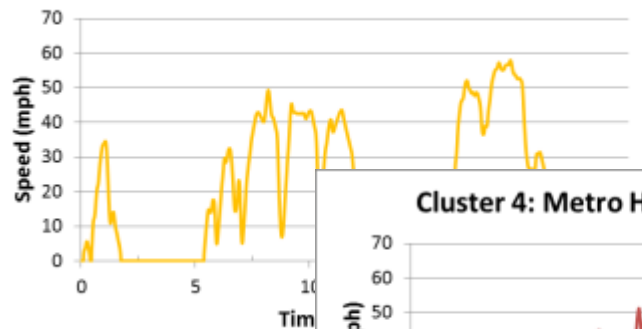
Cluster 1: Creep/Queue Drive Cycle



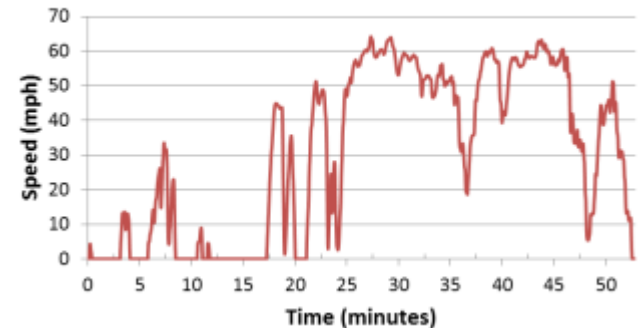
Cluster 2: Port/Near Dock Drive Cycle



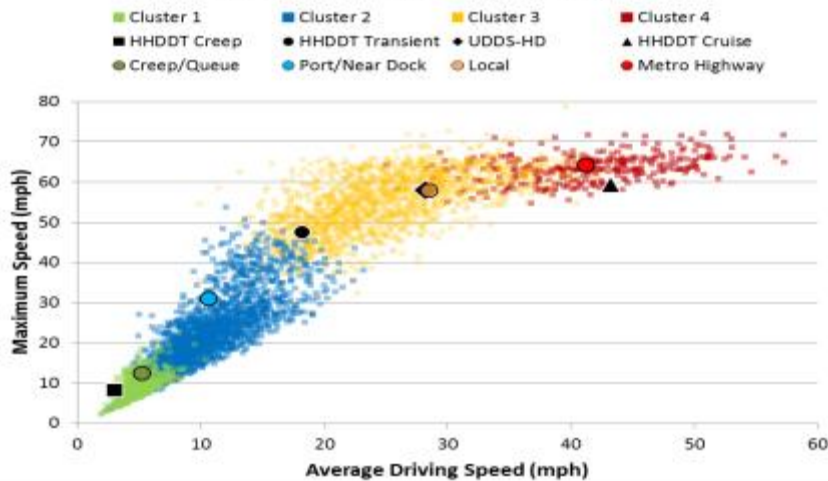
Cluster 3: Local Drive Cycle



Cluster 4: Metro Highway Drive Cycle



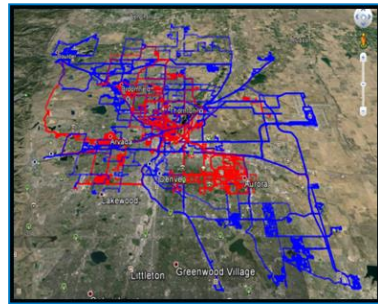
Maximum Speed vs Average Driving Speed



Exploring Options – NREL FASTSim



Future Automotive Systems Technology Simulator (FASTSim)



Step 3:

Use real world, duty cycle data for model tuning

- Drive cycle based results
- Fast and easy to use

Step 1:

Input Vehicle & component details -

- Powertrain type
- Power rating
- Energy storage
- Vehicle size & weight
- Wheel/Tire info
- Auxiliary loads and more....

FASTSIM



Step 4:

Evaluate outputs -

- Fuel Economy
- Driving Performance
- EV Range
- Drive cycle matching

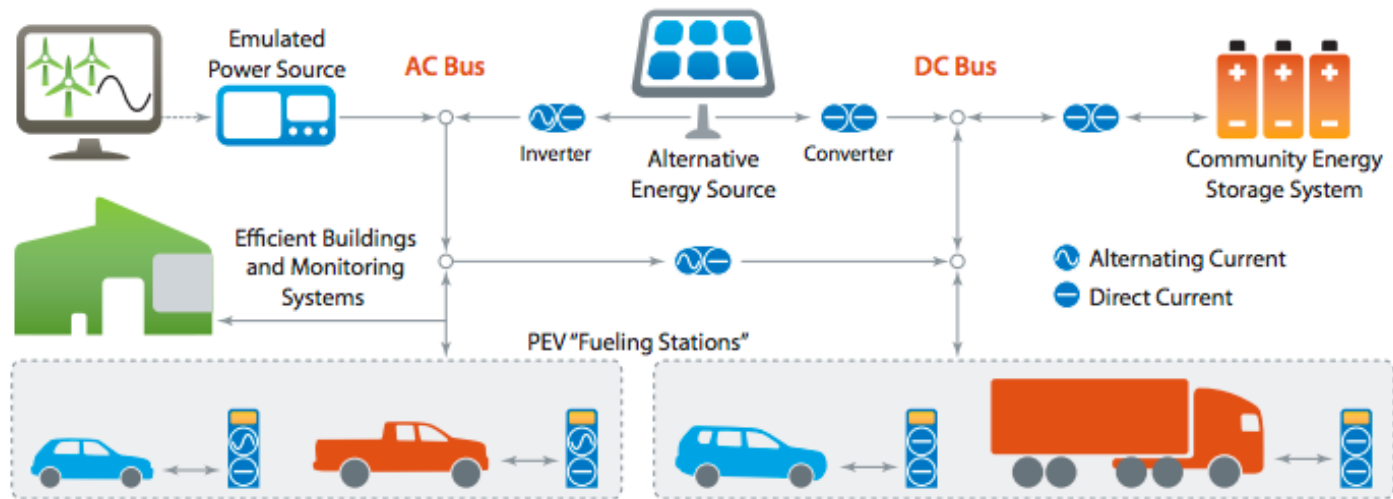
Step 2:

Select a Standard or Custom Drive Cycle



Electric Vehicle Grid Integration at NREL

Vehicles, Renewable Energy, and Buildings Working Together



Developing Systems Integrated Applications

Managed Charging

Evaluate functionality and value of load management to reduce charging costs and contribute to standards development

Local Power Quality

Leverage charge system power electronics to monitor and enhance local power quality and grid stability in scenarios with high penetration of renewables

Emergency Backup Power

Explore strategies for enabling the export of vehicle power to assist in grid outages and disaster-recovery efforts

Bi-Directional Power Flow

Develop and evaluate integrated V2G systems, which can reduce local peak-power demands and access grid service value potential

Vehicle-to-Grid Challenges

Life Impacts

Can functionality be added with little or no impact on battery and vehicle performance?

Information Flow and Control

How is information shared and protected within the systems architecture?

Markets and Opportunities

What role will vehicles play and what value can be created?

NREL Fleet Evaluations Website

<http://www.nrel.gov/transportation/fleettest.html>

Fleet DNA Website

www.nrel.gov/fleetdna

DriveCAT

www.nrel.gov/transportation/drive-cycle-tool

www.nrel.gov

