## **EVMT ANALYSIS OF ON-ROAD DATA FROM PLUG-IN HYBRID ELECTRIC AND ALL-ELECTRIC VEHICLES** Matt Shirk, Barney Carlson, Idaho National Laboratory





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## Introduction

Idaho National Laboratory (INL) leads U.S. DOE's Advanced Vehicle Testing Activity (AVTA) for light duty vehicles

#### **On-Road data collection and analysis (since 1994)**

27,400 Advanced Technology Vehicles

• EV, PHEV, HEV, and Alt. Fuel vehicles 232 million miles of data

#### Charging Infrastructure data collection and analysis

17,000 EVSE (through out the U.S.) 44,300 MWh (AC charge energy)



## **eVMT** Analysis

#### **Collaborative groups**

Idaho National Laboratory Honda North America Ford Motor Company Toyota Motor Engineering & Manufacturing NA General Motors

#### Calculated electric vehicle miles traveled (eVMT) for:

Ford Fusion Energi Ford C-Max Energi Honda Accord PHEV Toyota Prius PHEV Chevrolet Volt Ford Focus Electric Honda Fit EV Nissan Leaf

#### Data is from actual customer, on-road vehicle operation

158,468,000 miles from 21,600 vehicles

Across the U.S. (i.e. widely varying regions and climates)

















## eVMT Data Analysis Method

#### Data completeness was calculated on monthly basis

- Check for missing data when able
- eVMT analysis conducted only for months with high data completeness
- If data format does not enable completeness check, all data is used

#### To align results from the differing data formats, three calculation methods were evaluated

eVMT calculation methods only differed by <2.5% for the 3 methods

#### Final results are from two of the methods

- Based on EPA Label Fuel Economy and Elec. Energy Consumption
- Based on vehicle average Charge Sustaining fuel consumption

#### for All-Electric Vehicles, by definition, eVMT = total VMT

## eVMT Calculations Based on Label Fuel Economy

#### Every trip is classified as one of three types:

- All-Electric
- Blended
- Charge Sustaining mode of operation

#### From the EPA Label Fuel Economy and Electrical Energy Consumption:

The slope is determined from EV to CS (i.e. "A" to "C")

(∆gal/mi / ∆Wh/mi)

#### For each blended trip

Fuel Displaced by Electrical Energy is determined

- Disp\_Gal = Trip Wh consumed x (∆gal/mi / ∆Wh/mi) Calculated Trip eVMT\_Blended
- eVMT\_Blended = TripLength x <u>Disp\_Gal</u>

(Trip\_Gal + Disp\_Gal)



eVMT = sum(All-Electric trips miles) + sum(eVMT\_Blended miles)

#### Every trip is classified as:

- All-Electric
- Blended
- Charge Sustaining

Dist<sub>Electrified</sub> is calculated using the following methodology for trips that consume both fuel and electricity:

$$Dist_{Electrified} = Dist_{CD} - \frac{Gasoline_{CD}}{FC_{CS}} \longrightarrow Dist_{Electrified} = Dist_{Total} - \frac{Gasoline_{Total}}{FC_{CS}}$$

For the amount of fuel consumed during the trip, Dist<sub>Electrified</sub> is the distance driven in excess of what could have been driven in CS mode, as enabled by grid energy

Using a calculated average Fuel Consumption data (FCcs) for each vehicle, the Dist<sub>Electrified</sub> (EV Equivalent) was calculated for every Blended trip.

eVMT = sum(<u>EV trip</u> miles) + sum(Dist<sub>Electrified</sub> of Blended Trips)

## **Nissan Leaf and Chevrolet Volt Geographic Distribution**



<i># of distinct Vehicles <u>ever</u> Driven in the Region</i>	Region 1	Region 2	Region 3	Region 4
Ford C-Max Energi	2500	2024	1890	1556
Ford Fusion Energi	2885	1571	2189	1393
Ford Focus Electric	1337	289	313	328



## **Analysis Results**

	Nissan		Ford Focus	Ford C-Max	Ford Fusion	Honda	Honda Accord	Toyota Prius
	LEAF	VOIt	Electric	Energi	Energi		PHEV	PHEV
Number of Vehicles	4,039	1,867	2,193	5,368	5,803	645	189	1,523
Number of Vehicle Months	35,294	20,545	12,622	38,096	32,022	6,090	1,437	15,676
Total Vehicle Miles Traveled <i>VMT</i> (miles)	28,520,792	20,950,967	10,043,000	39,376,000	33,098,000	4,912,920	1,794,494	19,772,530
Total Calculated Electric Vehicle Miles Traveled <i>eVMT</i> (miles)	28,520,792	15,599,508	10,043,000	12,918,000	11,572,000	4,912,920	399,412	3,224,981
		-	-	-		-		
Avg. Monthly VMT	808.1	1,019.8	795.7	1,033.6	1,033.6	806.7	1,248.8	1,261.3
Avg. Monthly eVMT	808.1	759.3	795.7	339.1	361.4	806.7	278	207.0
estimated Annual VMT	9,697	12,238	9,548	12,403	12,403	9,680	14,986	15,136
estimated Annual eVMT	9,697	9,112	9,548	4,069	4,337	9,680	3,336	2,484
Data Format Description	Key-On / Key-Off	Key-On / Key-Off	Enhanced Key-On / Key-Off			Trip Summary		Trip Summary
Geographic Characterization	CA, OR, WA, AZ, TX, TN, GA, D.C., PA, IL	CA, OR, WA, AZ, TX, TN, GA, D.C., PA, IL	Nationwide		CA, OR, NJ, MD, CT, MA, RI, NY	CA, NY	ZEV States and other states	

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\* http://avt.inel.gov/pdf/EVProj/eVMTMay2014.pdf

## Average Monthly eVMT and VMT by Model



Distance Bins: =0, >0 to 100, >100 to 200, >300 to 400, >400 to 500, etc.

## Average Monthly eVMT by Model



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Distance Bins: =0, >0 to 100, >100 to 200, >300 to 400, >400 to 500, etc.

## Summary

#### On-road data from customer operation was analyzed

158,468,000 miles from 21,600 vehicles eVMT analysis

- Annual eVMT ranged from
  - BEV: 9,548 to 9,697 mi
  - PHEV / E-REV: 2,484 to 9,112 mi

#### Data from all vehicle models were from varying regions and climates

#### Multiple eVMT calculation methods were compared

eVMT calculation methods only differed by <2.5%

## Acknowledgement

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# **More Information**

http://avt.inl.gov