NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Contributing Data to the Fleet DNA Project

Sponsored by the U.S. Department of Energy, the Fleet DNA project aims to accelerate the evolution of advanced vehicle development and support the strategic deployment of market-ready technologies that reduce costs, fuel consumption, and emissions. The Fleet DNA clearinghouse of commercial fleet transportation data helps vehicle manufacturers and developers optimize vehicle designs and helps fleet managers choose advanced technologies for their fleets. This online tool—www.nrel.gov/fleetdna—provides data summaries and visualizations similar to real-world "genetics" for medium- and heavy-duty commercial fleet vehicles operating within a variety of vocations.

To contribute your fleet data, please contact Adam Duran of the National Renewable Energy Laboratory (NREL) at adam.duran@nrel.gov or 303-275-4586.

Photo from iStock/9420677

Vehicle Selection

When selecting vehicles for data collection, choose a sample of vehicles representative of your fleet operation. Make a list of fleet vehicles that includes vehicle make, model, year, gross vehicle weight rating (GVWR), and fuel type. This information helps characterize vehicle makeup within the fleet and is fundamental for sorting and filing data in the Fleet DNA database. Depending on the fleet size and vocation, typically four to 24 vehicles are instrumented to ensure that the data captured and vehicles instrumented are representative of overall fleet operating behavior.

Data Collection

Once the vehicles are selected, there are two ways of collecting data—either through existing onboard controller area network(CAN)/GPS devices or via data logger installation.

Pre-Installed Telemetric and CAN Devices

Many fleet vehicles are purchased with pre-installed onboard CAN/GPS devices. If the fleet of interest has such vehicles, data collection can be performed by asking the telemetric system provider to capture the required data (see Minimum Requirement section).

Data Logger Installation

To collect the required drive cycle and CAN data, it may be necessary to install logging devices in the vehicles of interest.

Instrumenting vehicles is a quick process (~30 minutes per vehicle) that can be performed by anyone with access to the interior of the vehicle and the on-board diagnostics port. The installation process must ensure that the data logging equipment does not interfere with normal driver operation—the equipment should be installed with Velcro-style attachments and the cabling secured with zip ties.

Data logger installation. *Photos from Adam Ragatz, NREL 31125, 31126, and 31127*

Data Logger Removal

Data loggers are typically installed on vehicles to collect drive cycle data for a period of three weeks. This timeframe can be extended for vehicles with sporadic operation, such as emergency vehicles and support trucks; however, the typical upper bound for data logging is about six weeks. At the end of the logging period, the data loggers should be removed, which takes about 20 minutes per vehicle. Then, the data captured by each device can be downloaded onto a computer and uploaded into the Fleet DNA database for analysis and reporting.

**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.**

Vehicle Body Types Currently Included in the Fleet DNA Database

Delivery Van	Delivery Truck	Class 8 Truck	Specialty Truck	Service Van
Walk In	Furniture	Beverage	Tow Truck	Service Van
Step Van	Straight Truck	Heavy Semi Tractor	Dump Truck	Utility Van
Conventional Van	Single Axle Van	Semi Sleeper	Fire Truck	
City Delivery	Stake Body	Medium Semi Tractor	Fuel Truck	
		High Profile Semi	Cement Mixer	
		Fuel Transport Tanker		
		Tractor		
School Bus	**Transit Bus**	**Refuse Truck**	**Bucket Truck**	**Shuttle Bus**
School Bus	Tour Bus	Refuse Truck	Bucket Truck	Mini Bus
	City Transit Bus			

Vehicle Specifications

Detailed vehicle specifications are fundamental for improving understanding of vehicle behavior and operation. Fleet DNA provides the capability to sort and visualize data based on such specifications.

When collecting data, the following vehicle-specific information is required:

- Vehicle description (vehicle body type and vocational use)
- GVWR
- Average/estimated weight of vehicle and load
- General location (city and state)
- Vehicle make, model, and year
- Engine manufacturer, model, year, maximum horsepower, and maximum torque
- Fuel type and fuel capacity
- Drivetrain type (conventional, hybrid, or electric)
- Hybrid specifications, if applicable (battery-pack size, motor power, and system manufacturer).

New vehicle types and vocations will be added as more data become available.

Fleet DNA Drive Cycle Data – Minimum Requirements

Fleet DNA requires, at a minimum, 1-Hz telemetric information gathered using onboard GPS or CAN/GPS loggers. The logging device should be capable of collecting vehicle speed, date/time, latitude/longitude, elevation, engine status (on/off), and power take-off status (on/off). NREL's Fleet DNA processing system is capable of processing files in .txt or .csv file format. If possible, file names should be formatted as "vehicleid_ddmmyyyy.extension," where "vehicleid" is an integer value used to identify individual vehicles in the supplied dataset; "ddmmyyyy" is the file date in day, month, and year format; and ".extension" is the appropriate file format extension. The table below provides an example of some of the basic data typically collected by GPS/CAN logging devices.

Several GPS/CAN-based telemetric logging systems that meet these data needs are available on the market and can be purchased by the fleet. In some cases, existing onboard telemetric systems can be reconfigured (i.e., sample speed/data records) to supply the necessary data, negating the need to install additional equipment.

Example GPS Logger File (File Name: 25_02102012.csv)

Data Check	Latitude	Direction	Longitude	Direction	Time	Date	Speed (mph)	Heading (degree)	Altitude	HDOP	Satellites
A	44.99508	N	93.21397	W	74920	150710	8.9	122	889	2.1	7
A	44.99528	N	93.21172	W	74938	150710	12.7	92	932	1.9	5
A	44.99528	N	93.21165	W	74939	150710	10.2	89	932	2	5
A	44.99528	N	93.21158	W	74940	150710	10.2	89	932	2	5
A	44.99528	N	93.21152	W	74943	150710	6.3	94	945	1.7	5
A	44.99527	N	93.21148	W	74944	150710	6.3	94	945	1.7	5
A	44.99527	N	93.21145	W	74945	150710	0	94	945	2.1	5

Fleet DNA Drive Cycle Data – Additional Data of Interest

To enable deeper analysis of the influence of drive cycles on vehicle fuel consumption, performance, and emissions, a number of additional data channels can be collected at 1 Hz in conjunction with standard telemetric data. The following table contains the name, description, and SAE-specified parameter group number (PGN) and suspect parameter number (SPN) for the channels most valuable in determining fuel economy, engine efficiency, and emissions conversion efficiency during vehicle operation.

If the vehicle is capable of logging CAN channels in addition to basic telemetric data, simply add the appropriate SPN number to the list of current parameters recorded to capture this information. Additional CAN channels may be recorded depending on the area of interest.

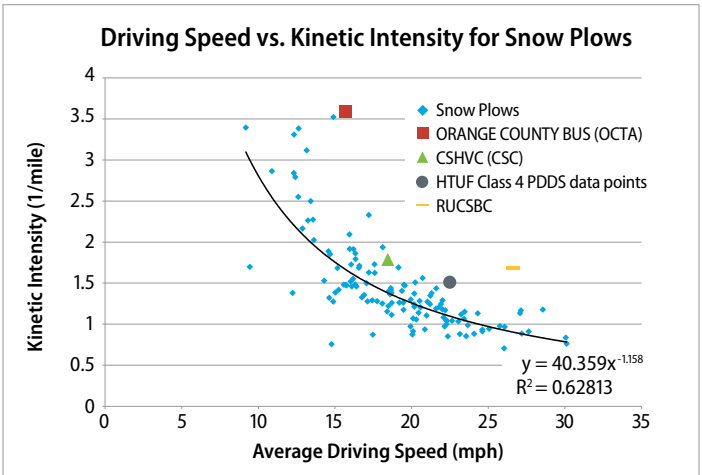
Additional CAN Channels

Data Channel Name	PGN#	SAE SPN#	Channel Description
Actual Engine - Percent Torque	61444	513	The calculated output torque of the engine. The data is reported as a percent of reference engine torque.
Aftertreatment 1 Outlet NO_X	61455	3226	The amount of combined NO and NO_2 in the exhaust exiting the aftertreament system measured by a NO_X sensor at the aftertreament outlet, represented in NO_X molecules parts per million non-NO_X molecules.
Aftertreatment 1 Intake NO_X	61454	3216	The amount of combined NO and NO_2 in the exhaust entering the aftertreament system measured by a NO_X sensor at the aftertreament outlet, represented in NO_X molecules parts per million non-NO_X molecules.
Engine Fuel Rate	65266	183	Instantaneous amount of fuel consumed by the engine per unit of time.
Engine Intake Air Mass Flow Rate	61450	132	Mass flow rate of fresh air entering the engine air intake, before exhaust gas recirculator mixer is used, if applicable. Flow rate of fresh air conducted to the engine cylinders to support combustion.
Engine Speed	61444	190	Actual engine speed calculated over a minimum crankshaft angle of 720 degrees divided by the number of cylinders.
Estimated Engine Parasitic Losses - Percent Torque	65247	2978	The calculated torque that indicates the estimated amount of torque loss due to engine parasitics, such as cooling fan, air compressor, air conditions, etc.
Nominal Friction - Percent Torque	65247	514	The calculated torque that indicates the amount of torque required by the engine including additional losses via pumping torque loss, fuel, oil, and cooling pumps, and frictional and thermodynamic engine losses.
Referenced Torque	65251	544	This channel is the 100% reference torque value for all defined indicated engine torque paramters. It is only defined once and does not change if a different engine torque map becomes valid.
Wheel-Based Vehicle Speed	65265	84	Speed of the vehicle as calculated from wheel or tailshaft speed.

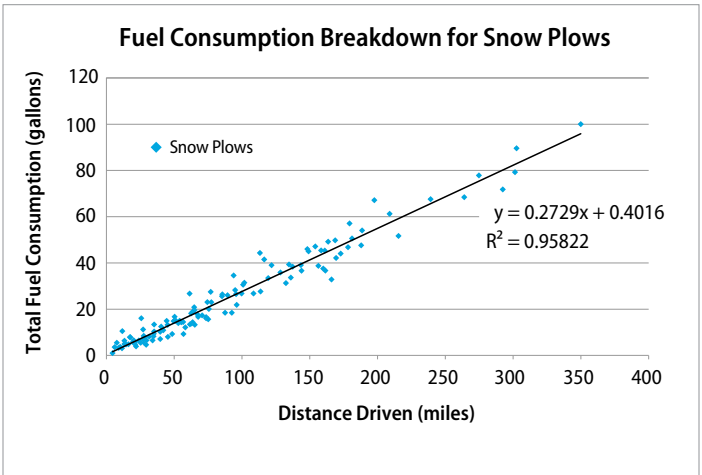
Data Reporting

User-Specific Reports

Once the data have been sorted, filtered, and analyzed by the Fleet DNA database algorithms, each unique dataset will be given its own identification number, allowing contributors/users to view their own fleet statistics compared to all others in the database. In addition, contributors will be provided individual fleet sub-reports that focus more closely on individual vehicle performance and comparisons. These sub-reports provide information regarding vehicle daily mileage breakdowns, idling time, performance (driving speeds, acceleration rates, and stops per mile), and representative chassis test cycles.



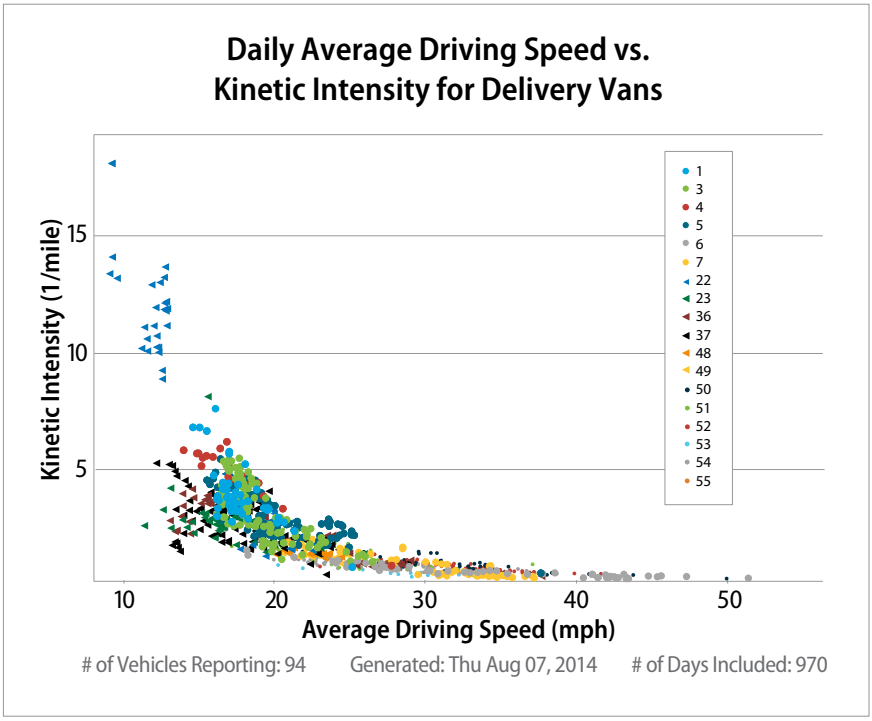
Example graph, as shown in sub-report



Example graph, as shown in sub-report

Fleet DNA Website Reporting

In addition to enabling the visualization of individual fleet information, all data supplied to Fleet DNA is aggregated into anonymous, vehicle category-specific reports and datasets featured at www.nrel.gov/fleetdna. These publicly available datasets are useful tools—for researchers, regulators, original equipment manufacturers and developers, and other fleets—for understanding the typical use of the wide range of vehicle types and vocations in the medium- and heavy-duty vehicle arena.



Example graph, as shown on Fleet DNA website

About NREL's Transportation RD&D

The only national laboratory dedicated to renewable energy and energy efficiency, NREL is at the forefront of RD&D for tomorrow's sustainable transportation solutions. NREL's innovative and integrated whole-system approach helps government, industry, and other research partners develop market-ready, high-performance, low-emission, fuel-efficient vehicles, components, and systems.

Fleet Testing and Evaluation

NREL's fleet testing and evaluation activities support the development and deployment of alternative fuel and advanced vehicle technologies in medium- and heavy-duty fleet vehicles. NREL conducts real-world evaluations of advanced technology vehicles versus their conventional counterparts and publishes unbiased information about the performance and durability of these vehicles.

Partnership Opportunities

NREL works with a variety of organizations that use and/or contribute Fleet DNA data. Please contact us if you would like to explore collaborative opportunities.

Contact

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