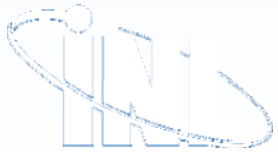
U.S. Department of Energy's Vehicle Technologies Program -

Clean Cities Webinar – Charging Infrastructure Micro Climate Process and Data Collection

Stephen Schey and Jim Francfort

Advanced Vehicle Testing Activity
June 21, 2010



Idaho National Laboratory

Presentation Outline

- AVTA Participants and Goals
- AVTA Background – Vehicle Testing
- Micro Climate
  - Overview
  - Plan Approach
  - Roadmap
  - Soft Infrastructure
  - Electric Utility Interests
- Data Collection Rational
- PHEV Data Collection Examples
- EV Project Data Collection
- Other Vehicle and Charging Data Collection
- Acknowledgements

AVTA Participants and Goals

- **Participants**
  - **The Advanced Vehicle Testing Activity (AVTA) is part of DOE's Vehicle Technologies Program**
  - **The Idaho National Laboratory (INL) and Electric Transportation Engineering Corporation (ETEC) conduct the AVTA per DOE guidance**
  - **100+ fleets and organizations as testing partners**

- **The AVTA goals:**
  - **Provide benchmark data to technology modelers, research and development programs, vehicle manufacturers (via VSATT), and target and goal setters**
  - **Assist fleet managers in making informed early adaptor vehicle purchase, deployment and operating decisions**

AVTA Background – Vehicle Testing

- Plug-in hybrid electric vehicles (PHEVs)
  - 12 models, 259 vehicles, 1.5 million test miles
- Hybrid electric vehicles (HEVs)
  - 18 models, 47 vehicles, 5 million test miles
- Neighborhood electric vehicles (NEVs)
  - 23 models, 200,000 test miles

- Hydrogen internal combustion engine (ICE) vehicles
  - 7 models, 500,000 test miles

- Full-size battery electric vehicles (BEVs)
  - 41 EV models, 5+ million test miles
- Urban electric vehicles (UEVs)
  - 3 models, 1 million test miles
- 13 million test miles accumulated on 1,600 electric drive vehicles representing 97 different models

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EV Project Overview

- **$230 million project**
  - **US Department of Energy grant**
  - **Partner Cost share match**
- **Purpose: To build and study mature electric vehicle charging infrastructure in seven regions – 13 cities**
- **Product: Lessons learned**

eTec's Micro-Climate Overview

- **An Integrated Program to Advance Electric Transportation**
  - **Establish Area Manager in each Market Area**
  - **Organize and Focus Advisory Group of Stakeholders**
  - **Conduct Current Situation Assessment**
  - **Develop Implementation Documents with Stakeholder Groups**
  - **Plan Locations for Electric Vehicle Supply Equipment**
  - **Integrate Deployment Plans with OEMs**
  - **Develop Soft Infrastructure**
  - **Conduct Installation of EVSE Assets**
  - **Evaluate legislative and regulatory recommendations**

Geographic Areas

- Washington State (greater Seattle area)
- Oregon (Portland, Eugene, Corvallis, Salem)
- California (San Diego, Los Angeles)
- Arizona (Phoenix, Tucson)
- Tennessee (Chattanooga, Knoxville, Nashville)
- Washington, DC
- Transportation Corridors
  - I-5 Corridor Eugene to Canadian border
  - I-5 San Diego to Los Angeles
  - I-10 Phoenix to Tucson
  - I-75 Chattanooga to Knoxville
  - I-40 Knoxville to Nashville
  - I-24 Nashville to Chattanooga

Equipment Deployment

- 5,700 Nissan Leafs in Market Areas included in EV Project
- 2,600 Chevy Volts in Market Areas included in EV Project
- 8,300 Level 2 (240 Volt AC, 6.6 kW) residential and fleet EVSE
- 5,500 Level 2 Commercial EVSE in Market Area
- 125 additional Level 2 in ORNL Solar Project
- 750 Level 2 Public EVSE in Market Areas
- 260 DC Fast Chargers (480 Volt AC, 40 – 60 kW) in Market Areas
- 50 DC Fast Charger for Corridors between major cities

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Level 2 EVSE Deployment

- **Where should they be installed?**
  - **Micro-Climate© process**
  - **Where people shop**
  - **Where people play**
  - **Where people gather**
  - **Target is 1 – 3 hours**

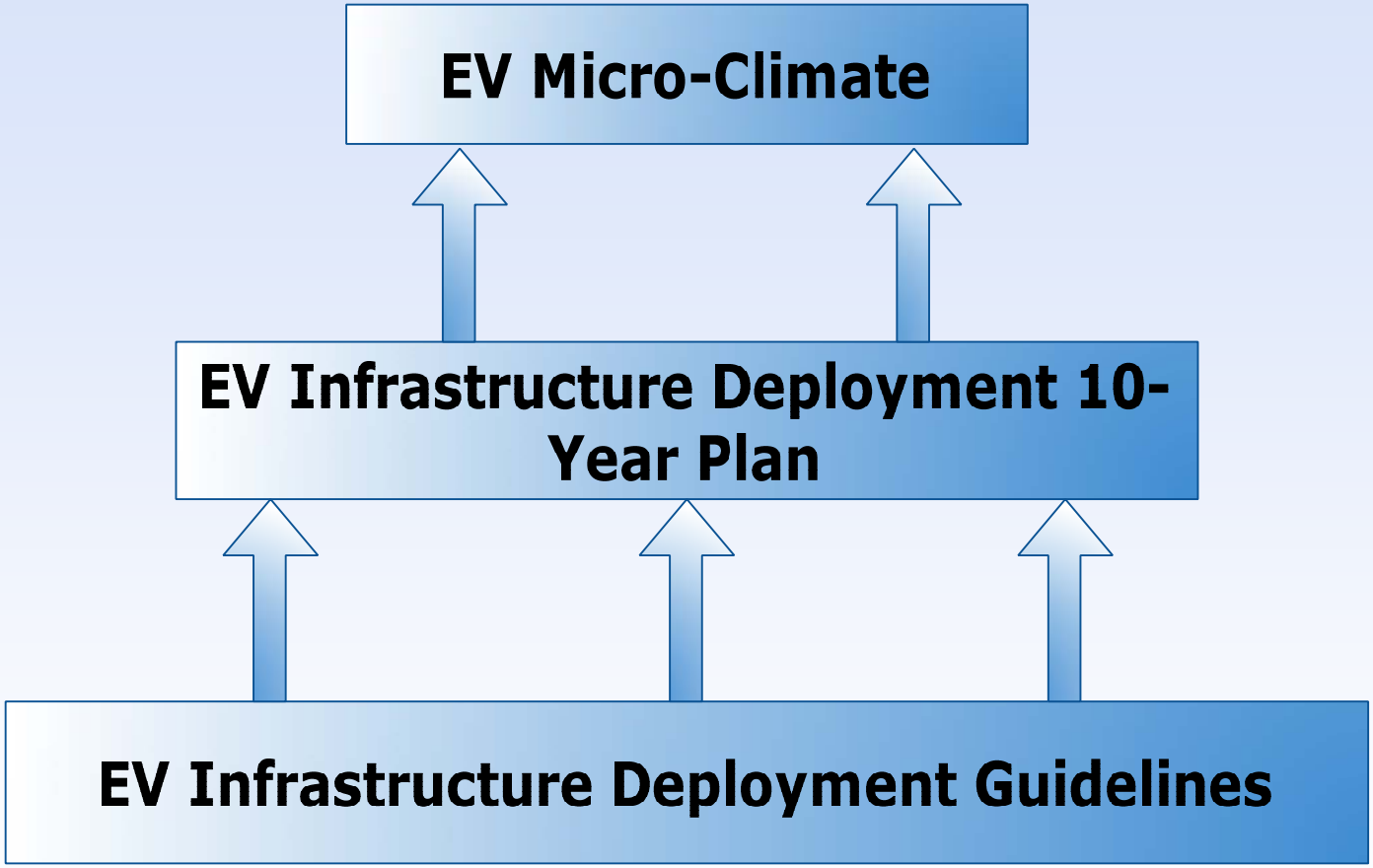
- **Expand effective operating range of the EV**
  - **Allows for unscheduled trips**
  - **Provides ‘comfort’ to new EV users: ‘Range Anxiety’**
- **Businesses want to install EVSE**
  - **Draws EV customers—they stay longer**
  - **Advertising Advantages**
  - **Revenue Collection Systems**

DC Fast Charger Deployment

- Where do they go?
  - Where energy is needed fast
    - Near highways or cross-town roads
    - Highway corridors between towns
    - Busy fleet locations
  - Where people stay a short time
    - Gasoline stations
    - Rest stops
    - Convenience Stores
    - 10 – 15 minute charge

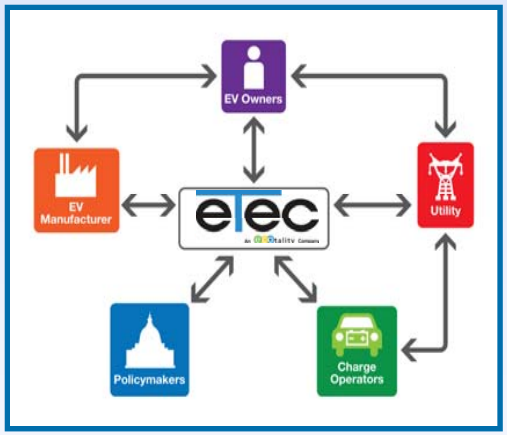
  - What will it do?
    - Fast energy return—50% fill in 30 minutes

Micro-Climate Plan Approach



Planning Phase I

- Organize Regional Stakeholders
  - Government
  - Utilities
  - Enthusiasts
  - Others
- Develop Deployment Guidelines
  - Develop Installation Processes
  - Identify Infrastructure Requirements
  - Address Issues
- Develop Cooperation
  - Build teamwork, synergy



Infrastructure Deployment Guidelines

Electric Vehicle
Charging Infrastructure
Deployment Guidelines
for
the Oregon I-5 Metro Areas of
Portland, Salem, Corvallis and Eugene

April 2010
Final Version 3.1

ELECTRIC TRANSPORTATION ENGINEERING CORPORATION

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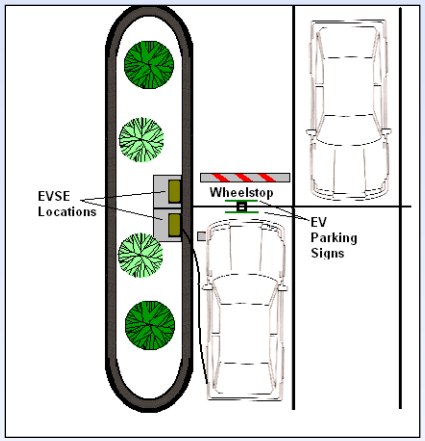
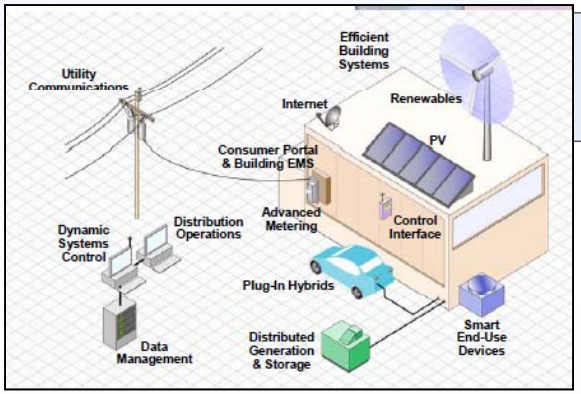
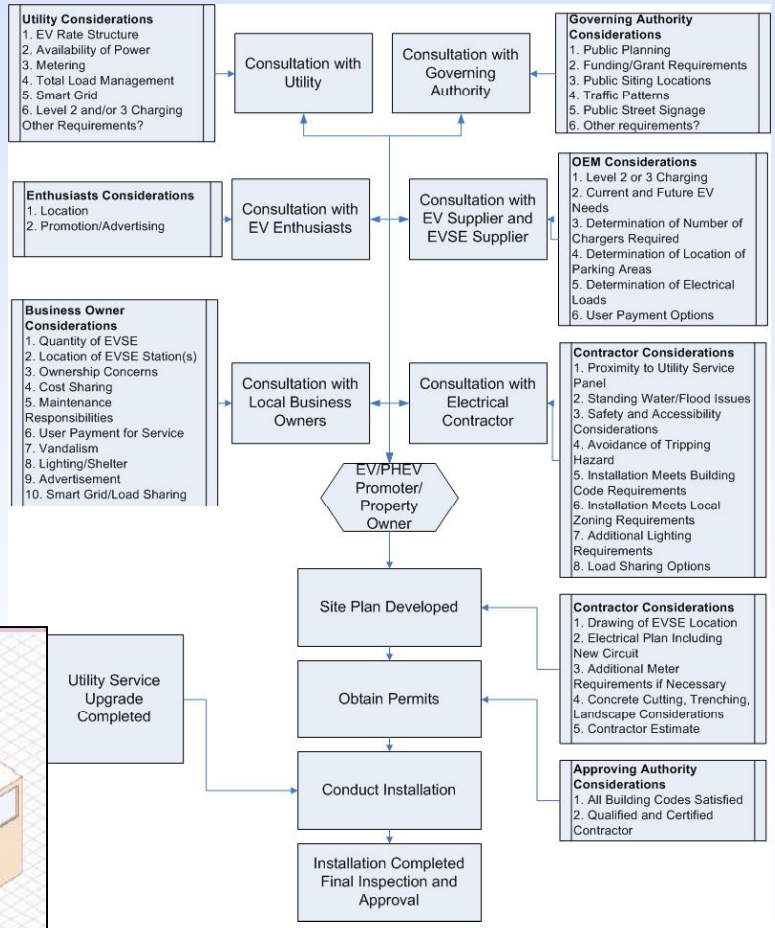
Infrastructure Deployment Guidelines







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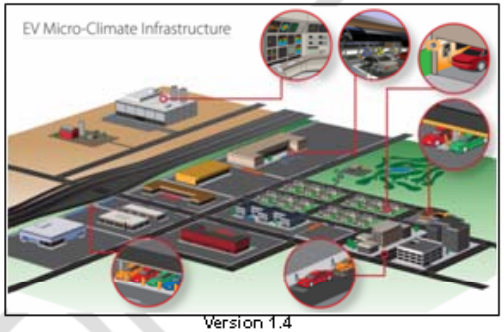
Planning Phase II

- Long Range Plan Input
  - National Household Travel Survey
  - National EV and EVSE Deployment Projections
  - Local Market EV and EVSE Deployment Projections
- Develop Local Long Range Plan
  - Develop Local Traffic Studies
  - Develop Local Characteristics
  - Gather Local EVSE Deployment Interest
- Develop Cooperation
  - Gain Local Support for Input on Locations and Densities
  - Include local areas not provided with EV Project asset

Planning Phase II

Long-Range
EV Charging Infrastructure Plan
for
Western Oregon

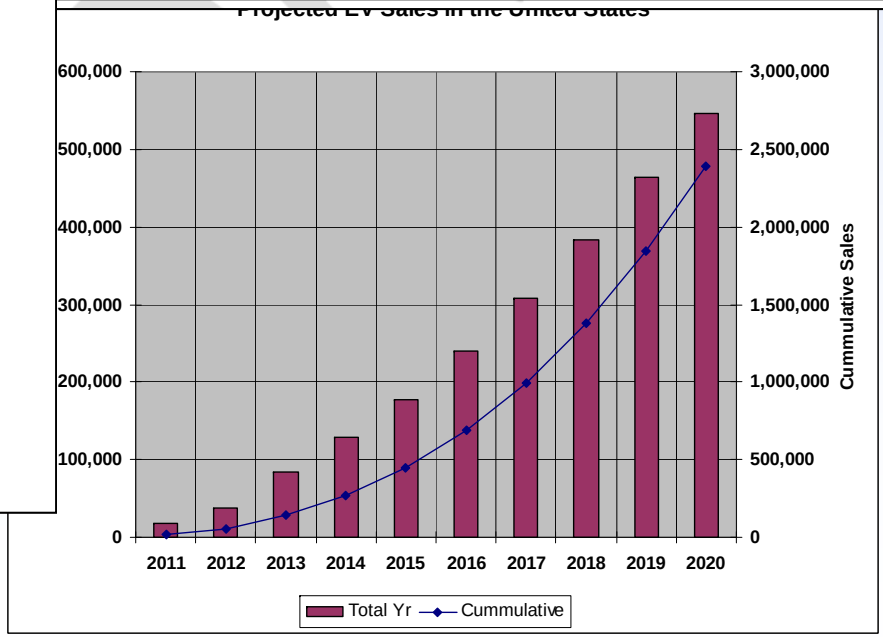


Version 1.4

ELECTRIC TRANSPORTATION ENGINEERING CORPORATION

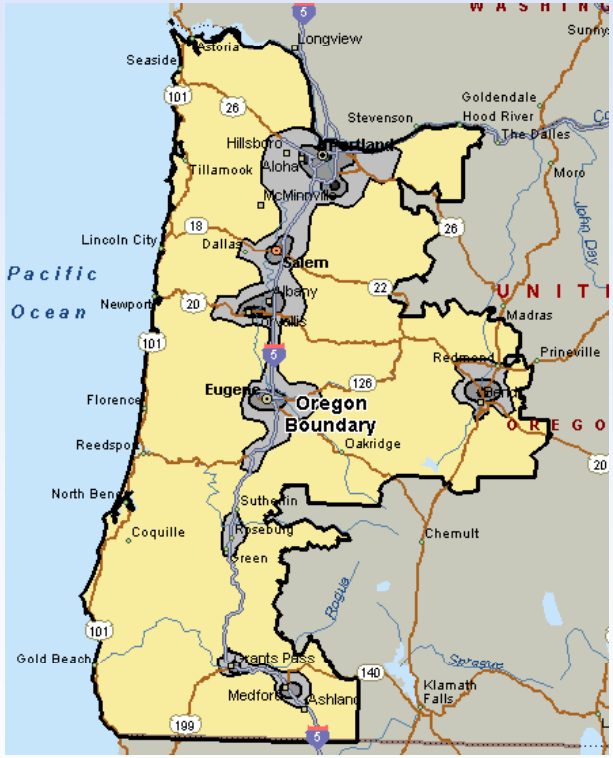
Table 4-1 Projected Cumulative EVSE Penetration in the United States

	Vehicles Fleet	Vehicles Residential	EVSE Fleet	EVSE Residential	EVSE Pub/Comm	EVSE Total	EVSE % EV Total
	3,692	14,767	2,474	11,814	41,053	55,340	300%
	7,895	48,496	5,289	37,342	113,966	156,598	278%
	11,308	130,048	7,577	96,235	256,194	360,005	255%
	17,840	252,467	11,953	176,727	416,570	605,250	224%
	26,367	420,536	17,666	281,759	609,778	909,203	203%
	34,335	652,360	23,004	410,987	815,451	1,249,442	182%
	43,782	951,258	29,334	570,755	1,093,946	1,694,035	170%
	55,166	1,323,972	36,961	754,664	1,403,411	2,195,036	159%
	70,031	1,772,896	57,644	1,151,930	2,349,937	3,559,511	153%
	86,036	2,303,860	57,644	1,151,930	2,349,937	3,559,511	149%

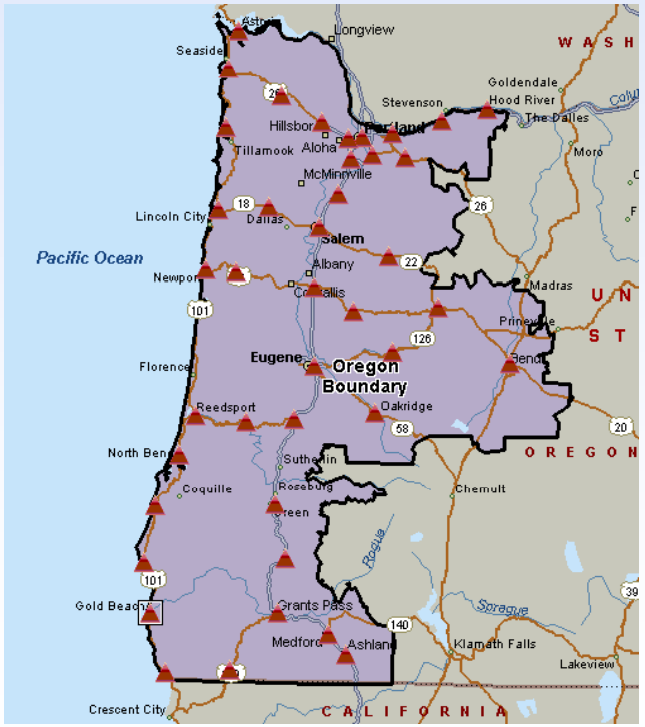


Long Range Plan

Level 2 Density Projection



DC Fast Charge Locations

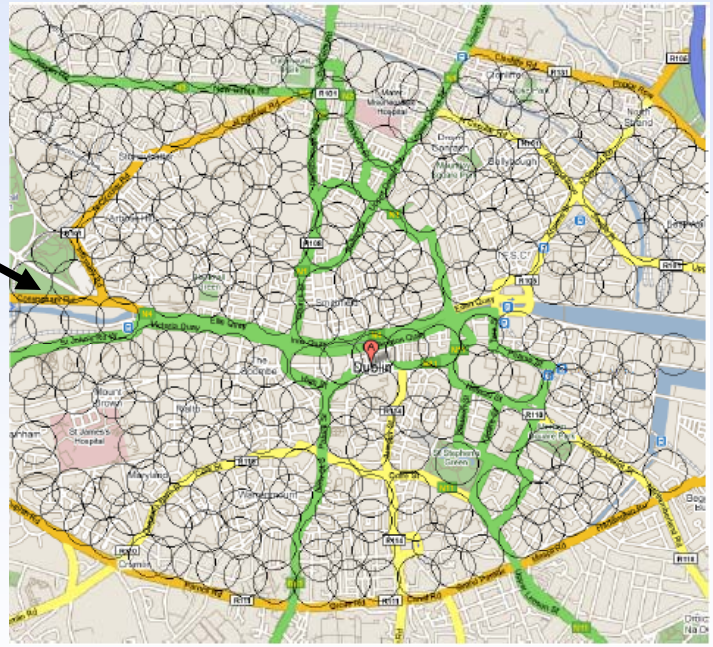


Planning Phase III

- EV Micro-Climate Plan Input
  - Long Range Plan Input
  - EVSE Resources
  - Guidelines to Local Area for EV Infrastructure Deployment
- Develop Local Micro-Climate Plan
  - 1 to 2 Years into Long Range Plan
  - Develop Local Demographics of Early Adopters
  - Gather Local EVSE Deployment Interest
  - Match Locations to eTec National Accounts
  - Electric Utility Review of EVSE Placement – especially DC Fast Charge

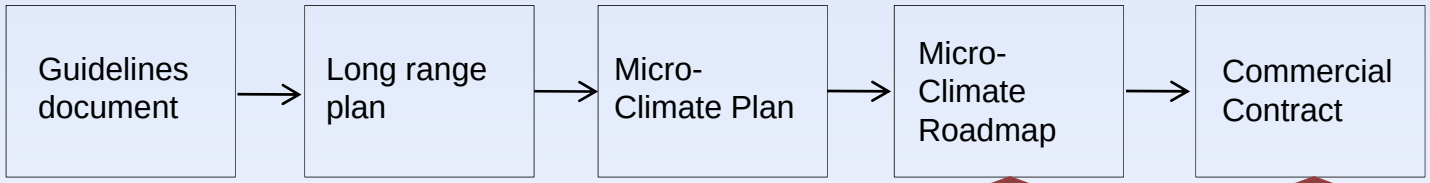
EV Micro-Climate Plan

Refine from EVSE Densities to smaller geographic areas



¼ mile radius circles

Planning Phase II



- Site selection
- Local Input
- National Accounts
- Retailer Interest
- Owner Interest
- Retailer Agreement Review
- Cost/benefit

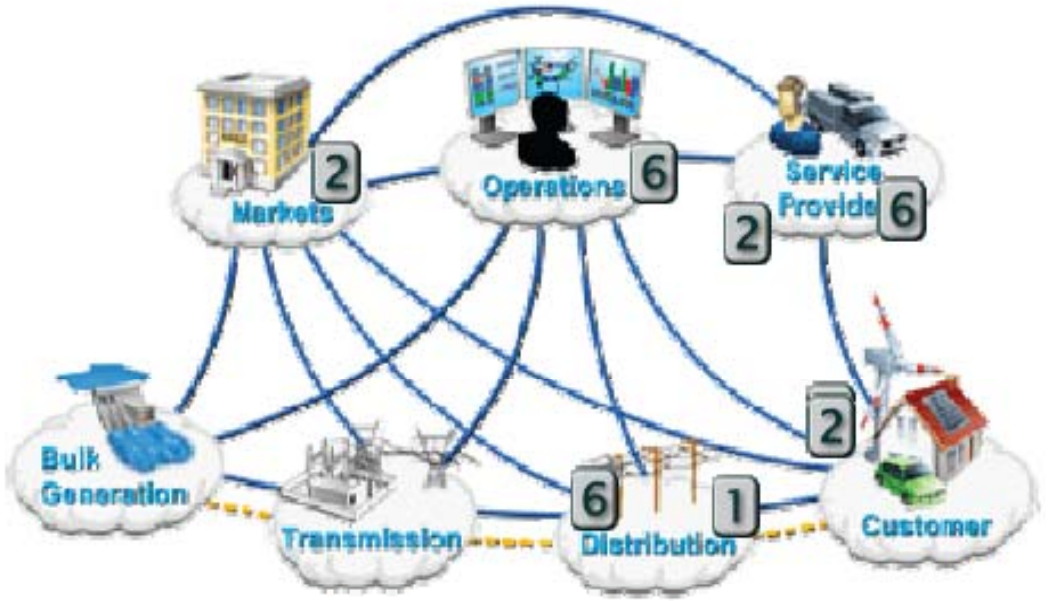
- Site Assessment
- Contractor Quote
- Install Contract
- Retailer Contract
- Permits
- Installation

Soft Infrastructure

- First Responder Training
- Methods For Utility Notification When EVSE Installed
- Streamline Permitting In Each Region
- Electric Utility Smart Grid/Demand Response Preparations
- OEM Dealer Training Materials
- Public Education

Electric Utility Interests

1. **Local Grid Reliability -** clustering, etc.
2. **Peak Shaving Strategies** - Time of Use and Demand Response
3. **Regulatory Activities for EVSE Penetration**
4. **Carbon Mitigation and Revenue Strategies**
5. **Public Perceptions and Jobs**
6. **Grid Support Services**
7. **Informed Customer Relations - including real time pricing**



Lessons Learned

- Charging Stations
  - Planning - how effective was our process?
  - Location - did we select the correct locations?
  - Utilization - when and how long are they being used?
  - Electric Utility Impact - home use vs. publicly available
- Vehicles
  - Utilization
  - Behavior Change
  - PHEV vs. BEV
- Clean Cities Application
  - EVSE location and utilization
  - Vehicle type, utilization and ICE replacement

Overall Data Collection Rational

- **Document electric drive vehicle technologies' ability to reduce petroleum use by collecting data on:**
  - **Vehicle performance**
  - **Operational profiles and ambient conditions**
  - **Charging profiles**
- **Document fueling infrastructure technology, including:**
  - **Sitting**
  - **Use**
  - **Time-of-day pricing**
  - **Charging level (I, II, fast charging) utilization**
  - **Public vs. private charging**
  - **At-home vs public charging**
  - **Micro versus macro grid issues / impacts**

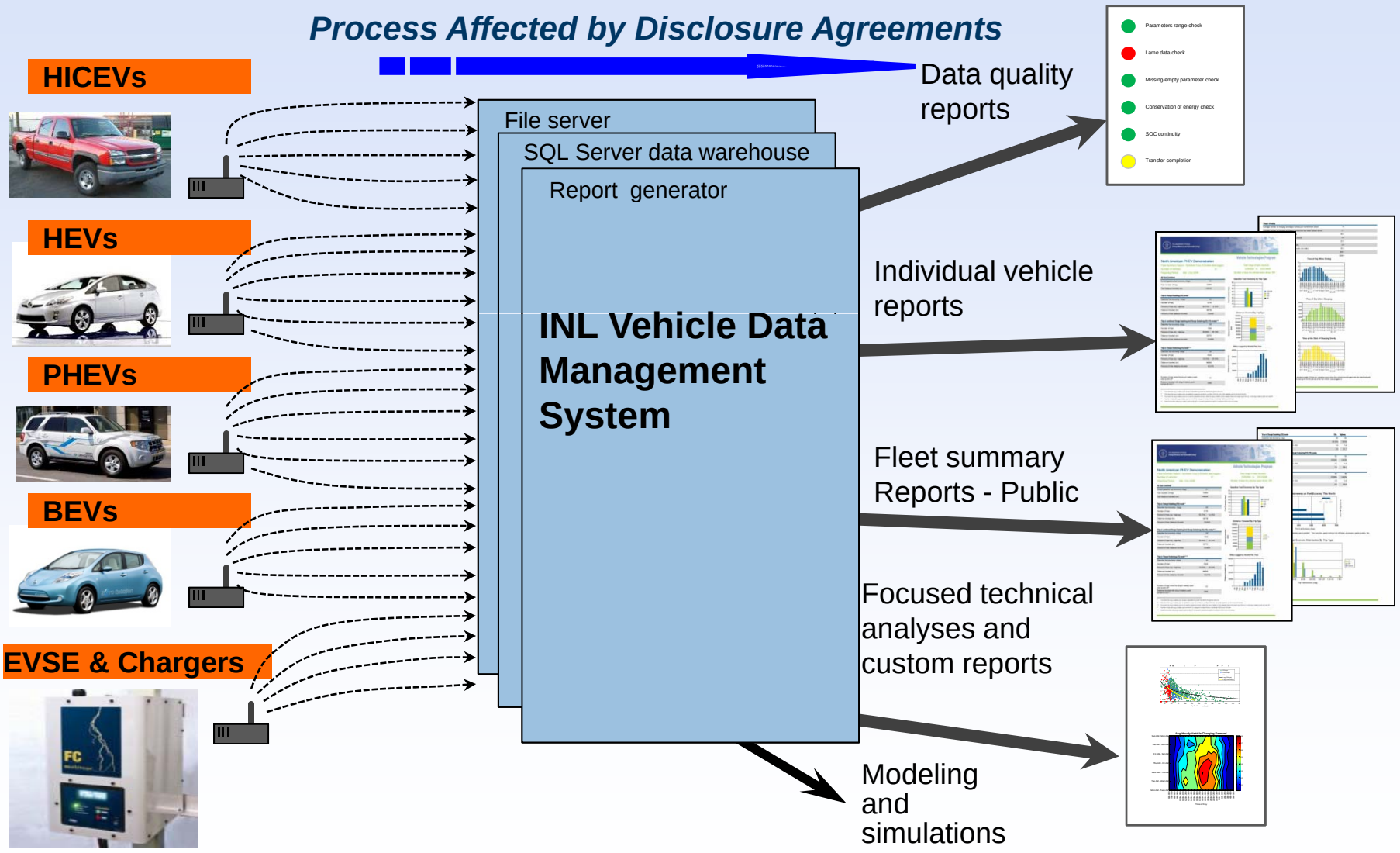
Overall Data Collection Rational

- **Quantified testing results that avoid subjective reporting results**
  - **No “best” or “worst” results**
  - **Only “highest” or “lowest”, or “longest” or “shortest” achieved by reporting testing numbers**
  - **Minimize subjective and maximize quantitative measurements**
- **The independent testing is conducted by the AVTA, the EV Project, and other 3rd party testing partners, including:**
  - **Public and private fleets**
  - **Government fleets**
  - **Universities**
  - **(Many) Electric utilities**

Overall Data Collection Rational

- Publish AVTA testing procedures
  - Developed with industry input
  - Follow and incorporate industry published testing procedures (when available)
  - Sometimes formalized testing procedures development follow introduction of new technologies
- Publish testing results in usable formats. Sometimes "confuses people with the facts"
- Provide testing results to:
  - Target and goal setters, and others needing independent technology evaluations
  - Early adaptor fleet managers and the public
  - Modelers and OEMs

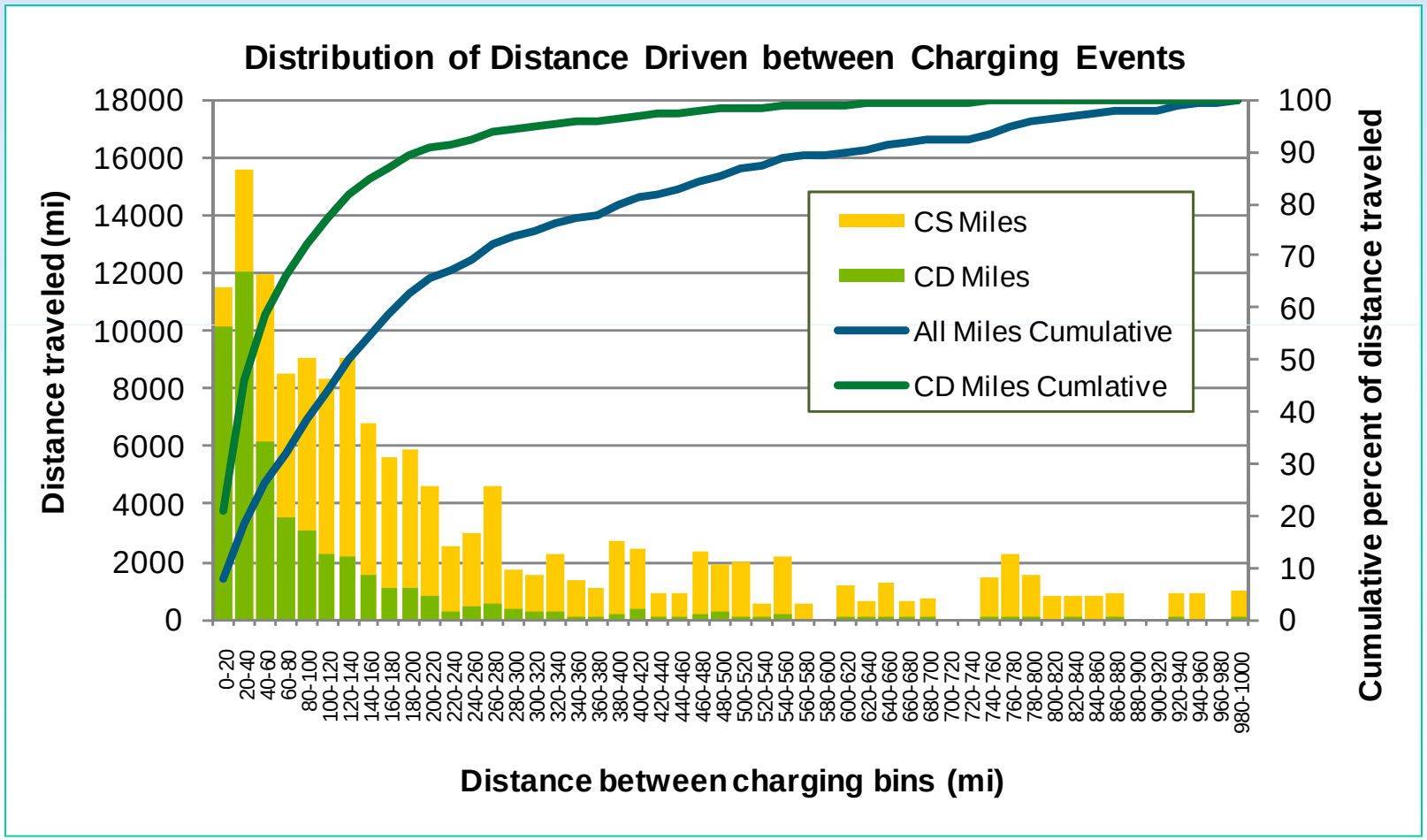
INL Vehicle Data Management Process



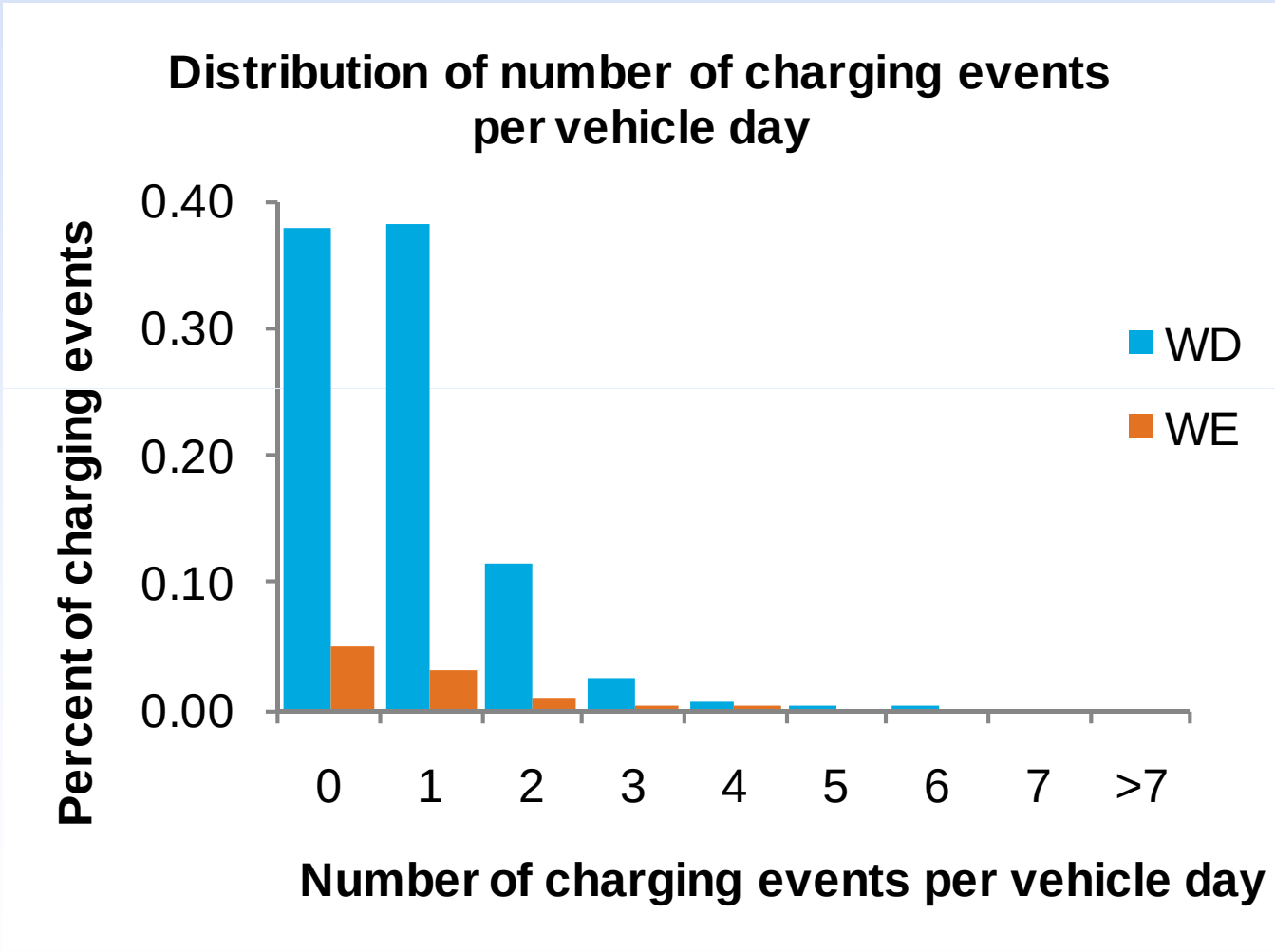
PHEV Data Collection Examples

- **Results for 145 Hymotion Prius PHEVs, with GridPoint data loggers, Jan – Feb 2010**
  - **17,214 Trips**
  - **167,000 Miles**
  - **50,715 Charge depleting miles driven**
  - **3,206 Charging events**
  - **8,956 AC kWh consumed charging**
  - **0.8 Charging events per vehicle day**
  - **2,139 Charging events after all trips in a day (67%)**
  - **6,755 AC kWh charged after all trips in a day (75%)**
  - **1,067 Charging events between trips in a day (33%)**
  - **2,201 AC kWh charged between trips in a day (25%)**
  - **45.2 Average miles driven per vehicle day**

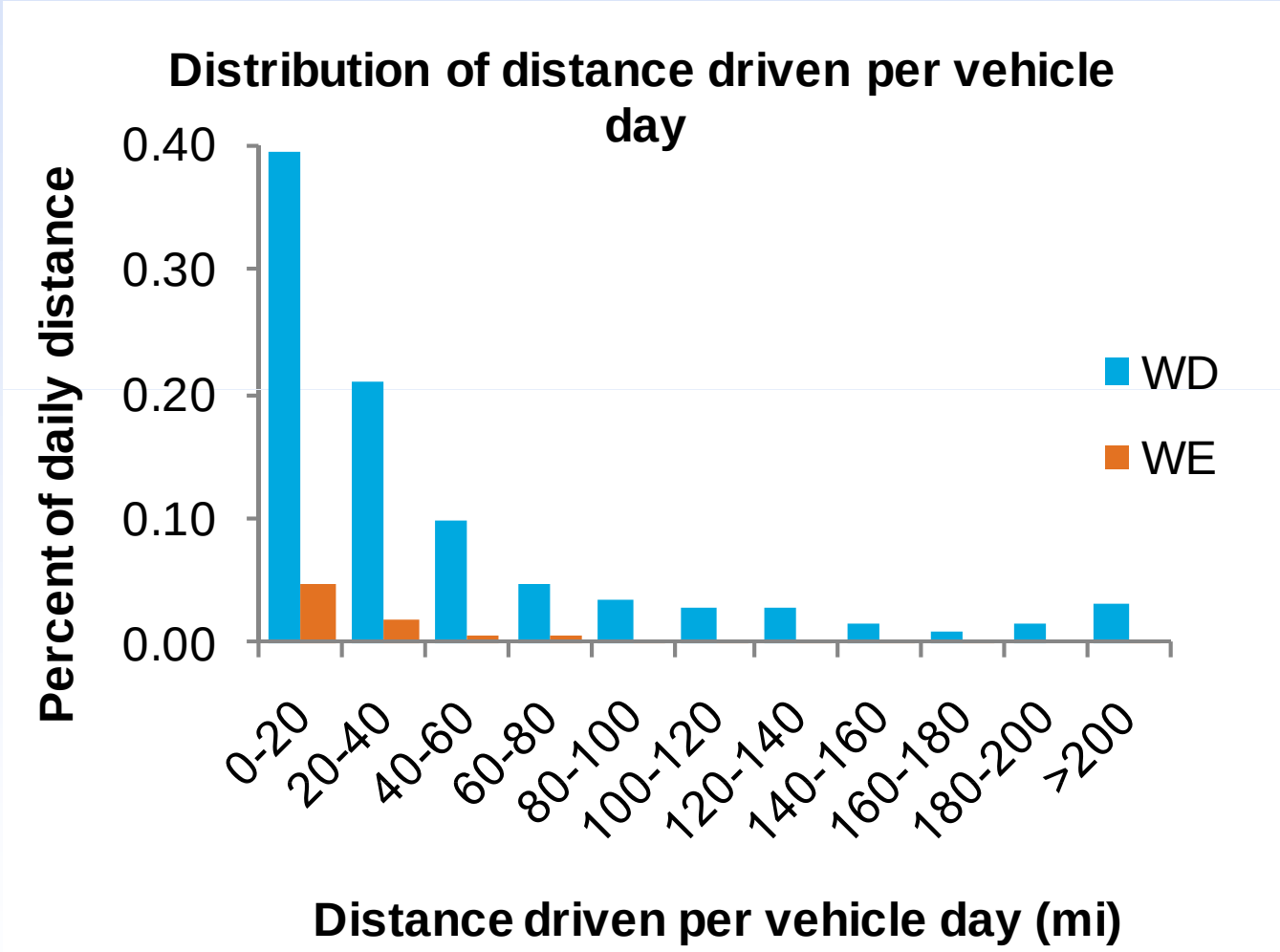
PHEV Data Collection Examples – cont'd



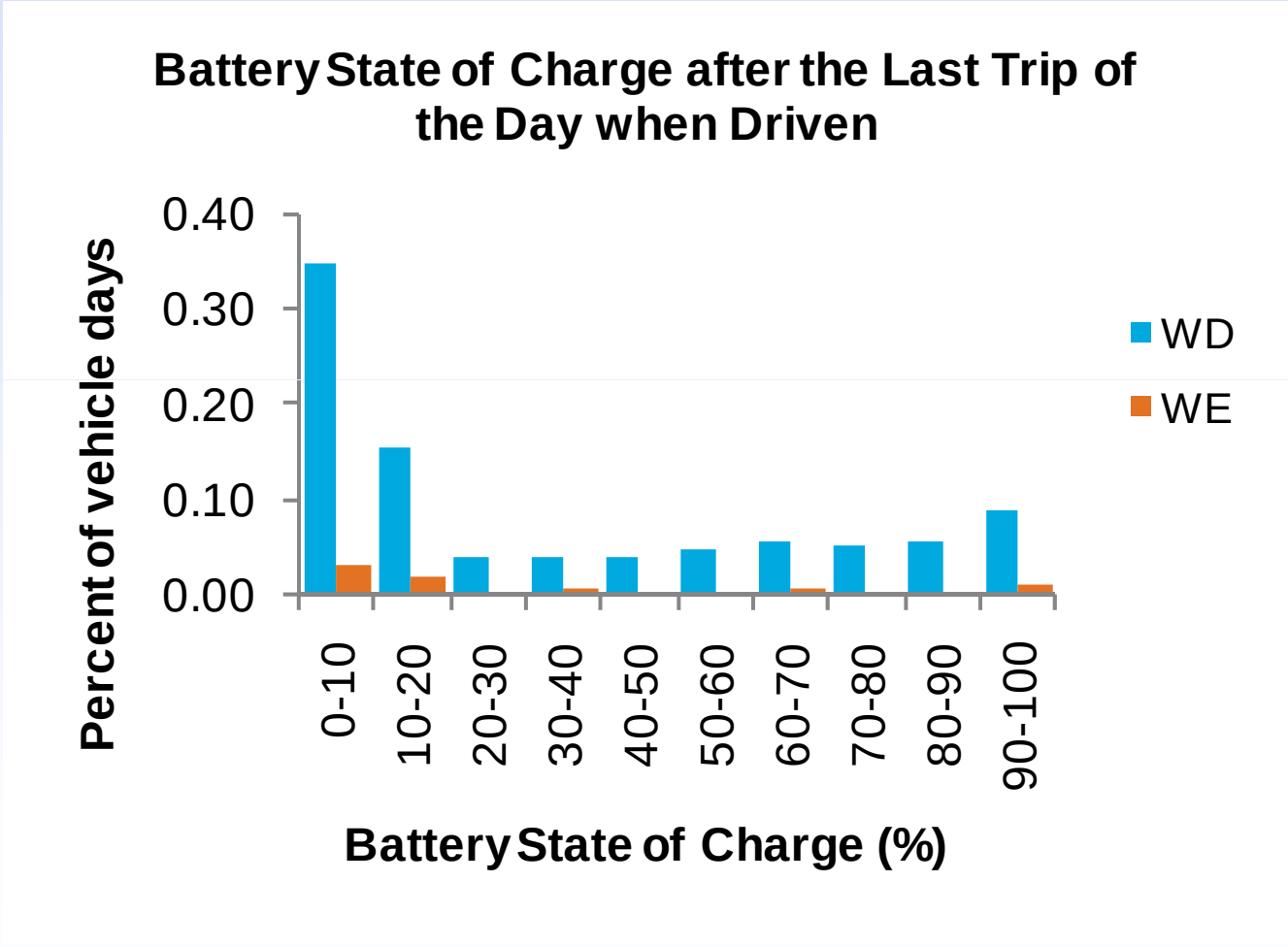
PHEV Data Collection Examples – cont'd



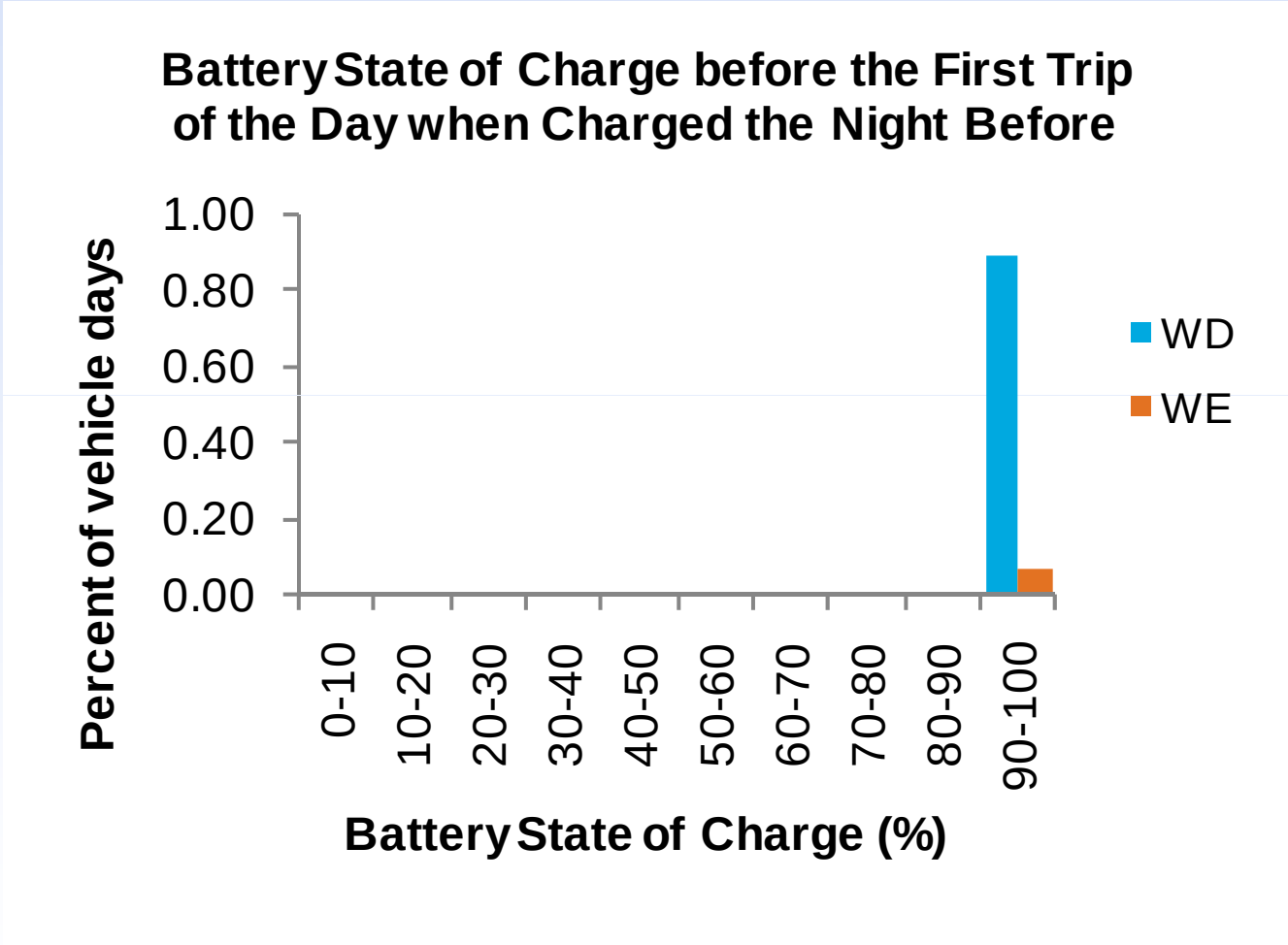
PHEV Data Collection Examples – cont'd



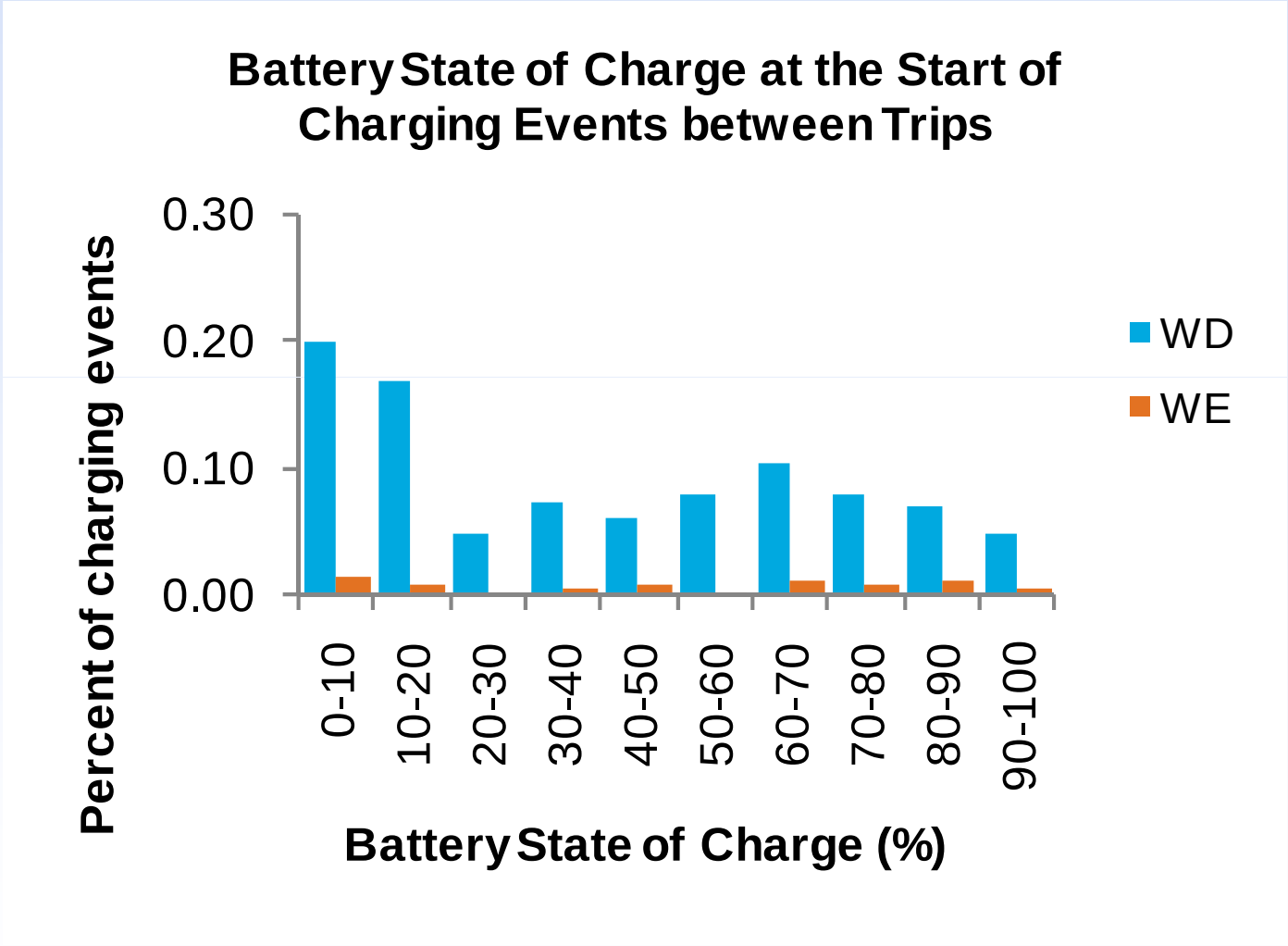
PHEV Data Collection Examples – cont'd



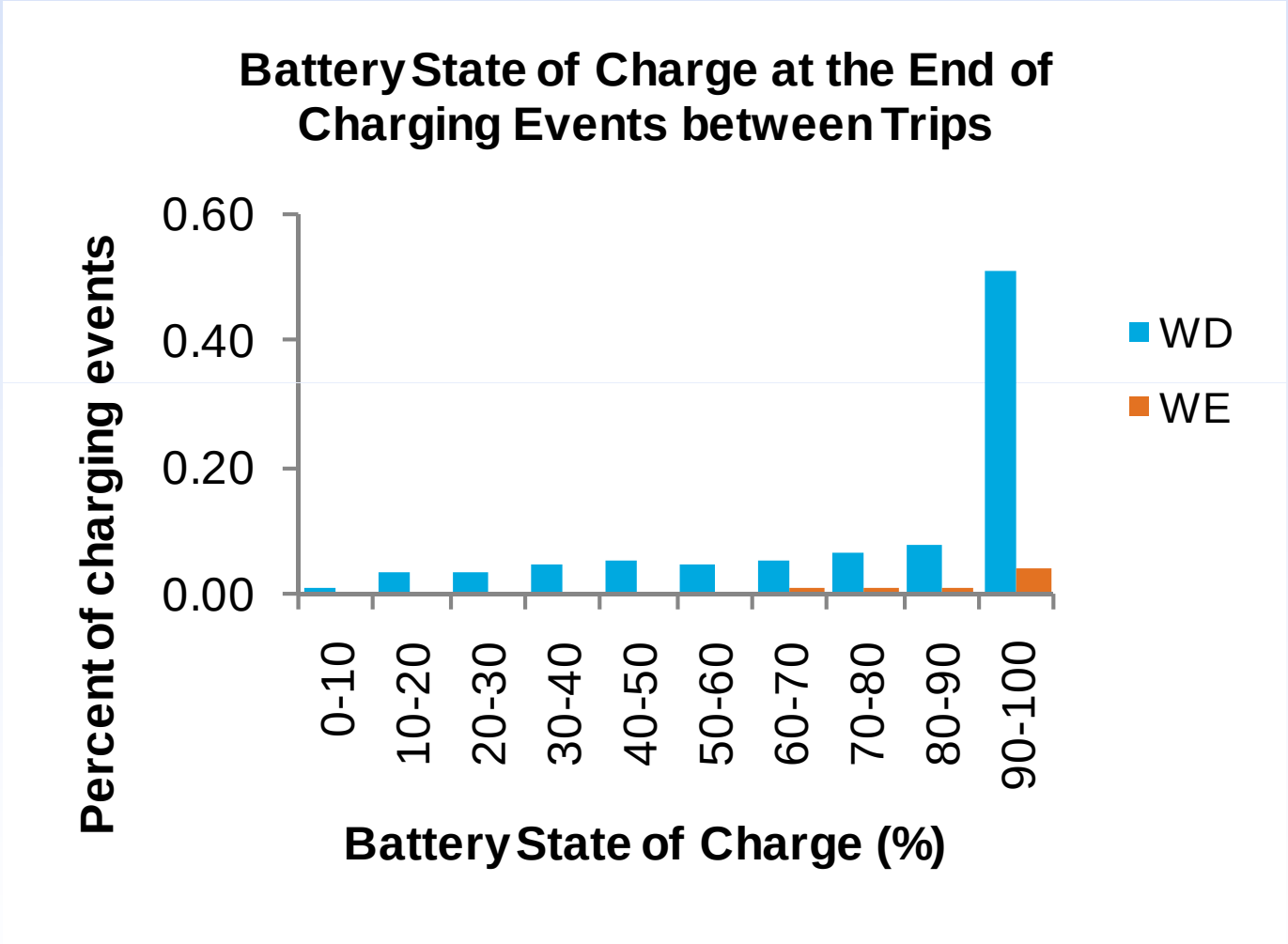
PHEV Data Collection Examples – cont'd



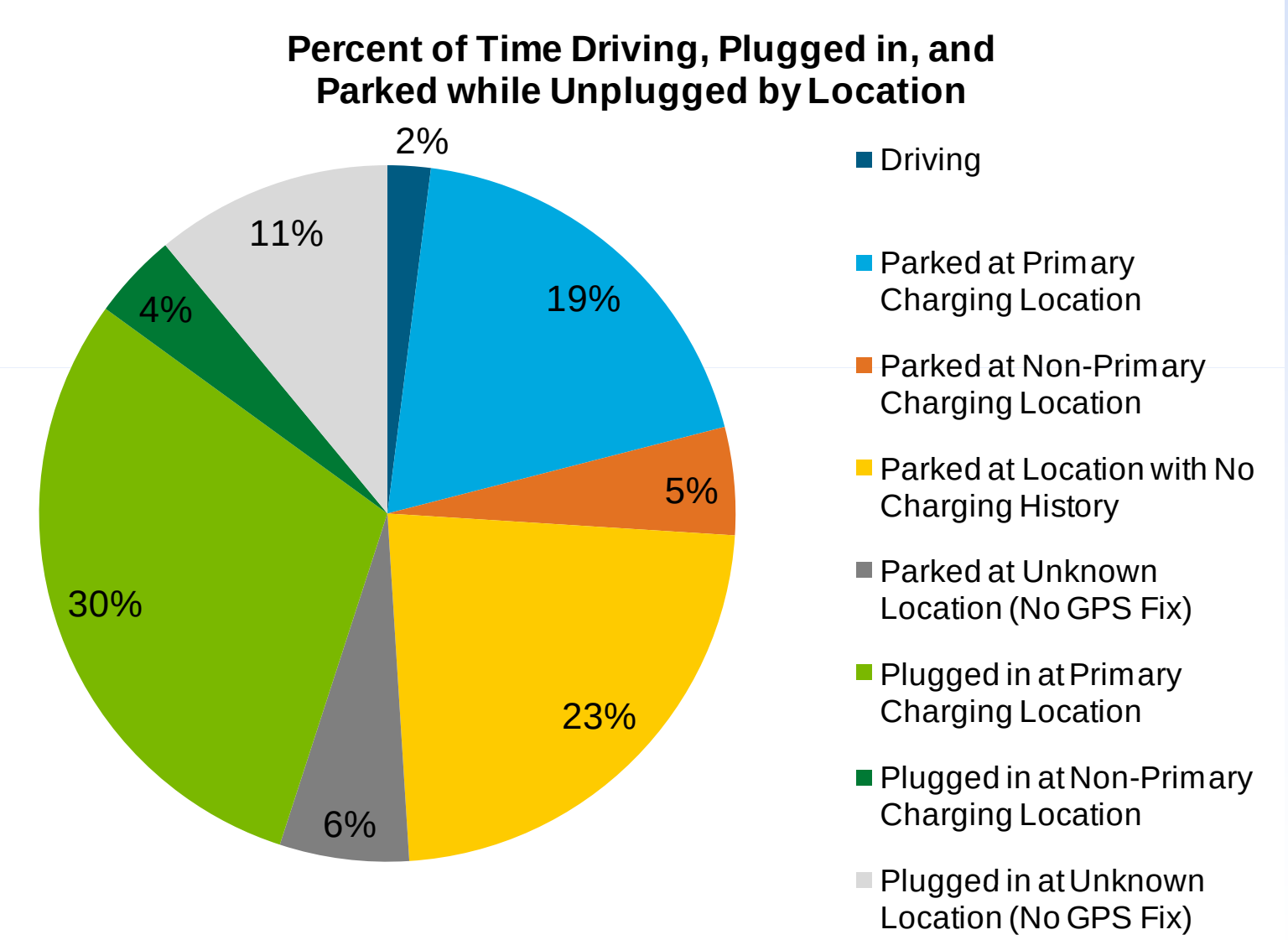
PHEV Data Collection Examples – cont'd



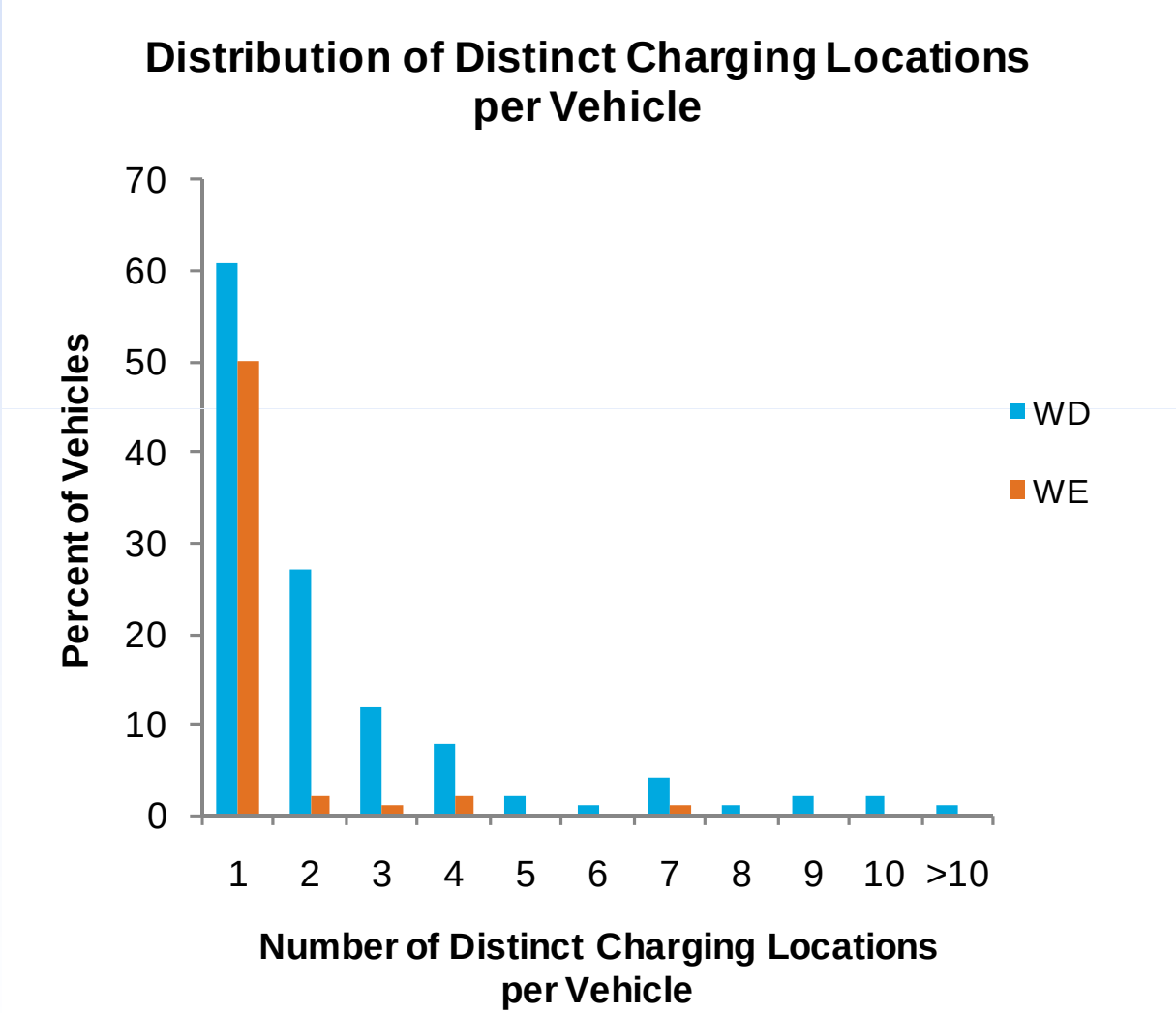
PHEV Data Collection Examples – cont'd



PHEV Data Collection Examples – cont'd



PHEV Data Collection Examples – cont'd



EV Project - Infrastructure Demonstration

- Includes 15,000 electric vehicle supply equipment (EVSE) and fast chargers in:
  - Oregon, Washington, California, Arizona, Tennessee and the District of Columbia area
- Includes 5,700 battery electric Nissan Leaf vehicles in:
  - Oregon, Washington, California, Arizona, and Tennessee
- Includes 2,600 General Motors Volts in:
  - Oregon, Washington, California, and the District of Columbia
- Charging and vehicle data for approximately 23,000 EVSE, fast chargers and vehicles will be collected by INL via data streams from eTec (charging infrastructure), Nissan and GM (vehicle data), and possibly 3rd party infrastructure providers

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EV Project – cont'd

- EV Project will analyze and report on the charging infrastructure utilization (Level II EVSE units and fast chargers) by the 8,300 Leaf and Volt drivers
- EV Project will report on driver/vehicle charging patterns, and charging infrastructure utilization patterns
- Many of the 42+ EV Project partners are electric utilities with high interest in demand / smart charging controls
  - There will be at least one utility smart charging test component
  - Smart charging will include multitier time-of-day pricing
- Fast charge / grid energy storage test component is also being developed

EV Project – Infrastructure Data Parameters Collected per Charge Event

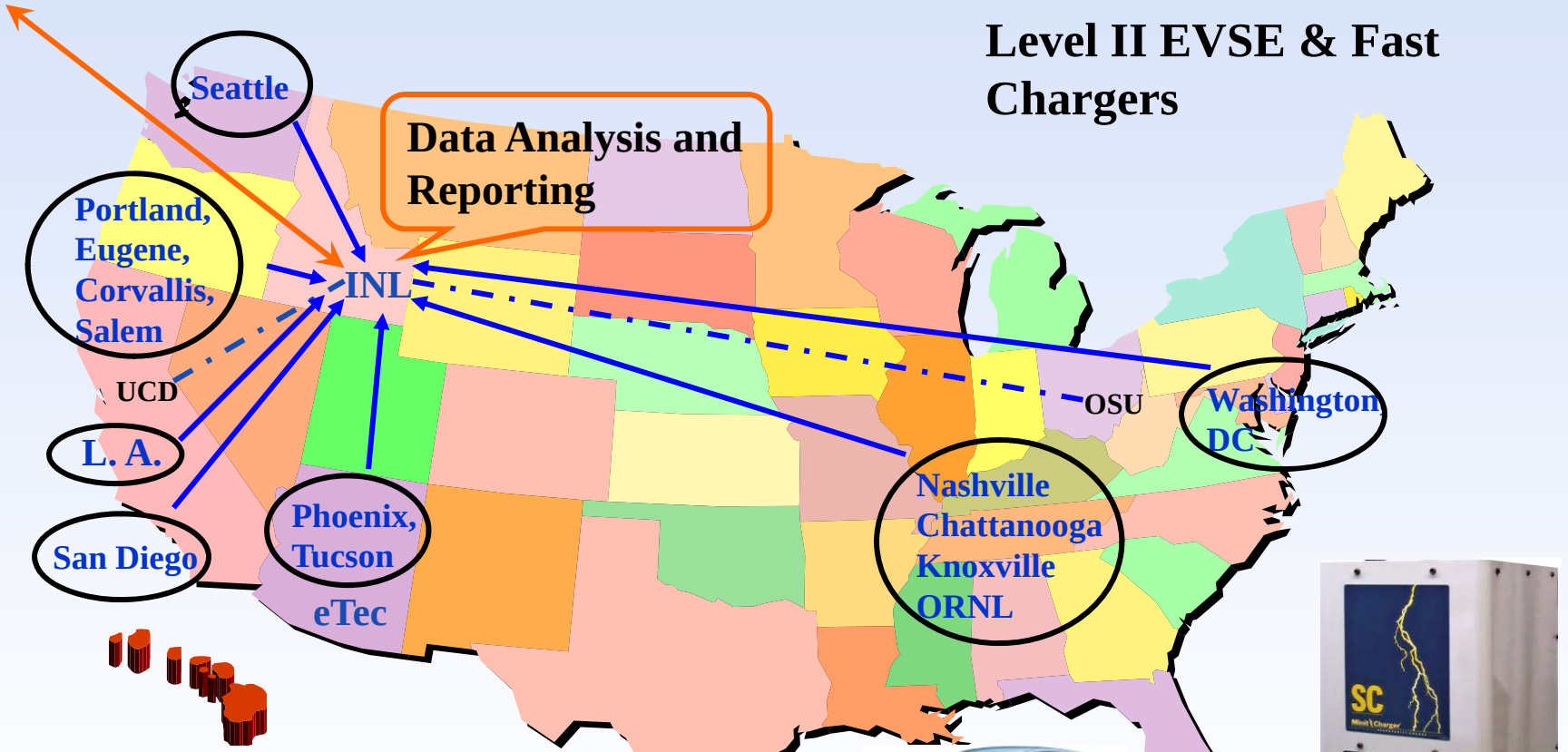
- Date/Time Stamp
- Unique ID for Charging Event
- Unique ID Identifying the EVSE – may not change
- Connect and Disconnect Times
- Start and End Charge Times
- Max Instantaneous Peak Power
- Average Power
- Total energy (kWh) per charging event
- Rolling 15 Minute Average Peak Power
- And other non-dynamic EVSE information (GPS, ID, type, contact info, etc.)

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

- Vehicle ID
- Date/Time Stamp
- Event type (key on / key off)
- Odometer
- Battery state of charge
- GPS (longitude and latitude)
- Fuel consumption (some vehicles)
- Recorded for each key-on and key-off event

EV Infrastructure Project

eTec/INL/Nissan/GM/Regional Partners



5,700 Nissan Leaf BEV. ~24 kWh Li-ion, Projected 100 Mile All Electric Range

2,600 GM Volt EREV. ~15 kWh Li-ion, Projected 40 Mile All Electric Range, & then gas or E85

THE EV Project

eTec

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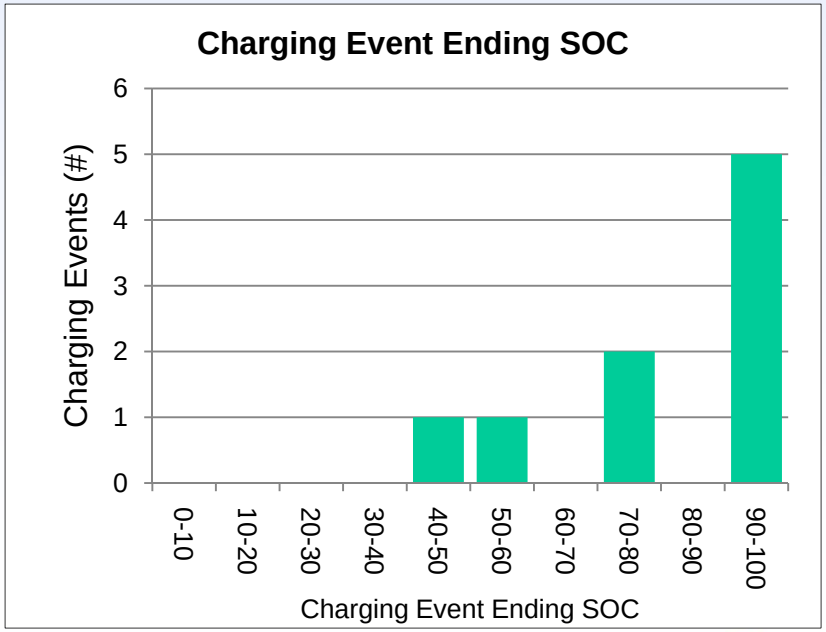
EV Project – Probable Data Presentations

- Driving (by reporting period)
  - Number of trips
  - Distance driven (miles)
  - Average number of trips between charging events
  - Average distance between charging events
- Charging
  - EV Project charging
    - Number of charging events
    - Percent of all charging events
    - Total time plugged in (hours)
    - Percent of all time plugged in
  - Non-EV Project charging events
    - Number of charging events
    - Percent of all charging events

EV Project – Probable Data – cont'd

- **Charging Completeness**

	Base Charging Location	Away-from-base Charging Locations
Number of complete charging events	X	X
Percent of all charging events	X	X
Number of partial charging events	X	X
Percent of all charging events	X	X



Data Collection Summary

- Utilize a systematic process for planning and installing charging infrastructure
  - Document travel patterns
  - Document charging patterns
- Provide feedback on infrastructure deployment decisions
- Successful grid connected electric drive vehicle deployment is dependent on successful infrastructure deployment
- Future charging infrastructure deployments must be based on real-world travel and charging patters
- Replace internal combustion engine vehicles with grid connected, and infrastructure dependant, electric drive vehicles

Acknowledgement

This work is supported by the U.S. Department of Energy's Vehicle Technologies Program's

Advanced Vehicle Testing Activity &

Clean Cities Program

More Information

- **EV Project: www.theevproject.com**
- **ECOtality North America: www.ecotalityna.com**
- **Advanced Vehicle Testing Activity: http://avt.inl.gov**

INL/MIS-10-19112