

Workplace Charging Case Study: Charging Station Utilization at a Work Site with AC Level 1, AC Level 2, and DC Fast Charging Units - WA State EV Working Group

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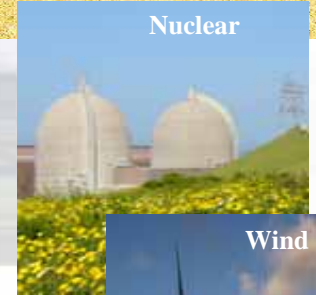
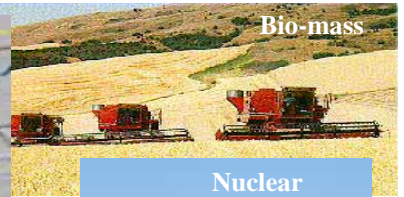


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WA State EV Working Group
July 21, 2014**

*This presentation does not contain any proprietary,
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INL/MIS-14-32498

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 Vehicles and Battery Development**
 - **Homeland Security and Cyber Security**

Introduction

- **Study of the usage of workplace charging stations at Facebook's office campus in Menlo Park, CA from May 1 to August 15 (2013)**
- **Charging stations included**
 - **12 ChargePoint EVSE units capable of AC Level 1 and AC Level 2 charging rates**
 - **10 Blink AC Level 2 EVSE (electric vehicle supply equipment) units**
 - **1 Blink DC fast charger All**
 - **All were part of The EV Project and ChargePoint America project**
- **The EVSE were installed over time as the number of employees owning PEVs and the demand for workplace charging increased**

Summary of EVSE Usage by EVSE Power Level

	AC Level 1	AC Level 2	DC Fast Charger
Number of EVSE ports	12 (34%)	22 (63%)	1 (3%)
Number of charging events	194 (6%)	2,553 (83%)	339 (11%)
Total energy consumed (kWh)	1,273 (4%)	30,743 (87%)	3,150 (9%)

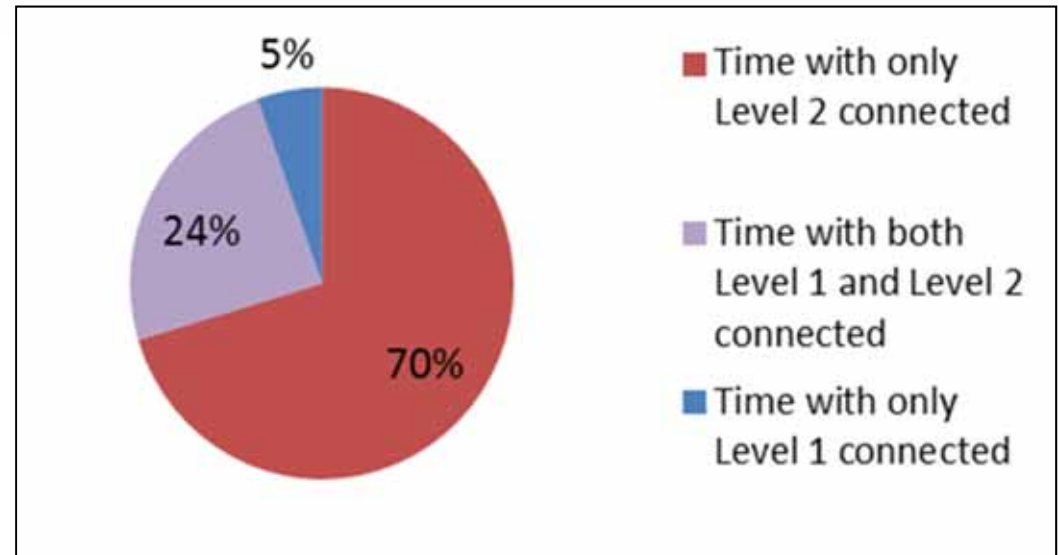
- 75 work days, excludes weekends and holidays
- A total of 3,086 charging events were performed

Summary of EVSE Average Usage by Charge Power Level

	AC Level 1	AC Level 2	DC Fast Charger
Average number of charging events per cord per work day	0.22	1.5	4.5
Average time connected to a vehicle per charging event (hr)	8.9	5.6	0.36
Average time transferring power to a vehicle per charging event (hr)	4.6	2.9	0.36
Average time connected to a vehicle per cord per work day (hr)	1.9	8.7	1.6
Average time transferring power to a vehicle per cord per work day (hr)	1.0	4.5	1.6

Percent of Time ChargePoint EVSE had their Level 1 Outlet, Level 2 Cord, or Both in use.

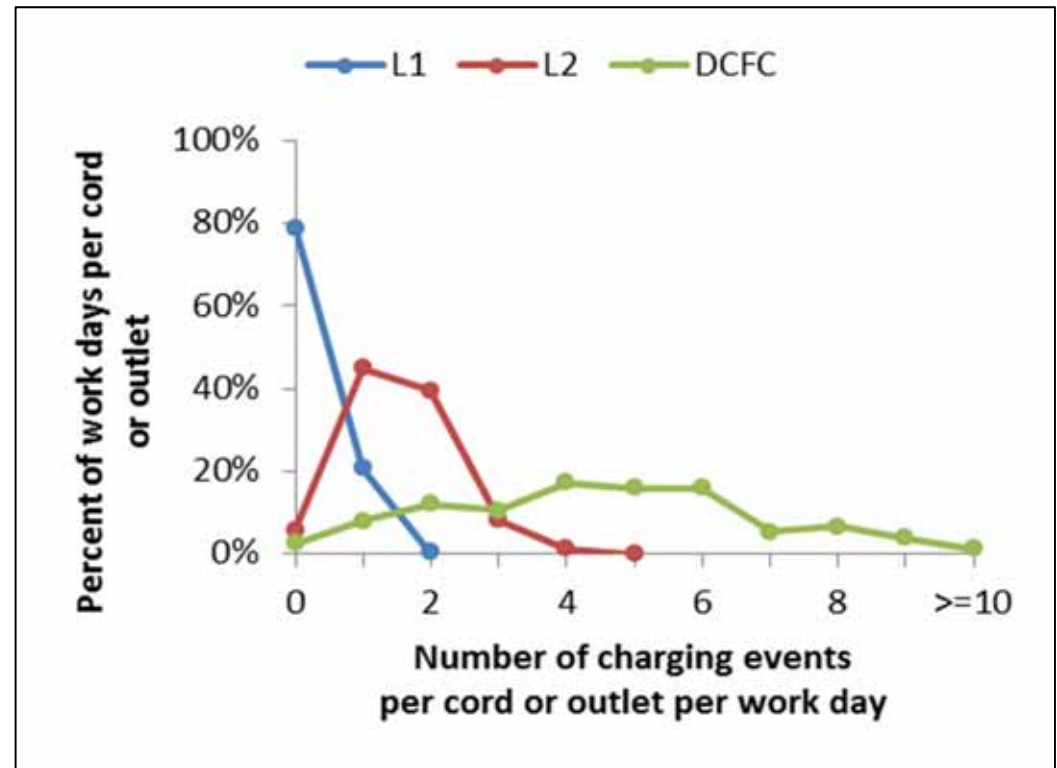
- **When drivers arrived at a ChargePoint EVSE and there was no one already connected to the EVSE, drivers opted to use the Level 2 cord 98% of time**



- **The Level 1 outlet was only selected first for 2% of the charging events**
- **This means that nearly every time a driver chose to use a Level 1 outlet, it was because the Level 2 cord was already in use**

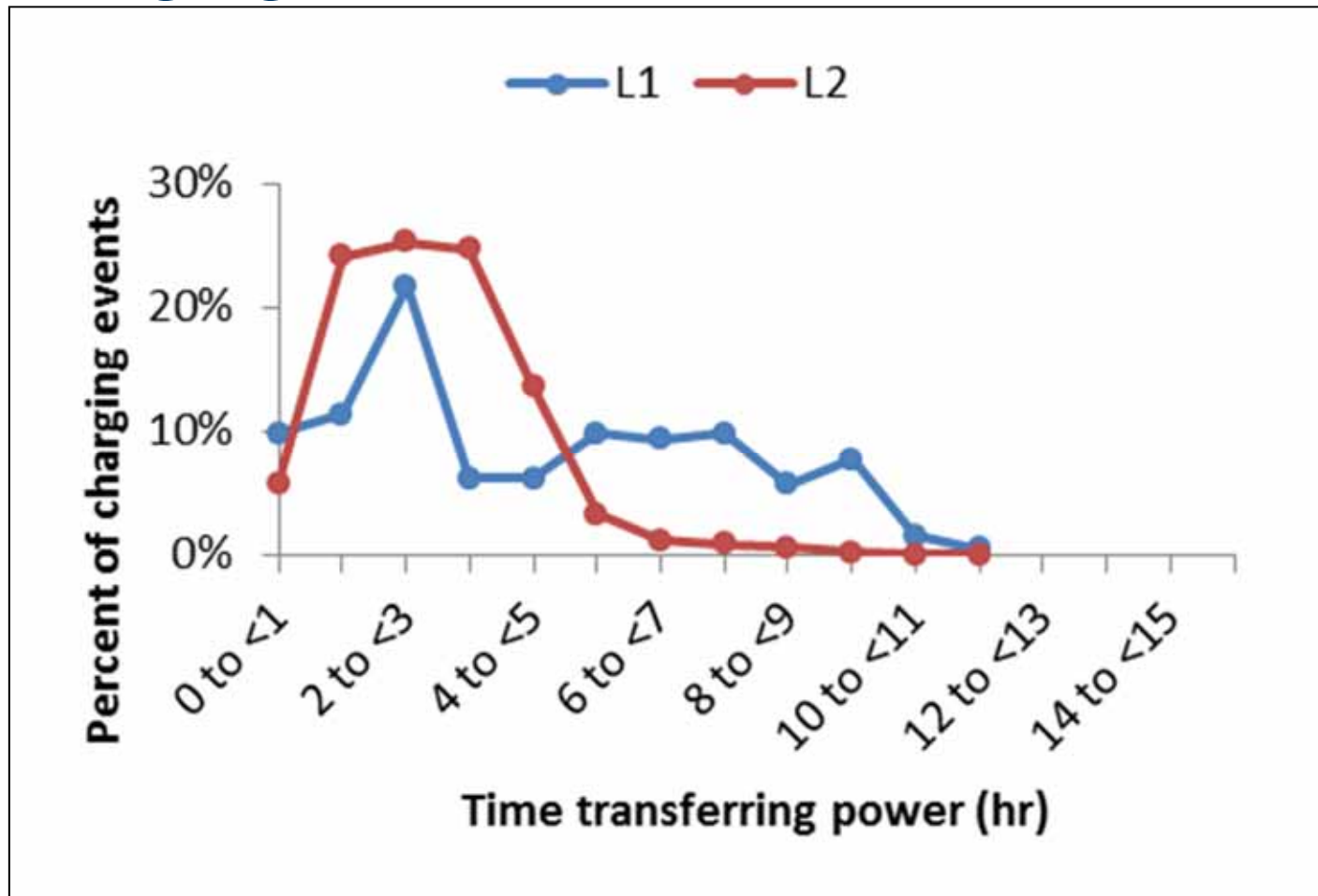
Frequency Distributions of Number of Charging Events per Cord or Outlet per Work Day for Different Charge Power levels

- Drivers may have consciously chosen the faster charge rate to charge their batteries more quickly to ensure they received a full charge before departing

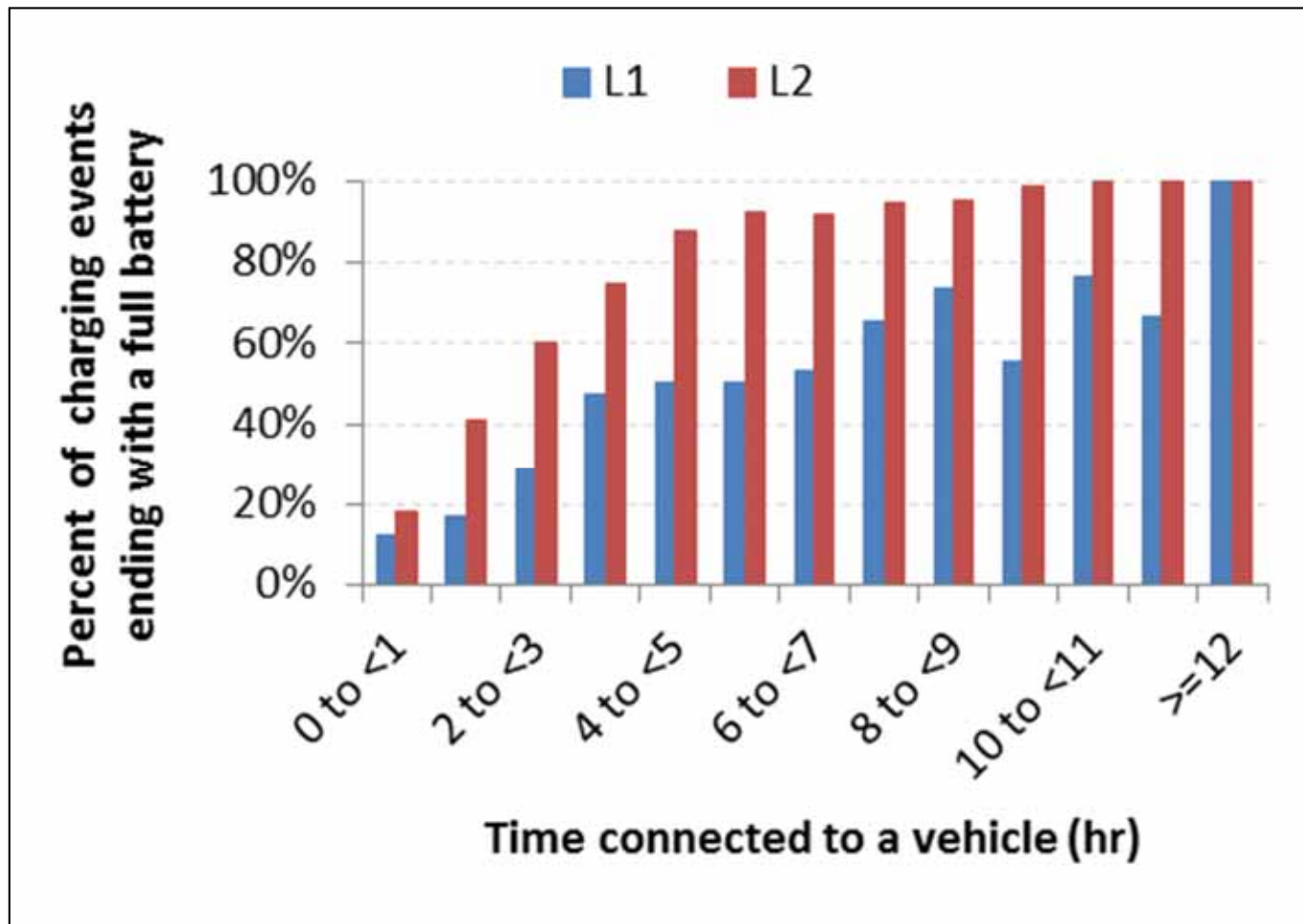


- Otherwise, drivers may have been motivated simply by convenience as the Level 2 cord was available on the EVSE, but a driver needed to retrieve their own Level 1 cord to plug into the Level 1 outlet on the EVSE

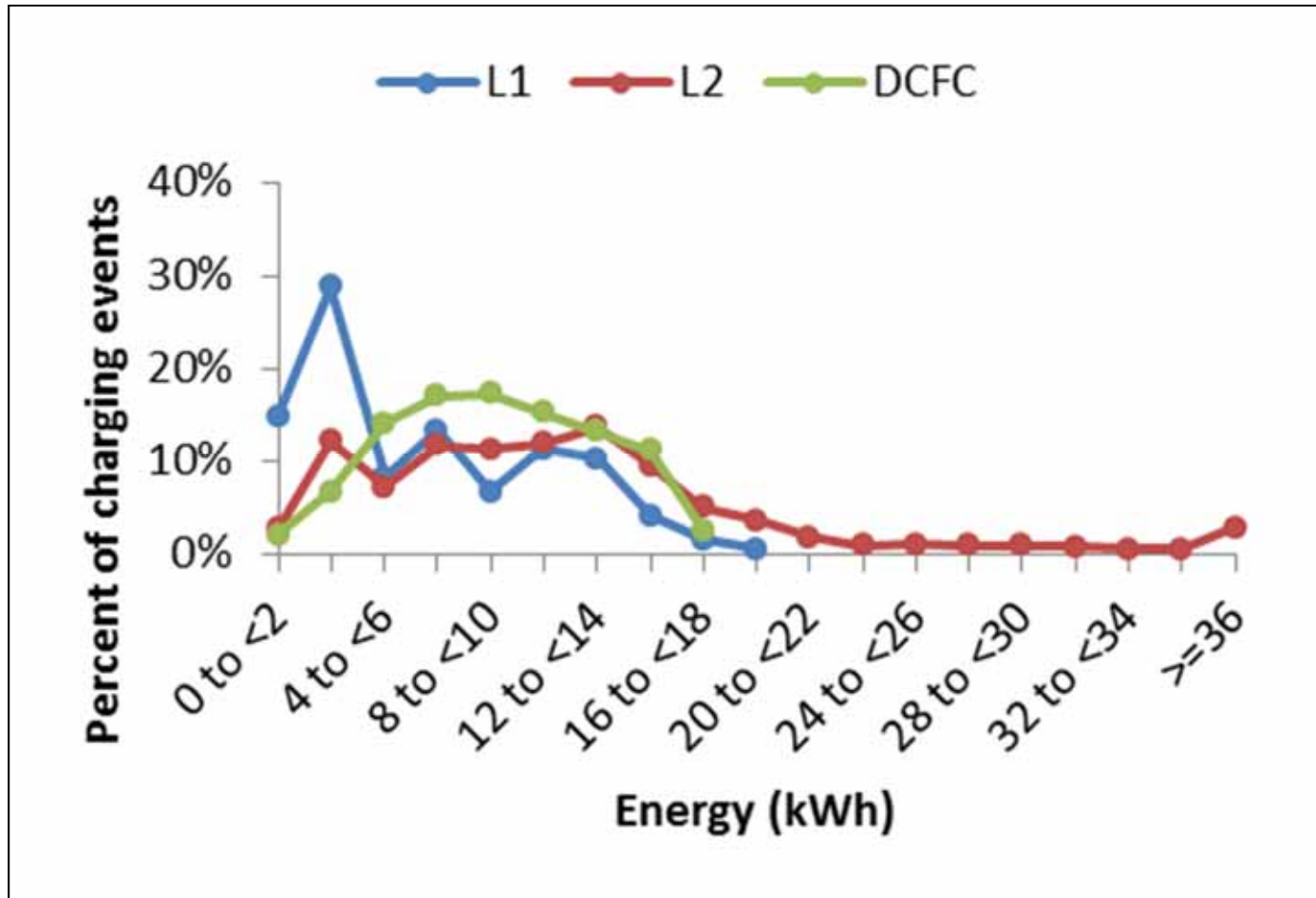
Frequency Distributions of Time Level 1 Outlets and Level 2 Cords Transferred Power to a Vehicle per Charging Event



Percentage of Charging Events Ending with a Full Battery for Charging Events of Varying Length

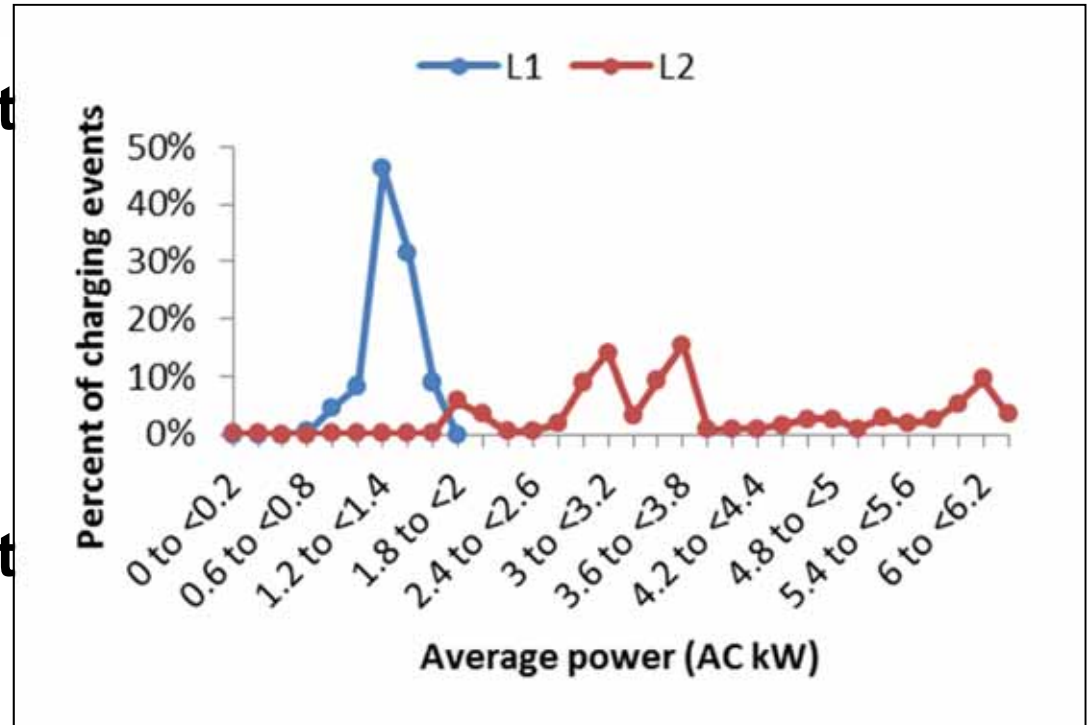


Distribution of Energy Consumed per Charging Event by Charge Power Level



Distributions of average power per charging event for Level 1 and Level 2 charging

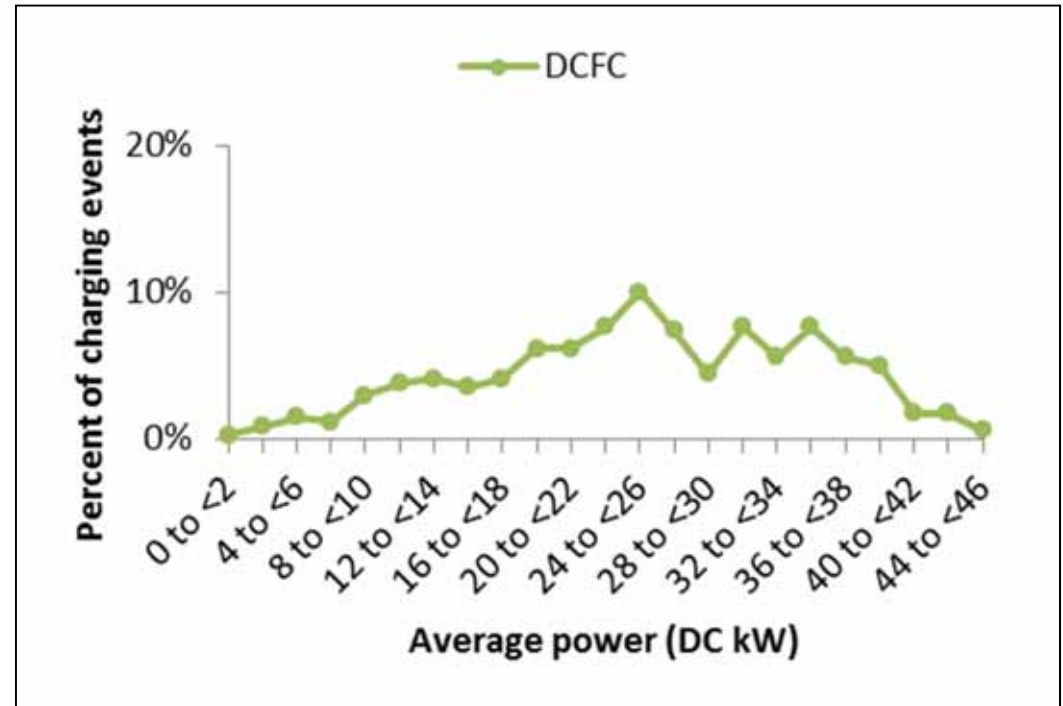
- Level 1 charging was limited by the power limit of the EVSE or sometimes onboard charger
- Most Level 1 charging occurred at ~ 1.4 kW
- Level 2 charging was limited by the power limit of the vehicle's onboard charger



- Level 2 charging occurred across a wide range of power; however, there were obvious groups of charging events averaging around 2.0 kW, between 3.0 and 3.8 kW, and above 6.0 kW. Driven by vehicle model

Distributions of average power per charging event for DCFC charging

- DC fast charge power level is controlled by the vehicle and is a function of a number of factors, including:
 - Vehicle state of charge
 - Battery temperature



- Nissan Leafs were the only vehicles known to have used the DC fast charger at the work site during the study period, and it is capable of charging at up to 50 DC kW. However, the charge power drops quickly as state of charge increases

Summary – Level 1

- **AC Level 1 was used infrequently and typically remained connected to vehicles for 8 or more hours per charging event**
- **Drivers opted for AC Level 1 charging only 6% of the time**
- **Because of the slower charge rate, many charging events required 5 to 10 hours to fully charge the vehicles' batteries**
- **A significant number of charging events required only 2 to 3 hours to reach full charge**

Summary – Level 2

- **The AC Level 2 charging units were the most heavily utilized, accounting for 83% of the charging events**
- **The AC Level 2 charging units were used heavily during the work day, averaging 8.7 hours connected per cord per work day**
- **Drivers tended to stay connected to Level 2 cords for around 4 hours or for around 9 hours – either half a work day or an entire work day**
- **Most of the time, vehicles fully charged their batteries in less than 5 hours**

Summary – Comparing Level 1 & 2

- **Data were collected from 10 charging units at this work site that were capable of both AC Level 1 and AC Level 2 charging**
- **Drivers overwhelmingly preferred AC Level 2 charging over AC Level 1 charging**
- **When drivers arrived at these units and both Level 1 and Level 2 options were available, they chose to use the Level 2 cord 98% of time**
- **With only a few exceptions, the Level 1 outlet was only used if the Level 2 cord was already connected to another vehicle**

Summary – DCFC

- **The DC fast charger (DCFC) was typically used between 2 and 6 times per work day for 24 minutes or less per charging event**
- **11% of the time when a DC fast charge event ended and another event began on the same work day, a vehicle was already connected to the second DC fast charger cord prior to the end of the first vehicle's charging event**

Summary – Company Policies & Practices

- **Facebook followed a few simple guidelines to encourage employees to self-manage electric vehicle supply equipment (EVSE) usage**
- **First, charging units were installed to allow access from multiple parking spaces**
- **Second, employees were provided with an online message board – a Facebook page – allowing them to coordinate charging station usage**
- **Data from the EVSE suggest that drivers leveraged these resources to minimize the time EVSE were not in use**

Summary – Company Policies & Practices – cont'd

- **Drivers were encouraged to plug in neighboring vehicles after their vehicle completed charging**
- **Thirty-seven percent of the time when one charging event ended and the next began at the same AC Level 2 EVSE during the same work day, less than 30 seconds elapsed between the two charging events**
- **Sixty percent of the time, less than 3 minutes elapsed between consecutive charging events**

Additional Information

**For publications and general plug-in electric vehicle performance,
visit**

<http://avt.inl.gov>

Funding provided by DOE`s Vehicle Technologies Office