Legislative Energy Horizon Institute - Plug-in Electric Vehicles and Charging Infrastructure

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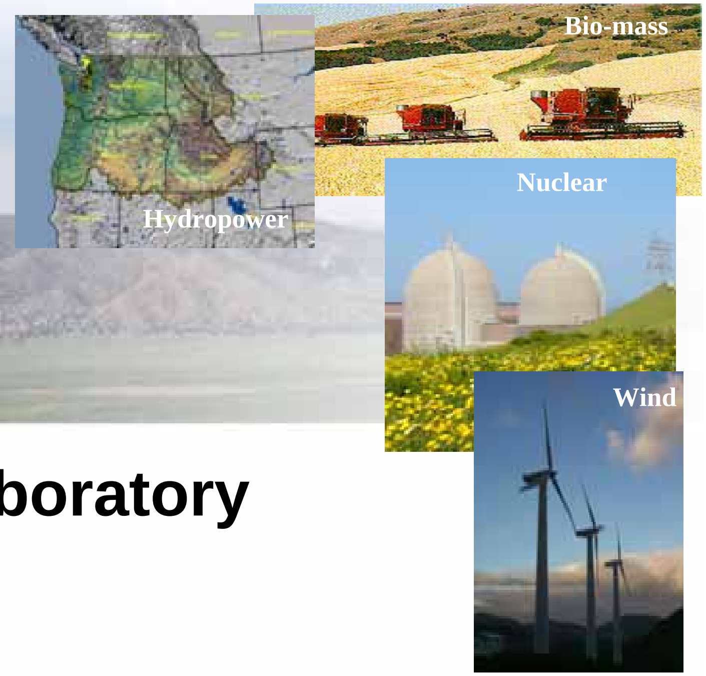
Idaho National Laboratory



- U.S. Department of Energy (DOE) laboratory
- 890 square mile site with 4,000 staff
- Support DOE's strategic goal:
  - Increase U.S. energy security and reduce the nation's dependence on foreign oil
- Multi-program DOE laboratory
  - Nuclear Energy
  - Fossil, Biomass, Wind, Geothermal and Hydropower Energy
  - Advanced Vehicle Testing Activity & Battery Testing
  - Homeland Security and Cyber Security

Idaho National Laboratory

Vehicle / Infrastructure Testing Experience

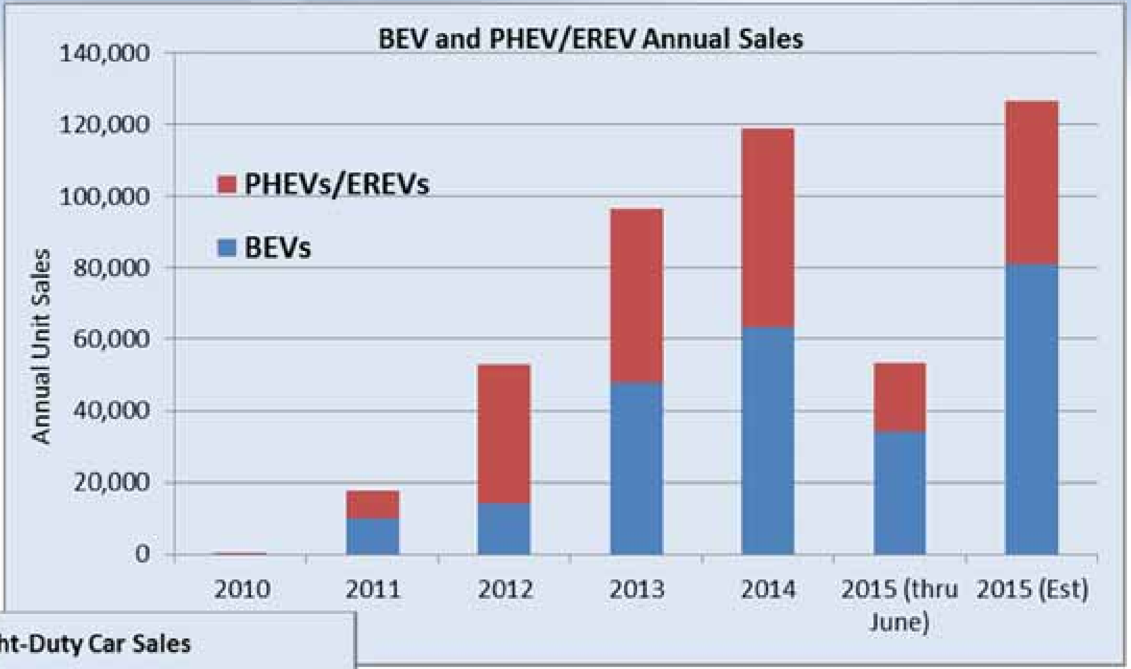
- Since 1994, INL staff have benchmarked PEVs with data loggers in the field, and on closed test tracks and dynamometers
- INL has accumulated 250 million PEV miles from 27,000 electric drive vehicles and 16,600 charging units
- Currently, approximately 100 PEV, HEVs, CNG and advanced diesel vehicles in track, dyno and field testing: BMWs, KIAs, Fords, GMs, Nissans, Smarts, Mitsubishi, VWs, Hondas, Hyundai, Toyotas
  - EV Project: 8,228 Leafs, Volts and Smarts, 12,363 EVSE and DCFC
    - 4.2 million charge events, 124 million test miles. At one point, 1 million test miles every 5 days
  - Ford, GM, Toyota and Honda requested INL support identifying electric vehicle miles traveled (eVMT) for 15,721 new PHEVs, EREVs and BEVs
    - Total vehicle miles traveled (VMT): 158 million miles
- INL also tests HEVs, NEVs, HICEs, charging infrastructure and other advanced technology vehicles with petroleum reduction technologies

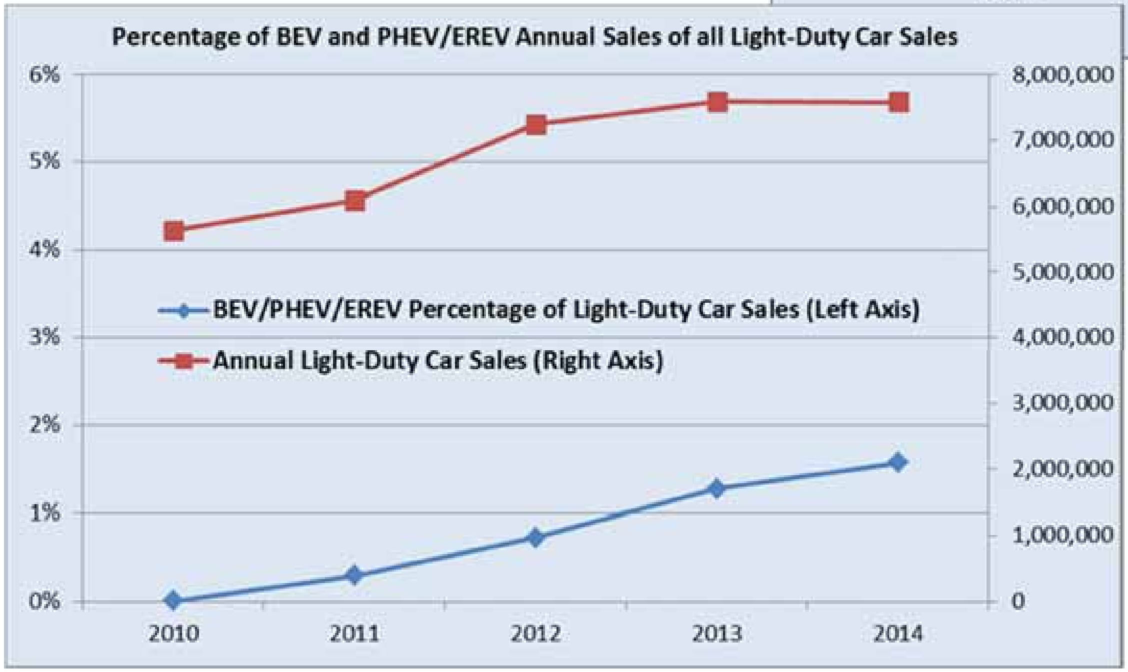
Nomenclature

- PEV (plug-in electric vehicle) are defined as any vehicle that connects or plugs in to the grid to fully recharge the traction battery pack
  - BEVs: battery electric vehicle (no internal combustion engine ICE)
  - EREVs: extended range electric vehicles (operates on electric first and when electric range has been exceeded, operates like a normal hybrid electric vehicle)
  - PHEVs: plug-in hybrid electric vehicles (blended electric and ICE operations in various schemes)
- Charging infrastructure
  - DCFC: high voltage DC fast chargers 440V
  - Level 2 EVSE: AC 208/240V electric vehicle supply equipment
  - Level 1 EVSE: AC 110/120V electric vehicle supply equipment

PEV Annual Sales

- PEVs cumulative sales of 340,000 (June 2015)
- 119,000 PEVs were sold in 2014, 23% gain over 2013
- No less than 21 PEV models available in MY15 with up to 7 more expected this year





Sources:
http://electricdrive.org/index.php?ht=d/sp/i/20952/pid/20952
http://www.afdc.energy.gov/data/10314

2015 Current and Expected PEV Availability*

Light Duty Vehicles

Battery Electric

- BMW i3
- Chevrolet Spark
- Fiat 500e
- Ford Focus
- Kia Soul
- Mercedes Benz B Class Electric
- Mitsubishi i
- Nissan Leaf
- Renault Twizy
- Smart Electric Drive
- Tesla Model S
- Tesla Model X
- VW e-Golf

Plug-In Hybrid Electric

- Audi A3 e-tron
- Audi Q7 Plug-in
- BMW i3 with range extender
- BMW i8 Plug-in
- BMW X5
- Cadillac ELR
- Chevrolet Volt
- Ford C-Max Energi
- Ford Fusion Energi
- Honda Accord Plug-in
- Mitsubishi Outlander
- Porsche Cayenne S E-Hybrid
- Porsche Panamera SE-Hybrid
- Toyota Prius Plug-in
- Via Motors eRev
- Volvo XC90 T8

Medium and Heavy Duty Vehicles *(battery electric)*

- Balgon Mule M150 (vocational)
- Balgon XE-20 (tractor)
- Balgon XE-30 (tractor)
- Boulder Electric Vehicle DV-500 (delivery truck)
- Capacity Trucks HETT (tractor)
- Design Line Corp Eco Smart 1 (transit)
- Electric Vehicles International EVI-MD (vocational)
- Electric Vehicles International WI EVI (van)
- Enova Ze Step Van (van)
- GGT Electric
- New Flyer Xcelsior (bus, transit, trolley)
- Proterra EcoRide BE35 (bus, transit)
- Smith Electric Vehicles Newton (vocational)
- Smith Electric Vehicles Newton Step Van
- Zero Truck Zero Truck (vocational)

* Many vehicles are only found in select locales around the country

PEV Challenges and Opportunities

Challenge	Opportunity
Cost: more expensive to purchase than conventional vehicle counterparts	• Cut battery costs and improve life and durability • Lower electric drive systems cost
Range: all-electric vehicles are generally less (1/4 – 1/3) than conventional vehicles (unless you are rich)	• Reduce vehicle weight • Develop high efficiency climate control systems • Expand charging infrastructure
Vehicle Availability: There is a lack of electric options in several vehicle classes (minivans, pickups, SUVs)	• OEMs are expected to further expand PEV availability
Consumer Acceptance: Most consumers know little about PEVs	• Further consumer awareness and incentives, Workplace Charging Challenge, and training

Infrastructure Challenges and Opportunities

Challenge	Opportunities
Cost: Equipment, permitting, installation, maintenance *Siting Public Infrastructure: Expensive and time consuming due to constraints and number of entities involved	• L1 vs L2, dual port, sequential charging, lower power DC fast charging • EVSE closer to power source, shorter conduit runs, minimal trenching • Innovative business partnerships, ownership, and payment models • Streamlined permitting • Managed energy networks • Discounts and incentives, credits, rebates (Federal, State, utilities, etc.) • Advertising and other money making/saving strategies • Smart wayfinding, signage, and stripping
*ADA Accessibility: Challenging in some situations and often more expensive	• Innovative parking configurations and EVSE placement
Interoperability: Charging network providers and utilities must be able to interact seamlessly	• Codes and standards • Business models to support infrastructure for interactions

* Comprehensively addressed in Clean Cities PEV Community Readiness Resources

Insights into Type and Placement of EVSE

EVSE Type	Positives (+)	Negatives (-)
Level 1	• Cheaper equipment, installation can be less • Lower electricity demand	• Up to 4 mi/hr @ 1.44kW
Level 2	• 12-60 mi/hr @ 3.4-19.2 kW • Charge multiple vehicles/day • Option of managing load	• Can be more costly than L1
DC Fast Charging	• 120-300 mi/hr • Flexible, good for emergencies	• **Expensive equipment and installation** • **Can trip demand charges**

- **Generally, level 2 is preferred at homes and public locations**
- **DCFC is more suitable in travel corridors**

PEV Reported Charging Locations

- DOE Alternative Fuels Data Center - Electric Vehicle Charging Station Locations
  - http://www.afdc.energy.gov/fuels/electricity_locations.html
  - 10,003 electric stations and 25,958 charging outlets (excludes private locations) in the United States
  - Interactive map that provides additional information for each location
  - (Note that these are self reported stations)

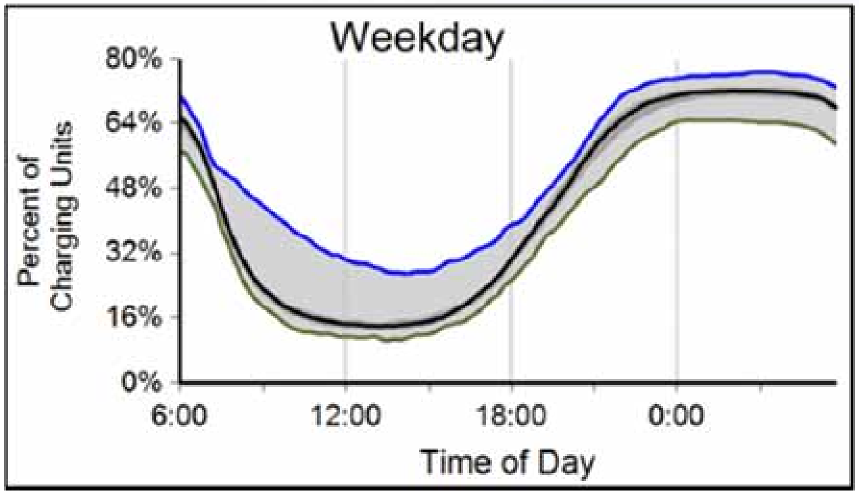
State Policy Considerations

- **PEVs operating solely on electricity don’t pay motor fuel excise taxes, BUT:**
- **Some states requiring PEV fees***
  - **CO, GA, ID, NE, NC, OR, VA, WA**
  - **OR assessing tax per mile driven in test project**
  - **Others like IN and VT have studied options**

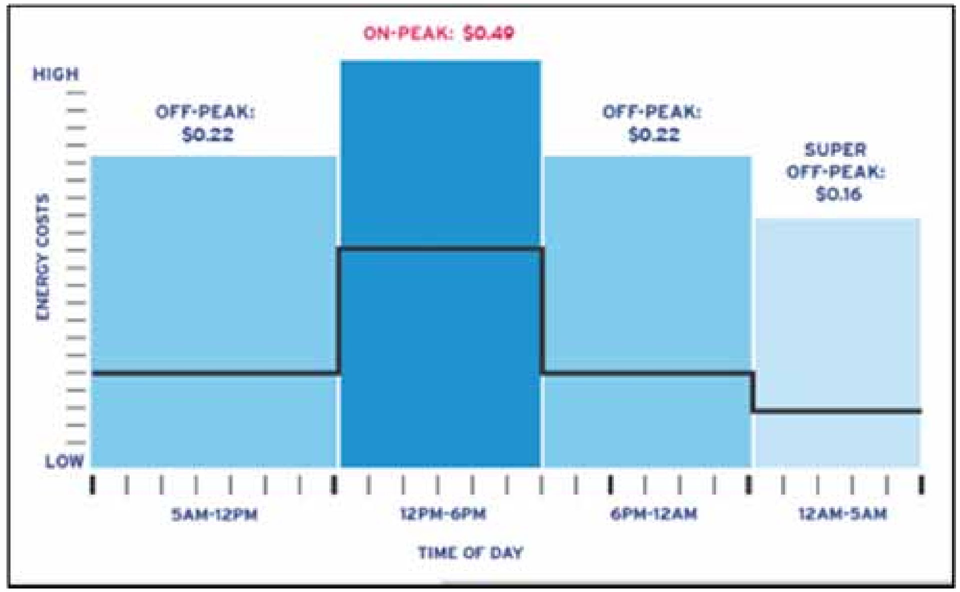
- **For more information, see**
  - **State Laws and Incentives, http://www.afdc.energy.gov/laws/state**
  - **State Fees as Transportation Funding Alternatives policy bulletin, http://www.afdc.energy.gov/bulletins/technology_bulletin_2014_03_10.html**
  - **Analysis to baseline fuel tax for PEVs to comparable ICE vehicles, http://avt.inl.gov/pdf/phev/PEVandPHEVeVMTforIAHD.pdf**

**As of July 1, 2015*

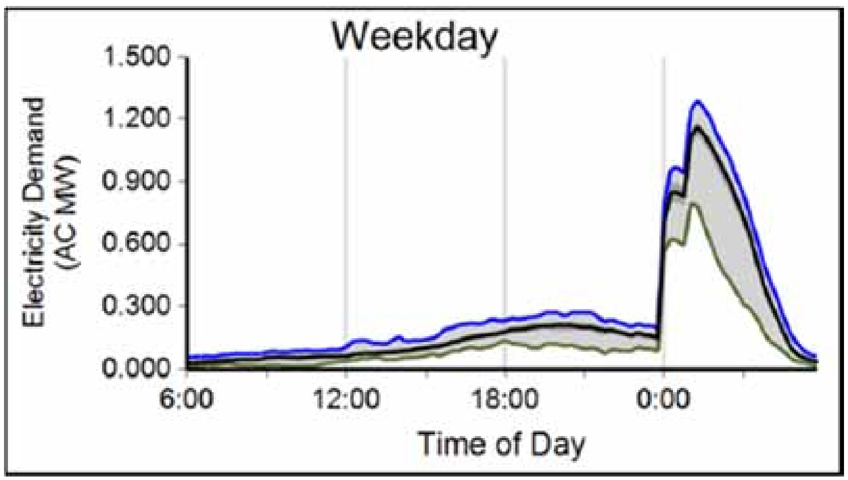
Time of Use Impacts (Mostly on Residential EVSE)



SDG&E residential EVSE connect profile



SDG&E EV-TOU-2 summer schedule



SDG&E residential EVSE demand profile

GHG Emissions by Grid Mix

	MPG (MPGe)	U.S. Mix	Coal Only	NG Only	Nuclear Only
Nissan Leaf (BEV)	(115)	180 g/mi	328 g/mi	148 g/mi	4 g/mi
Chevy Volt (PHEV40)	38 (after 1st 40 miles as electric)	284 g/mi	411 g/mi	258 g/mi	134 g/mi
Toyota Prius Plug-in (PHEV10)	50 (as 1st 12 miles as electric)	234 g/mi	286 g/mi	223 g/mi	172 g/mi
Conventional Gasoline Vehicle (2014)	23.5	460 g/mi			
Conventional Gasoline Vehicle (2025)	54.5	200 g/mi			

Environmental and Speed Impacts on PEVs

- **2013 Ford Focus Electric**
- **Representative results**

DYNAMOMETER TESTING[9]

Cycle Results[10]

	72 °F	20 °F	95 °F + 850 W/m²
UDDS (Cold Start)	243.9 Wh/mi	582.6 Wh/mi	312.8 Wh/mi
UDDS	235.3 Wh/mi	479.1 Wh/mi	301.5 Wh/mi
HWFET	261.5 Wh/mi	411.5 Wh/mi	298.1 Wh/mi
US06	355.0 Wh/mi	476.1 Wh/mi	400.1 Wh/mi
SC03			315.6 Wh/mi

City Range	110.9 miles	US06 Range	74.1 miles
Highway Range	100.7 miles		

Energy Consumption at Steady-State Speed, 0% Grade

10 mph	149.9 Wh/mi	50 mph	253.6 Wh/mi
20 mph	151.4 Wh/mi	60 mph	306.8 Wh/mi
30 mph	174.1 Wh/mi	70 mph	356.6 Wh/mi
40 mph	194.5 Wh/mi	80 mph	433.8 Wh/mi

Leaf and Volt Use (EV Project 2nd quarter report 2013)

Parameters	EV Project BEV Leafs	EV Project EREV Volts
Number of vehicles	4,261	1,895
Total miles driven (miles)	8,040,300	5,753,009
Average trip distance (miles)	7.1	8.3
Average distance traveled per day when the vehicle was driven (miles)	29.5	41.0
Average number of trips between charging events	3.8	3.3
Average distance traveled between charging events (miles)	26.7	27.6
Average number of charging events per day when the vehicle was driven	1.1	1.5
Percent of home charging events	74%	80%
Percent of away-from-home charging events	20%	14%
Percent of unknown charging locations	6%	7%

National Look at Public Charging & Installation Costs

Defining Public Venues

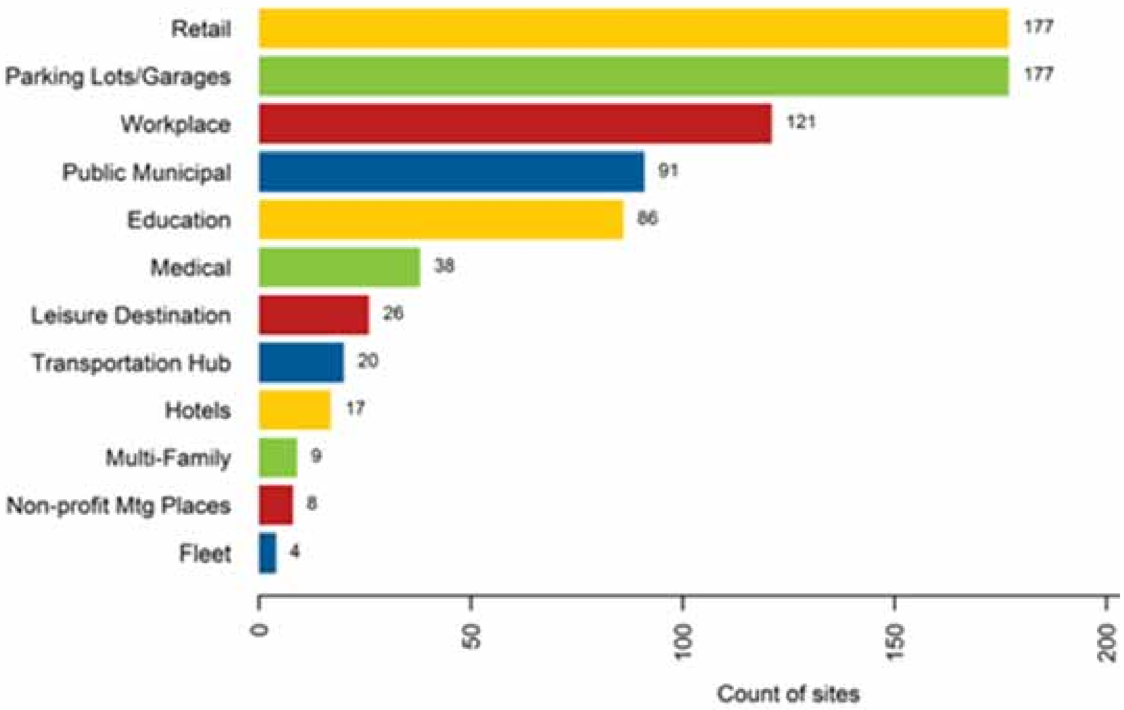
- **Venue definition was originally different across all EVSE (electric vehicle supply equipment & DCFC (direct current fast charger) studies & deployments**
- **INL settled on venues mostly defined in NYSERDA deployment**
- **Primary Venues used to define AeroVironment & Blink EVSE & DCFC used in the The EV Project, ChargePoint America, and West Coast Electric Highway projects:**
  - **Education:** **Training facilities, universities, or schools**
  - **Fleet:** **EVSE known to be used primarily by commercial or government fleet vehicles**
  - **Hotels:** **Hotel parking lots provided for hotel patron use**
  - **Leisure Destination:** **Parks and recreation facilities or areas, museums, sports arenas, or national parks or monuments.**
  - **Medical:** **Hospital campuses or medical office parks**
  - **Multi-Family:** **Parking lots serving multi-family residential housing (also referred to as multi-unit dwellings)**

Defining Public Venues – cont'd

- **Primary Venues cont'd:**
  - **<u>Non-Profit Meeting Places: Churches or charitable organizations</u>**
  - **<u>Parking Lots/Garages</u>: Parking lots or garages that are operated by private parking management companies, property management companies, or municipalities that offers direct access to a variety of venues**
  - **<u>Public/Municipal</u>: City, county, state, or federal government facilities**
  - **<u>Retail</u>: Retail locations both large and small, such as shopping malls, strip malls, and individual stores**
  - **<u>Transportation Hub</u>: Parking locations with direct pedestrian access to other forms of transportation, such as parking lots at airports, metro-rail stations, or ferry port parking lots**
  - **<u>Workplace</u>: Business offices, office parks or campuses, or industrial facilities**

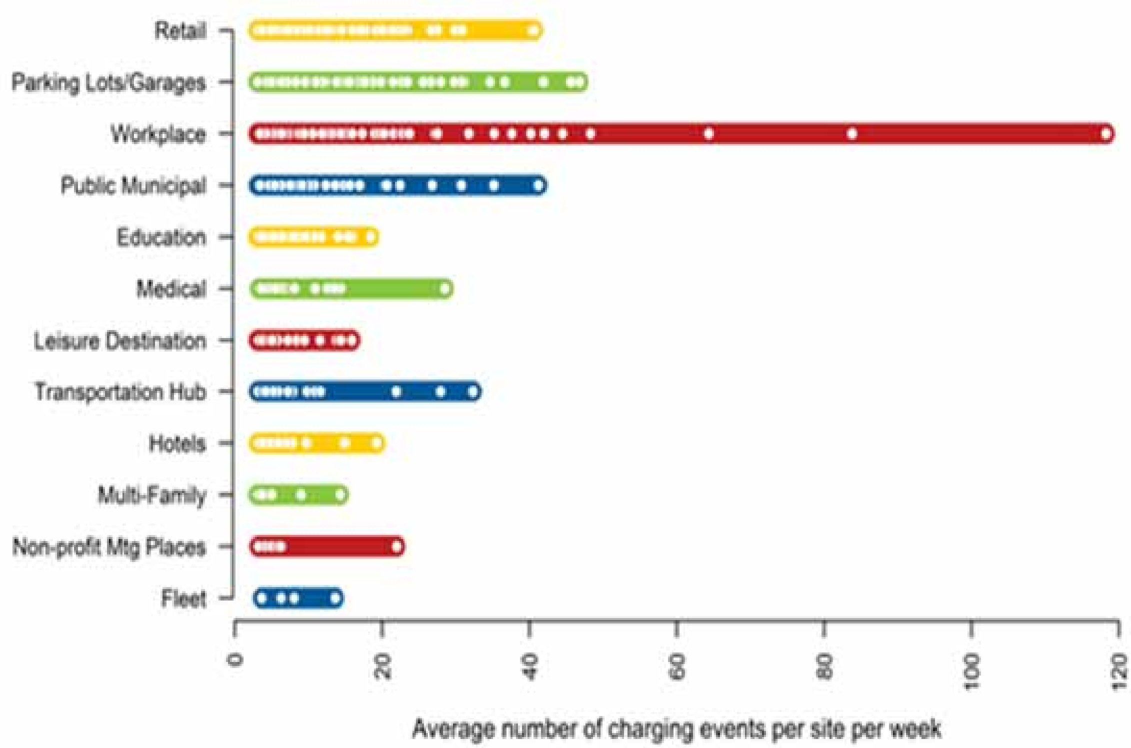
Public EVSE Charging Venues

- EVSE & DCFC sites discussed here were comprised of as few as one EVSE and as many as 18 EVSE per site
- The first four weeks of usage of EVSE at a site were not included in the calculation of performance metrics for that site
- The subset of data chosen for this research was restricted between September 1, 2012, and December 31, 2013
- 774 public Level 2 (240V) sites in primary venues
- The retail and parking lots/garages venues contained over 45% of all Level 2 sites, workplace 16%



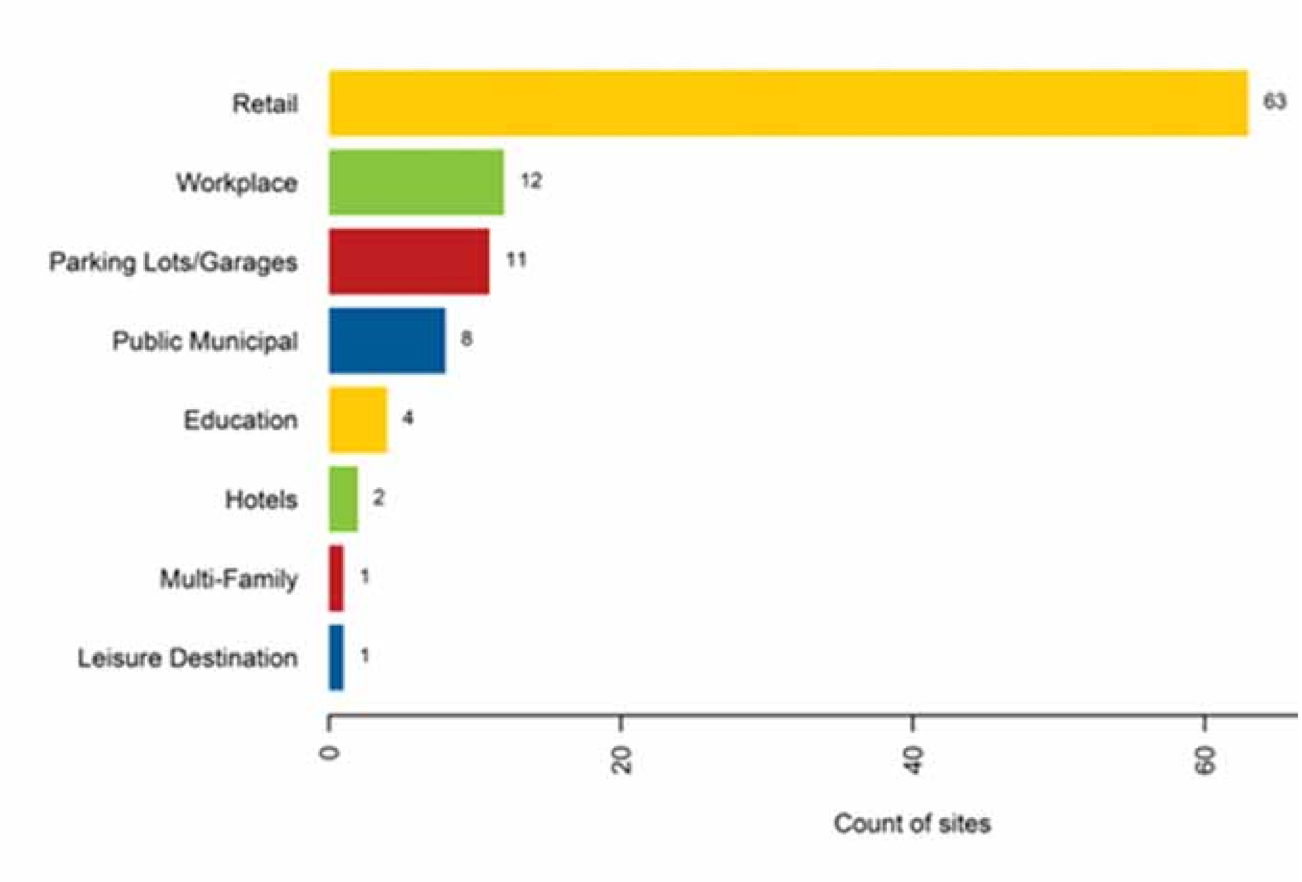
Public EVSE Venue Frequency of Charge Events

- **Average charging events per week per site (white circles)**
- **The range is the colored bar**
- **One retail venue averaged 40 average events per week**
- **The top 7 workplace sites averaged over 40 charging events per week**



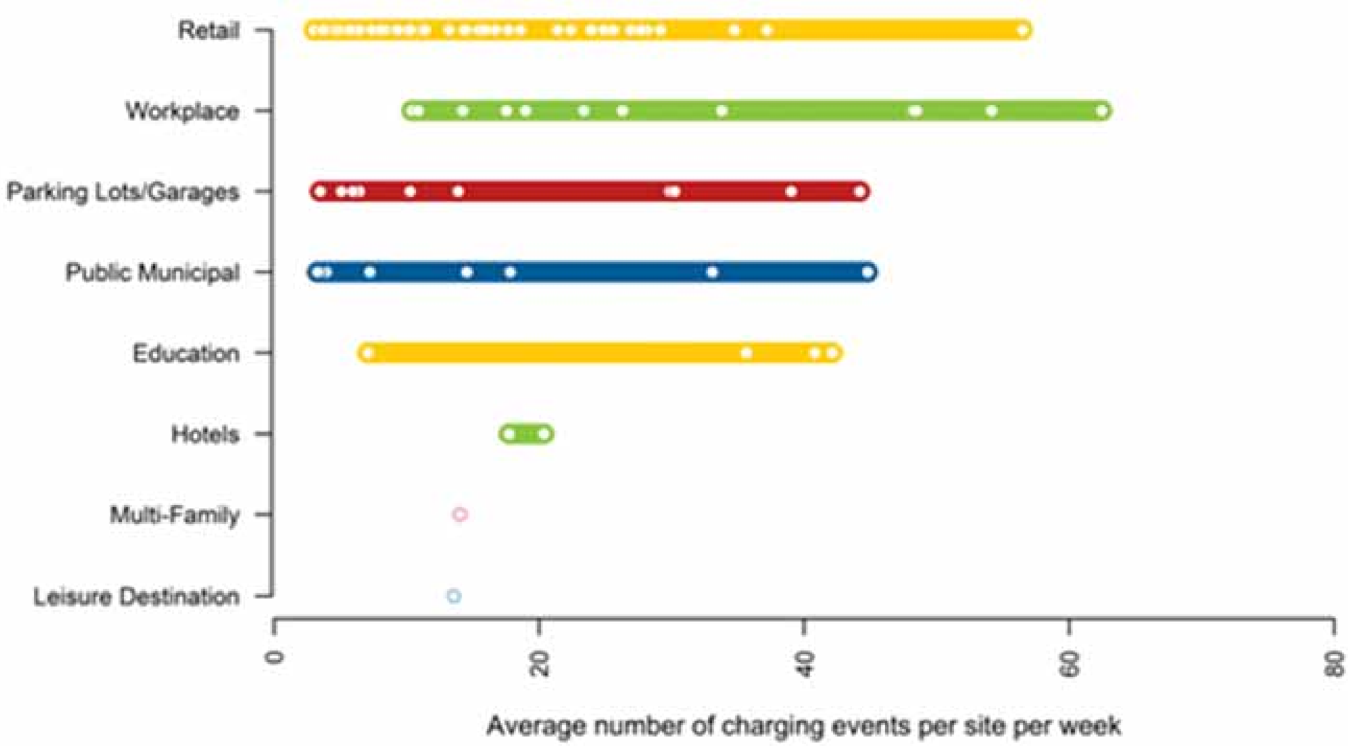
Public DCFC Use (Direct Current Fast Charger)

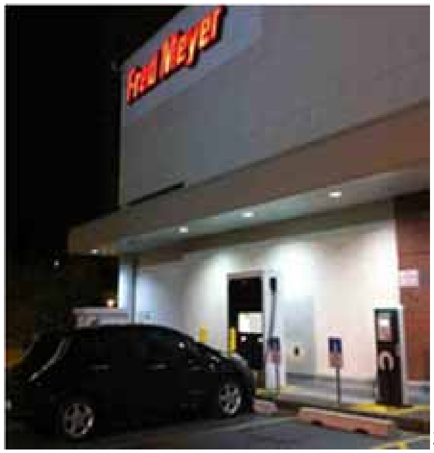
- **102 AeroVironment & Blink DCFC average number of charging events per week per site for DCFC sites by venue**
- **The retail venue contains 62% of all deployed DCFC**



Publicly Accessible DCFC Use

- **The site with the most usage is at a workplace venue**
- **DCFC utilization ranged from 3 to just over 60 charging events / week**
- **Workplace and education venues had the highest median charging frequency at 25 & 38 events per site per week**





Analyzing Public Charging Venues: Summary

- **Aspects of location may contribute to an EVSE site's popularity (or lack thereof), such as:**
  - **Site's geographic proximity to a large business district or an interstate highway**
  - **Demographics of local drivers or commuting drivers to workplaces and local commercial venues**
  - **The general location of the EVSE site, such as the part of town, city, or region where it is located, may also influence its use**
- **Defining the "best" location for EVSE is a complex undertaking**

Analyzing Public Charging Venues: Summary cont'd

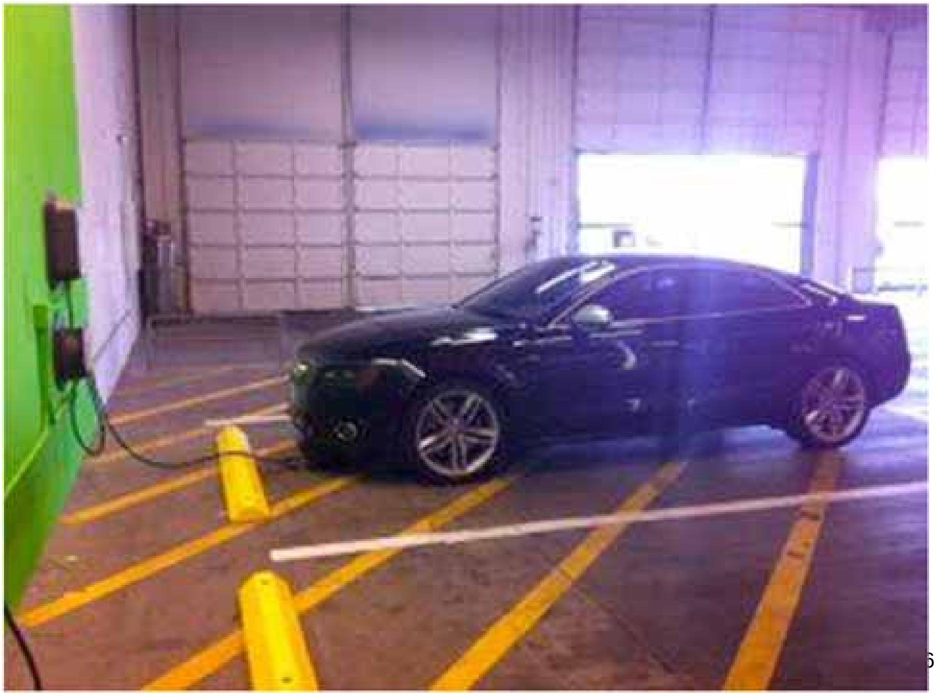
- Businesses, government agencies, & other organizations have many reasons for providing EVSE. Their definition of the "best" location for EVSE varies
  - Some are concerned with installing EVSE where it will be highly used & provide a return on investment
    - This return may come in the form of direct revenue earned by fees for EVSE use (but we can talk about this)
    - Or indirect return by enticing customers to stay in their businesses longer while they wait for their vehicle to charge or by attracting the plug-in electric vehicle driver customer demographic (it has been documented)

Analyzing Public Charging Venues: Summary cont'd

- Other organizations have non-financial interests, such as supporting greenhouse gas or petroleum reductions, or furthering other sustainability initiatives
- Others organizations install EVSE to boost their public brand image
- Employers provide them as a benefit to attract employees

Public Installation Considerations

- Establishing an EV charging infrastructure has unique challenges in that the public is not used to seeing EVSEs in public and may be unfamiliar with its purpose and use
- Without specific signage to the contrary, ICE vehicles may park in spaces equipped with an EVSE because they are convenient and vacant
- When an PEV arrives, the driver finds the space occupied and is unable to recharge

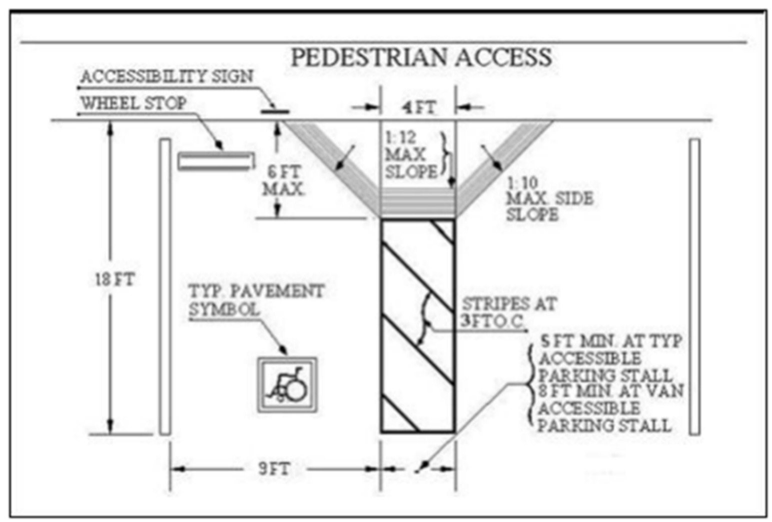


Public Installation Considerations

- It is recommended that municipalities adopt specific ordinances to:
  - Prohibit non-EVs from parking in spaces marked for "EV Charging Only"
  - Require that EVs parked in spaces marked for "EV Charging Only" must be connected to the EVSE while parked
- It may not be feasible to install EVSE in existing accessible parking spaces because
  - that space then becomes exclusively designated for an EV and would remove one of the
  - accessible spaces originally required for the facility.

Disabled Parking Considerations

- Recommendations to enable persons with disabilities to have access to a charging station per ADA and IBC (International Building Code):
  - An accessible space is required to park, exit vehicle and access the EVSE
  - Operable controls within 48” front and side reach range; and a 30” x 48” clear floor space is required
- In general, for every 25 parking spaces, one parking space should be accessible. For every six parking spaces that are accessible, one parking space should be van accessible. See: http://avt.inel.gov/pdf/EVProj/EVProjectAccessibilityAtPublicEVChargingLocations.pdf

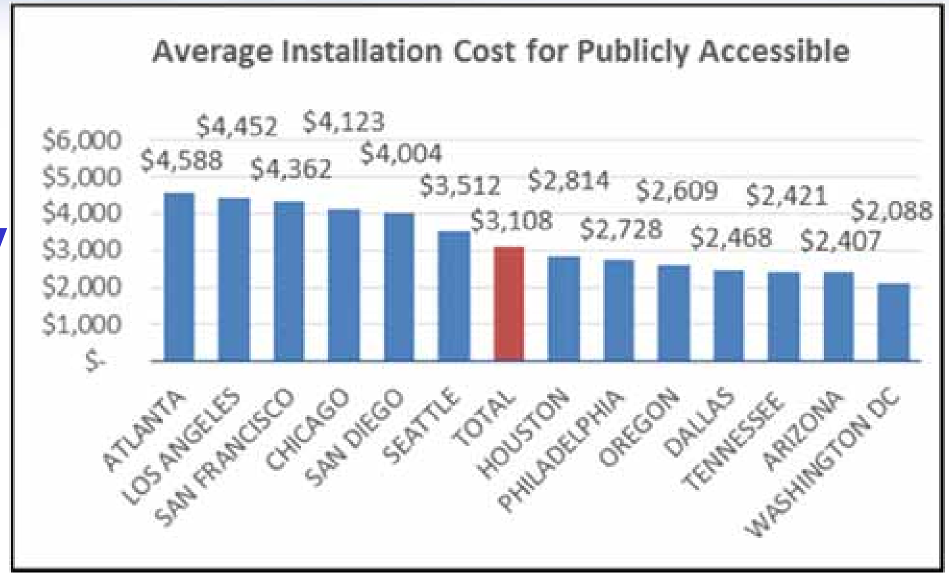


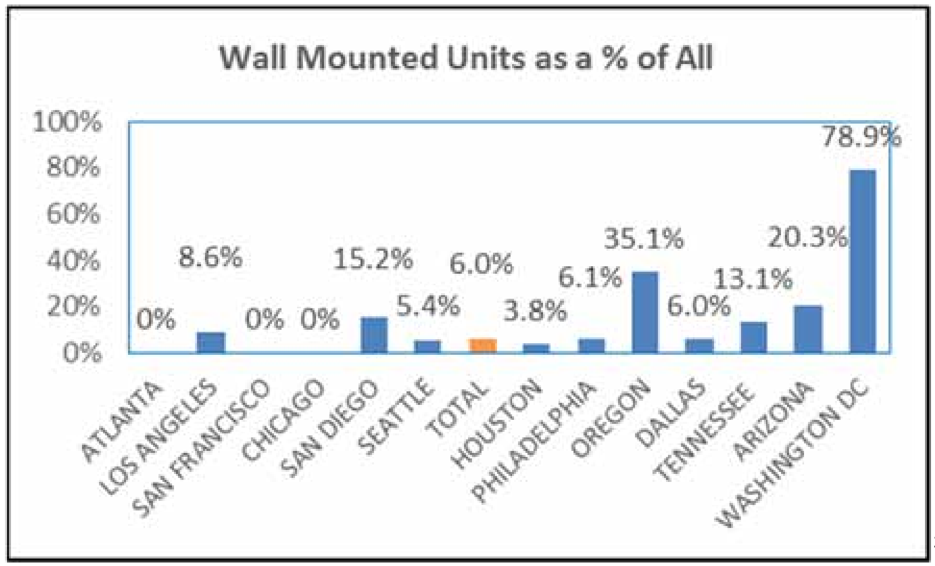
Public Level 2 EVSE Installation Costs

- Installation cost data for analysis is available for 2,479 units
- Average installation cost per unit for all publicly accessible Level 2 EVSE installed in EV Project markets was $3,108
- The five most expensive geographic markets had per unit installation costs over $4,000 ($4,004 to $4,588)
- The five least expensive geographic markets had per unit installation costs under $2,600 ($2,088 to $2,609)
- Similar to residential EVSE and direct current (DC) fast charger installation costs, AC Level 2 EVSE installed in California were the most expensive installations

Public Level 2 EVSE Installation Costs

- **Labor was the primary geographic differentiator of EVSE installation cost**
- **Labor costs can be mitigated by wall mount versus pedestal installation**
- **Another factor that affected installation costs in different markets was implementation of Americans with Disability Act (ADA) requirements as understood by the local permitting authority having jurisdiction**

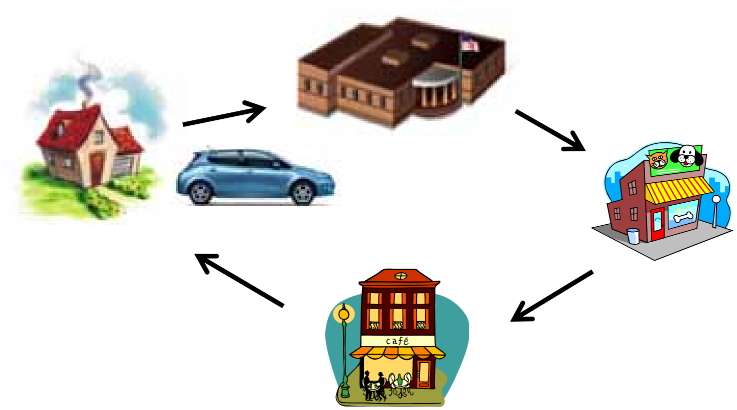




Oregon and Washington I-5 and other Travel Corridors with DC Fast Charger Usage

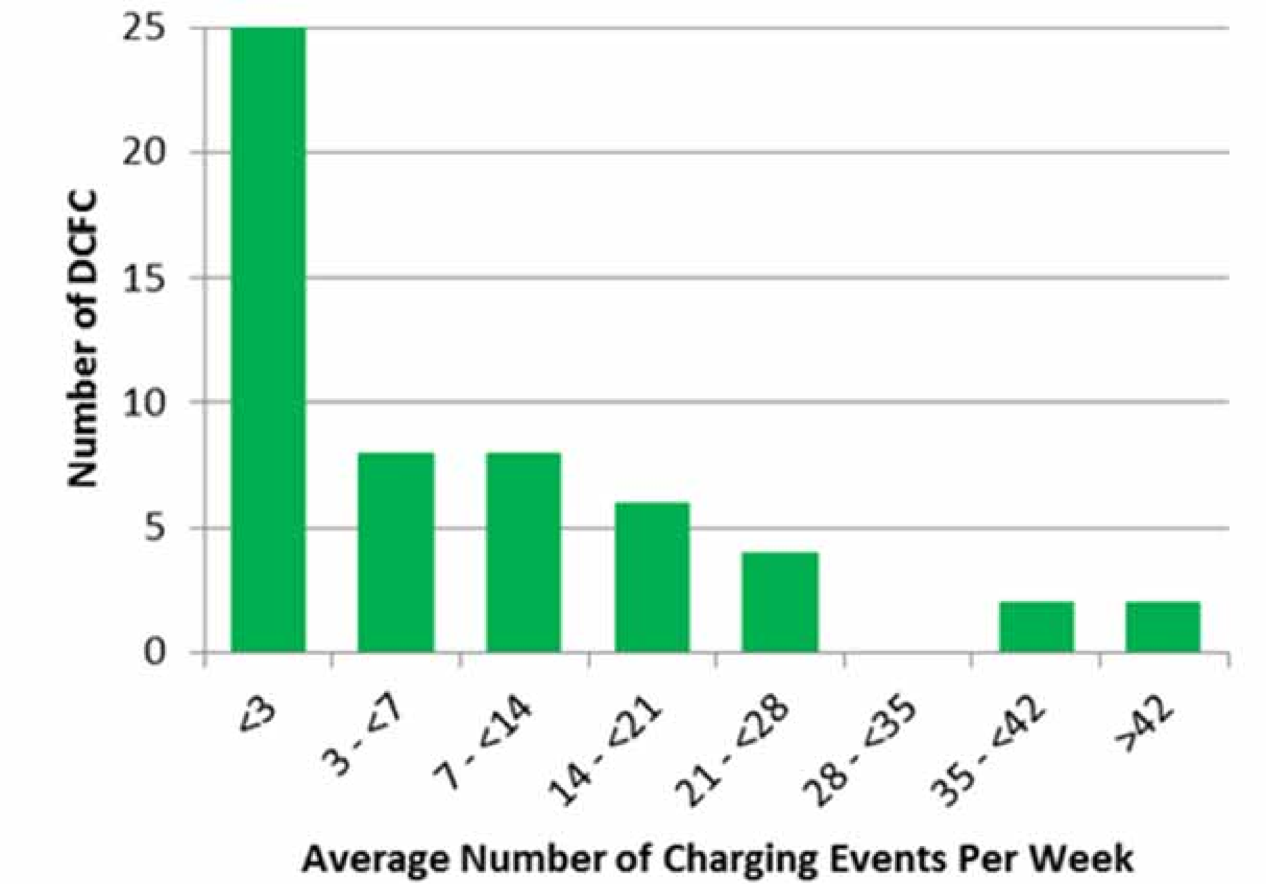
West Coast Electric Highway

- West Coast Electric Highway (WCEH) was designed to support long distance EV travel in WA, OR, and CA
- Analysis included 45 AeroVironment and 12 Blink DCFC (Not part of the WCEH, but sited in the travel corridor) located in Oregon and Washington (9/1/2012 to 1/1/2014)
- Using EV Project data, we can look at Nissan Leaf charging at these DCFC
  - 1,589 EV Project Leafs in Oregon and Washington
  - 319 used at least one of the 57 DCFC in the study
- During this period, the 57 corridor DCFCs reported 36,846 charges by 2,515 distinct PEVs



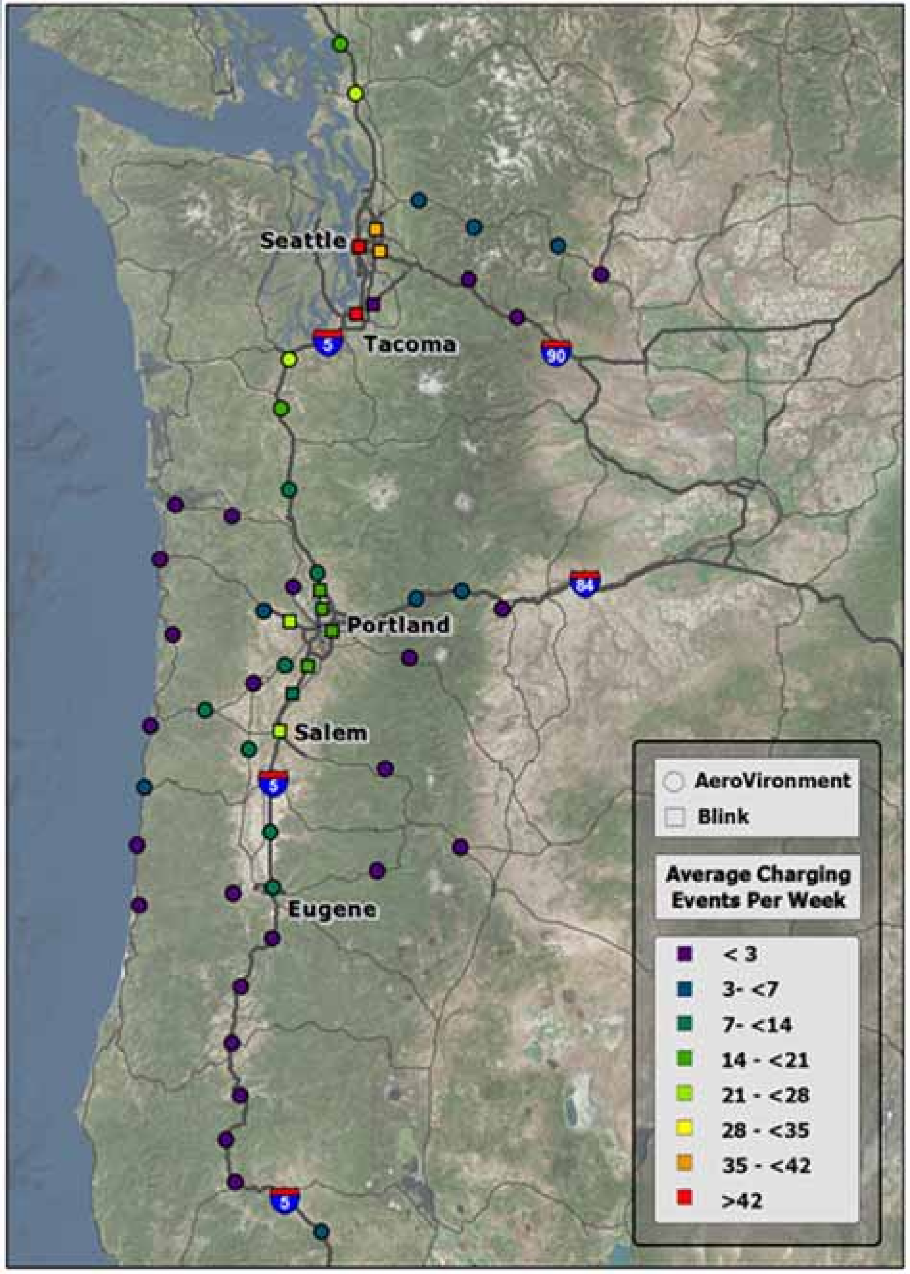
DCFC Usage Frequency

- There was a wide range in the usage of DCFCs
- Majority were used less than seven times per week, or once per day
- Four were used 35 or more times per week, or 5 or more times per day



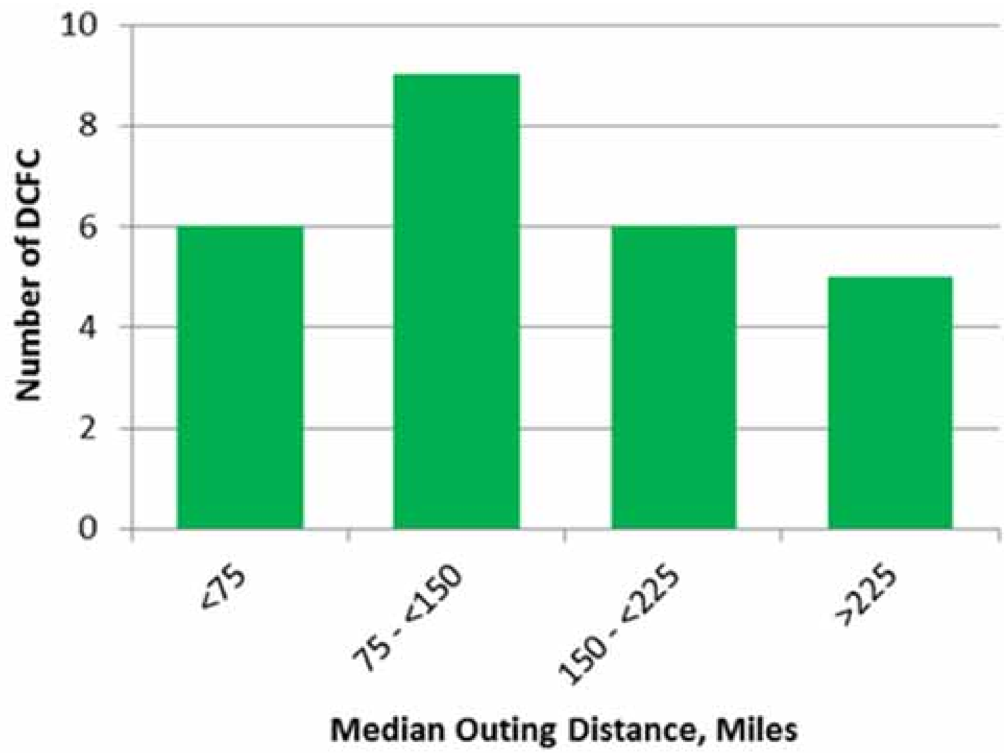
Usage Locations

- **DCFC that are closer to large cities were used more frequently**
- **DCFCs directly between the larger cities (i.e., Portland, Seattle, & Vancouver, British Columbia) had high usage**
- **DCFCs installed farther from large cities, especially east & west of I-5 & south of Eugene, were generally used less than 7 times per week**
- **Low usage may not create high value for DCFC owners seeking revenue**
- **Individual charge events may have been highly valued by the EV driver**



Maximizing Outing Distances

- **Data from 319 Nissan Leafs in The EV Project, which used the corridor DCFC in this study, were analyzed**
- **An Outing represents all driving done from when a driver leaves home to when they return home**
- **A DCFC had to be used in 30 or more outings to be included in this analysis**
- **DCFC are used to maximize Outing distances beyond the range of the Leafs (75+ miles)**



Median Outing Distance

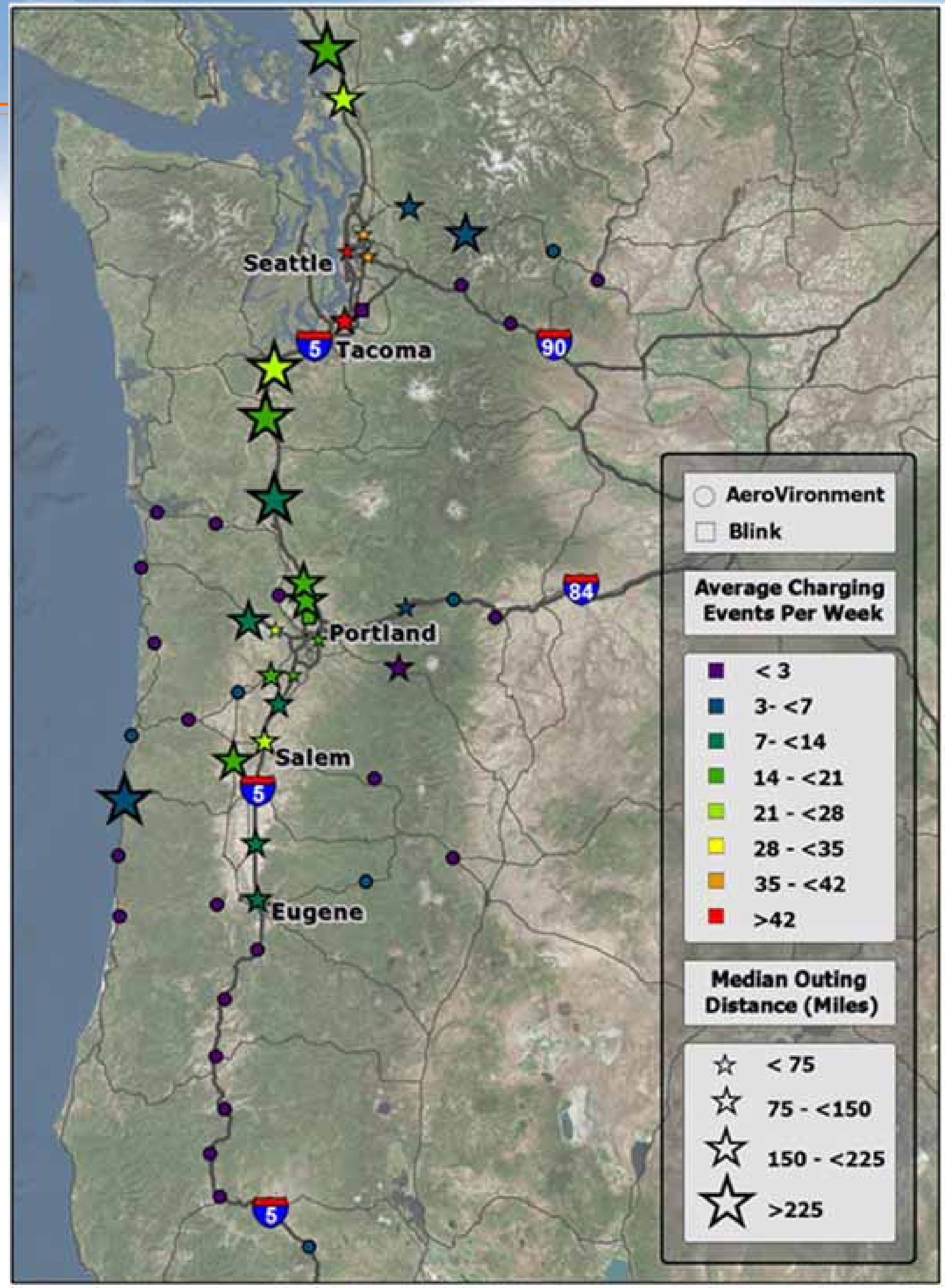
- DCFC in cities were used in much shorter outings (usually less than full charge range of Leaf)
- As distance from DCFC to cities increases, outing distance increases
- Many DCFC along I-5 were used 2 to 4 times per day for outings over 150 miles
  - Some >225 miles
  - Regularly being used for outings that require 2, 3 or more full charges to complete
- 19 outings longer than 500 miles
- Longest outings was 770 miles. This driver performed 16 fast charges at nine different DCFCs
- Tough to build a business case around a few PEV drivers

Leaf Drivers' DCFC Use and Outing Distances

- Color highlights charge events per week
- Star size highlights outing distances

- DCFC is clearly of high value but only to a small group of PEV drivers

- But the question remains
  - Do drivers use PEVs more because DCFC exist even if drivers never use them?

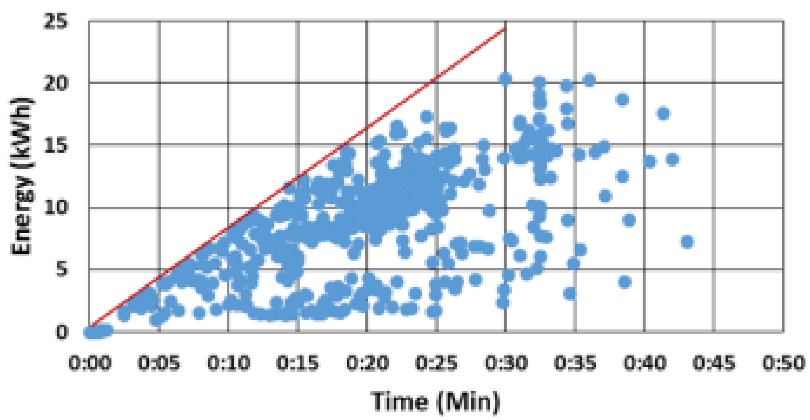


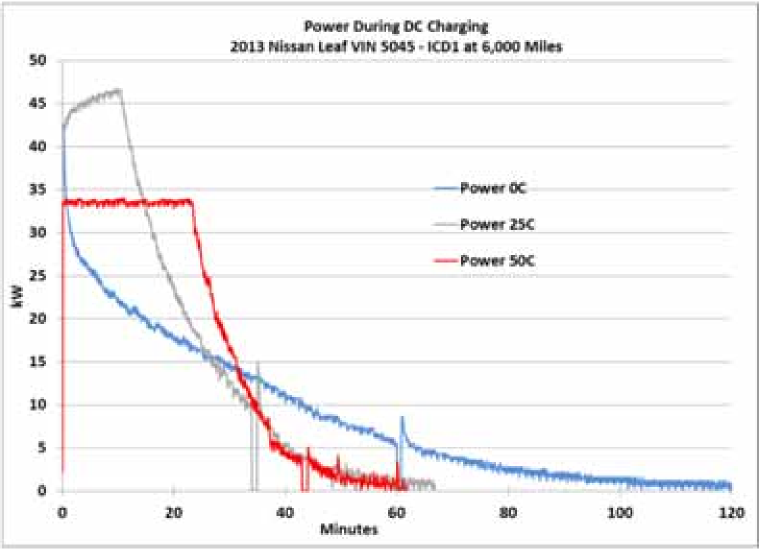
DC Fast Charger Installation Costs for 111 Units

- By the end of 2013, the EV Project had installed 111 DCFCs
- Overall, installation costs varied widely from $8,500 to over $50,000
- The median cost to install the Blink dual-port DCFC in the EV Project was $22,626. Does NOT include DCFC hardware cost
- The addition of new electrical service at the site was the single largest differentiator of installation costs
- The surface on or under which the wiring and conduit were installed was second largest cost driver
- Cooperation from the electric utility and/or the local permitting authority is key to minimizing installation costs (both money and time) for DCFCs

What is the Impact of Utility Demand Charges on a DCFC Host?

- **DCFC energy transferred versus charge time and Leaf charge profile**





- **Demand charges associated with 50-kW high power charging of a DCFC can have a significant impact on a monthly electric utility bill**
- **Owner will need to choose whether to power the DCFC on the original business service electrical supply or provide separate service**

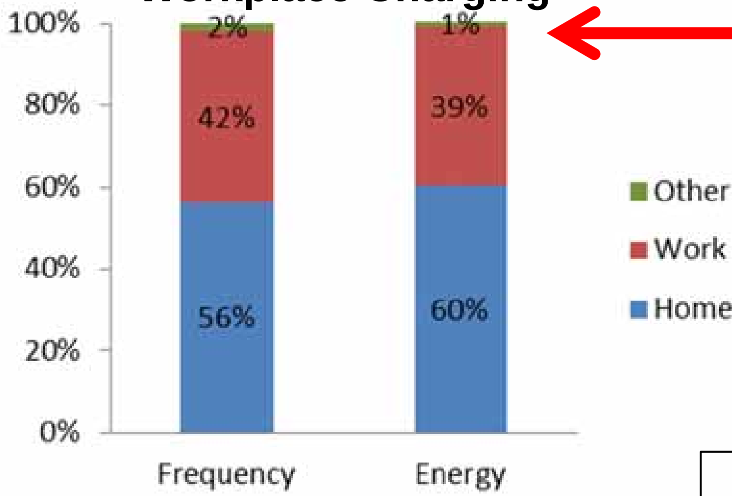
What is the Impact of Utility Demand Charges on a DCFC Host? Cont'd

- **Detailed analysis of potential costs and the electric utility rate schedule options to determine the optimal rate schedule for a DCFC site is important and should be conducted in consultation with the electric utility**
- **Some electric utilities provide rate schedules for commercial customers without imposing demand charges**
- **DCFC site hosts may be compensated for energy used in DCFC charging through access or use fees imposed on PEV drivers**
- **The host's monthly DCFC demand charge is based on the single highest power required by the DCFC during the month, regardless of the number of charge events in the month**
- **A higher number of PEV charges in a month reduces the average demand charge cost per PEV charge**
- **Monthly charge can exceed $1,000 per DCFC**

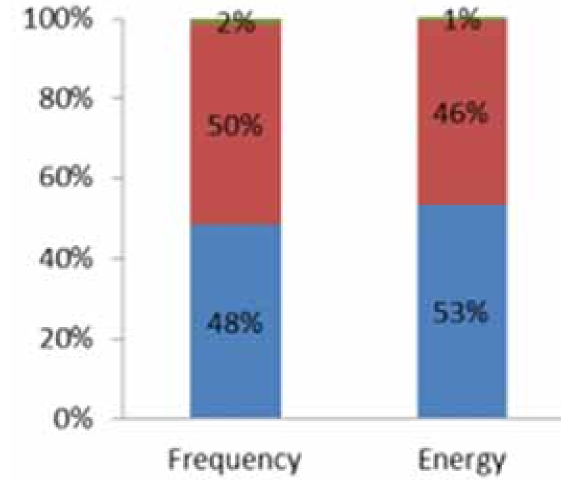
Workplace Charging & Installation Costs

Summary: Leafs & Volts With Workplace Charging

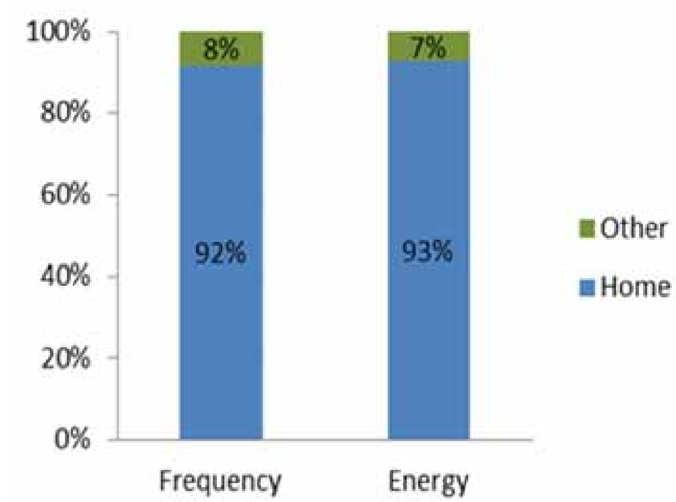
707 Leafs with Access to Workplace Charging



96 Volts with Access to Workplace Charging

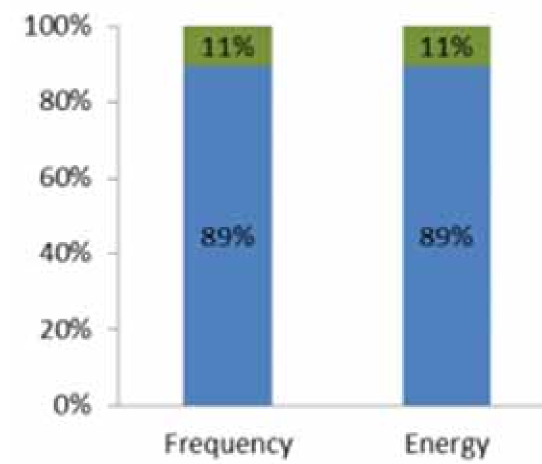


Same Leafs on non-work days



In aggregate, workplace vehicle drivers had little use for public infrastructure on days when they went to work

Same Volts on non-work days



Workplace Cost Drivers – Facility Location

- **Location Relative to the Facility**
  - **Typically installed in existing employee parking lots, normally at the rear of the workplace or at the side of the building**
  - **This typically puts the EVSE closer to the building's power distribution panels**
  - **Shorter electrical conduit runs and, therefore, less expensive installation costs**
  - **Some workplace charging stations were installed in multi level parking garages**
    - **Also located away from the front of the building and were more likely to be nearer electrical service**
    - **Typically utilized surface-mounted electrical conduit, which is less expensive to install than conduit buried underground**
    - **These units typically utilized surface-mounted electrical conduit, which is less expensive to install than conduit buried underground**

Workplace Cost Drivers – Wall Mounted

- **Wall-Mounted Installations**
  - Greater freedom as to the installation location at a site led to more wall-mounted installations
  - Wall-mounted EVSE were typically less expensive to install, because they did not require underground conduit to supply power, which is typical for a pedestal unit
  - The average cost to install a wall-mount AC Level 2 EVSE was $2,035
  - The average cost to install a pedestal AC Level 2 was $3,209

Workplace Cost Drivers – Location Flexibility

- **Flexibility of the Installation Location and the ability to install the units with fewer accessibility requirements. For example**
  - **Typically there were few, if any, parking signage or striping requirements**
  - **ADA accessibility, including an accessible pathway to the workplace building, was only necessary if an employee was a PEV driver and required this accessibility**
  - **Units did not need to be in conspicuous locations**
  - **Public accessibility during hours outside of normal business hours was also not a concern**

Workplace Cost Drivers – Too Successful?

- **One workplace installation cost factor that did emerge over the course of The EV Project, was the cost to install additional EVSE**
  - **Employers providing workplace charge stations for their employees found that the offer of refueling commuter vehicles while at work (whether at a cost to the driver or free) encouraged more employees to obtain PEVs for their work commute**
  - **Puts pressure on employers to add more stations, with the “easy” installations often being the first ones (i.e., ones already done)**
  - **Additional electrical service and parking places further from the electrical distribution panel usually were required for additional EVSE, which added to the cost of these subsequent installations**

Workplace Charging Installation Costs

- The average cost for installation of electric vehicle supply equipment (EVSE) at workplace locations was $2,223
- Average installation costs for EV Project non-residential AC Level 2 EVSE

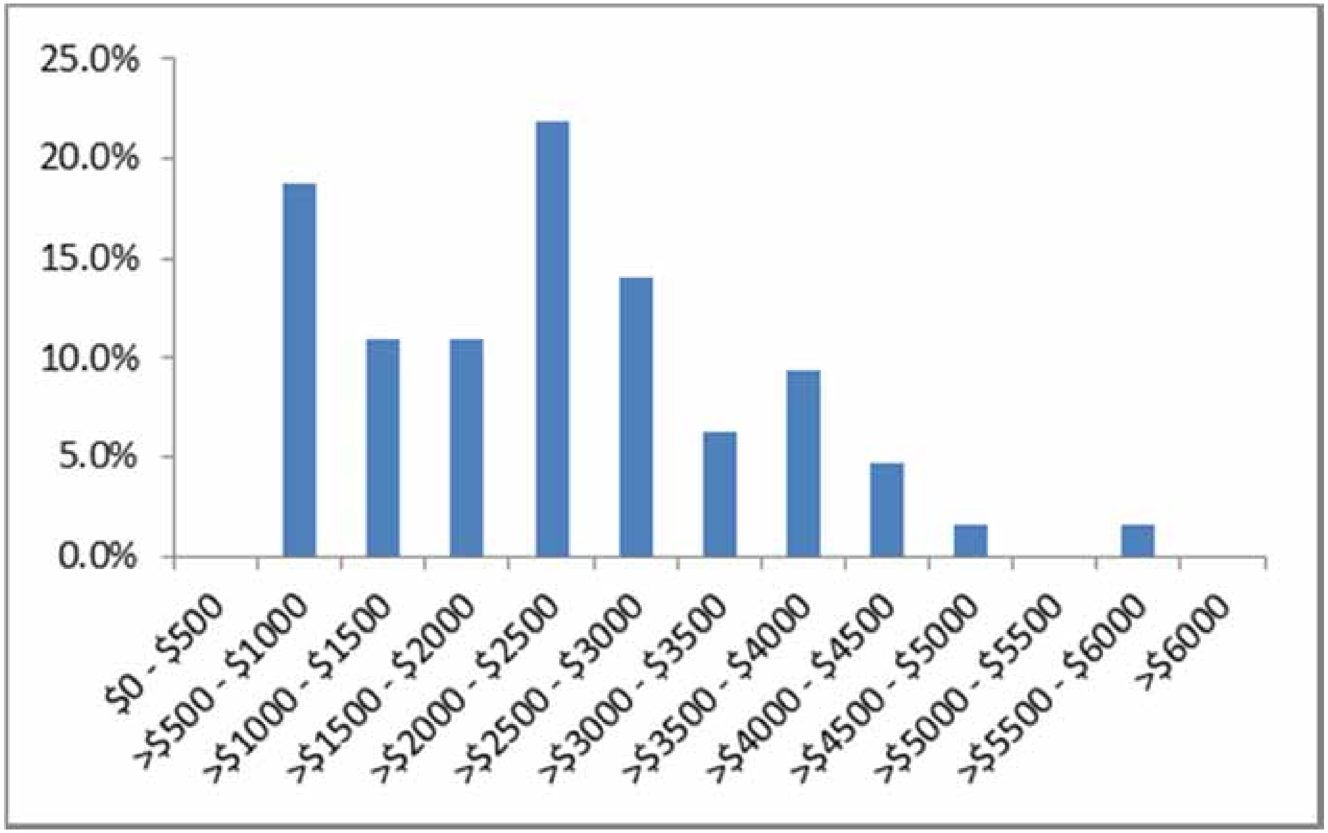
Average Installation Cost			
	All Non-Residential	Publicly Accessible	Workplace
All	$2,979	$3,108	$2,223
Pedestal Units	$3,209	$3,308	$2,305
Wall-Mount Units	$2,035	$2,042	$2,000

- Maximum and minimum installation costs for EV Project non-residential AC Level 2 EVSE

Maximum and Minimum Installation Costs			
	All Non-Residential	Publicly Accessible	Workplace
Maximum	$12,660	$12,660	$5,960
Minimum	$599	$599	$624

Workplace Charging Installation Costs

- **Distribution of per unit workplace installation costs**
  - **80% of the workplace stations were installed at costs that were below the average installation cost of $3,108 for stations installed for public use**

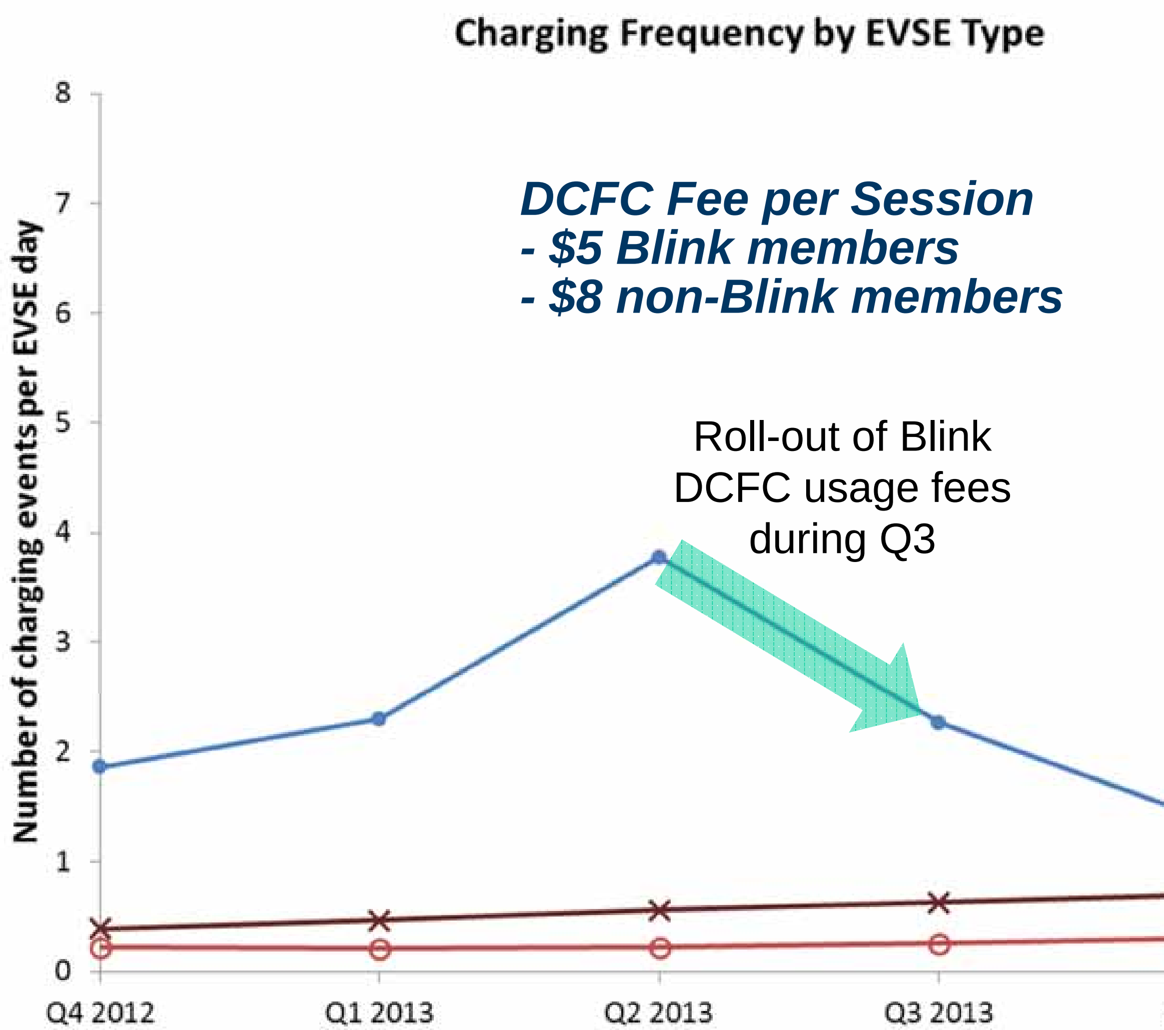


Utility Demand Charges on AC Level 2 EVSE

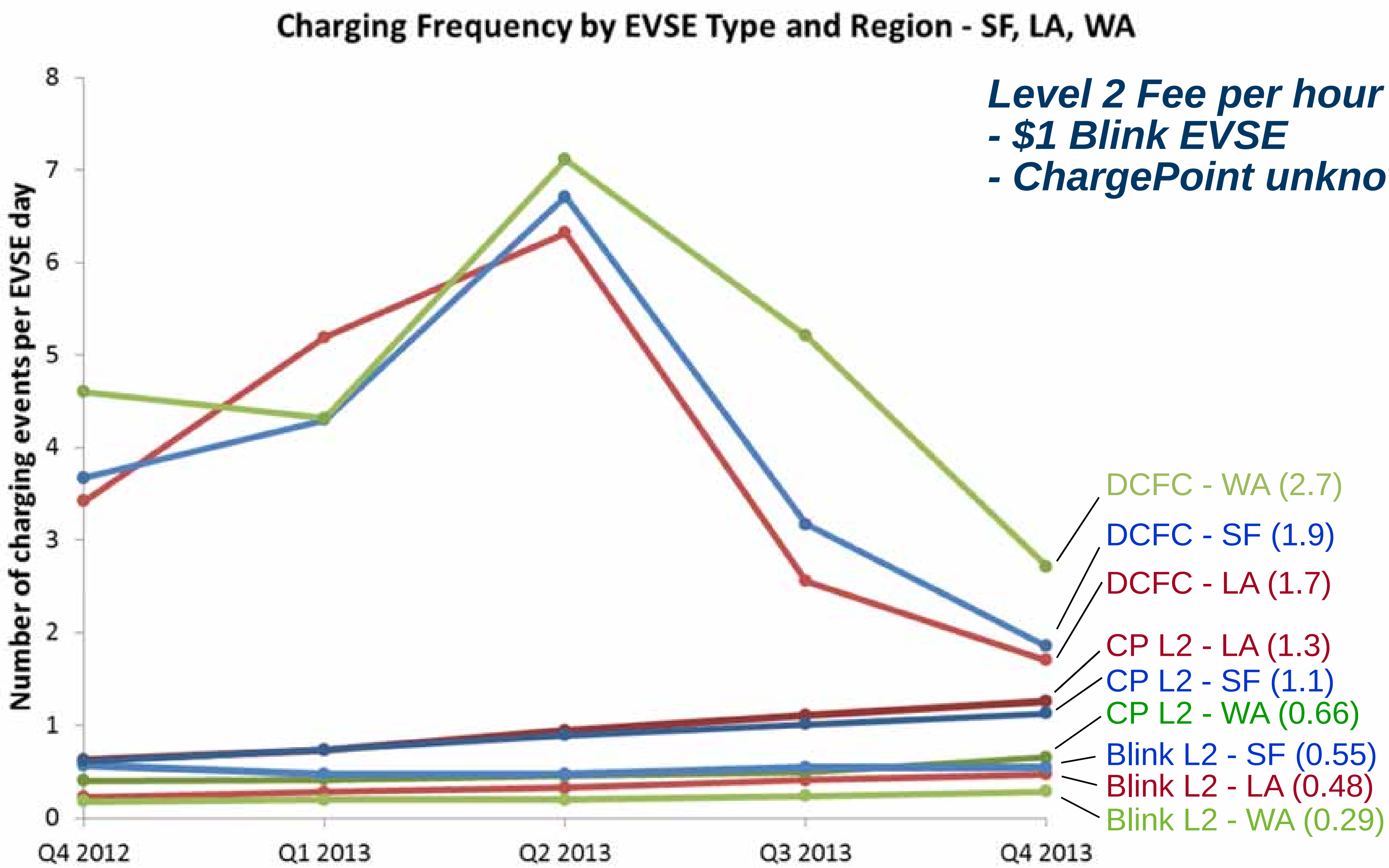
- **Some electric utilities impose demand charges on the highest power delivered to a customer in a month**
- **Simultaneously charging plug-in electric vehicles via multiple AC Level 2 EVSE can create significant increases in power demand**
- **The increased charging rate allowed by many newer plug-in-electric vehicles (PEVs) will exacerbate this impact**
- **3 EVSE x 6.6 kW = 19.8 kW**
  - **Many utilities start demand charges at 20 kW**
  - **Demand charge can exceed $1,000 per month**

Charging Fee Impact on Use Rates

National Blink DC Fast Chargers - Fee Impacts

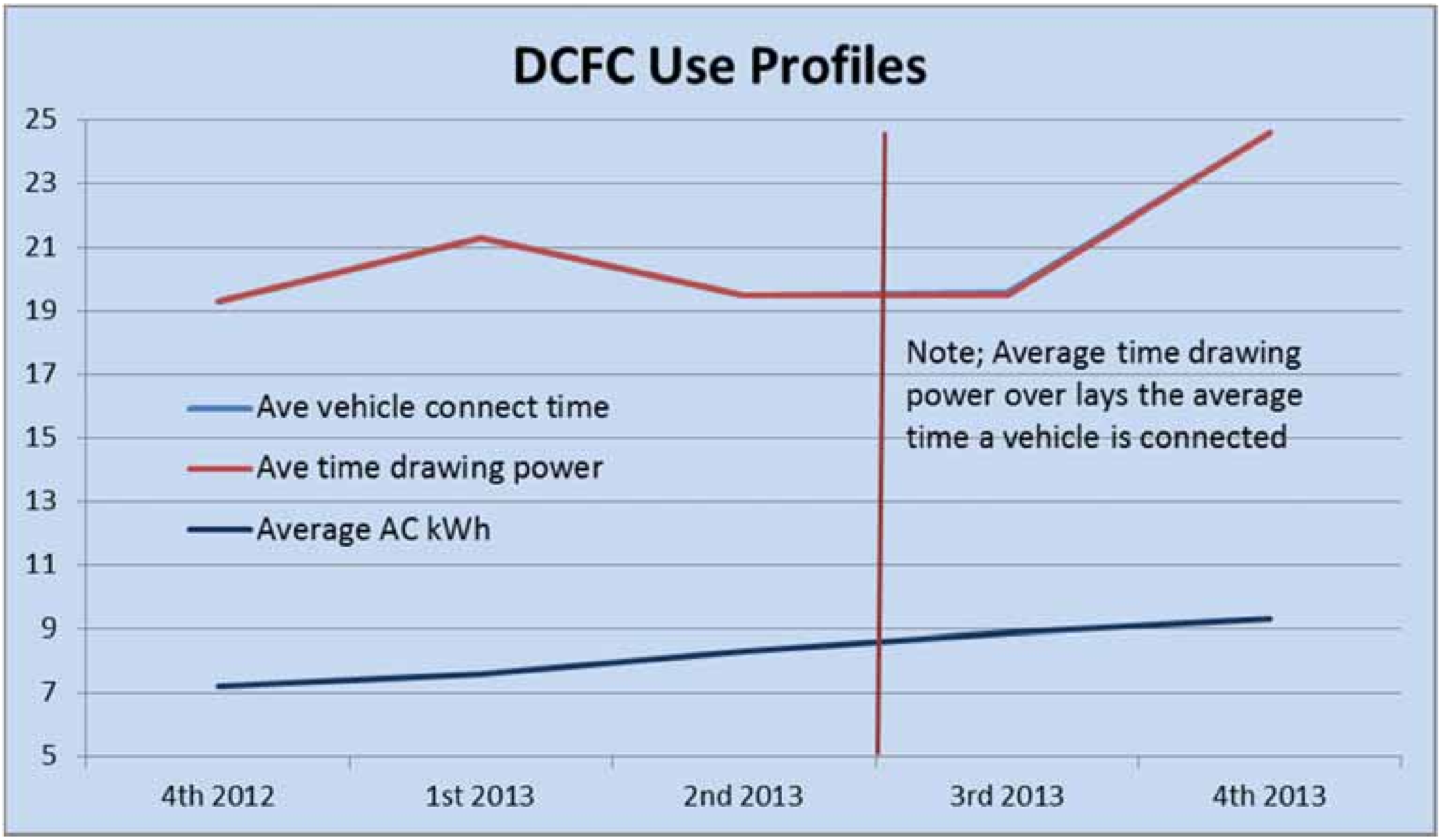


Average Usage Rate for Public Level 2 EVSE & DC Fast Chargers per Select Regions



DC Fast Charger Use Profiles

- 4th 2013 Quarter connect time and energy transfer rates suggest users may want to maximize energy transferred due to fees
- In below graph, connect and drawing power times sit on each other
- Low use rates suggest a difficult business case



Electric Vehicle Miles Traveled (eVMT)

eVMT Analysis

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

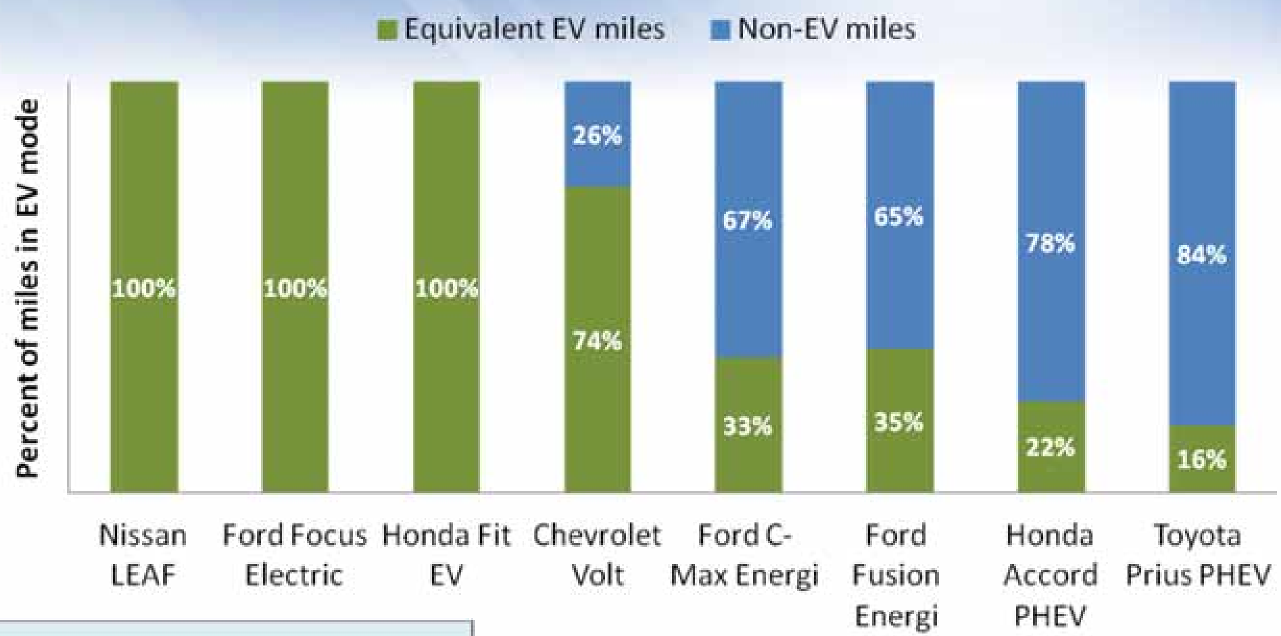


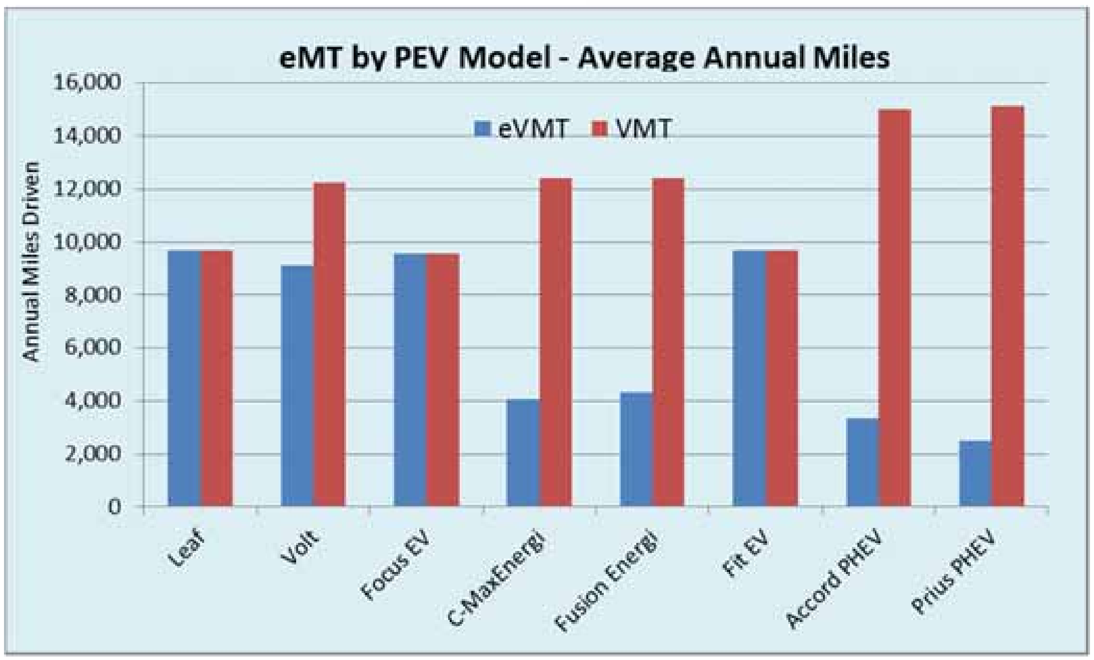
- **Calculated electric vehicle miles traveled (eVMT) for:**
  - **Ford Fusion Energi**
  - **Ford C-Max Energi**
  - **Honda Accord PHEV**
  - **Toyota Prius PHEV**
  - **Chevrolet Volt**
  - **Ford Focus Electric**
  - **Honda Fit EV**
  - **Nissan Leaf**




- **Data is from actual customer, on-road vehicle operation**
  - **<u>158,468,000 miles</u> from <u>21,600</u> vehicles**
  - **Across the U.S. (i.e. widely varying regions and climates)**

eVMT vs. VMT





- **Even partial electric drive can have significant petroleum reduction benefits**

Electric Utility News

- December 2014 California Public Utilities Commission issued Order allowing utility ownership of EV charging infrastructure.
  - Southern California Edison
    - Estimates 350,000 plug-in vehicles in service area by 2020
    - Seeking CPUC approval to spend $355M to install >30,000 EV charging stations over 5 years
  - Pacific Gas & Electric
    - Presently over 60,000 plug-in electric vehicles registered in service area
    - Seeking CPUC approval to install 25,000+ EV charging stations at a cost of $654M funded by rate payers
  - San Diego Gas & Electric
    - Presently over 15,000 plug-in electric vehicles in service area
    - Seeking CPUC approval to spend >$100M to contract with 3rd parties to build, install, operate and maintain 5,500 EV charging stations

Provided by Idaho Power

Additional Information

For publications and general plug-in electric vehicle performance, visit http://avt.inl.gov

Funding provided by DOE`s Vehicle Technologies Office