

## Odyne PHEV System Performance Evaluation – Cumulative

The Fleet Test and Evaluation Team at the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) is evaluating and documenting the performance of electric and plug-in hybrid electric drive systems in medium-duty trucks across the nation. U.S. companies participating in this evaluation project received funding from the American Recovery and Reinvestment Act to cover part of the cost of purchasing these vehicles. Through this project, Odyne deployed 119 plug-in hybrid electric medium-duty utility trucks with a parallel hybrid system that were operated by a variety of companies in diverse climates across the country. Operating data from 94 of these vehicles were reported to NREL and are summarized in this report.

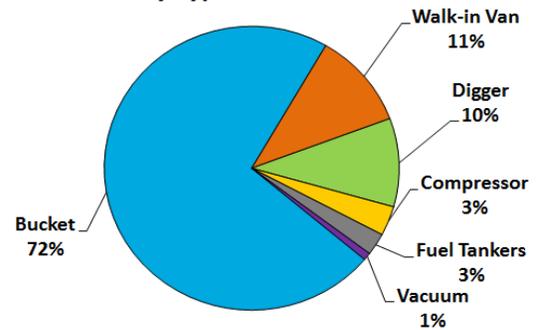
Number of vehicles (collected / deployed): 94 / 119  
Reporting period: 12/1/2014 to 6/30/2015

Number of driving days recorded: 1,057

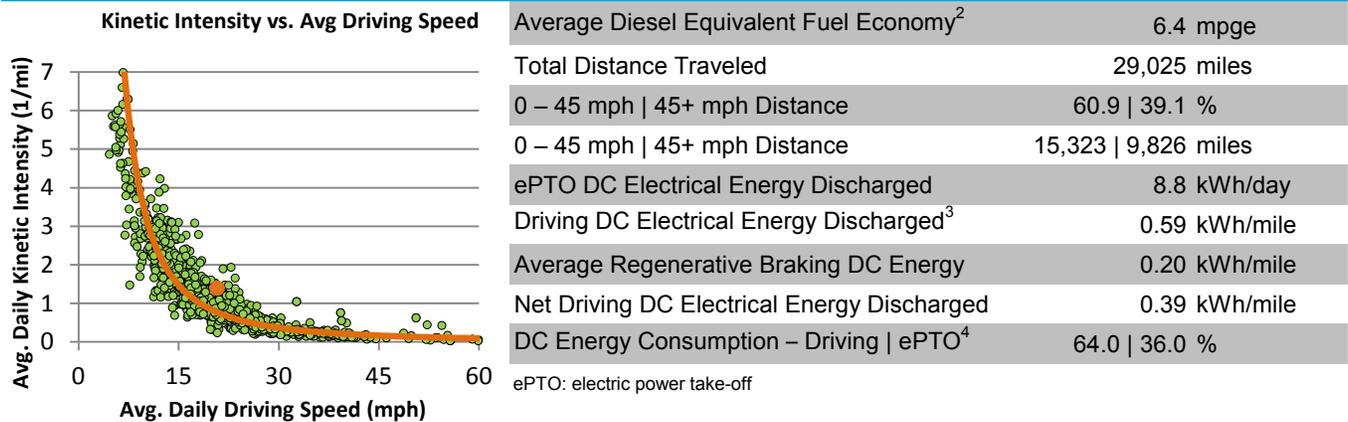
### Project System Specifications<sup>1</sup>

Platform GVWR	23,000–56,000 pounds
Motor Power	Peak: 95 hp   Cont.: 56 hp
Motor Torque	232 ft-lbs
Battery Capacity	28.4 kWh
Battery Voltage	350 V
Onboard Charger	3.0 kW
Exportable Power	6–12 kW
Transmission	Allison 2000, 3000 & 4000
Drive	RWD 4X2 or 6X4
Hybrid System Weight	1,200 –1,600 pounds

### Body Type Distribution



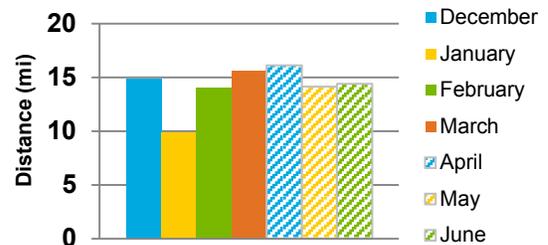
### Trip Data



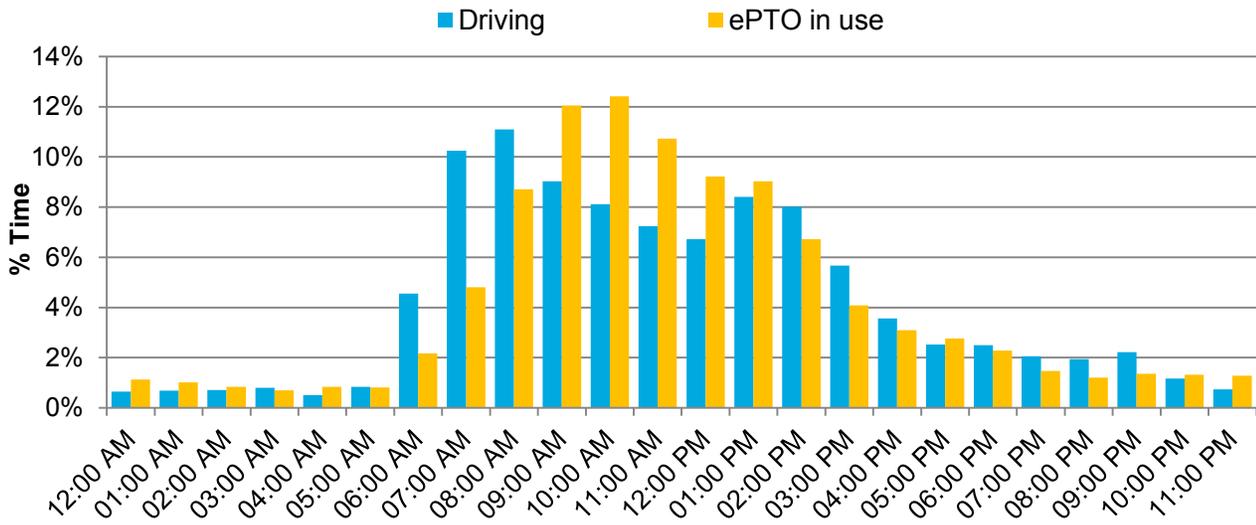
### Route Information

Average Distance Traveled per Day	23.8 miles
Average Daily Kinetic Intensity <sup>5</sup>	1.4 1/mile
Average Number of Stops: per Day   per Mile	37.9   2.98
Average Brake (Regen) Events	10.4 per mile
Average Maximum Acceleration	0.29 g
Average Daily Maximum Driving Speed	45.5 mph
Average Daily Driving Speed	20.8 mph

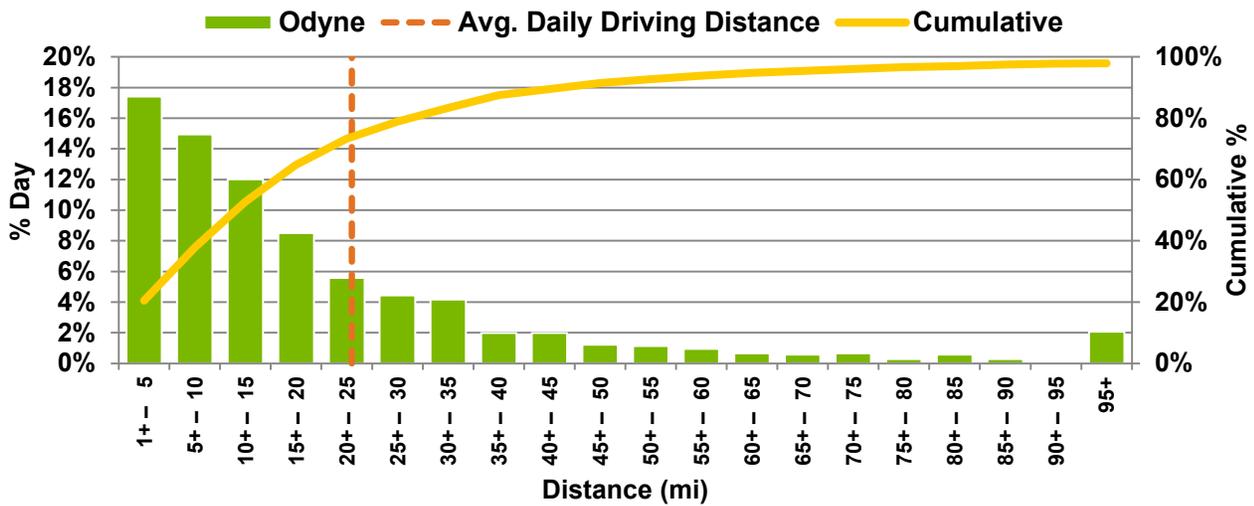
### Median Daily Driving Distance by Month



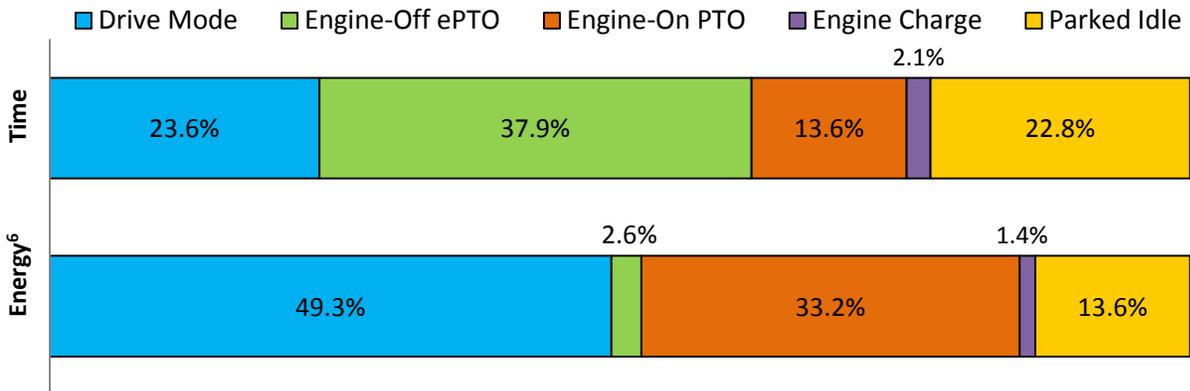
## Time of Day Driving or Using ePTO



## Daily Driving Distance

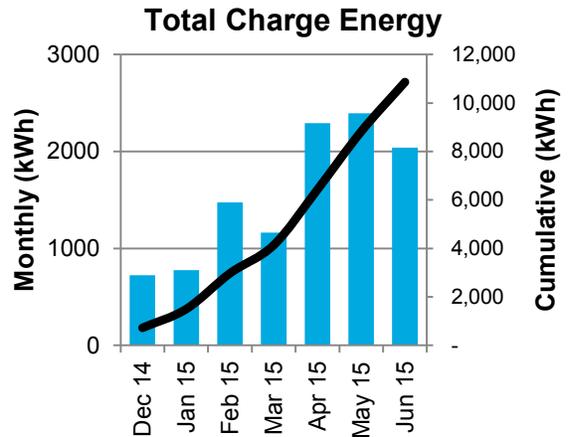


## Energy Use and Time by Operating Mode

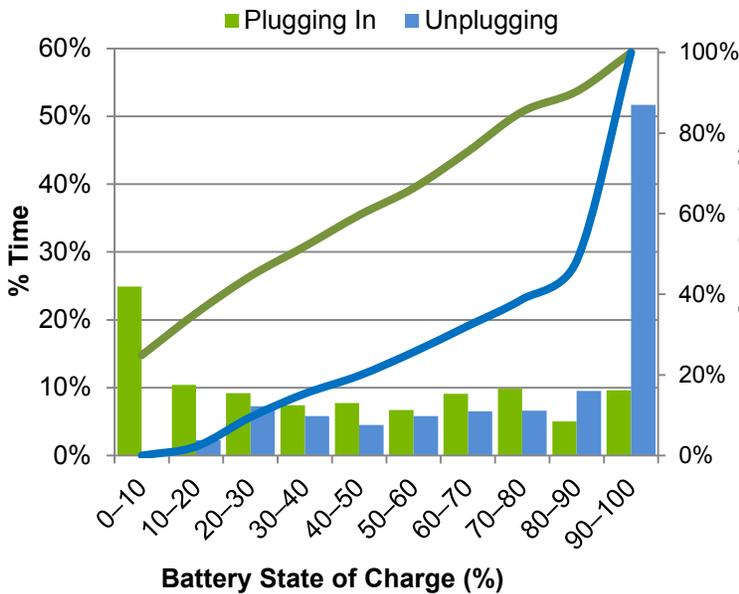


### Plug-In Charging

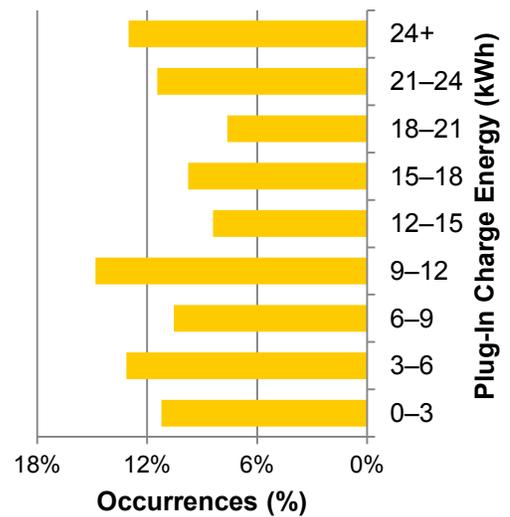
Total Number of Plug-In Charges	892
Median Duration Plugged-In	13.3 Hours
Avg Vehicle Charging Frequency	1.06 per day
Average Charge Energy	12.2 kWh/Charge
Median SOC When Plugged In	32.6 %
Median SOC When Unplugged	87.6 %
Overall AC Energy	12,097 kWh
Overall DC Electrical Energy Charged	10,863 kWh



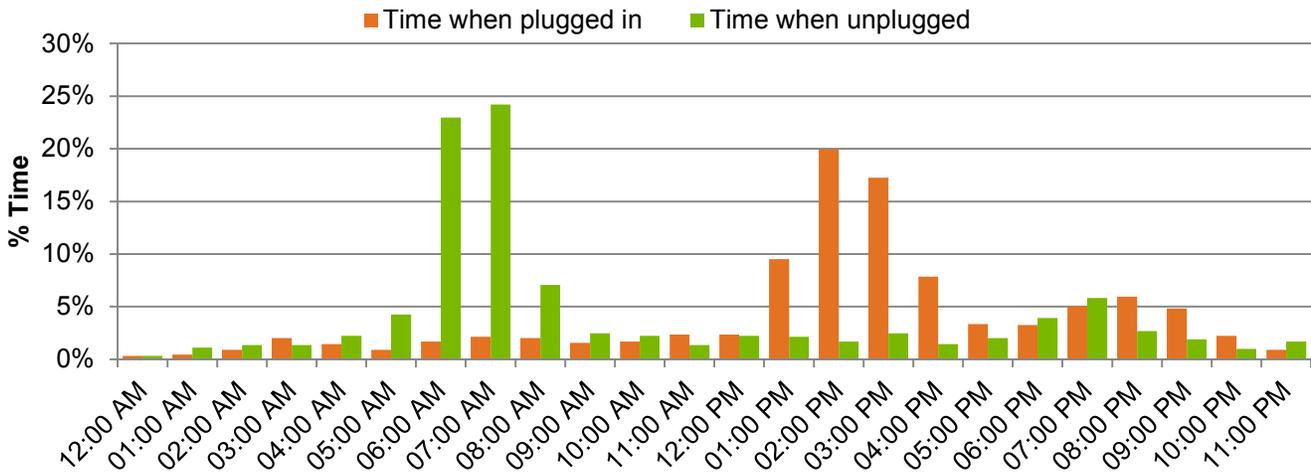
### Average Battery Pack SOC at Plug Events



### AC Plug-In Energy per Charge

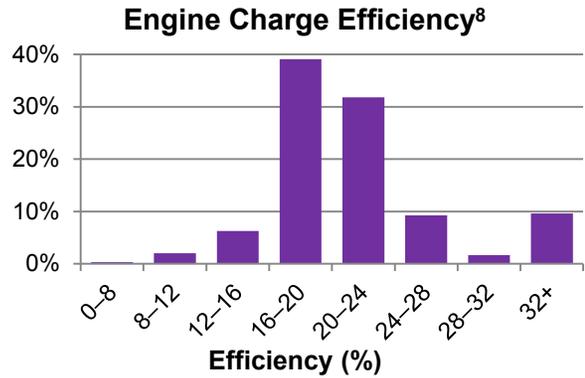


### Time of Day when Plugged In and Unplugged

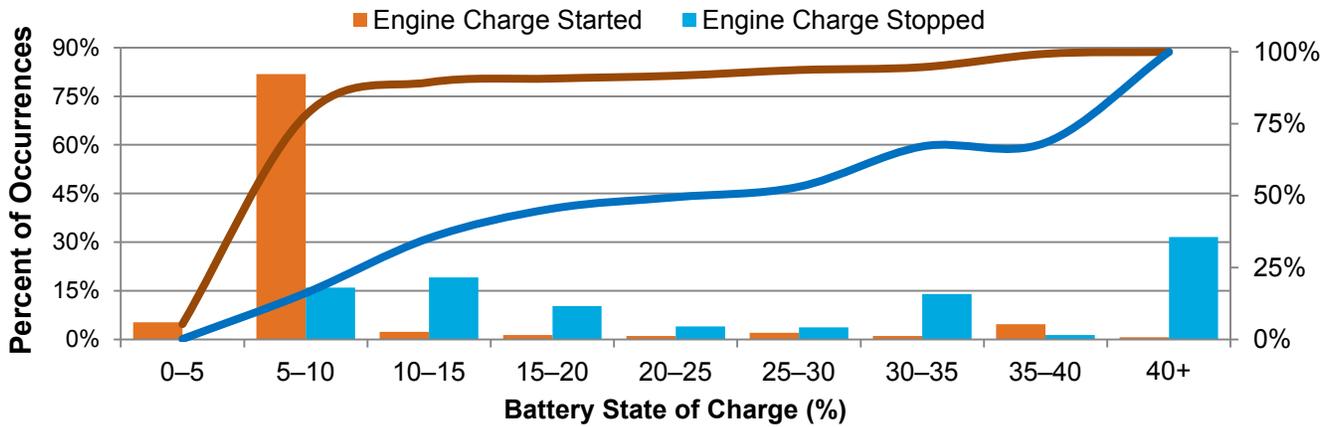


## Engine Charging<sup>7</sup>

Total Number of Engine Charges	164
Average Engine Charge Duration	24.0 minutes
Average SOC at Start of Engine Charge	6.0 %
Average SOC at End of Engine Charge	27.2 %
Average Engine Energy per Charge	4.80 kWh
Average Eng. Charge Energy Efficiency	6.11 kWh/gal
Average Eng. Charge Energy Efficiency	16.2 %
Average Eng. Charge Fuel Consumption	0.80 gal/event



## Stationary PTO Use – Engine Charging



1. Vehicle specifications provided by Odyne Systems & EPRI (*Plug-In Hybrid Medium-Duty Truck Demonstration and Evaluation* 3002006566 Final Report, September 2015).

2. Miles per gallon diesel equivalent (mpge) is calculated based on a 128,488 Btu per diesel gallon energy density provided by U.S. Department of Energy’s Alternative Fuels Data Center. Using this information, diesel fuel mpge equates to 37.656 kWh.

3. Battery pack state of charge (SOC) as reported over telematics used to track tractive energy usage when speed is greater than zero.

4. Distribution of total DC energy from battery pack, including charge-depleting mode and energy from regenerative braking, does not distinguish between mild and aggressive driving calibrations for hybrid drive systems and therefore is not representative of any particular vehicle.

5. Kinetic intensity measures hybrid advantage. For more information on kinetic intensity, please refer to O’Keefe, Simpson, Kelly, and Pedersen, “Duty Cycle Characterization and Evaluation Towards Heavy Hybrid Vehicle Applications,” SAE Technical Paper 2007-01-0302, 2007, doi:10.4271/2007-01-0302.

6. Energy usage includes battery pack energy and diesel fuel consumed (see note 2). Engine charge energy indicates fuel consumed to charge battery and is not a net energy value.

7. Engine charge events (battery charging using diesel engine) shorter than 10 minutes were removed from the data.

8. Engine charge energy<sup>7</sup> efficiency measures the conversion of diesel fuel (see note 2) to DC battery pack energy.

General note: These figures cover multiple vehicle configurations in multiple cities with multiple environments, topologies, and load profiles. These numbers are averages of a diverse fleet of vehicles and cannot be used to predict the efficiency of any particular Odyne hybrid vehicle.



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