EV Infrastructure Corridor Development Workshop: Lessons Learned from the West Coast Experience

Workshop Summary Report

September 1, 2015

Hosted By: ODOT/U.S. DOT-FHWA/U.S. DOE Clean Cities
Tuesday July 28, 2015
World Trade Center, Portland, Oregon

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This workshop was held as part of the Deployment of Alternative Vehicle and Fuel Technologies initiative, a joint project of Oregon Department of Transportation and other state DOTs, along with the U.S. Department of Transportation's Federal Highway Administration. The initiative is being supported by The Cadmus Group, Atlas Public Policy, and Vermont Energy Investment Corporation.

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Background

In June 2014, the Oregon Department of Transportation (ODOT) and the U.S. Department of Transportation's Federal Highway Administration (FHWA) initiated a pooled fund to assist state and local transportation agencies interested in promoting the use of alternative vehicle and fuel technologies at a state, regional, or corridor scale and provide tools, information, and knowledge to do so. The Deployment of Alternative Vehicle and Fuel Technologies initiative will implement a series of workshops around the country and develop a "toolkit" for state and local transportation agencies that will facilitate their deployment of alternative fuel vehicle and related technologies.

Workshop Summary

ODOT and FHWA, in conjunction with the U.S. Department of Energy's Clean Cities Program, hosted the first workshop under this initiative, titled "EV Infrastructure Corridor Development Workshop: Lessons Learned from the West Coast Experience", on July 28, 2015. Attendees included Clean Cities coordinators; federal, state, and local energy, environmental, and transportation officials; industry and non-profit representatives; and national laboratory personnel. The workshop featured presentations and discussion of the latest research and data collection efforts related to deployment of charging infrastructure along EV corridors, including the West Coast Electric Highway, and lessons learned to develop potential new corridors in the Northeast and other regions. Most speaker presentations are available upon request.

Key Outcomes

The workshop consisted of a lively discussion among the diverse group of participants. Following morning presentations by EV leaders from the public and private sectors, participants engaged in a discussion of opportunities and challenges related to EV corridor development from the perspectives of state departments of transportation (DOTs) and Clean Cities coalitions. The following are some of the key outcomes as identified by workshop participants:

- EV charging stations are best sited alongside highway corridors where 3-phase electric service already exists. Retail centers, travel plazas, and tourist destinations could all be viable hosts for charging stations.
- In considering EV corridor development, the driver's experience should be paramount. The EV charging experience should be streamlined and straightforward for the user (e.g., supporting payment without a network membership).
- EV corridor development should begin by deploying charging stations within regions, expanding to connect regions over time. EV drivers are currently more concerned about traveling around the immediate vicinity of their home, as opposed to long distance trips. In Georgia, for example, 90% of the 20,000 EVs in the state are in nine counties; 50 counties have no EVs at all. The state is currently focused on ensuring drivers are never more than five miles from a charging station.
- One key issue in EV corridor development is attaining the support and approval of state and municipal host locations. In the Northeast in particular, this can be challenging because of the large number of local, regional, and state entities involved.
- State transportation departments do not necessarily need to take a lead role in EV corridor development, but it is important for them be a part of the process to address issues related to signage, access, and throughput.
- A key challenge to EV market development is matching charging infrastructure with consumer preferences. Five EV drivetrains are currently available and consumers can struggle to identify the most suitable technology. This technology choice has a considerable effect on their charging needs. The U.S. Department of Energy is working on tools to evaluate the value proposition of

driving an EV in order to better educate consumers about the EV technology most suitable for them.

- The use of federal funds for EV corridors may be needed, but it can complicate the process due to programming, environmental, and other requirements. As a result, relying on public-private partnerships using state funds may be more effective in some cases.
- Federal legislation encouraging establishment of EV charging corridors may serve to accelerate EV adoption by promoting robust charging networks.
- State and local governments can play a pivotal role by establishing partnerships between electric utilities, regulatory authorities, private parties, and institutions of all kinds to identify opportunities and barriers to EV charging deployment.

Workshop Agenda

10:00 – 10:20	**Welcome** *Art James, Senior Project Executive, Oregon DOT* *Phil Ditzler, Division Administrator, FHWA OR Office* *Dan Mathis, Division Administrator, FHWA WA Office* *Bob Graham, Director, EV Everywhere, U.S. DOE*
10:20 – 10:40	**Purpose of Meeting and Introductions** *Purpose for Clean Cities Coalitions: Linda Bluestein, Co-Director, National Clean Cities, U.S. DOE* *Purpose for State DOTs: Diane Turchetta, Office of Natural Environment, U.S. DOT*
10:40 – 12:00	**PEV Corridor Development: PEV Framework, Planning, Market, Lessons Leaned** • PEV Framework Analysis: Jake Ward, Vehicle Technologies Analyst, U.S. DOE • PEV Data and Analysis Corridors and Other PEV: Jim Francfort, Principal Investigator, Advanced Vehicle Testing Activity, Idaho National Laboratory • PEV Feasibility: Josh Proudfoot, Principal, Good Company
12:00 – 12:15	*Break*
12:15 – 1:15	**Working Lunch: The Corridor Business Experience and NESCAUM Action Plan Update** *Tracy Woodard, Director, Government Affairs, Nissan North America* *Jonathan Oakley, Director of Sales - EV Solutions, AeroVironment* *Andrew Dick, Transportation Analyst, NESCAUM*
1:15 – 3:00	**Interactive Moderated PEV Corridor Development Discussion** *Art James, Senior Project Executive, Oregon DOT* *Tonia Buell, Interim Director, Innovative Partnerships, Washington DOT* *Dan Mathis, Division Administrator, FHWA WA Office* *Satvinder Sandhu, Local Program Manager, FHWA OR Division Office* *Sandy Fazeli, Program Director, NASEO* *Steve Russell, Coordinator, Massachusetts Clean Cities Coalition, Massachusetts Energy Office* Discussion to Focus On: • Barriers • Success Stories • Lessons Learned • Planning
3:00 – 3:20	*Break*

3:20 – 4:00	**General Roundtable Discussion** Facilitated General Discussion: • How can the ZEV state transportation leaders in the Northeast learn from and capitalize on the experiences of the West Coast? • Collaborative discussion with state energy and transportation and Clean Cities coordinators on progress on policy, planning, outreach, education and consumer acceptance issues.
4:00 – 4:45	**"Takeaways" from the Workshop** • Key Corridor Deployment Ideas • Information Gaps • Ideas for Future Pooled Fund Meetings to Best Help DOTs • How Can Clean Cities Coalitions and State DOTs Foster Better Partnerships?
4:45	*Close*

Workshop Participant List

*Not in Attendance

First Name	Last Name	Affiliation	Title
Jeff	Allen	Drive Oregon	Executive Director
Marco	Anderson	Southern California Association of Governments	Coordinator
Brett	Aristegui	National Energy Technology Laboratory	Regional Manager
Thomas	Ashley	Greenlots	Director, Gov. Affairs & Public Policy
Leslie	Baroody	California Energy Commission	EV Program Manager
Bryan	Bazard*	Washington State Department of Enterprise Services	Vehicle Maintenance and Alternate Fuel Technology Manager, Fleet Operations
Linda	Bluestein	U.S. Department of Energy	Co-Director
Ellen	Bourbon	New West Technologies, Contractor on Behalf of the U.S. Department of Energy	Senior Analyst
Meredith	Brady*	Rhode Island Department of Transportation	Dept. Budget Administrator
Travis	Brouwer	Oregon Department of Transportation	Assistant Director
Tonia	Buell	Washington State Department of Transportation	Interim Dir., Innovative Partnerships
Andrew	Campbell	Energy Efficiency and Conservation Authority	
George	Carter III	Washington State Department of Enterprise Services	Fleet Manager
Jen	Ceponis	Capital District Clean Cities Coalition	Coordinator
Kimberley	Cline	Western Washington Clean Cities Coalition	Co-coordinator
Tammie	Cooper	Utah Clean Cities	Communications and Northern Coordinator
Andrew	Dick	Northeast States for Coordinated Air Use Management	Transportation Analyst
Phil	Ditzler	Federal Highway Administration, Oregon Office	Division Administrator
Jim	Evanoff	National Park Service	Consultant - NPS
John	Fairman	Nevada Governor's Office	Management Analyst
Rendall	Farley	Avista Corp.	
Sandy	Fazeli	National Association of State Energy Officials	Program Director
Christina	Ficicchia	Empire Clean Cities Coalition	Coordinator
Jim	Francfort	Idaho National Laboratory	Principal Investigator of The Advanced Vehicle Testing Activity
Don	Francis	Clean Cities – Georgia	Executive Director

First Name	Last Name	Affiliation	Title
Chris	Gearhart	National Renewable Energy Laboratory	
Bob	Graham	U.S. Department of Energy	Director, EV Everywhere
Richard	Hanley	Connecticut Department of Transportation	Electric Vehicle Infrastructure Project Manager
Zach	Henkin	Drive Oregon	Program Manager
Sharon	Hoff	San Francisco Clean Cities Coalition	Coordinator
Garth	Hopkins	California Department of Transportation	Office Chief for the Office of Regional Planning
Ashley	Horvat	PlugShare	Vice President, Strategic Initiatives
Merlyn	Hough	Lane Regional Air Protection Agency	Director
Andrew	Hudgins	National Renewable Energy Laboratory	Project Leader, Clean Cities
Art	James	Oregon Department of Transportation	Senior Project Executive
Brent	Jamison	California Department of General Services	Deputy Director, Interagency Support Division
David	Keefe	Genesee Region Clean Cities Coalition	Executive Director
Colleen	Kettles	Central Florida Clean Cities Coalition	Coordinator
Doug	Kettles	Florida Solar Energy Center, University of South Florida	Research Analyst
Jukka	Kukkonen	PlugInConnect, LLC	
Ross	Kunz	Idaho National Laboratory	
Jeanne	Kurasz	Norwich Clean Cities Coalition	Coordinator
Oana	Leahu-Aluas	The Cadmus Group, Inc.	Research Analyst
Wendy	Lucht	Ocean State Clean Cities Coalition	Coordinator
April	Marchese*	U.S. Department Of Transportation, Federal Highway Administration	Office Director
Abby	Matera	Vermont Clean Cities Coalition	Coordinator
Dan	Mathis	Federal Highway Administration, Washington Office	Division Administrator
Wes	Maurer	Colorado Governor's Office	Transportation Program Manager
Senan	McGrath	Electricity Supply Board	Chief Technology Officer
Peter	Moulton	Washington Department of Commerce	Bioenergy Coordinator
Nick	Nigro	Atlas Public Policy	Founder
Jonathan	Oakley	AeroVironment	Director of Sales - EV Solutions
Hongyan (Lily)	Oliver	Massachusetts Department of Transportation	Environmental Analyst
Patricia	Pontau	San Francisco Clean Cities Coalition	Intern
Ben	Prochazka*	Electrification Coalition	Director of Strategic Initiatives
Joshua	Proudfoot	Good Company	Principal
Jae	Pudewell	Oregon Department of Transportation	Alternative Fuel Workshop Contract Administrator
Dave	Roberts	Vermont Energy Investment Corporation	Senior Consultant

First Name	Last Name	Affiliation	Title
Marcy	Rood-Werpy	Argonne National Laboratory	Principal Environmental Analyst - Clean Cities
Steve	Russell	Massachusetts Clean Cities Coalition	Coordinator
Erin	Russell-Story	National Energy Technology Laboratory	Regional Manager
Satvinder	Sandhu	Federal Highway Administration, Oregon Office	Local Program Manager
Alex	Schroeder	National Renewable Energy Laboratory	Manager, Transportation Technology Deployment
Blake	Thomas	Utah Governor's Office	Alternative Transportation Specialist
Diane	Turchetta	U.S. Department Of Transportation, Federal Highway Administration	Office of Natural Environment
Linda	Urata	San Joaquin Valley Clean Cities Coalition	Coordinator
Jake	Ward	U.S. Department Of Energy	Program Manager for Analysis in the Vehicle Technologies Office
Alan	Warde	New York State Department of Transportation	Acting Head, Policy Development Section
Paul	Wessel	Greater New Haven Clean Cities Coalition	Co-coordinator
Ivy	Wheeler	National Association of Regulatory Utility Commissioners	Senior Manager
Sera	White	Idaho National Laboratory	Advanced Trans. Computing Lead
Tracy	Woodard	Nissan North America	Director, Government Affairs
Joann	Zhou	Argonne National Laboratory	Assistant Transportation Systems Analyst

Workshop Proceedings

Welcome

Art James, Senior Project Executive, Oregon DOT

- Welcomed attendees and provided overview of the Pooled Fund study.
- Indicated that topics of future workshops will be determined by state DOTs.

Phil Ditzler, Division Administrator, FHWA OR Office

- Emphasized that auto emissions are a major issue in the United States and around the world, and EVs are a key strategy to address this issue.
- Encouraged attendees to engage, ask questions, and share thoughts. Then, take back the vision to expand EV networks and fleets in local areas.

Dan Mathis, Division Administrator, FHWA WA Office

- Kicked off the workshop with a tailored rendition of Eddy Grant's "Electric Avenue" to inspire attendees to pursue expanded EV charging networks and increase speed of EV charging.

Bob Graham, Director, EV Everywhere, U.S. DOE

- Explained DOE's EV Everywhere program:
  1. EV Everywhere is intended to be a national catalyst for increased adoption of EVs.
  2. DOE is open to suggestions and wants to make wise investments. Within the EV realm, costs are going down but adoption is not increasing as rapidly as they would like to see.
  3. The "everywhere" in EV Everywhere means highways, cities, regions – not just major metropolitan areas.
- U.S. DOE Clean Cities will be working on a Drive Electric Vermont case study to see what lessons can be learned from their success in working in less populated regions.

Purpose of Meeting and Introductions

Clean Cities Coalitions: Linda Bluestein, Co-Director, National Clean Cities, U.S. DOE

- Clean Cities is the deployment arm of DOE's vehicle technology office. Deployment happening in four areas:
  1. Local community partnerships: make technologies accessible to people in their communities
  2. Consumer outreach and education
     - There are 5-6 types of plug-in vehicle technologies and many consumers don't understand these different types (BEV, BEVx, PHEV, EREV, etc.).

- Consumers also don't understand the value proposition and cost of ownership for EVs. DOE manages fueleconomy.gov, which is a highly visited website where people can compare vehicles to understand the total cost of ownership.
- The AFV station locator has up-to-date information from EV charging networks across the country.

3. Technical and problem solving assistance
   - Troubleshoot EVSE projects through the national lab network, to help people at local level.
4. Competitive awards for alternative fuel vehicles (AFVs)
   - Example: 2011 Plug-in electric vehicle (PEV) readiness grants.

- Clean Cities has directly influenced the reduction of 7 billion gallons of petroleum and is currently saving about 1 billion gallons of gasoline annually.
- Clean Cities strategic planning workshops earlier this year highlighted importance of placing DC Fast Charging along highway corridors.
- Collaboration with FHWA is an opportunity to advance this work. Clean Cities can fill niches in coordination with DOTs; DOTs and Clean Cities should stay connected. For this workshop, the intent was to bring people from the Northeast to learn from Northwest experience.

State DOTs: Diane Turchetta, Office of Natural Environment, U.S. DOT

- Workshop to provide information on west coast activities to allow other regions to benefit.
- Clarify potential role of state DOTs in expanding availability of EV charging.
- FHWA is working to provide clarity on several EV charging corridor related issues such as signage, HOT lane access, and right-of-way issues associated with Title 23 prohibitions on commercial activity within the right of way.

PEV Corridor Development: PEV Framework, Planning, Market, Lessons Learned

PEV Framework Analysis: Jake Ward, Vehicle Technologies Analyst, U.S. DOE

- *See presentation for more information*
- On the subject of corridors:
  - Nationally, 20% of vehicle miles traveled (VMT) are within corridors (between cities).
  - Only 7.5% of vehicles in Atlanta didn't leave the region in a year.
  - Travel surveys - NHTS says 20% of miles traveled are inter-city.
  - Can reach a lot of people if the focus is on a small number of corridors:
    - SF, ATL, LA, SD - 3% of road length covers 50% of traffic volume

  - BEV has biggest net gain for potential savings on fuel and cost savings and emission reductions. The more a driver travels in a BEV, the more they save.
  - EV sales density increases away from city centers, but those consumers increasingly value range extension.
  - Can use technology and market data to model potential adoption patterns as costs shift over time.
  - There are differences between worthwhile (convenient) charging and urgent (necessary) charging.
    - Corridors can be more urgent than worthwhile - necessary to finish a trip or enable one you wouldn't have taken.
- On the subject of market trends:
  - Through the end of 2014, market was growing rapidly, faster than the adoption of non-plug-in hybrids.
- On the subject of corridor analysis, there are two approaches: theoretical and empirical.
  - Theoretical - Level 2 charging does not serve traditional long distance trips well. High penetration of EVs requires some DCFC.
    - Chicago - Madison travel example: As the number of vehicles increases there is an eventual saturation point where it may not be worth adding more charging infrastructure. As charging station costs decrease, you should consider installing more. As battery costs decrease, you may not need as many charging stations.
  - Empirical – NREL study using data on where people are driving and will likely want to charge is forthcoming.
- Last week, EV Everywhere launched the SMART Mobility program to focus on vehicle-infrastructure modeling for AFVs and benefits of alternative fuels.
- **Questions**
  - What is the need for DCFC when vehicles can go 200 miles on a charge?
    - Modeling suggests that DCFC does increase market, but there are no definite conclusions on what the future will bring.
  - Was willingness-to-pay taken into account for the model results presented?
    - The model is set up to indicate public investment; this was an exogenous input; assuming that if DOE or others are doing this it is public sector, haven't looked at private investment yet.

PEV Data and Analysis Corridors and Other PEV: Jim Francfort, Principal Investigator, Advanced Vehicle Testing Activity, Idaho National Laboratory

- *See presentation for more information*

- Idaho National Lab (INL) has extensive vehicle experience, including the EV Project data analysis and reporting. The EV Project, funded by DOE, is intended to study how PEV drivers operate and recharge their vehicles in different charging infrastructure environments. The EV Project facilitated the deployment of 12,300 Level 2 and DC fast charging stations, and measures 8,250 PEVs. All vehicles and charging equipment are being actively measured for analysis and reporting by INL.
- EV sales measures - 340,000 cumulative sales to-date, 21 models available with 7 more models anticipated this year.
- Automakers are considering technologies that will support their efforts to meet federally required vehicle standards, which could reach 54.5 mpg-equivalent in 2025. EPA has estimated that meeting this requirement will require increased use of electric drive technology.
- Environmental impacts
    - EVs are about 88% efficient; ICE vehicles are about 18% efficient on average.
    - 20 degree temperatures can cut the efficiency of an EV by as much as 50%.
    - High speeds also have a big negative impact on PEV efficiency.
- West Coast Electric Highway – I-5 Corridor
    - The EV Project study identified 2,500 vehicles that were using the 57 DC fast chargers along the West Coast Electric Highway route.
    - DC fast charger usage frequency - wide range in usage; with the majority used less than 7 times/week.
    - DC fast chargers are most heavily used in the metropolitan areas of Seattle and Portland.
    - Important to have infrastructure outside metro areas.
- Outing Distances - good number of LEAF owners going 200 miles; one driver went 770 miles in one trip.
    - Some longer tours are locations in wine / eco-tourism regions.
    - Some people will make a trip because EVSE exists, but don't use the equipment; hard to quantify the value in those cases.
- Utility Demand Charges
    - Nationwide, most electric utilities have demand charges that start at approximately 20 kW. These demand charges can exceed $1,000 per month which can have a negative impact on the business model economics of DC fast chargers.
    - Some utilities eliminating these demand charges for EV charging. An example of which is the eight electric utilities that waived demand charges in Tennessee during the EV Project.
- Median cost of a DC fast charger installation during the EV Project was $23,000. This does not include the DC fast charger equipment cost. The main cost drivers include:

  - Installation materials, repaving, etc.
  - Administrative costs (e.g., permitting can cost $3-$5,000).
  - Ground service conditions - water, gas, electric service; boring vs cutting
  - Service upgrades - will utility absorb some of the cost? New service ranged from $3,500-9,500.
  - Time can also be an important factor with installations lasting between 30 and 90 or more days.
  - Low cost locations: Sears tire stores had good sites (under $9,000); used existing conduit.
  - Most expensive sites required new electricity service, cutting and digging of concrete.
- DC fast charger utilization rates
  - Seattle and San Francisco had the highest DC fast charger use rates. Both areas were among the top markets for LEAF.
  - Installations along commuter routes that are also in metropolitan areas can have higher than average utilization rates.
  - DC fast chargers located near high-tech employers have higher than average use rates; some issues with meeting demand at popular workplaces as more employees may request additional charging stations.
- Must consider signage for public installation of EVSE.
- DC fast charger fee Impacts
  - 50% reduction in usage when going from free to fee-based charging
  - People paying were using DCFC longer (likely greater need).
- Electric Vehicle Miles Traveled (eVMT)
  - Volts had 74% of eVMT, almost as much as all-electric vehicles.
  - Even partial electric drive can have significant petroleum reduction benefits.
- California examples - how do you pay for EVSE?
  - Public charging infrastructure business models are challenging due to low utilization rates, high upfront installation costs, and competition with home charging.
  - IKEA example, customers stay 58 minutes longer in store, but don't have data on how much more they spend.
  - California utilities could try to recover costs through ratepayers; 7-8% rate of return, potential partner on corridor installations.
- **Questions**
  - Temperature efficiency; can high speed or low temperature results in an EV efficiency that is as low as an internal combustion engine?

        - EVs will still work well in low temperatures; reduced efficiency is also an issue with gasoline powered vehicles (% loss may be the same, but not as noticeable in ICE vehicle).
    - How does Idaho National Lab collect data and going forward to whom should people be sending data?
        - EV project worked with telematics providers (OnStar); Nissan CarWings, Smart 2go; Blink data from ECOtality; 4 data streams needed to be combined.
        - Initially, characterizing venues was challenging at locations with more than one nearby store, such as strip malls. Venue definitions were eventually identified for EV project installation sites.
        - Some projects included INL data loggers.
        - Data collection methods and parameters should be defined that answer specific questions since additional data can be superfluous and expensive to collect and store.
        - EV project participants had a L2 charger installed at home
        - LEAFs with workplace charging resulted in 98% of charging occurring at home or work.
    - Are you continuing to get eVMT data from OEMs?
        - INL completed a project on eVMT for OEMs last fall and had to sign a non-disclosure agreement.

PEV Feasibility: Josh Proudfoot, Principal, Good Company (20 minutes)

- *See presentation for more information*
- Part of team working on FHWA study, "Feasibility and Implications of Electric Vehicle (EV) Deployment and Infrastructure Development"
    - http://www.fhwa.dot.gov/environment/climate_change/mitigation/publications_and_tools/ev_deployment/
- Looked at different penetration rates of EVs and considered potential impacts to FHWA, including the federal highway trust fund.
- EV context
    - Low carbon fuels will necessitate EVs. Cellulosic ethanol could supply a small fraction (7%) of gasoline equivalent required.
    - Running vehicles on electricity is lower cost and more stable than gasoline, which is particularly advantageous for fleet applications.

  - Greenhouse gas emissions (GHG) per mile for an EV depends on the upstream source of electricity. The Union of Concerned Scientists analyzed this in a 2012 study[1] and found electricity generated from coal is the equivalent of a 30 mpg vehicle when used to charge an EV, but renewable sources such as hydropower reach an equivalent of 5,800 mpg.
  - Grid is decarbonizing over time, with significant differences just in a one year period between 2011 and 2012 as noted in a Climate Central report.[2]
- FHWA study methodology was to gather information through interviews, research and a forum.
- Developed 8 EV deployment scenarios based on a range of assumptions from 5-150 million plug-in vehicles.
- Findings and Conclusions[3]
  - Federal, state and local incentives make a difference in adoption rates. As an example, Nissan tracked incentives in some areas and found they led to a 9 times increase in EV sales.
  - Current federal highway authorization in MAP-21 clarified charging infrastructure could not be placed in Interstate Highway rest areas. This issue could be reframed as a safety and access issue to address the prohibition on commercial activities.
  - California's ZEV Program, Low Carbon Fuel Standards (LCFS) and federal vehicle standards support EV markets
  - Business models for providing charging networks are shifting with the end of federal stimulus funds.
  - Home and work EVSE should come first.
  - Three levels of recommendations for EVSE in other areas:
    - Market Response – EVSE along right-of-way (ROW), e.g. park and rides, turnpikes and grandfathered locations.
    - Market Support – EVSE along commuter corridors, likely near interchange locations as a potential loss leader for businesses.

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1 Anair, D., & Mahmassani, A. (June 2012). State of Charge: Electric Vehicles' Global Warming Emissions. Retrieved August 23, 2015, from http://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean_vehicles/electric-car-global-warming-emissions-report.pdf

2 Yawitz, D., Kenward, A., & Larson, E. (September 2013). A Roadmap to Climate-Friendly Cars: 2013. Retrieved August 23, 2015, from http://assets.climatecentral.org/pdfs/ClimateFriendlyCarsReport_revised.pdf

3 For a summary of suggested pathways for FHWA, State DOTs, and Other Transportation Agencies, please see Appendix A.

        - Market Acceleration – Connecting corridors between regions with significant EV numbers.
    - Design standards and infrastructure
        - Multiple plug types for DC Fast Charging is a challenge, but with newer dual plug units it is not a major barrier.
        - Americans with Disabilities Act (ADA) standards for EV charging need to be considered and may provide opportunities for inductive charging – moving the heavy plugs and cables can be difficult.
        - Signage should provide wayfinding all the way to the charging station and indicate the type of charge available (Level 1, Level 2, DC Fast).
    - User fee revenue impacts
        - EV registration fees may gain in popularity as political leaders consider how EVs support infrastructure.
            - Washington state fee of $150 for all electric vehicles and $50 for plug-in hybrids with more than 30 miles of range will provide funding for charging networks.
        - Vehicle miles traveled user fees are in pilot stage in Oregon, but much work required before these are more widespread.
        - In the highest scenario considered with 150 million EVs there was a 4% erosion in the highway trust fund. Broader fuel economy and greenhouse gas standards have a much greater impact on trust fund revenues.

- **Questions**
    - Are there issues with regulating use of EV charging parking spaces (e.g., ticketing non-EVs in these spots)?
        - Washington and California have policies in place to support this. Illinois recently passed legislation to address this. Depends on the traffic authority in the state. Signage should say “NO PARKING EXCEPT ELECTRIC VEHICLE CHARGING”. Enforcement usually requires a local municipal ordinance with specific language.
    - FHWA has guidance on MUTCD requirements: http://mutcd.fhwa.dot.gov/resources/policy/rsevcpfmemo/

The Corridor Business Experience and NESCAUM Action Plan Update

Tracy Woodard, Director, Government Affairs, Nissan North America

- *See presentation for more information*

- 75,000 Nissan LEAFs sold in the United States, with the number one market being Atlanta, but since EV tax credit went away, rate of growth in Atlanta region will decrease. California, Portland, Seattle are consistently in the top ten.
- Consumer education is still needed. In many places, after taking out the luxury cars, sales are stagnant. The EV manufacturers are moving from cooperation to "coopetition," with the increase in competition creating need for convening entities, like DOTs and Clean Cities, to bring partners together on EVs.
- Utilities are getting more involved, such as Georgia Power and the Orlando Utilities Commission see EVs as a place where they can do good for themselves and the public.
- Nissan provides business development for workplace charging – provide education and promotional programs. There are incremental increases happening at the companies they've worked with. Nissan also helps track program success.
- PEVs with longer ranges are coming, with announcements from Nissan likely coming soon.
- **Questions**
    - How are EV programs considering all income levels? Concern over the perception of EVs being a luxury for the wealthy.
        - States and regions are responding to this issue. California now has household income cap of $250,000 to qualify for an EV rebate and Washington has imposed a $35,000 "fair market value" cap on the vehicle to qualify.
        - Several California air quality management districts have specific incentives for low income populations in addition to the regular rebate.
        - Nissan is considering how to support these efforts, potentially through bulk purchases of used Leafs becoming available off-lease.
        - Massachusetts recently had a meeting with community agencies on low income issues related to EVs and is investigating how they might be used in rural areas with limited access to public transportation options.

Jonathan Oakley, Director of Sales - EV Solutions, AeroVironment

- *See presentation for more information*
- Provided background on AeroVironment
    - Helped develop GM Impact, which turned into EV1.
    - Has been a partner since 2010 on the West Coast Electric Highway (WCEH) installations.
- Provided insight into WCEH work:
    - West Coast Electric Highway was really built for public benefit, not driven by profit motive.
    - Network started with 8 or 9 stations, now 58 stations (56 of which are DCFC). At 30-60 mile intervals spread out over Oregon and Washington.

- For main timeline, there are four stages.
  - Site selection and acquisition
  - Permitting/design
  - Construction
  - Commissioning
- Takes about 6 months to get through these stages.
- Lease negotiations took vast majority of the time (driven by lack of knowledge and understanding at the host level). Majority of stations on privately owned land. Some on federal land, but that has its own layers of complexity. Construction phase is only about one or two weeks.
- User subscription costs $19.99/month. Partnered with Plugshare to allow users to pay one-time fees with smartphone apps. Demand charges constitute 2/3rds of electricity charges. Maintains 97% + up time.
- High use stations in and around Seattle.
- Wall mount typically costs less than pedestal mount.

- **Questions**
  - What is the length of the WCEH corridor?
    - Bellingham, WA to Ashland, OR
  - Did you consider 25kW vs 50kW chargers?
    - Only had 50 kW available when WCEH installations occurred.
    - Smaller wall mount units now available may lower costs.
    - 50 kW may be more necessary as longer range vehicles with larger batteries become widely available.
  - How much do demand charges vary by utility?
    - Different practices across 22 different utilities in the corridor, but generally about 2/3 of power costs.
    - Didn't know what level of usage to anticipate initially, current usage is lower so working with utilities to examine tariffs which might have a higher kWh rate, but lower peak kW demand charge.
  - How are chargers maintained?
    - AeroVironment does the maintenance for the chargers. AV has contractor network across the county. Have developed assets that can be called on.
    - The Level 2 units are very reliable. DC Fast Chargers had some issues when first rolled out, but now working well.
  - Have they considered support for SAE Combo DC Fast Charging?

        - If upgrades are made, AV would put in dual plug chargers. SAE Combo was not available when they were installing.
    - How are the private land lease agreements handled?
        - Lease agreements are 5 or 10 years that can be renewed. Equipment is owned by AV but is sitting on the leased land. AV pays electricity bill, and pay royalties which are about 5-10%.
    - Is a fee based network sustainable?
        - Challenging to be profitable, but reduced utility demand charges will help reduce expenses and could lead to more sustainable operation in the future with increased use.
    - Charging reliability is a concern – 97% uptime sounds good, but 1% downtown means offline 3.5 days/year which does not seem acceptable for users. Can this be improved?
        - Experience indicates DCFC manufacturers need to get quality to same point as automakers. As the number of stations increases it will improve; going through extensive automaker OEM certification process on some residential EVSE products has improved quality. Some issues result from standard for CHAdeMO which has flexibility for OEMs that complicates the vehicle-charger communication.

Andrew Dick, Transportation Analyst, NESCAUM

- *See presentation for more information*
- Described the 8 state ZEV task force
    - Committed to 11 priority actions that states could take together, established in ZEV Action Plan released in May 2014.
- States have made significant progress on incentives. CT established point of sale EV rebate in May 2015. Buyers receive $750-$3,000 dollars based on battery capacity. Research has shown that people are really motivated when they get the rebate right at the point of purchase.
- About to publish dealership best practices.
- Issued dealership recognitions awards in three states. In CT, there is a small incentive that actually goes to the dealer ($300).
- State and municipal fleets present a major opportunity. New Bedford, MA just added 10 LEAFs.
- Infrastructure planning – will require legislation to eliminate Title 23 prohibitions on charging in ROW, but fees at EVSE situated at park and rides outside the Interstate ROW can work.
- Working on best practices for Public Utility Commissions (PUCs) to affirm sellers of electricity for EV charging are not getting categorized as utilities, and to consider demand charge reductions for charging

- Outreach and education – ZEVstates.us website launched in April. Working on survey with UC Davis on customer knowledge and attitudes toward PEVs. Many think the standard Prius is a PEV, so there is a need for more education and outreach.
- **Questions**
    - Are there states that are "low hanging fruit" for EV charging corridors?
        - CA is further along, but many states working on DCFC deployment
    - Are there NESCAUM resources for states that aren't in the ZEV program?
        - Best practices documents are intended to be broadly applicable outside ZEV states
        - Also working with UC Davis Zero Emission Map program to get knowledge beyond ZEV region

Interactive Moderated PEV Corridor Development Discussion

Art James, Senior Project Executive, Oregon DOT

- *See presentation for more information*
- West Coast Electric Highway was constructed by contractors through AeroVironment (AV)
- In some casts AV just handled the final installation to make sure the equipment warranty was valid.
- Process of moving from site selection (e.g., "a dot on a map") to final installation requires a significant amount of time and effort. Learned that early involvement of local officials could streamline concerns over new technologies
- Locations funded by U.S. DOT TIGER program required soil testing and hazardous material removal in some cases, particularly at service station locations.
- Fred Meyer, a grocery store that is part of the Kroger line of businesses, has been an excellent partner.
- Dual plug connector fast charging is a current issue, but when the WCEH started CHAdeMO was the only option. Oregon would love to swap out the existing units to dual plug equipment with growing number of vehicles using SAE Combo connectors, but this will be a significant expense and unclear if funds are available to do this.
- Oregon is currently piloting a road user charge, which is one way to resolve concerns over EV contributions to infrastructure maintenance.
- The federal highway bill under consideration in Congress, referred to as the DRIVE Act, includes a provision calling for alternative fuel corridor designations, but the likelihood of passage is uncertain and it is not clear what benefits this designation might provide.

Tonia Buell, Interim Director, Innovative Partnerships, Washington DOT

- *See presentation for more information*

- All stations done by AV as a contractor except for two handled by the DOT at rest areas which were Level 2 only, which took significantly longer and were almost as expensive as DC Fast Charging. These Level 2 were installed as educational and promotional without a fee to avoid concerns over prohibitions on commercial activity. The Adopt a Charger program is covering the electric utility costs.
- Goal was to connect cities throughout the routes and give people confidence with a safety net of EV charging.
- Branding of WCEH helped bring partners together and raise awareness. This handled through a professional design firm in Portland to establish a green, clean, strong "hero" symbol.
- There are close to 15,000 EVs in WA.
- Partners started work with US DOE EV Project, Western Washington Clean Cities and municipalities using state energy block grants for EV charging. They have EV coordinator meetings every few weeks.
- EVs can play an important role in state economies
    - BMW's carbon fiber plant for the i3 and i8 vehicles is located in WA.
    - Many airports use AV industrial chargers for ground operations equipment.
    - EV tourism is growing with EV owners now able to travel a 480 loop around the Cascades.
- King County Metro is considering up to 200 electric buses for their fleet and are currently testing 2 Proterra buses.
- Did not have a large marketing budget, but have created media attention through events, such as ribbon cuttings, press releases, etc.
    - Launched connection to British Columbia's electric highway with "golden plugs" ceremony with partners.
    - Governor's proclamation of EV tourism month.
    - Celebration of the first person to reach 100,000 miles on their Nissan LEAF.
- Recognize the purpose of electric highway is not to expect users to travel the entire length, but to extend range and have charging available when needed for peace of mind.

Dan Mathis, Division Administrator, FHWA WA Division Office

- FHWA supports EV infrastructure.
- Head office deals with policy. Divisions are more involved in implementation, coordination, funding of these projects.
- Much of the funding for EV charging has come through CMAQ and Surface Transportation Program (STP) funds.
- State and local partners select federally funded projects; division offices make sure implementation meets federal regulations.

- Recommend bringing FHWA into the process early when federal funds are anticipated for EV charging projects to help partners through the process.

Satvinder Sandhu, Local Program Manager, FHWA OR Division Office

- Noted there are two general approaches for project implementation:
  1. State DOT develops scope and project and then sends obligation request to FHWA, who then iterates back and forth with the DOT until project is approved. Not recommended for these projects.
  2. Bring FHWA division into team to work cooperatively from the start. For the WCEH OR and FHWA met every month on the progress. This helped consolidate required environmental analysis for NEPA so they did not have to complete 22 separate NEPA analyses.
- Historic areas and parks ("4(f) areas") can complicate federal environmental review
- Work in partnership with FHWA to identify and resolve issues.

Sandy Fazeli, Program Director, NASEO

- NASEO represents 56 state and territory energy directors.
- EVSE deployment is not generally seen as a primary issue for state energy offices.
- Transportation is often part of a broad portfolio of clean energy development, including policy support, codes and standards, renewable energy portfolios, grid reliability, etc.
- NASEO has run a transportation energy panel the last 3 years with Wisconsin and NYSERDA helping lead the effort with Clean Cities Coalitions as important partners.
- When appropriately deployed, EVs can help states achieve environmental goals.
- Bandwidth
  - Willing partners
  - Authorization, priority from governors
  - Complements other environmental and energy goals

Steve Russell, Coordinator, Massachusetts Clean Cities Coalition, Massachusetts Energy Office

- MA EV engagement started with an event celebrating 7 charging stations in 2009.
- Used utility penalty funds to create community grant program for EVSE which generated significant interest with 25 community requests.
- Now working on DC Fast Charging corridors. Level 2 is good, but not practical for longer distance travel.
  - $2 million in CMAQ funds funding EV corridors. Many along Mass pike and 12 EVgo installs at Simon Mall properties.
- State agencies (DEP, DOER, DOT) meet regularly which has helped them overcome communication barriers across silos.

- EV license plates were developed with first responders in mind to make sure they understand when EVs are involved in a crash. Learned dealerships have standard plates on hand, so it will take time to develop a system to get the plates to the dealers. Out of 6,000 EVs in the state they have 300 plates in circulation.

Moderated Discussion

Question: How best to get states involved in EV charging work?

- Get in touch with Clean Cities coordinators. They all meet, they all talk. Critical in getting that communication going. There can be frequent staff changes in state agencies but Clean Cities staff tend to be more stable.
- When getting ready for Nissan LEAF to come out, WA DOT was careful to not go within EV Project boundaries because they didn't want to duplicate efforts but now realize this was a mistake since the EV Project contractor, ECOtality, did not deliver charging in more urban areas as planned. Creating a Washington electric vehicle task force was helpful – a group of them still meet.
- It's important to show business case of EVs to states.
- In the case of CT DOT, Tesla came to them to talk about EV charging, it was then on CT DOT's shoulders to reach out to neighboring states. There was no model for it. This is the first basic changeover in transportation fuels in 90 years. It's been two steps forward one step back, two steps sideways. To boil it down, try something.
- The EV Project was funded by DOE. ODOT assumed major metro areas were going to be covered. ECOtality didn't deliver on all promises. Had to rely on expertise of utilities for developing charging station specifications.

Question: Are EVs commuting cars, or are they for families with 2-3 cars or stand-alone cars? What are the gaps in rural areas? How do you legitimize that market?

- In some areas, in order to gain broader political support for EVs, widespread infrastructure may need to be deployed, including in rural areas.
- Some of the rural areas in WA are some of the highest used stations. Some lowest performing sites are on the EV tourism sites. WA DOT worked with the cities to do economic development work. It was a way to bring the community together and have something to rally for.
- In MA, they worked with EPRI to identify general locations for building out a network of charging. Let the volunteer groups that form naturally work, be aware of policy groups that are established.
- In highly urbanized areas, 40% of trips are home to work trips. Start with that first. Then go to major destinations outside of urbanized areas.

- Think about engaging rural electric cooperatives. EVs can manage their demand and increase their volume.
- The Great River Energy electricity cooperative took membership fees for EV infrastructure, and residential time of use programs. Can be easier for co-ops as they are not under the same regulatory requirements as investor owned utilities. Cast a wide net when you're talking about electricity providers.
- EV owners could push further to push organizations, hotels to think about additional charging that wouldn't cost much to them.
- On East Coast, need to mobilize EV owners. Need to hear from more ordinary owners, need to tell stories that inspire. PEV corridor is not sexy. West Coast Electric Highway is.

Question: What role did metropolitan planning organizations (MPOs) play or not play in the West Coast Electric Highway?

- MPOs play an important role in the installation and deployment of charging infrastructure. To date, no MPOs have contributed funds to the pooled fund study.
- Clean Cities coalitions are working with MPOs in New York.
- Timing is crucial for working with MPOs to make sure EV charging is included in long range plans and shorter term funding programs.
- In MA, during a utility merger, the energy office was able to put in an EV pilot project in the merging agreement with regulators. The state benefited from a garage EV charging study, and the utility had a staff person placed in the call center knowledgeable about electric vehicles, and now can use their map to determine locations. So, find out what's going on with utilities and see if you can get involved during merger proceedings.
- Big challenge for EVs is that we only have about 4 years of data but for internal combustion engines, we have 40+ years of data.

Question: What is the role of utilities in doing an EV corridor?

- One of the key barriers is getting utilities to be proactive. They're beginning to recognize the value of electrifying transportation. Load growth from transportation is crucial, especially when utilities are losing to rooftop solar. So there's more and more interest. Utilities look at the market and see it's growing but it's not here yet. So they don't feel a sense of urgency. How you can help – talk to PUCs and begin to join with utilities. Environmental community and utilities have started to work together in CA and that's important. Many municipal utilities have developed electric transportation programs so they're proactive.

- Municipal utilities are responsive to the people that own them, although in many cases they are restricted in giving out free electricity for charging so there needs to be a whole business case. Can't assume they will solve the problem with their own funds.
- Distributed generation is the new buzzword with utilities. There is a pilot in MA to do four electric school buses, designed to flow electricity back into grid when not in use. So to utilities, talk about energy storage and distributed generation.
- Some utilities (Great River Energy), are offering EV owners/potential buyers an upgrade to renewables at no cost. They still have to pay for the electricity but now it will come from renewables. This serves as a promotional piece for the utility company. People just have to sign up.
- UK is a very liberalized market, similar to the U.S. in terms of focus on short financial gain. In the rest of Europe, most EV chargers are put in by utilities. In southern Germany, because of solar PV, prices have dropped. In Ireland, they have to curtail wind when the amount of wind generation goes above 50% of instantaneous electricity. In Ireland, about 1,000 charge points across the country every 50 kilometers. They have 50kW chargers because they didn't want to dig up the ground again. At some point, had more chargers than cars. Looking at it as the key to future success.

Question: Strategies to use CMAQ funds for EVs and corridor building?

- In CT, CMAQ funds are preprogrammed so they know few years out how much is available. Some money goes to state, some goes to MPOs. Overall, CMAQ has not been available for EVSE due to other priorities, but will vary by state.
- Sometimes having policy people on a committee can be used as an asset. You have to get someone from a high level on your side to say we want to use your dollars. Once you can tap into those CMAQ dollars. Clean Cities coordinators have tapped into that.
- Using CMAQ funds will vary widely among states. Demand charge is in some cases an impediment to making business case. In CO, when you co-locate different fuels that have similar demand charges (e.g., DC Fast Charging paired with CNG fueling), that helps make the business case.
- MA has funding for inductive charging, but has had a lot of false starts with companies. Would love to do inductive charging with buses so they don't have to stop and charge.

General Roundtable Discussion

Facilitated General Discussion

- How can the ZEV state transportation leaders in the Northeast learn from and capitalize on the experiences of the West Coast?
- Collaborative discussion with state energy and transportation and Clean Cities coordinators on progress on policy, planning, outreach, education and consumer acceptance issues.
- NYSERDA is funded for energy projects. As a state DOT, NY DOT's hands are tied as to where to locate these. All rest areas are federally funded.

Question: What does success look like for state DOTs?

- Electric highway in southern CA is about connecting our region.
- Yesterday, a $10 million opportunity (GFO) was released by the CA Energy Commission. It will provide infrastructure along I-5 and Highway 99. Primary way – to do I-5 from OR border, to Sacramento and to LA would be on Highway 99. Secondary – I-5 through the second section. The third part of the project is US101. Applicants could be public entities or private entities.
- Metrics for success are vehicle registrations (5%+ EVs of market is used as metric that there is viable market) or not having to have government incentives.
- Other metric could be reductions in fuel use.

Question: What is the role of state DOTs in facilitating corridors?

- Concessionaries want the demographic of EV owners as customers. That's what CT was attempting to leverage. There is a value proposition for a business to help. That can help be the decision point for which location is chosen.
- In RI, DOT is a guest at the process, not a leader. They're taking stewardship of signage, but it's been an energy office and environmental office driven process.
- In OR, the first 10 installations were DOE funded. They received a Categorical Exclusion from NEPA since they were working in existing parking lots. Then received TIGER funding through DOT and ODOT environmental unit got very concerned about historical artifacts, endangered species, etc. So one person would go to do inspections, then another person would do another, etc., which increased cost and time for project implementation.
- Might be helpful to have NEPA guidance for EV charging stations.
- CT DOT was totally disengaged from EVs in 2012. What brought us to the table was Tesla because CT is between DC and Boston. Tesla is about three years ahead of us. CT realize wanted to have charging for everyone, not just expensive cars.

- EV charging is not a high priority for a lot of DOTs right now due to concerns over funding for basic maintenance.
- ODOT recognizes there can be conflicting goals with EVs – GHG reduction, energy independence, infrastructure funding, etc. Road user fee pilot is helping resolve this.

Question: Is there any role for DOTs and energy offices in correlating with building codes?

- In MA, they are encouraging commercial buildings to provide conduit for many charging stations, but the governor has put a hold on new regulations. The MA energy office is going to tell commercial buildings to install charging stations and conduit.
- In NY, NYSERDA helps fund the costs to update local building codes to incorporate EV charging infrastructure recommendations or requirements.
- RI is about to have open solicitation for RGGI funds for EVSE to be used for public organizations – working on having universities. If you're working with colleges and universities, they redo their lots in the summer. So work with them before the summer to get some EVSE installed before September.
- In San Francisco, a one size fits all code is probably not appropriate. States can utilize existing programs like energy efficiency programs, similar to rural electrification.

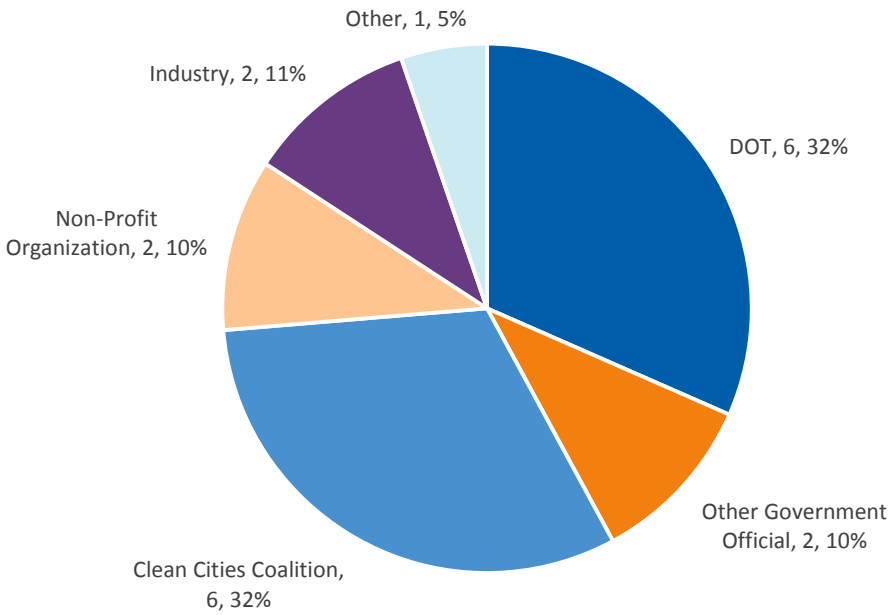
"Takeaways" from the Workshop

Participants discussed their key takeaways from the workshop during the last session of the day. The most critical issues highlighted by participants are documented as part of the "Key Outcomes" summarized at the beginning of this document.

Summary of Workshop Evaluations

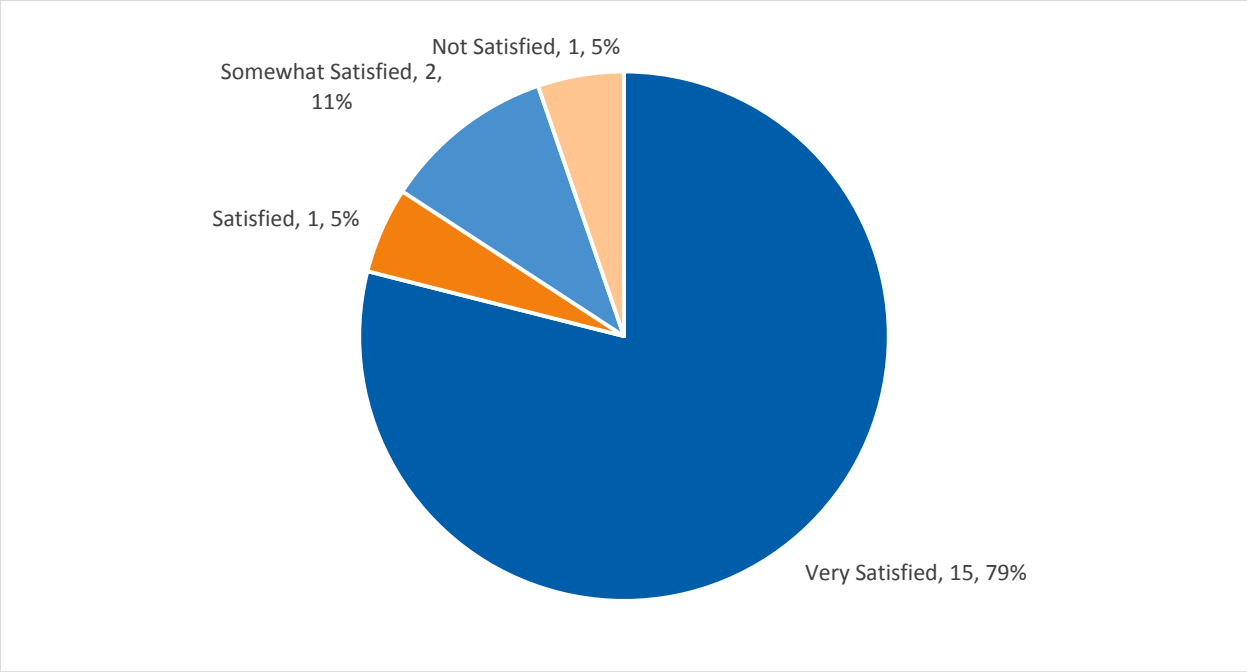
An online survey was distributed to workshop attendees on August 6, 2015. The survey was intended to assess the effectiveness of the workshop, as well as generate ideas for the development of future workshops. A total of 19 attendees responded, and their answers are summarized below.

Figure 1. What best describes your role in EV deployment?



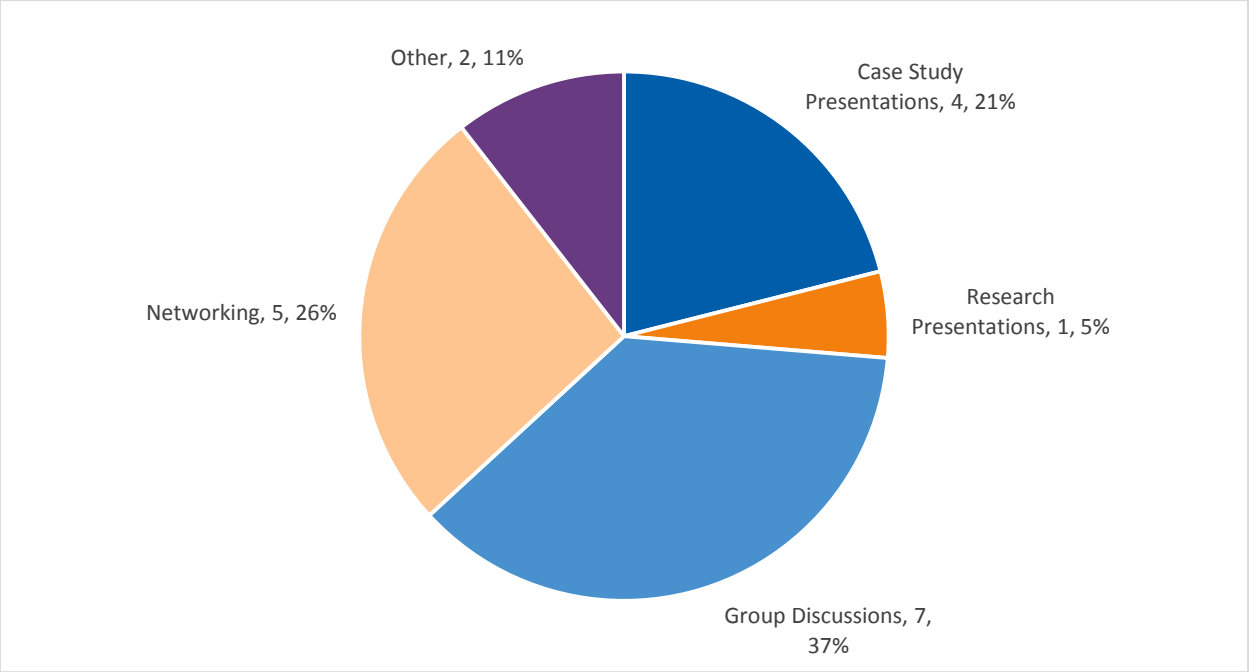
Out of those that responded to the survey, most were either from DOTs or Clean Cities Coalitions. The respondent who selected "Other" indicated they were from a U.S. DOT funded research center.

Figure 2. How satisfied were you with the content and organization of the workshop?



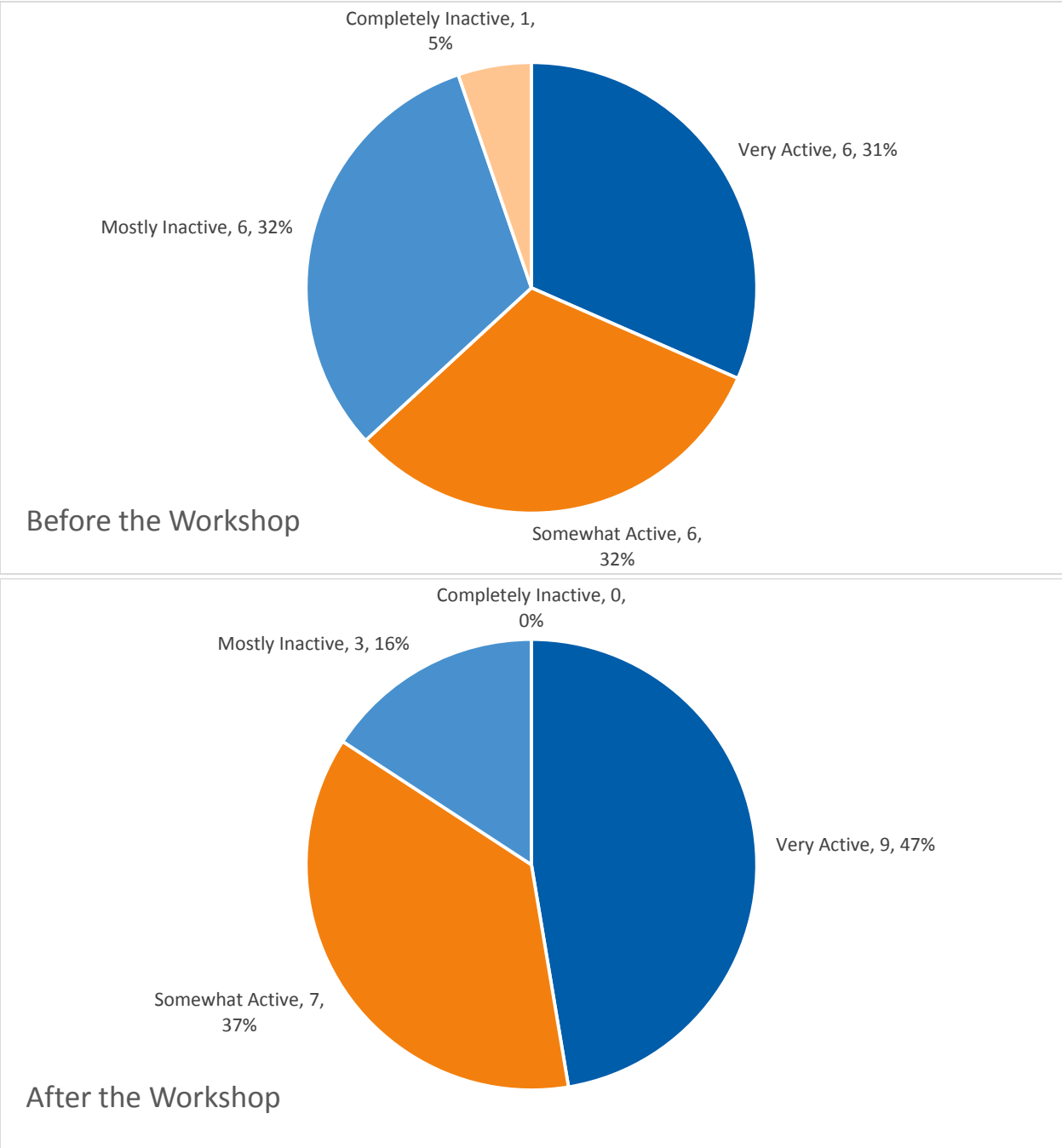
The vast majority of respondents (79%) were very satisfied with the content and organization of the workshop. The attendee that expressed dissatisfaction indicated that the workshop format was not conducive to audience engagement.

Figure 3. What was the most valuable aspect of the workshop for you?



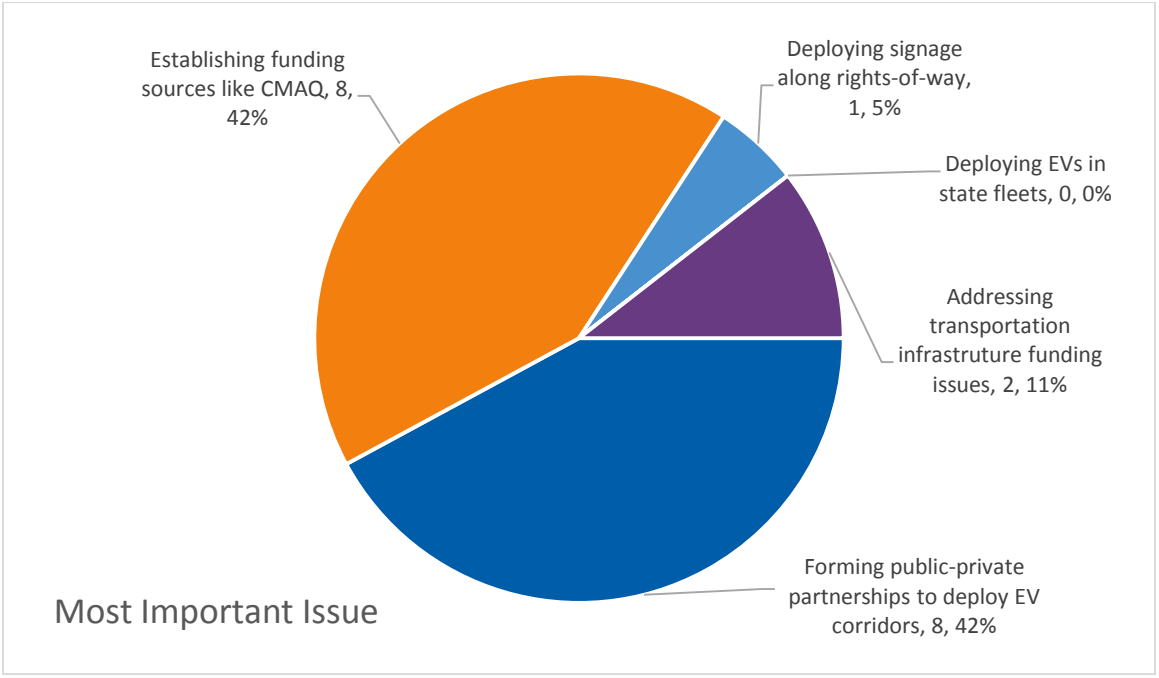
Group discussions were the most valuable aspect of the workshop (37%), with networking (26%) and case study presentations (21%) coming in second and third, respectively. The two respondents that selected "Other" left similar comments indicating that all aspects were required together in order to gain a broader perspective.

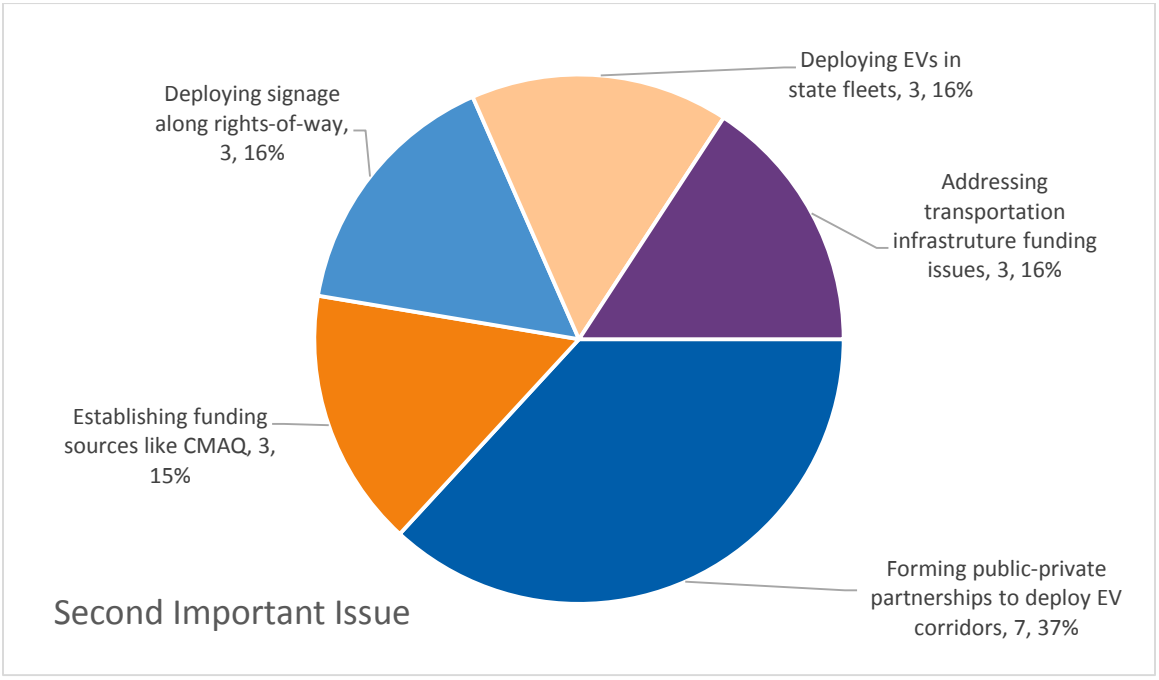
Figure 4. Perception of DOT engagement in EV charging deployment



The workshop appears to have portrayed DOTs as being more engaged in supporting EV charging deployment than participants first believed. Before the workshop, an equal number of participants believed DOTs were very active, somewhat active, and mostly inactive. Following the workshop, more participants believed DOTs were very and somewhat active. No participant believed DOTs were completely inactive following the workshop.

Figure 5. Most important issues for DOTs to focus on in EV corridor development





Forming public-private partnerships to deploy EV corridors emerged as the most important issue for DOTs to focus on in EV corridor development. In addition to the results displayed above, three respondents wrote comments with additional suggestions:

1. "Coordinating efforts with private sector [to] roll out of both [Level 2] and [DC fast charging] infrastructure"

2. "Coordinating statewide resources for corridor development"
3. "Figuring out whether [DOTs] play a leading or secondary role"

The last question in the survey was optional and requested additional feedback or suggestions for future workshops. In particular, participants were asked for suggestions on how DOTs can work with Clean Cities Coalitions moving forward. Nine respondents replied to this question with their comments. They suggested three follow up activities following the workshop: 1) a forum for information sharing across states and regions, 2) establishing a model working group for DOT/Clean Cities and other important stakeholders, and 3) hosting another workshop at Central Florida Clean Cities. Another respondent expressed that the approach Washington and Oregon DOTs took with the West Coast Electric Highway may not be the appropriate model for every state and expressed hesitation about the public sector leading EV deployment. The respondent preferred the private market being the primary leader in developing a sustainable strategy for charging infrastructure deployment. Participants also suggested the need for more "focused attention [on] the Southeast region of the U.S." and "[r]esearch [on] the ability of EV infrastructure to become financially self-sustaining [versus] the continuing need for governmental subsidies."

Appendix A: Suggested Pathways from FHWA EV Deployment Report

The table below is from the 2015 FHWA report titled "Feasibility and Implications of Electric Vehicle (EV) Deployment and Infrastructure Development."[4] It summarizes the three action pathways for FHWA, State DOT, and other transportation agencies based on the eight EV deployment scenarios FHWA analyzed, referenced in Josh Proudfoot's presentation. The market response, market support, and market acceleration pathways build on each other, meaning that the second and third are in addition, not exclusive of, the first. The market response column represents the minimum response level and indicates how to catch up to the PEV market activity so transportation agencies do not become a hindrance to technology advancement. The next pathway represents a more involved effort by FHWA and state and local agencies to keep pace with the deployment of EVs and charging stations. The final pathway is the most aggressive, representing a proactive promotion of PEVs throughout the U.S.

Source	Market Response	Market Support	Market Acceleration
Policy, regulations, and statutory issues	Support the renewal of the Federal Tax Credit for PEVs. Support local state tax incentives for PEVs. Support the adoption of a single permit type for home charging stations at the state building code office.	Support one plug standard. Support utilities in the development and implementation of time of use pricing, programmed off-peak charging and the balancing of intermittent renewables with smart metering. Support the development of state Renewable Portfolio Standards.	Support increased performance in CAFE standards. Support a national Low Carbon Fuel Standard. Support increased performance in, and expansion of, zero emission vehicle rules. Support third-party right to sell electricity.
EVSE in different travel markets	Promote charging stations at opportunity sites.	Develop charging station in key intercity corridors.	Develop an expanded intercity charging station network.
Highway design standards and infrastructure	Encourage PEV use of HOV lanes.	Adopt standards for charger parking space dimensions.	Support research into the integration of charging technology and highway infrastructure (e.g., wireless charging).

[4] Holsinger, H. et al. (January 2015). Feasibility and Implications of Electric Vehicle (EV) Deployment and Infrastructure Development. Retrieved August 23, 2015, from http://www.fhwa.dot.gov/environment/climate_change/mitigation/publications_and_tools/ev_deployment/fhwahep15021.pdf

Source	Market Response	Market Support	Market Acceleration
Safety, emergency services, and incident response	Promote the distribution of new national guidance that provides an online safety training course for first responders. Promote the distribution of information to second responders such as tow truck	Coordinate with NHTSA which chairs the Global Technical Regulations (GTR) international effort to address occupant safety from high-voltage electric shock and safety protocols for electrical components.	Continue to coordinate with NHTSA on safety and emergency response issues.
Signage, information networks, and online mapping	Provide better signage for motorists that differentiates between charging types. Provide way-finding signage off the ROW and all the way to the charging station. Parking space signage standardization.	Promote the use of smartphone apps (e.g., http://www.plugshare.com/ and Alternative Fueling Station Locator). "Next Charge in X Miles" signage.	Continued promotion of smartphone apps and other trip planning and charger way finding.
Revenue impacts and potential costs	No action suggested.	Consider state-level registration fees. Consider state efforts on VMT tax such as Oregon's pilot for any vehicle.	Consider federal-level PEV excise tax. Consider a Road User Fee.

Source	Market Response	Market Support	Market Acceleration
Administrative activity and additional research	Switch a portion of FHWA's fleet to PEVs. Lead the coordination of Federal agencies, EPRI, and vertically integrated utilities. Provide technical assistance to state-level programs and respond to their specific needs. Map the actual locations of retail-dense interchanges that correlate to approximately 25–60-mile intervals on intercity corridors. Track locations of charging stations to determine adequacy of corridor charging. Research future regional deployment variations	Distribute and promote the C2ES Plug-In Electric Vehicle Action Tool to state DOTs and local agencies. Map the actual locations of retail dense interchanges that correlate to approximately 25–60- mile intervals on a broader network that links all intercity corridors with PEV and charging station density. Collaborate with other government agencies on public service advertisements to communicate the importance of PEVs on the overall transportation system.	Expanded administrative and research activities described in the preceding pathways.