



U.S. Department of Energy's Vehicle Technologies Program -

Fully Charged 2012 International EV Summit – The EV Project Update

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**Fully Charged 2012 International EV Summit
Dublin, Ireland
July 11, 2012**

Outline

- **Participants, goals and testing experience**
- **Data processes and data security**
- **EV Project**
 - **Description and data parameters**
 - **Project status**
 - **Leaf, Volt, and EVSE benchmarking results**
 - **Bulk of presentation**
- **Potential grid impacts**
- **Other electric drive vehicle research activities**
- **Summary**
- **Future work**



Idaho National Laboratory (INL)

- Eastern Idaho based U.S. Department of Energy (DOE) Federal research 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
 - Energy Critical Infrastructure Protection
 - Homeland Security and Cyber Security
 - Advanced Vehicles and Battery Development
 - Fossil, Biomass, Wind, Geothermal and Hydropower Energy



AVTA Participants and Goals

- **INL manages the Advanced Vehicle Testing Activity's (AVTA) field testing of advanced technology light-duty vehicles for DOE**
 - AVTA is part of DOE's Vehicle Technologies Program
 - ECotality provides testing support via DOE's National Energy Testing Laboratory
- **Test partners include electric utilities, Federal, state and local government agencies, private companies, and individual vehicle owners**
- **The AVTA goal: Petroleum reduction and energy security**
 - **Confusing people with facts via testing regimes**
 - Providing benchmark data to DOE, technology modelers, R&D programs, vehicle manufacturers (via VSATT), and target and goal setters
 - Assist fleet managers, via Clean Cities, FEMP and industry gatherings, in making informed vehicle and infrastructure deployment and operating decisions

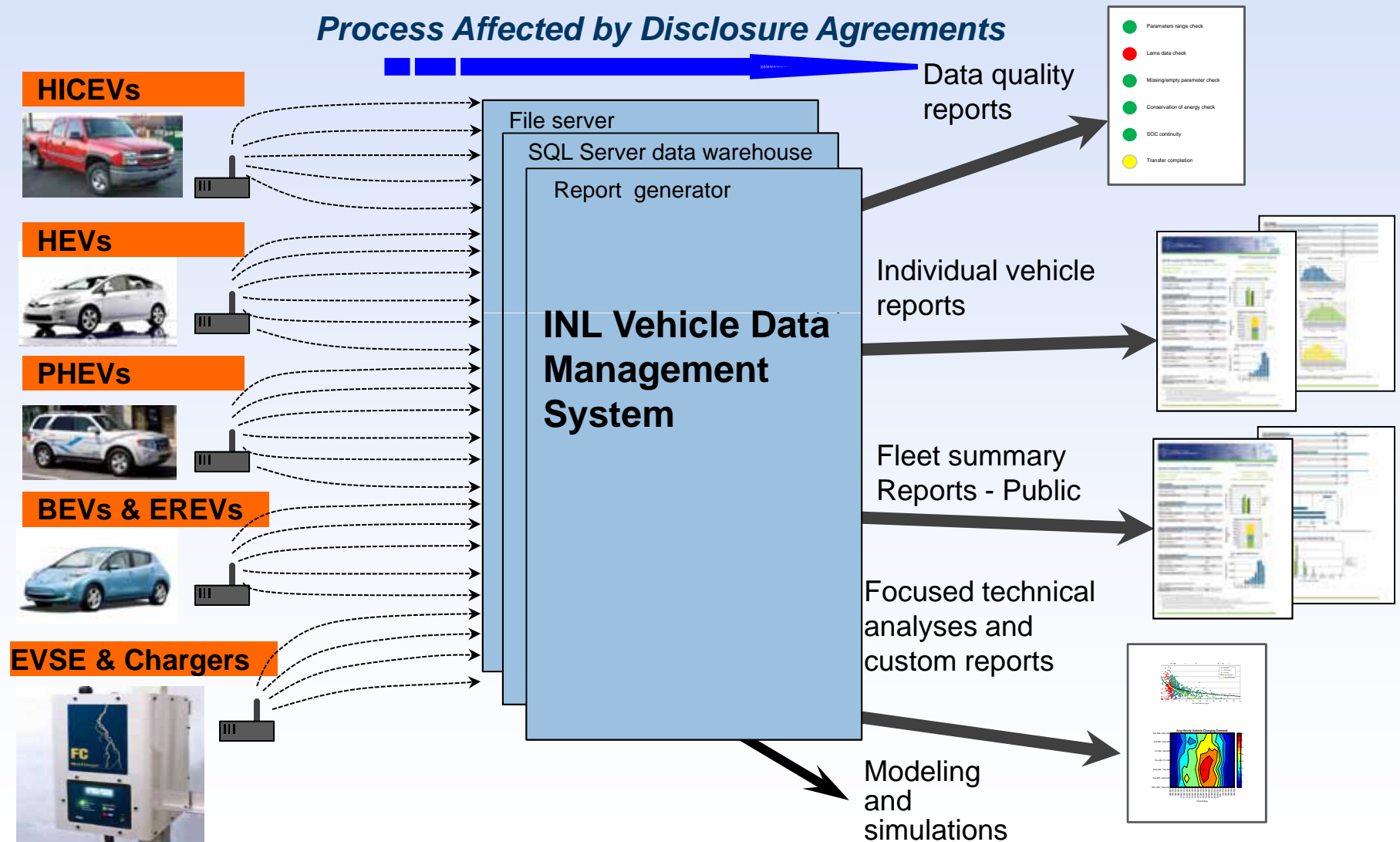


Vehicle / Infrastructure Testing Experience

- **48 million test miles accumulated on 8,200 electric drive vehicles representing 114 models**
- **EV Project: 4,700 Leafs and Volts, 6,200 EVSE (electric vehicle supply equipment)**
 - **30.3 million test miles**
 - **865,000 charge events, 7,300 MWh**
- **PHEVs: 14 models, 430 PHEVs, 4 million test miles**
- **EREVs: 1 model, 150 EREVs, 900,000 test miles**
- **HEVs: 21 models, 52 HEVs, 6.2 million test miles**
- **Micro hybrid (stop/start) vehicles: 3 models, 7 MHVs, 485,000 test miles**
- **NEVs: 24 models, 372 NEVs, 200,000 test miles**
- **BEVs: 47 models, 2,000 BEVs, 5 million test miles**
- **UEVs: 3 models, 460 UEVs, 1 million test miles**
- **Other testing includes hydrogen ICE vehicle and infrastructure testing**



INL Vehicle/EVSE Data Management Process



Data Security, Protection and Use

- **All vehicle, EVSE, and personal information raw data protected by NDAs (Non Disclosure Agreements)**
 - Limitations on how proprietary data can be distributed, stored, and used
 - No raw data can or will be distributed by INL
 - Raw data, in both electronic and printed formats, is not shared with DOE in order to avoid exposure to FOIA
- Vehicle and EVSE data collection would not occur unless the above limitations are strictly adhered by INL
- **The AVTA has used data loggers on vehicles and EVSE (electric vehicle supply equipment) since 1993 to benchmark vehicle and charging equipment profiles**



EV Project Locations and Goal

The EV Project at a glance:



- 18 current locations with more being added
- **Goal: Build and study mature charging infrastructures and take the lessons learned to support the future streamlined deployment of grid-connected electric drive vehicles**
- **ECOtality is the EV Project lead, with INL, Nissan and GM/OnStar as significant partners**
- EV Project reporting requires INL to blend three distinct data streams based on GPS and time/date stamps, and provide independent reports to DOE, ECOtality, project participants, industry, and the general public

EV Project – EVSE Data Parameters Collected per Charge Event

- Data from ECOtality's Blink EVSE network
- Unique ID for Charging Event
- Unique ID Identifying the EVSE
- **Date/Time Stamp**
- **Connect and Disconnect Times**
- **Start and End Charge Times**
- **Maximum Instantaneous Peak Power**
- **Average Power**
- **Total energy (kWh) per charging event**
- **Rolling 15 Minute Average Peak Power**
- And other non-dynamic EVSE information (GPS, ID, type, contact info, etc.)



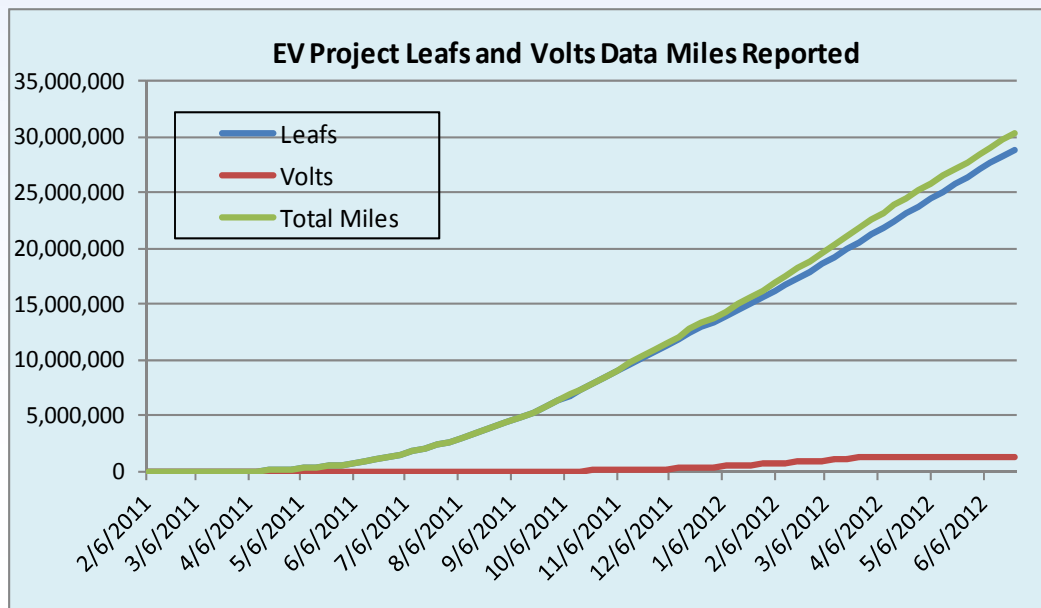
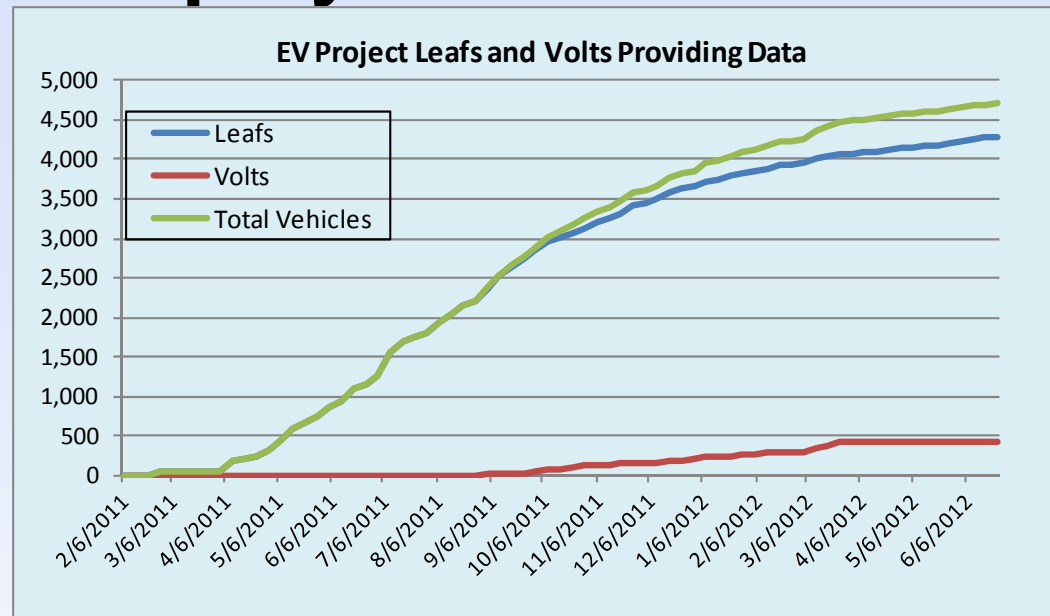
EV Project – Vehicle Data Parameters Collected per Start/Stop Event

- Data is received via telematics providers from Chevrolet Volts and Nissan Leafs
- Vehicle ID
- Event type (key on / key off)
- Odometer
- Battery state of charge
- Date/Time Stamp
- GPS (longitude and latitude)
- Recorded for each key-on and key-off event

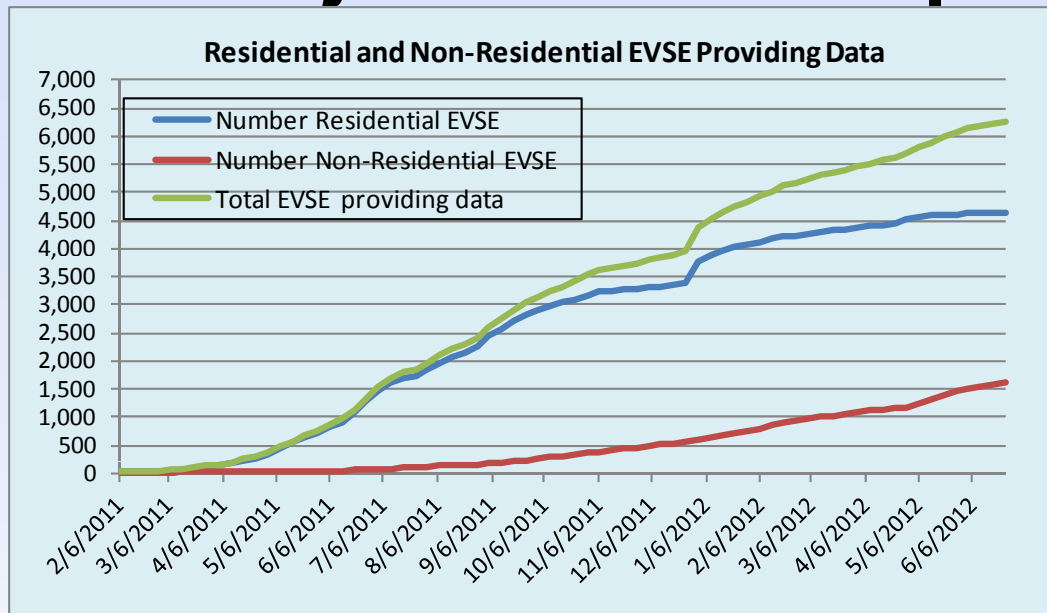


EV Project – Vehicle Deployments / Miles

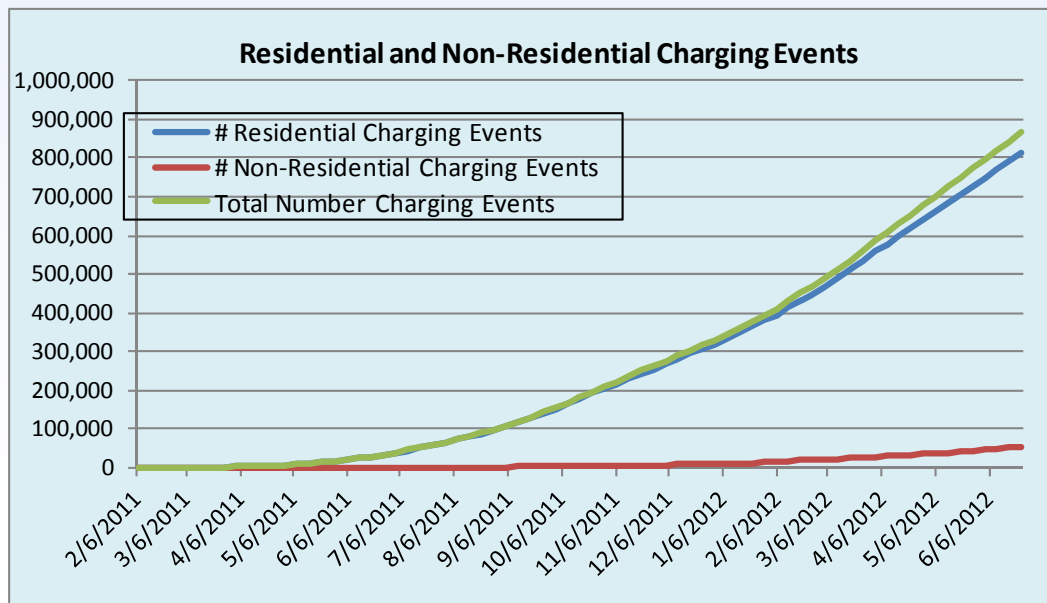
- 4,278 Leafs (6/24) and 428 Volts (4/01) reporting data
- 4,706 vehicles and growing
- 30.3 million total miles
- 105,000 test miles per day



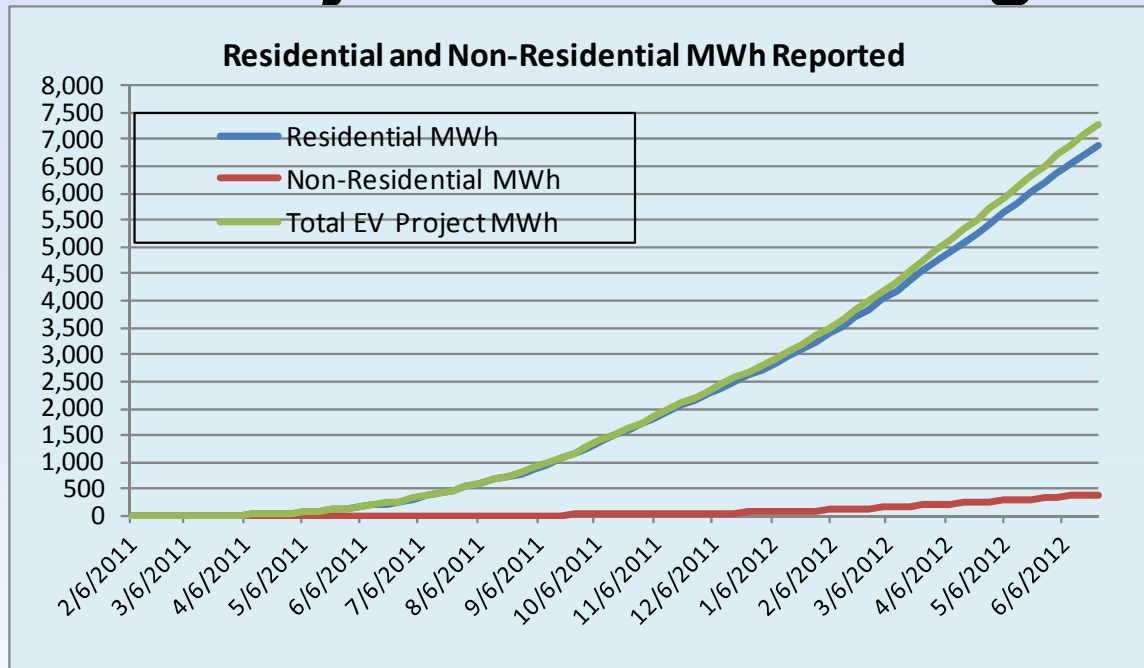
EV Project – EVSE Deployment and Use



- 4,634 Res. EVSE
- 1,623 non-Res EVSE
- **6,257 total EVSE**
- **865,000 charge events**
- **3,500 charge events per day**
- Non-Residential includes DCFC
- Above as of 6/24/12
- Data is continuously back-filled



EV Project – Total Charge Energy (MWh)



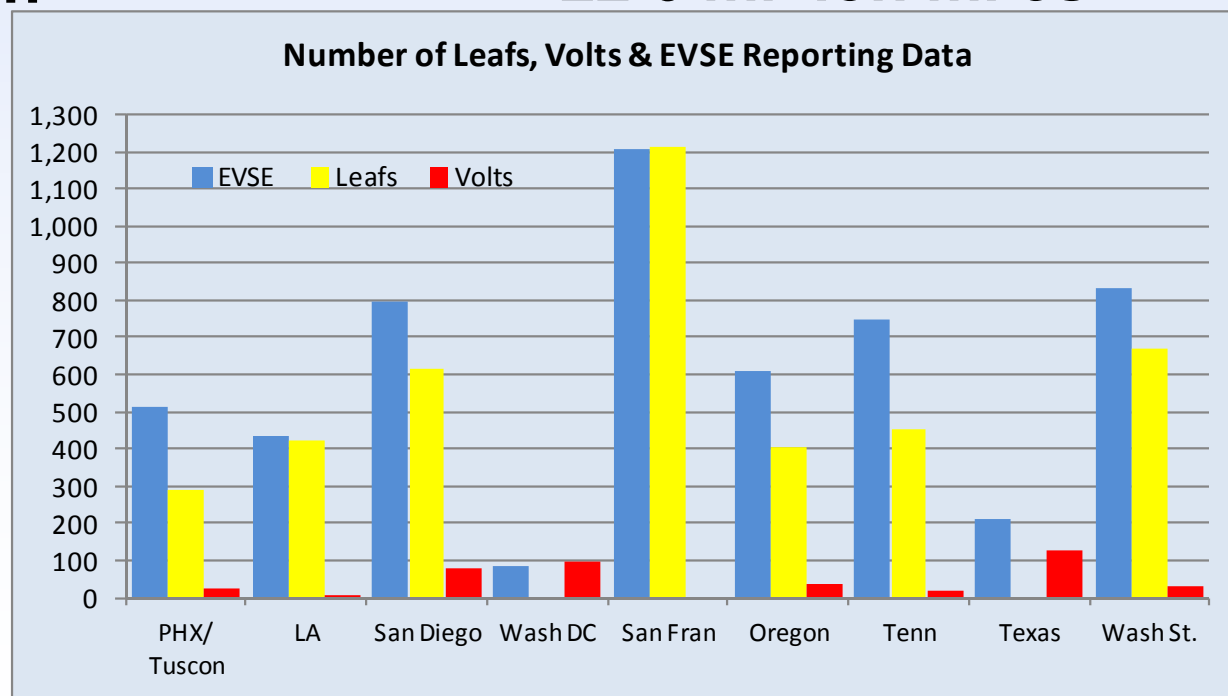
- 6,888 MWh residential
- 401 MWh non-residential
- 7,300 MWh total electricity charged
- 26 MWh used for charging per day

- Vehicle efficiency cannot be accurately calculated using total vehicle miles and total energy
- Non-EV Project vehicles sometimes charge at EV Project EVSE
- EV Project vehicles may charge at 110V or other 240V non-EV Project EVSE

EV Project – Overview Report 1st Quarter

- Vehicles and charging infrastructure deployed to date 1st quarter 2012 and data received by INL
- Charging infrastructure
 - 5,432 units installed
 - 665,968 charging events
 - 5,069 AC MWh
- Vehicles
 - 4,066 Leafs
 - 427 Volts
 - 22.6 million miles

- Regional analyses are conducted and reported each quarter as 4 summary reports (93 pages last quarter)



EV Project – Vehicle Usage Report

Vehicle Usage – 1st quarter 2012

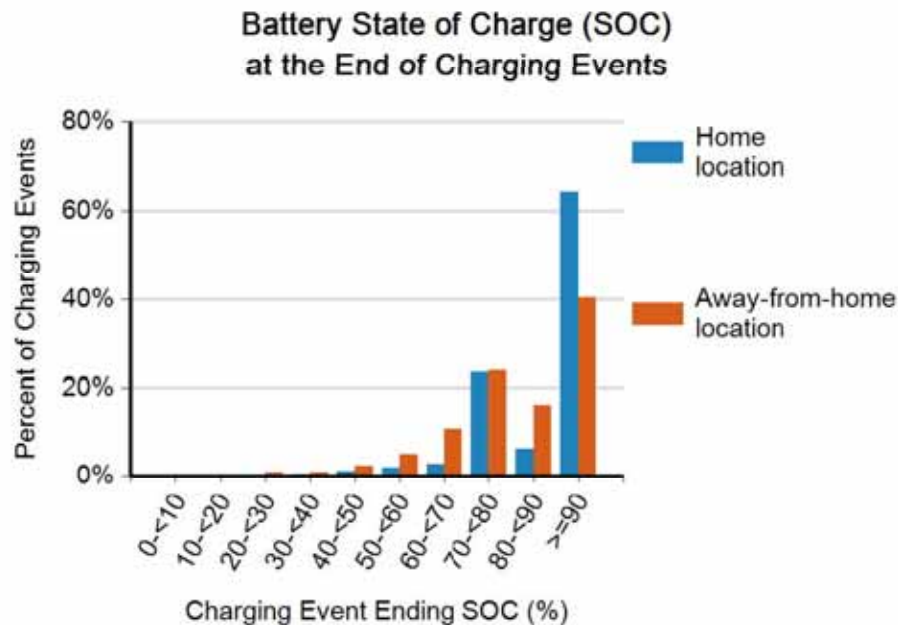
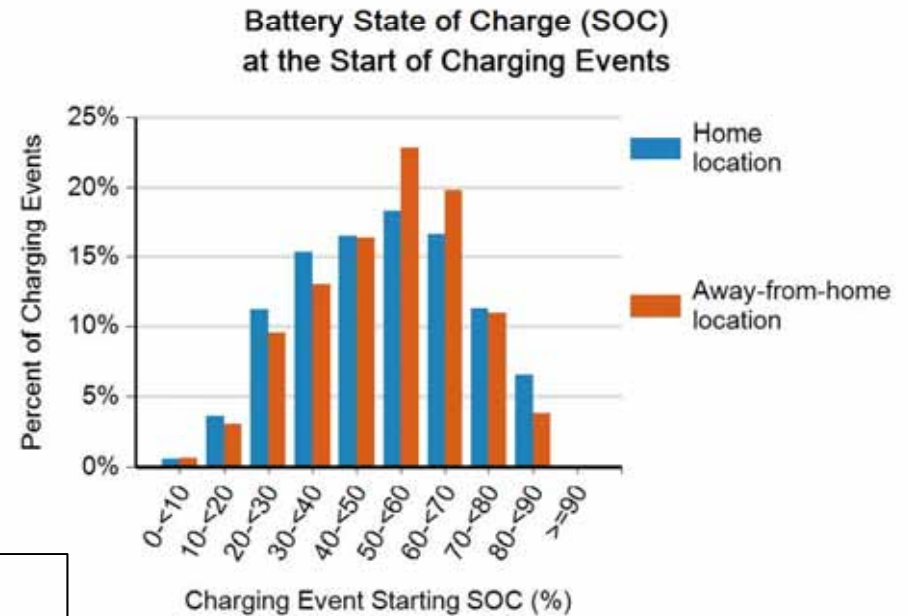
	<u>Leafs</u>	<u>Volts</u>
• Number of vehicles	2,987	317
• Number of Trips	773,602	76,425
• Distance (thousands)	5,558 mi	610 mi
• Average (Ave) trip distance	7.2 mi	8.0 mi
• Ave distance per day	30.2 mi	36.4 mi
• Ave number (#) trips between charging events	3.8	3.0
• Ave distance between charging events	27.4 mi	24.1 mi
• Ave # charging events per day	1.1	1.5

Note that per day data is only for days a vehicle is driven



EV Project – Leaf Usage Report (1st ¼ 2012)

- **Battery state-of-charge quarterly trends may indicate greater driver confidence in vehicle range and EVSE availability**

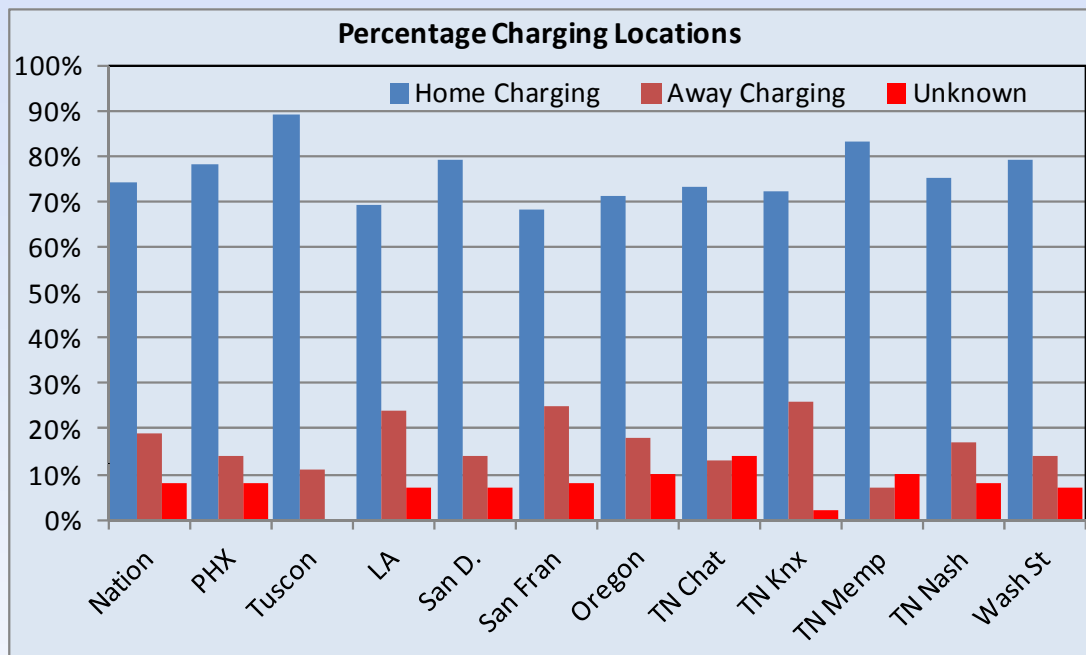


- **SOC is also available for Volts**

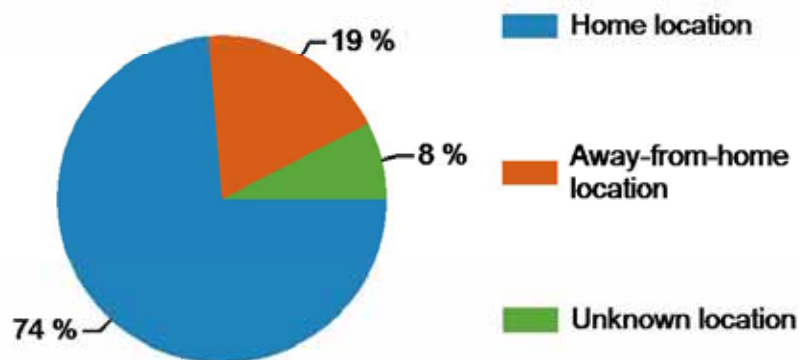


EV Project – Leaf Usage Report (1st ¼ 2012)

- Regional variations in charge behavior
- Possible rich versus non-rich public charge environment impacts



Frequency of Charging by Charging Location

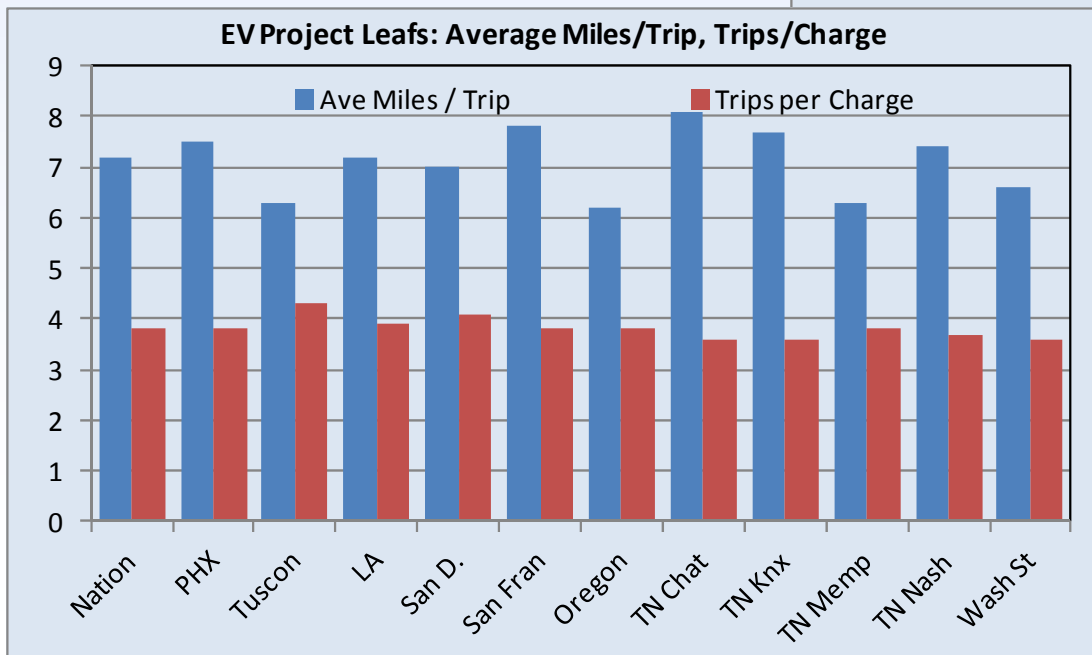
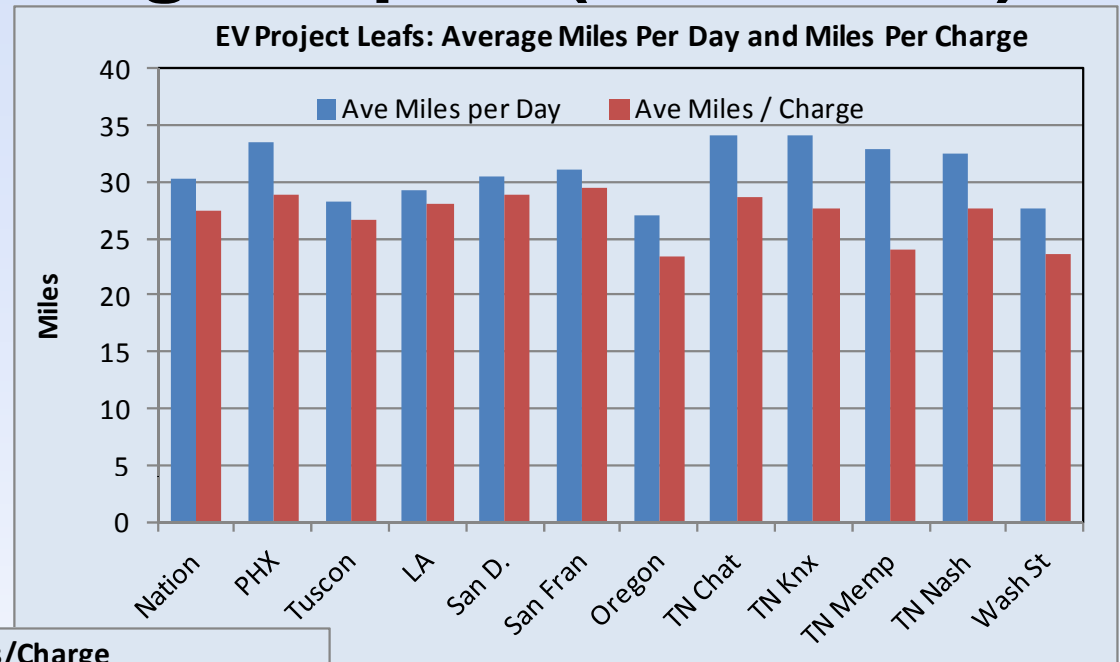


- Data is also available for Volts

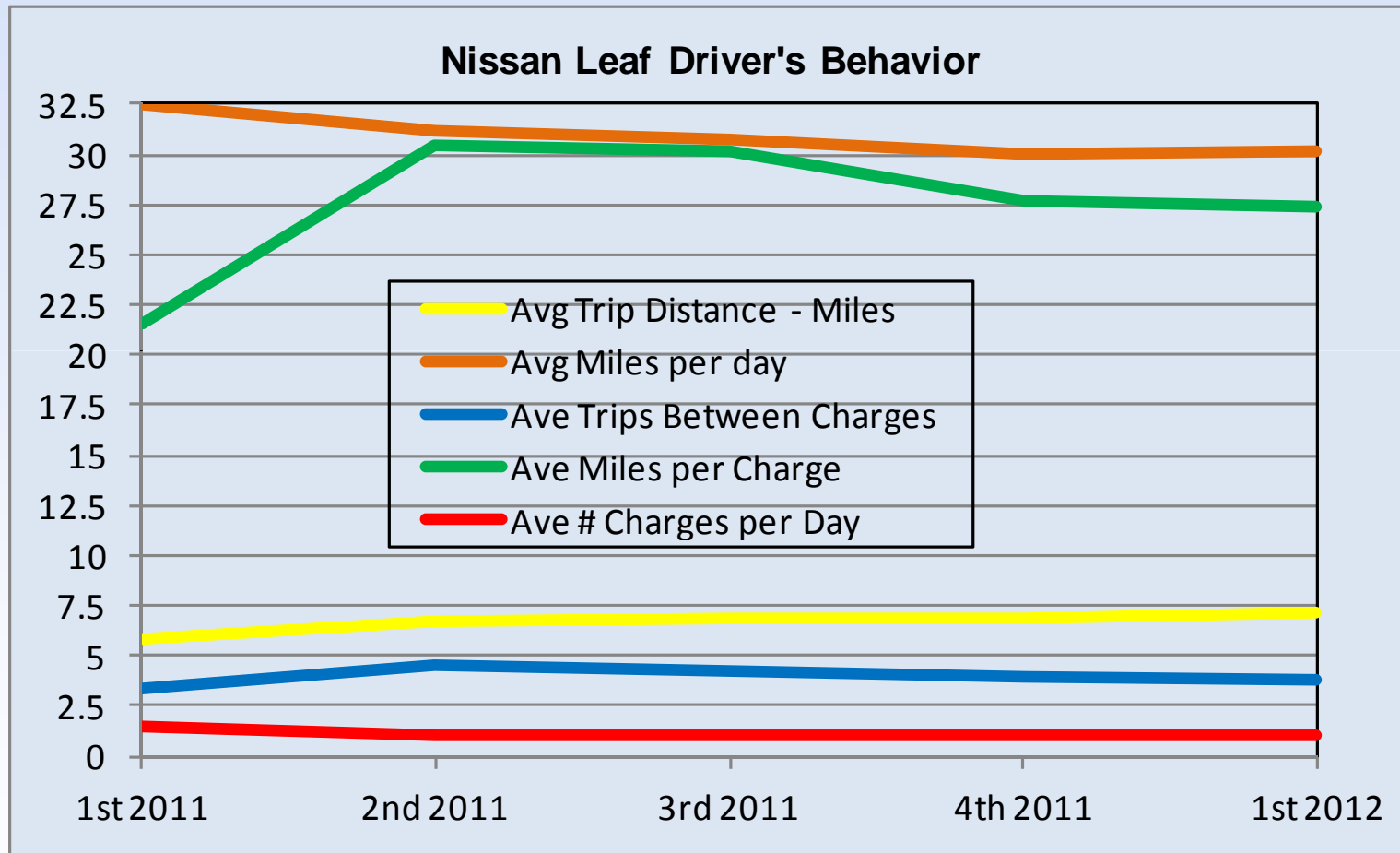


EV Project – Leaf Usage Report (1st ¼ 2012)

- Regional variations in drive profiles
- Need to be compared to ICE vehicle travel patterns (if data available)



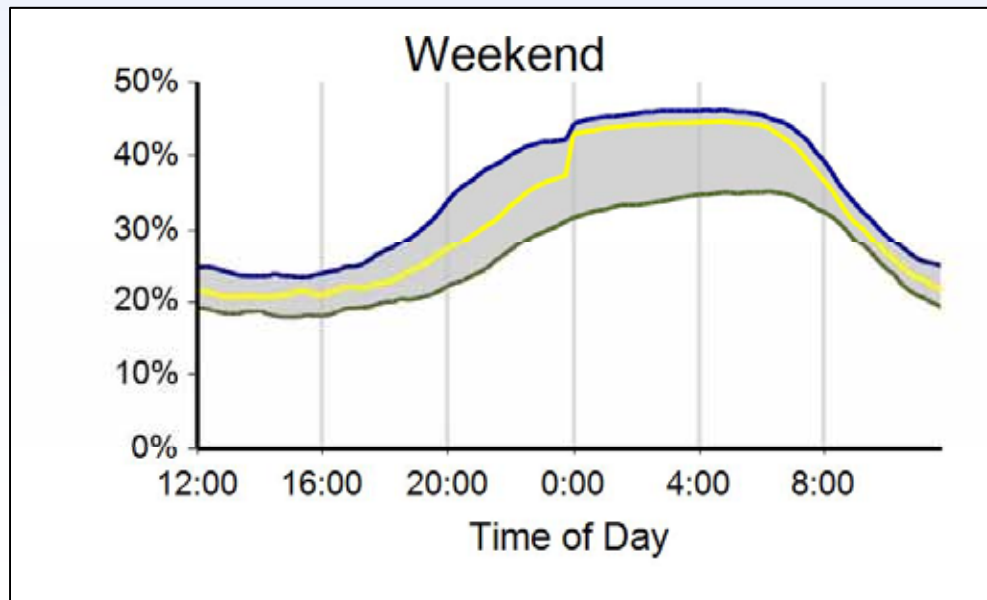
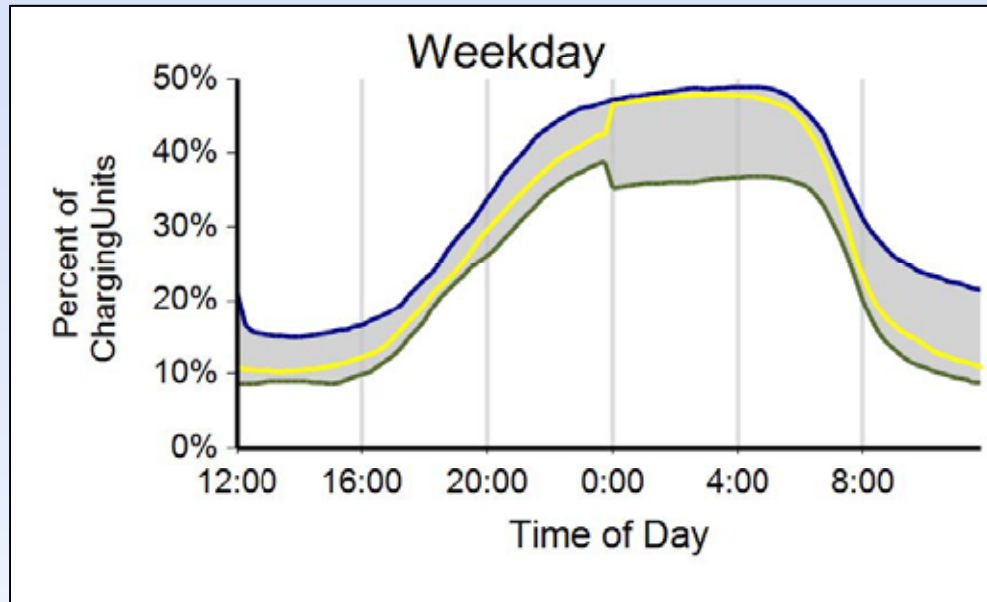
EV Project – Leaf Usage Report 5 Quarters



- **Seasonal variations may not be significant yet, given low number of vehicles and “early adapters” in early quarters**



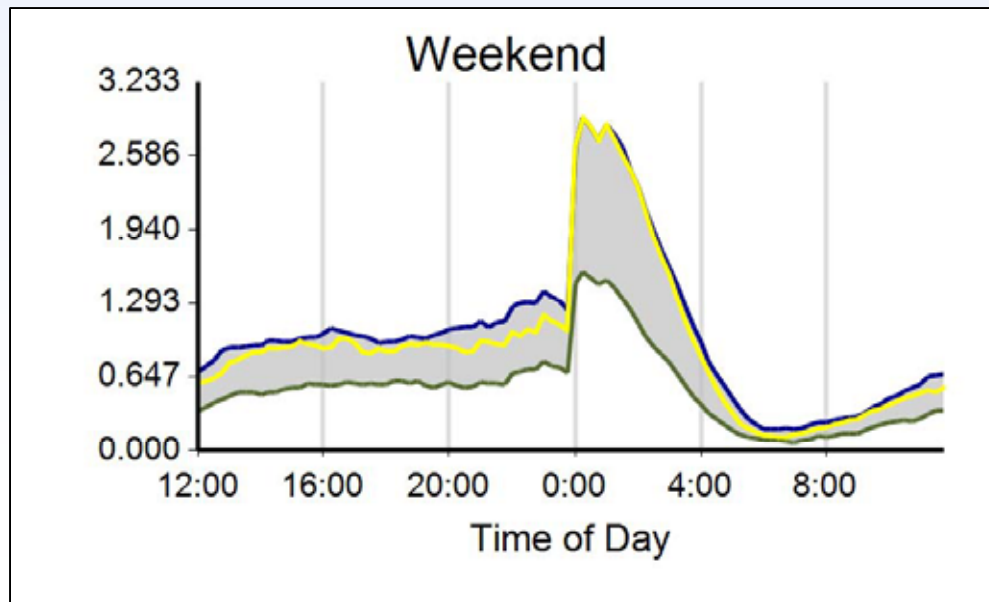
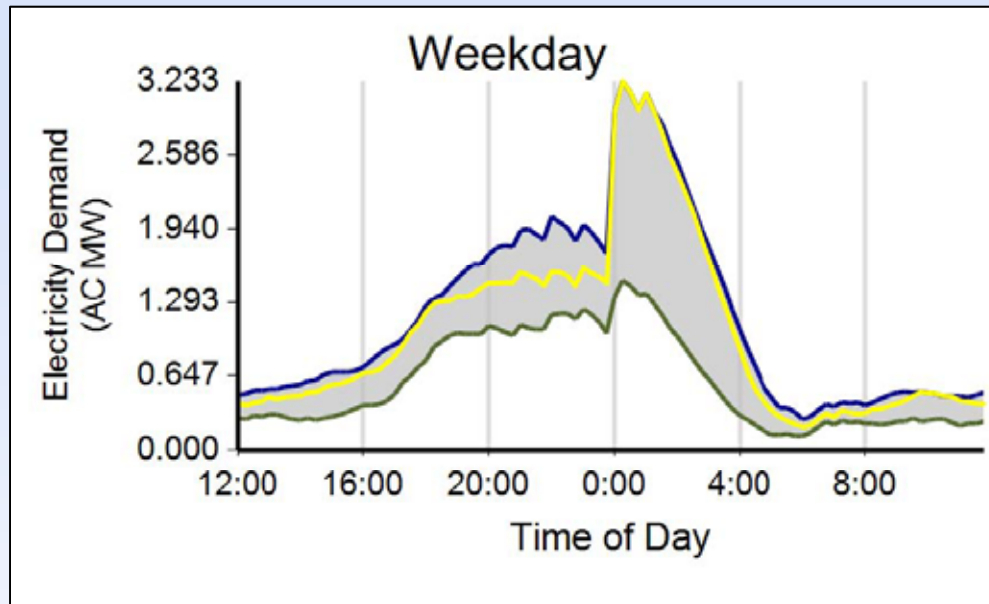
EV Project – EVSE Infra. Summary Report



- **Charging Availability**
- National Data
- Range of Percent of Charging Units with a Vehicle Connected vs. Time of Day
- 1st quarter 2012
- 3,324 residential and 955 publicly available Level 2 EVSE
- 10 DC fast chargers
- **51,476 values calculated just for 1st quarter 2012 infrastructure (Infra.) report**



EV Project – EVSE Infra. Summary Report

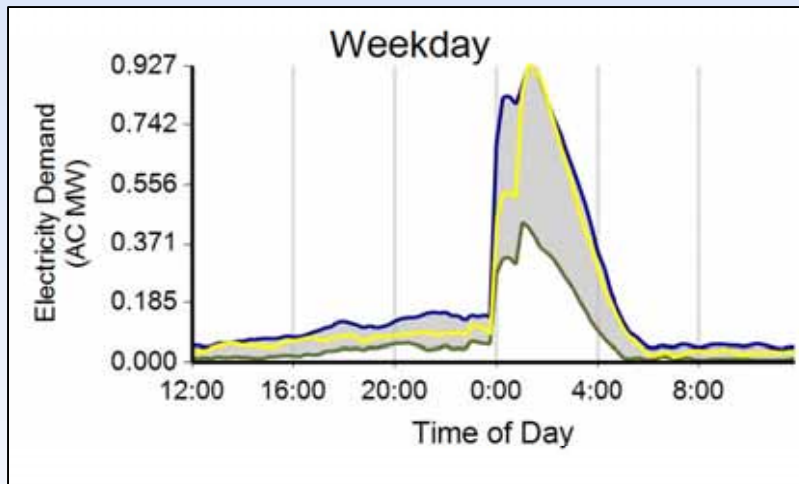


- **Charging Demand**
- National Data
- Range of Aggregate Electricity Demand vs. Time of Day (AC MW)
- 1st quarter 2012
- 3,324 residential and 955 publicly available Level 2 EVSE
- 10 DC fast chargers
- **Time of day kWh rates are influencing charging start times as measured by AC MW demand**

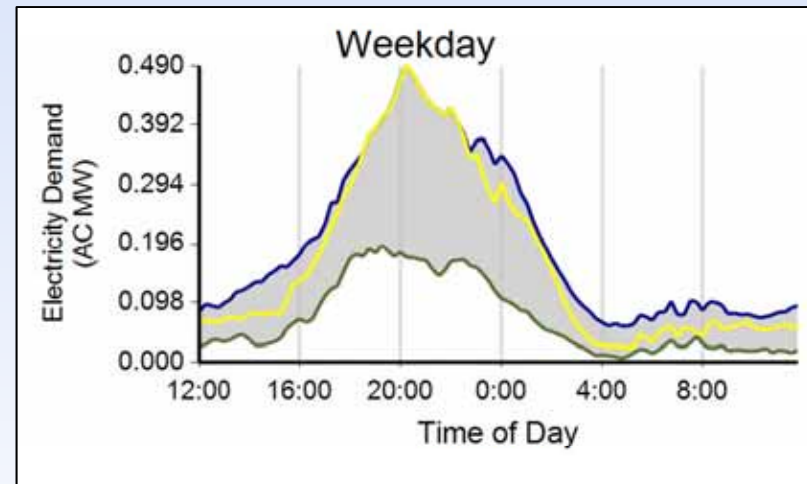
EV Project – EVSE Infra. Summary Report

- Residential Level 2 Weekday EVSE 1st Quarter 2012
- Time of day kWh rates clearly influence charge patterns

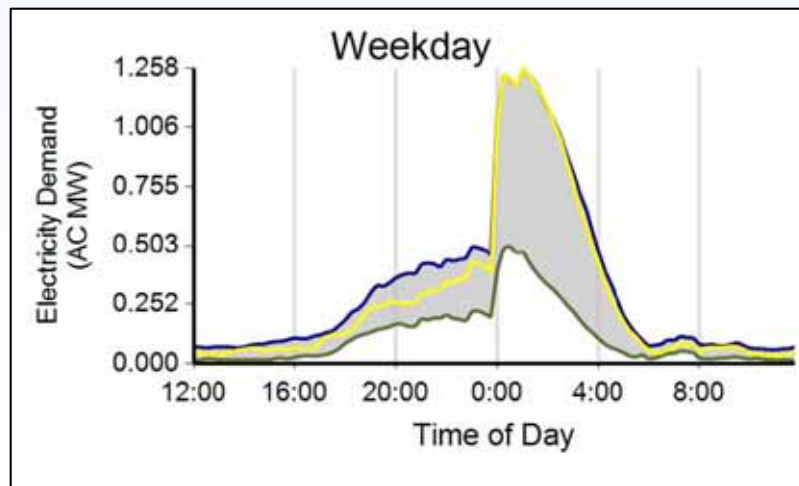
San Diego



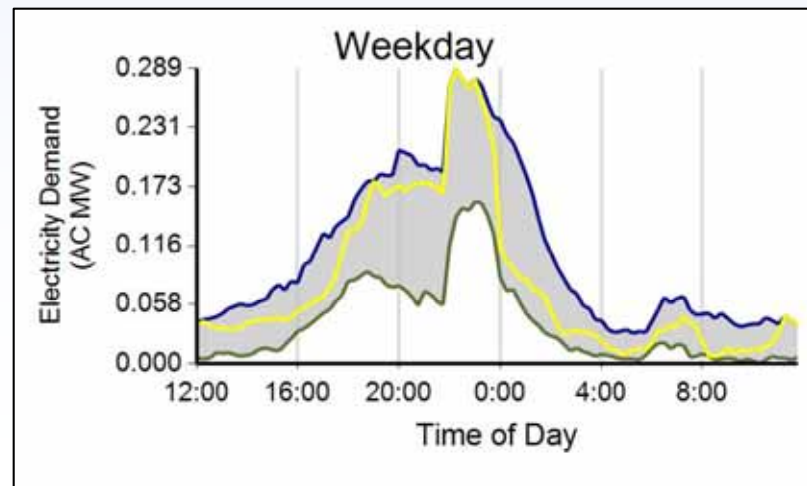
Washington State



San Francisco



Oregon



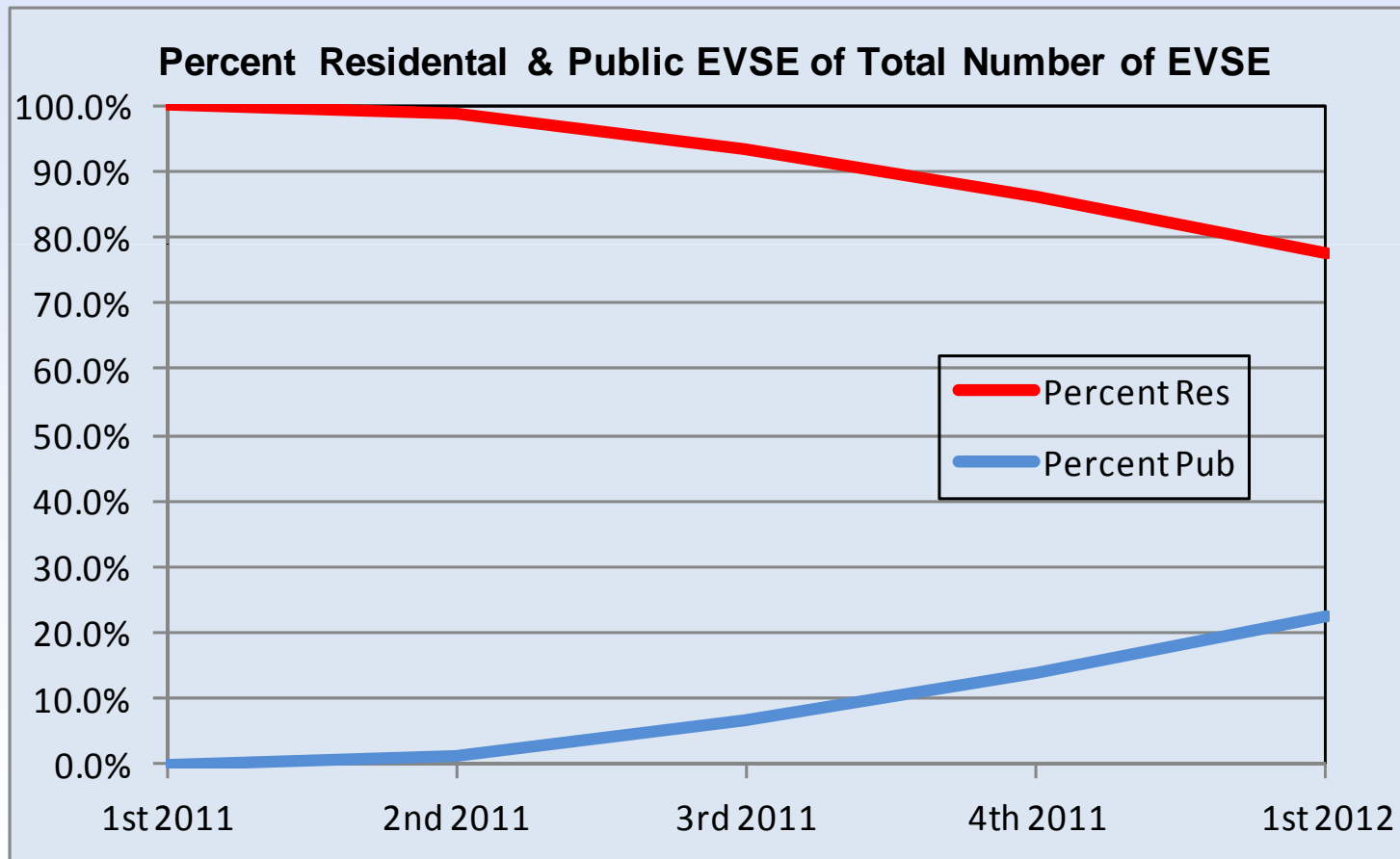
EV Project – EVSE Infra. Summary Report

- National Data – 1st quarter 2012
 - Ave time vehicle connected R2 WD **11.4 hours**
 - Ave time vehicle connected R2 WE **11.8 hours**
 - Ave time vehicle drawing power R2 WD **2.4 hours**
 - Ave time vehicle drawing power R2 WE **2.0 hours**
 - Ave energy per charge event R2 WD 8.7 AC kWh
 - Ave energy per charge event R2 WE 7.3 AC kWh
 - Ave time vehicle connected P2 WD **6.3 hours**
 - Ave time vehicle connected P2 WE **4.1 hours**
 - Ave time vehicle drawing power P2 WD **2.1 hours**
 - Ave time vehicle drawing power P2 WE **1.9 hours**
 - Ave energy per charge event P2 WD 7.3 AC kWh
 - Ave energy per charge event P2 WE 6.6 AC kWh
- **Yes, this is an ugly slide**
- R: residential, P: public, WD: weekday, WE: weekend, 2: Level 2 EVSE



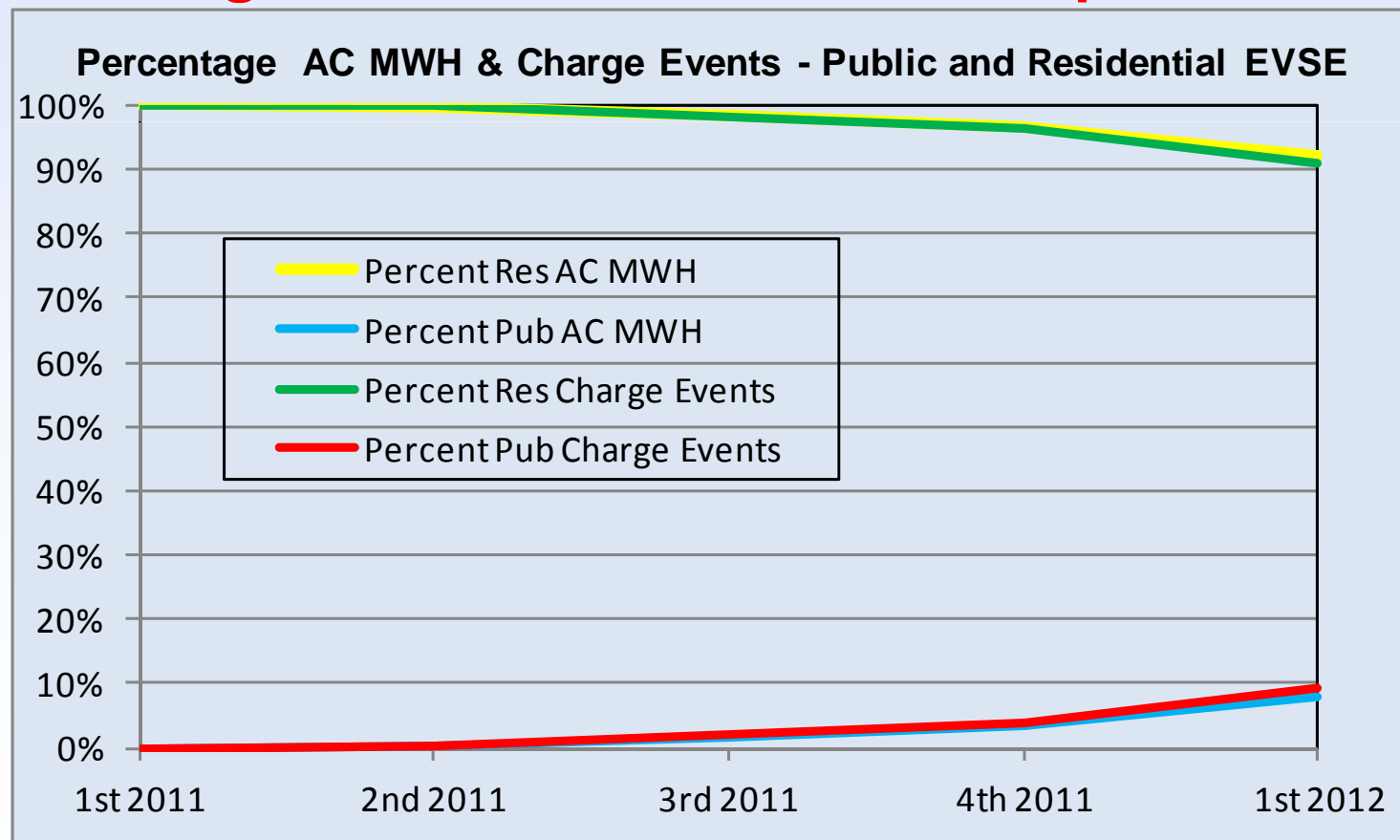
EV Project – EVSE Infra. Summary Report

- **Percent of public EVSE deployed is increasing (22%)**
- **However, use is increasing at a slower rate (next slide)**



EV Project – EVSE Infra. Summary Report

- Percent charge events and AC MWH use by residential and public EVSE each reporting quarter
- **Percent public EVSE use (red and blue lines) is clearing increasing as it is deployed in larger numbers**
- **9.1% charge events and 8.0% MWh 1st quarter 2012**



U.S. Grid Impacts

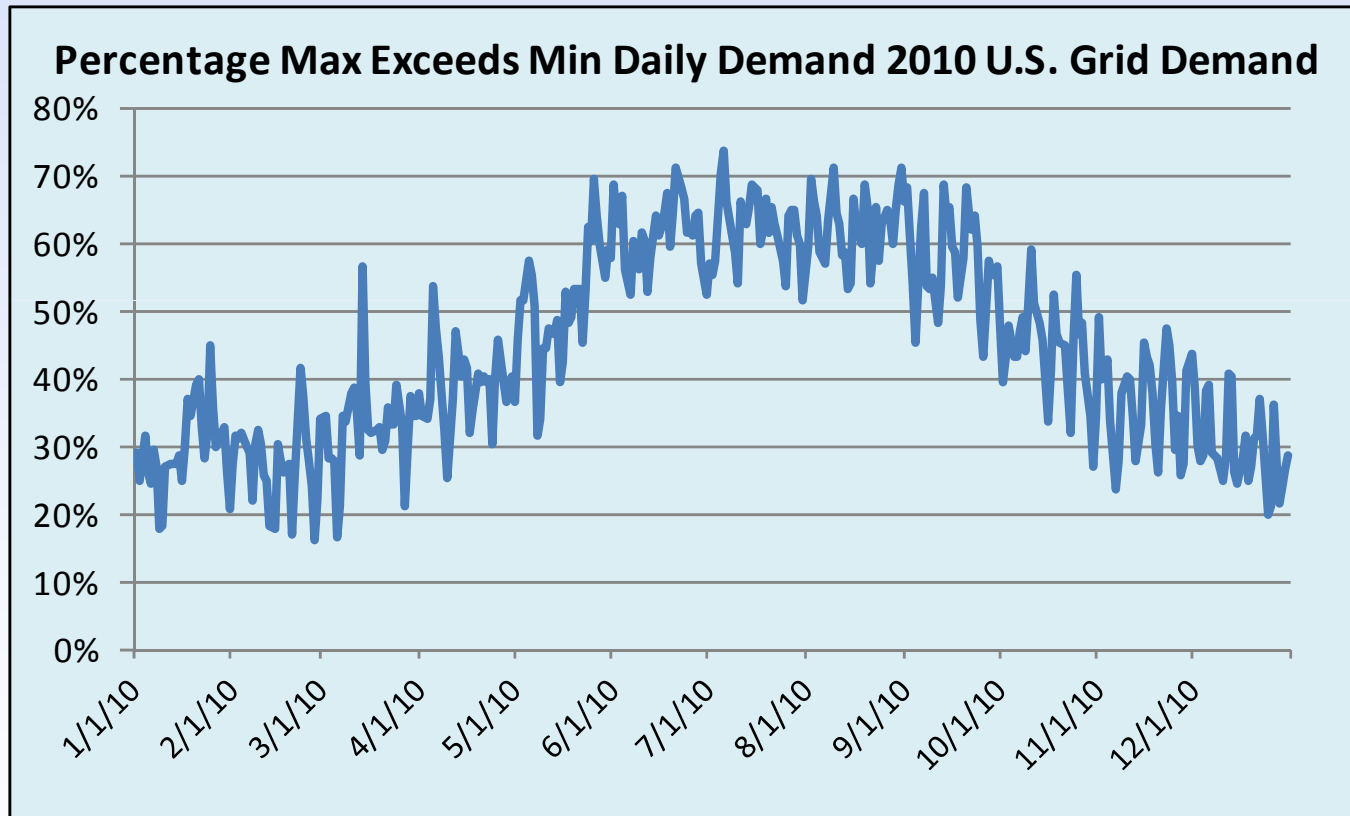
- **Average daily delta between peak and off peak demand**

Arizona Public Service Co.	33.7%
Salt River Project	32.2%
Tucson Electric Power Co.	34.0%
LA Dept of Water & Power	37.0%
Pacific Gas & Electric Co.	35.2%
San Diego Gas & Electric Co.	39.8%
Portland General Electric Co.	35.6%
Puget Sound Energy	35.7%
Seattle City Light	33.0%
Arizona Public Service Co.	33.7%
Average above utilities	35.1%



U.S. Grid Impacts

- Average daily delta between peak and off peak demand



U.S. Grid Impacts

- Average daily U.S. maximum demand is 45% higher than minimum demand = off-peak has much excess generation
- 2010 total generation was 4,125,060 GWh
- At 2,920 kWh per year (assumes approximate Leaf use)
 - 1% of generation charges 14.1 million Leafs
 - 2% of generation charges 28.3 million Leafs
 - 3% of generation charges 42.4 million Leafs
 - 4% of generation charges 56.5 million Leafs
 - 5% of generation charges 70.6 million Leafs
- Macro grid impacts are of no concern for the immediate future
- Micro grid impacts, if any, will hopefully be identified by the EV Project



Other AVTA Projects for DOE

- Other vehicle data collection activities
 - 150 Chevrolet Volt EREVs
 - 108 Chrysler Ram Pickup PHEVs
 - 21 Ford Escape Prototype PHEVs
 - 20 Quantum PHEV Escape conversions
 - 5 different US Postal Service electric delivery vehicle conversions
 - Field and laboratory fast charge study compares DC fast charging and Level 2 charging impacts on battery life in 6 vehicles
 - Above all equipped with lithium traction batteries



More AVTA Projects for DOE

- Mass impacts on fuel efficiency of HEVs, ICEVs and BEVs
- Conducting testing of “dumb” and “smart” EVSE
- Initiated wireless charging test program
- Benchmarking ChargePoint America project with 2,453 EVSE deployed, 223,000 charge events & 1,500 AC MWH
- Other EVSE providers have started to provide charging data to INL
- Initiated first responders training program with the National Fire Prevention Association and NHTSA
- Battery mule test vehicle provides field testing of traction battery packs at any power and efficiency level



EV Project Summary To Date

- EV Project vehicles connected much longer than needed to recharge - opportunities to shift charging times
- Significant residential Level 2 EV Project charging occurs off-peak with charge-starts occurring at the midnight starts of super off-peak kWh rates
- Significant opportunities to fully understand how the public uses public versus non-public infrastructure
- Revenue models for public charging being introduced – impacts?
- Only about 30% of EV Project data collected to date
- “Normal” research project process requires:
 - Design and execute the project, data collection completed, data analyzed, and finally, reports issued at completion of experiment
- INL/ECOtality needs to completely collect all data before definitively reporting seasonal trends and behaviors



Future EV Project Data Analysis Subjects

- **Pricing elasticity – TOU rate influences?**
- **Regional and seasonal demographics and charging behaviors?**
- **Density of residential and non-residential EVSE as input to local micro distribution studies – transformer failures?**
- **Charge control preferences – vehicle, Blink and web based, and scheduled versus random?**
- **Rich public versus non-rich EVSE charging behaviors?**
- **Level 2 EVSE versus DCFC behaviors?**
- **Travel corridor versus convenience charging at stores?**
- **Length of vehicle ownership and miles per day / week / charge?**
- **Non-residential subcategories (public and work parking)?**
- **Etc., etc., etc.?**

Acknowledgement

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Energy's EERE Vehicle Technologies Program
And this presenter is very grateful for their support**

More Information

<http://avt.inl.gov>

**This presentation can be found in the publications
section of the above website**

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