TECHNOLOGY

PLUG-IN ELECTRIC VEHICLE ACTION TOOL

CENTER FOR CLIMATE AND ENERGY SOLUTIONS

By

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INTRODUCTION

Plug-in electric vehicles (PEVs or electric vehicles) offer a transformative opportunity to address energy security, air quality, climate change, and economic growth.[1] As such, over the past few years, both private industry and government have invested significantly in electric vehicles. In its second year of mass market availability, electric vehicle sales are increasing rapidly; the number of PEVs sold will most likely see more than 150 percent year-over-year growth in 2012.

However, electric vehicles remain a small percentage of the U.S. vehicle fleet, and future market growth is uncertain because of economic, policy, and technical challenges. In order for public and private benefits to materialize fully, the PEV market must see sustained growth over a decades-long period. As such, state transportation departments (DOTs) and other public entities like metropolitan planning organizations (MPOs), local governments, and state energy agencies can play an important role in defining public policy that facilitates PEV deployment. In states that are not looking to actively promote PEV adoption, these same agencies could still benefit from better understanding and adequate preparation for a transition in the personal vehicle fleet that is already underway.

In order to share information and best practices on PEV deployment and define the role of state DOTs in this market, Washington State Department of Transportation initiated a Federal Highways Administration pooled fund study on strategies and best practices to support PEV and charging infrastructure commercialization. Representatives from seven other state transportation departments (Arizona, California, Georgia, North Carolina, Ohio, Oregon, and Wisconsin), Federal Highways Administration, and various other local and states entities (Siskiyou County, Oregon Governor's Office, City of Raleigh, and California Energy Commission) participated in two workshops in Berkeley, CA and Raleigh, NC in March and June 2012, respectively.

The Plug-in Electric Vehicle Action Tool is the synthesis of the workshops as well as previous research conducted by the Center for Climate and Energy Solutions (C2ES). The purpose of the Action Tool is to help state DOTs determine their goals for PEV deployment and to chart out a path for reaching those goals. The Action Tool is also a resource for learning about PEVs and best practices from other state agencies. Although state DOTs are the primary audience, many of the suggested actions and resources in the tool are

applicable to other public entities such as local governments and other state agencies.

The tool contains four parts: the Actions Map and Profile Descriptions, the Actions List, Briefs, and a Resource List. The Actions Map and Profile Descriptions present a high-level overview of the tool, and chart out 33 actions that state transportation agencies can take. This component allows state transportation departments to assess its profile type – whether it is just starting work, a Learner, an Actor, or a Leader on PEV deployment. It also allows a DOT to explore what aspect of PEV deployment to focus on, e.g., charging station deployment, or policy and research. Next, by clicking on a particular action, the DOT can read an in-depth description of the action within the Actions List. To supplement the Actions List, the Tool also contains two Briefs detailing the benefits and common concerns regarding PEVs. Finally, the Resource List contains a list of references, additional reading, and quantitative data.

For additional information, visit www.c2es.org/initiatives/pev to see all PEV-related work at C2ES.

Because the tool was originally developed for online viewing, this document attempts to replicate the online viewing experience by including a navigation menu and clickable links within the document. Every single reference to a numbered action (e.g., Action 1.4) is a link to the action description. Moreover, the navigation menu contains links to each of the primary components. The Actions Map also contains clickable graphics that take the user to a desired action.

ACTIONS MAP AND PROFILE DESCRIPTION

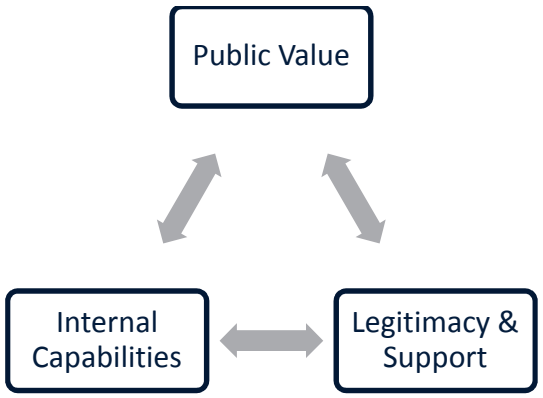
BACKGROUND

A framework developed by public policy researchers and practitioners called the "public value triangle" informed the development of the PEV Action Tool. This framework deals with two problems that public managers face. First, constantly shifting political contexts and priorities make it difficult for public managers to create consistent policies over the long term, or even to define the public mandate guiding the agency's planning and actions. Second, as public problems become increasingly complex, public sector management requires creating flexible, innovative policies that can keep pace with technological and societal change. As such, the strategic triangle applies insights to the public sector from the private sector's need to weather fickle, complex, and constantly evolving market conditions.

This framework is particularly relevant to state DOT work on PEVs because of the rapidly changing political and market contexts around PEVs. For example, charging infrastructure must account for differing charging standards and the possibility of building assets that may later become unused as technology changes. The strategic triangle attempts to include these complexities by looking at conditions external to the agency.

The role of a public manager working on PEVs, ultimately, is to create public value. In the case of PEVs, the user should be able to identify the reasons why PEVs benefit the public through a public value proposition. Specifically, the public manager must conceive of ways in which PEVs fit into the mission or charter of the DOT. Additionally, the manager must also know whether external stakeholders agree with his conception of the public value proposition of PEVs, and whether the DOT has the operational capabilities to realize this proposition, as reflected in the two-way arrows.

FIGURE 1: Public Value Triangle.



A convincing public value proposition for why DOTs should act on PEVs bolsters external legitimacy and support of the DOT's actions. Knowledge, acceptance, and action on the PEV public value proposition by a wider net of stakeholders (e.g., the governor, other agencies, other DOT offices, the legislature, nonprofits, and the public) enhance a DOT's operational capabilities for PEVs. For example, new laws may give DOTs authorization to work on PEVs.

If key stakeholders disagree with the state DOT's conception of the PEV public value proposition, then the public manager must either shift the public value proposition or convince key stakeholders otherwise. The importance of gaining external legitimacy and support is reflected in practice by intergovernmental partnerships, collaborative organizations, informing and advising legislative bodies, and educating members of the public. For example, the Partnership for Sustainable Communities is a partnership between the U.S. DOT, Housing and Urban Development (HUD), and Environmental Protection Agency (EPA) that leverages resources to implement projects a single agency may be unable to carry out alone. By coordinating with EPA and HUD, the DOT is able to implement a more holistic vision of transportation planning, which enhances the public value of projects.

Finally, the ability for DOTs to successfully choose and carry out PEV actions – its internal capabilities – affects public value creation and the support of the wider net of stakeholders. For example, poorly managed projects, misguided objectives, or inefficient operations damage the public value proposition for why DOTs should work on PEVs. Legitimacy and support is also affected by a DOT's internal operational capabilities through, for example, guidance and information given to legislators on draft bills pertaining to PEVs. In sum, the public value of a DOT's work on PEVs, its internal ability to carry out that work, and how key stakeholders view such work all interact with each other. Because of these feedback processes, a public manager ideally touches on all three components of the strategic triangle.

ACTIONS MAP

Figure 2 gives an overview of the range of actions a state DOT can take with respect to electric vehicle deployment. The map is divided into "Profiles," which describe the level of DOT commitment to PEV deployment, and "Categories", which describe the kinds of actions that DOTs can take. Regarding Profiles, The state DOT begins at a Starting Point, which is the impetus to start work on PEVs. It can then progress to becoming a Learner, Actor, and Leader. It is important to remember that these Profiles will not neatly fit the actual work of a DOT; for example, it is possible for a DOT to work on a single Leader action while primarily working on various Actor and Learner actions.

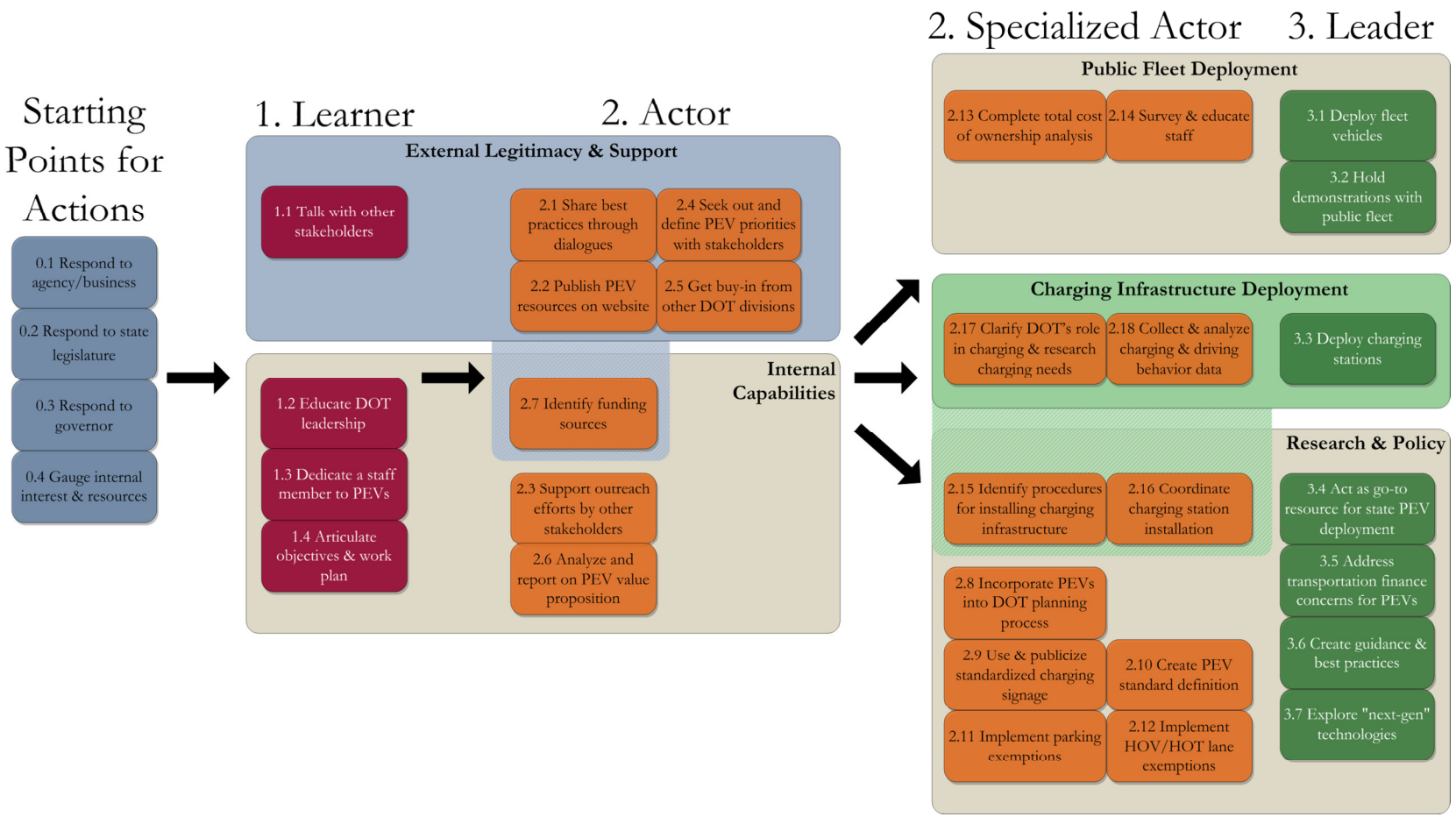
In addition to Profiles, the Actions Map is organized by Category. The agency begins working on more general actions like building external support and determining a plan of action, and eventually specializes in specific aspects of PEV deployment such as deploying charging stations.

Finally, each action is generally defined in order of succession and/or degree of complexity. For example, 2.4 Seek out and define PEV priorities with diverse, cross-sectoral stakeholders follows 2.3 Support communications and outreach by other electric vehicle stakeholders in the state because defining actionable priorities ought to come after the DOT has experience working with stakeholders.

The public value triangle can be found within the Categories. As seen on the Actions Map, building internal capabilities and external support and legitimacy building occur to the left. However, actions that create public value are spread out among various Categories. Specifically, defining the public value proposition occurs early on to the left of the map while actual public value creation occurs as agencies become more advanced Actors or Leaders and specialize in particular categories.

One key difference between the Actions Map and the public value triangle is that the Actions Map is depicted as being linear (i.e., progressing from Learner to Actor to Leader), whereas each component of the triangle relies on feedback for each of its actions. In fact, many of the earlier actions are meant to be continuous and ongoing even as the state DOT specializes in particular aspects of PEV deployment. Each time a DOT begins a new set of actions, it should revisit earlier actions (e.g., Actions 0.1 to 2.7) to build up external and internal support while carefully defining the desired outcomes. For example, Action 3.7 Explore and pilot test new technologies, including V2G and wireless charging, the very last action on the list, suggests that the state agency revisit defining its objectives in PEV deployment.

FIGURE 2: PEV Action Map.



Profile Descriptions

The Actions Map contains four profiles: Starting Point, Learner, Actor, and Leader. The DOT usually begins PEV work at Starting Points, which are external and internal prompts for the DOT to begin acting on PEVs (e.g., an executive order to study what the DOT can do on PEV deployment, or a request by internal leadership to explore potential PEV projects). This profile was created because of the difficulty in starting work on new initiatives; agencies must often find implicit or explicit support for its efforts from authorities such as the governor or political appointees within the DOT. The following bullets characterize a DOT at a Starting Point:

External Support and Legitimacy

- Is looking for support from high-level external authorities (e.g., governor) to begin work on PEVs (Actions 0.2 and 0.3).
- Has relationships and communication channels with other agencies and private entities working on PEVs but has not worked with them on PEVs specifically (see Action 0.1).

Internal Capabilities

- Has almost no institutional experience with electric vehicle deployment.
- Needs support from high-level internal authorities to begin working on PEVs (see Action 1.4).

Public Value Creation

- Understands broad reasons why PEVs are of interest to the DOT, but has not articulated a plan of action for getting involved with PEVs.

After successfully completing one Starting Point action, an agency becomes a **Learner**. Learners have obtained the necessary support from leadership to scope out what the agency can do on PEVs. Learners conduct research on PEVs, network with other stakeholders, and determine a plan of action on PEVs. In order to transition to an Actor, a Learner agency must articulate the public value proposition for PEVs – why it is working on PEVs – and an action plan for PEV work. Similar to the Starting Points, many Learner actions should be revisited later on; work on PEV deployment relies upon the base of expertise and support gained from learning about PEVs. The following bullets characterize a DOT as a Learner:

External Legitimacy and Support

- Is reaching out and establishing relationships with existing PEV stakeholders for PEV work (see Action 1.1).
- Is developing talking points and public messaging on why the DOT is getting involved with PEV deployment (e.g., through Action 1.1).

Internal Capabilities

- Has internal leadership that is supportive (see Action 1.2) and is educating relevant internal stakeholders about PEV technologies and the market.
- Is assigning a staff member to be accountable for PEV work (see Action 1.3).

Public Value Creation

- Is determining the objectives for PEV deployment as well as articulating the public value proposition for PEVs (see Action 1.4).

In order to transition into becoming an Actor, Learners should have a staff member assigned to PEVs (Action 1.3) and articulated objectives and reasons for PEV involvement (Action 1.4). **Actors** are agencies that have set concrete deployment goals and gathered the necessary internal and external support to sustain PEV efforts. Early Actors continue to build internal and external support, but more advanced Actors have begun working on concrete, well-defined actions to deploy PEVs and charging infrastructure. The following bullets characterize a DOT as an Actor:

External Legitimacy and Support

- Is linking up and coordinating action with PEV stakeholder groups (e.g., Actions 2.1 and 2.4).
- Is refining public messaging around DOT work on PEVs (e.g., Action 2.3).

Internal Capabilities

- Is obtaining buy-in from DOT staff and division leaders on PEV deployment initiatives (see Action 2.5).

Public Value Creation

- Is following a plan towards achieving the DOT's goals for PEV deployment.

- Is beginning to implement concrete actions such as charging infrastructure deployment that create public value.

Finally, **Leaders** are at the forefront of PEV deployment. Many of the Leader actions can be considered goals for PEV deployment by Learners or Actors. Moreover, transitioning to a Leader can take many different paths and involve many different actions; it is possible to be a Leader in one action Category (e.g., infrastructure deployment) but still be an Actor or Learner in other action Categories (e.g., public fleets). Despite variation in what constitutes a Leader for a DOT, the following bullets are general guidelines:

External Legitimacy and Support

- Is a central and trusted resource for PEV deployment in the state to consumers and other PEV stakeholders (see Actions 3.4 and 3.6).
- Public is supportive of DOT's deployment efforts (e.g., for Action 3.3).

Internal Capabilities

- Has worked on making all DOT divisions incorporate PEVs and transportation electrification more broadly into operations (see Action 3.7).
- Has created consistent, long-term policy for incorporating PEVs into the transportation system, including system finance (e.g., see Action 3.5).

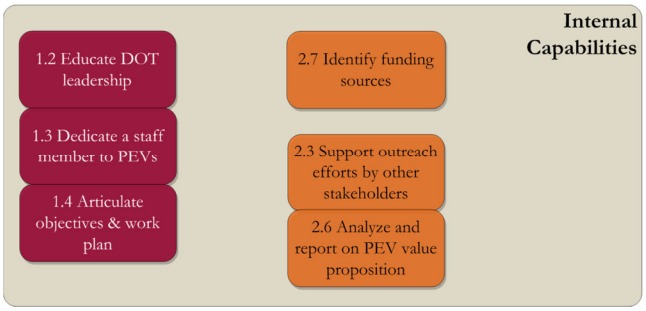
Public Value Creation

- Has implemented actions that aim to maximize the long-term net public benefits of electric vehicles.

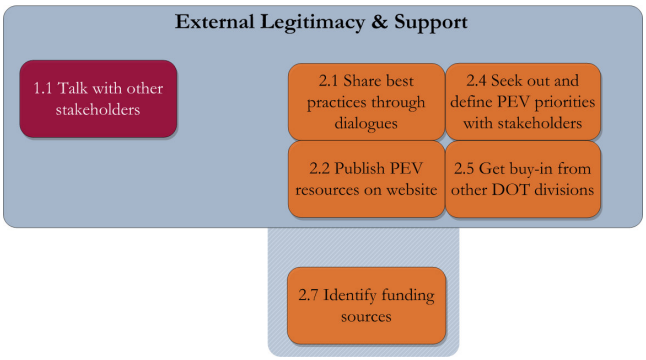
Action Category Descriptions

Some actions in the Learner, Actor, and Leader Profiles are also assigned to broad Categories: internal capabilities, external legitimacy and support, charging infrastructure deployment, public fleet deployment, and research and policy. These Categories were developed based on actions taken by state DOTs participating in two electric vehicle workshops. In addition to the topics above, two Categories not shown on the Actions Map include public value proposition (Actions 1.4 and 2.6) and Communications and Outreach (Actions 2.2, 2.3, and 3.4). These Categories were not included because they encompassed only a few actions; instead, the actions within these Categories were folded into the other Categories. Moreover, certain actions such as Action 2.7 belong in multiple Categories.

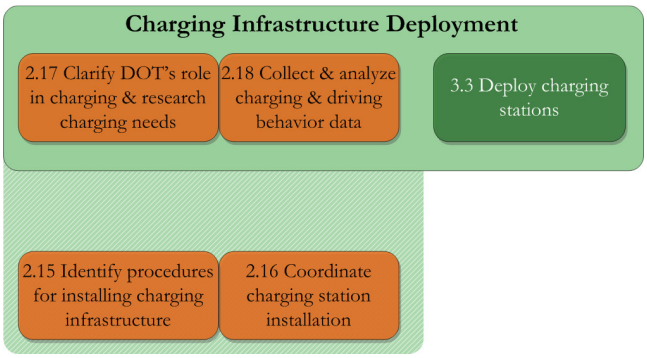
Internal Capabilities: See Public Value Triangle explanation above. Internal capabilities consist of Actions 1.2, 1.3, 1.4, 2.5, 2.6, 2.7.



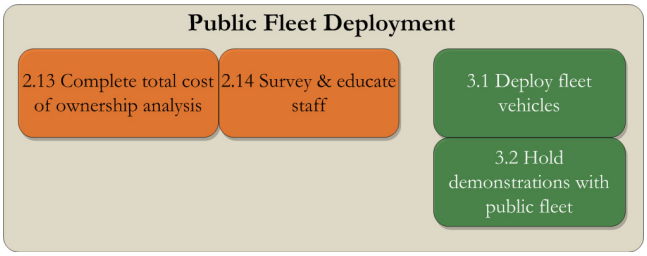
External Legitimacy and Support: See Public Value Triangle explanation above. External legitimacy and support consists of Actions 1.1, 2.1, 2.4, 2.4, 2.3, and 2.7.



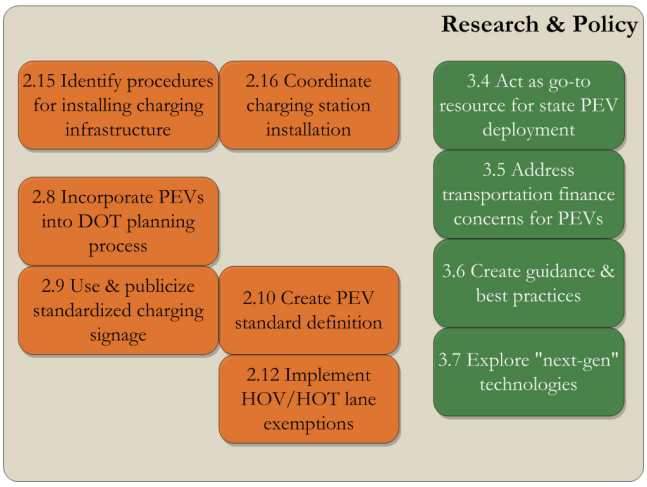
Charging Infrastructure Deployment: Charging infrastructure deployment consists of Actions 2.15, 2.16, 2.17, 2.18, and 3.3. Several state DOTs are playing an active role in installing charging stations along highway corridors, and research is needed on driver and charging behavior. Although most PEV drivers charge at home, public infrastructure may be needed to assuage driver fears of getting stranded. Because DOTs control highway operations as well as state roads and crossings, DOTs can build and finance charging infrastructure, help others deploy charging infrastructure, and study and research driver and charging behavior.



Public Fleet Deployment: Public fleet deployment consists of Actions 2.13, 2.14, 3.1, and 3.2. Many DOT fleets have mandates on alternative fuel vehicle fleet procurement; for example, 46 states have mandates for the use of alternative fuel vehicles in state fleets. However, few have experience with purchasing PEVs. Public fleets are an effective way of educating DOT staff and the public about PEVs. Fleets can also be leveraged to publicize and demonstrate potential fuel savings and emissions reductions.



Research and Policy: The largest of the specialized group of actions, research and policy actions consist of Actions 2.8, 2.9, 2.10, 2.11, 2.12, 2.15, 2.16, 3.4, 3.5, 3.6, and 3.7. These actions involve sharing best practices, issuing guidance, reconciling PEVs with transportation finance, creating incentives for DOTs like HOV lane exemption, and researching new technologies. Research and policy do not involve purchasing actual assets such as vehicles or charging stations; as such, many actions here may be less expensive to implement.



STARTING POINTS

STARTING POINT	0.1 RESPOND TO REQUEST TO HELP WITH PEV DEPLOYMENT FROM OTHER AGENCIES OR BUSINESSES
Background	For areas with low likelihood of gubernatorial or legislative action on PEVs, requests from other agencies and the private sector can begin PEV deployment efforts. **Spotlight**: North Carolina's role in PEVs began when a private vendor and the Department of Commerce asked for help siting charging stations under a U.S. Department of Energy (DOE) grant.
Next Steps	• Respond to request from other agencies. Requests may include aid in charging station siting from private entities, informational requests, local MPO or municipality requests for guidance, applications for federal or state grants, and more. • Research and gather information for these requests, which can allow a DOT to identify its role in PEV deployment. The DOT can also go through the Learner actions as it helps

	another agency with electric vehicle deployment.
Related Actions	• Move on to any of the Learner actions: 1.1 Articulate public value Proposition, objectives, and a plan of action; 1.2 Educate DOT leadership on PEVs; 1.3 Dedicate a staff member as the lead on PEVs; 1.4 Articulate public value Proposition, objectives, and a plan of action. • Find other ways to get started: 0.2 Act on legislation or legislative PEV request; 0.3 Act on Executive Order or gubernatorial PEV request; 0.4 Gauge internal DOT interest for proactive PEV deployment.

STARTING POINT	**0.2 ACT ON LEGISLATION OR LEGISLATIVE PEV REQUEST**
Background	In some states, the legislature may drive work on PEVs and authorize PEV work for the state DOT. DOTs may revisit this Starting Point as the legislature enables new DOT actions on PEVs. **Spotlight**: Washington State's House Bill 1481 in 2009 authorized a large amount of PEV work for the DOT, Department of Commerce, the Puget Sound Regional Council, Department of Labor, State Building Code Council, and more. Washington State had already been working on PEVs beforehand but the bill allowed the DOT to conduct new PEV work and actions. Legislative action may also require DOT to work on some facet of PEV deployment by law without being adequately prepared; DOTs can be prepared by advising and commenting on proposed bills through the legislative process.
Next Steps	• Advise legislators on the agency's perspective on electric vehicles, which could lead to legislative interest and authorization for PEV work. This action can be open up new action categories after the DOT is already a Learner, Actor, or Leader. • Monitor legislative proposals that could potentially harm PEV deployment. **Spotlight**: Washington State passed Senate Bill 5251 in February 2012 requiring a $100 registration fee for all PEVs. This registration fee may hamper early PEV adoption efforts. While the DOT can jump straight to any of the Actor actions from here, the DOT should first articulate the public value proposition for PEVs and undertake some or all of the Learner actions.
Related Actions	• Move on to any of the Learner actions: 1.1 Articulate public value Proposition, objectives, and a plan of action; 1.2 Educate DOT leadership on PEVs; 1.3 Dedicate a staff member as the lead on PEVs; 1.4 Articulate public value Proposition, objectives, and a plan of action • Find other ways to get started: 0.1 Respond to request to help with PEV deployment from other agencies or businesses; 0.3 Act on Executive Order or gubernatorial PEV request; 0.4 Gauge internal DOT interest for proactive PEV deployment

STARTING POINT	**0.3 ACT ON EXECUTIVE ORDER OR GUBERNATORIAL PEV REQUEST**
Background	Executive authorization – either formally via an order or informally – is a key entry point into electric vehicle work. Throughout PEV deployment efforts, this Starting Point can be revisited to authorize new actions. The governor appoints DOT leadership, helps set the direction of

	executive agencies, and has the power to issue executive orders, and therefore has substantial power in influencing the priorities of the DOT. However, some states DOTs have more autonomy and could refrain from conducting work on PEVs unless the governor directly orders it. **Spotlight**: Governor Martin O'Malley of Maryland appointed Maryland DOT's deputy secretary to the Electric Vehicle Infrastructure Council, thus ensuring that the DOT was part of a high-level conversation of PEVs. Some governors have campaigned to deploy PEVs and may order DOTs to conduct work on PEVs. **Spotlight**: Governor Ted Kulongonski of Oregon made transportation electrification a key part of his platform and his successor Governor John Kitzhaber introduced a new high-level policy position on sustainable land use and transportation policy into the DOT with some focus on PEVs, thus emphasizing PEV deployment as a key DOT goal.
Next Steps	• Advise and participate in dialogues with the governor's office. Executive decisions regarding PEVs may need to be informed by the DOT's perspective on PEVs. • Understand the extent to which DOT staff is willing to work closely with the governor on deploying PEVs. Some state DOTs may be somewhat independent from the governor's office. States can potentially have a supportive governor but reluctant DOT staff. Similar to Action 0.3, executive authorization could technically allow for any number of Actor and Leader actions to occur, but DOTs should undertake some or all of the Learner actions first, especially Action 1.4).
Related Actions	• Move on to any of the Learner actions: 1.1 Articulate public value Proposition, objectives, and a plan of action; 1.2 Educate DOT leadership on PEVs; 1.3 Dedicate a staff member as the lead on PEVs; 1.4 Articulate public value Proposition, objectives, and a plan of action • Find other ways to get started: 0.1 Respond to request to help with PEV deployment from other agencies or businesses; 0.2 Act on legislation or legislative PEV request; 0.4 Gauge internal DOT interest for proactive PEV deployment.

STARTING POINT	**0.4 GAUGE INTERNAL DOT INTEREST FOR PROACTIVE PEV DEPLOYMENT**
Background	A DOT can sometimes initiate a major initiative on PEVs without any outside authorization. For example, an agency can draw from internal authorization such as climate commitments from the governor, support from DOT leadership, or an unexpected budget surplus. This starting point is preferred for getting involved in PEVs because it is proactive as opposed to reactive; the agency is not forced to do something by an outside entity. However, it may be more difficult to be proactive.
Next Steps	• Assess internal interest and identify possible work on PEVs; the DOT staff conducting this information gathering could become the champion for PEV efforts. • Use the right opportunity to educate leadership on PEV-related opportunities and request formal approval to complete PEV-related work. The budget planning period for the next fiscal year is a time in which new projects could be pitched.

	The DOT is prepared for Learner actions after it completes these starting points.
Related Actions	• Move on to any of the Learner actions: 1.1 Articulate public value Proposition, objectives, and a plan of action; 1.2 Educate DOT leadership on PEVs; 1.3 Dedicate a staff member as the lead on PEVs; 1.4 Articulate public value Proposition, objectives, and a plan of action • Find other ways to get started: 0.1 Respond to request to help with PEV deployment from other agencies or businesses; 0.2 Act on legislation or legislative PEV request; 0.3 Act on Executive Order or gubernatorial PEV request.

LEARNERS

LEARNER	**1.1 LEARN ABOUT PEVS FROM OTHER PEV STAKEHOLDERS**
Reason for action	Broad stakeholder groups (e.g., legislators, executive committee, business groups, non-governmental organizations) play an important role in getting a DOT involved in PEVs, as well as maintaining resiliency through leadership change in the governor's office or the DOT. This action should be continued as the DOT progresses to other actions. **Spotlight**: DriveOregon is a public/private venture dedicated to promoting electric transportation throughout the State of Oregon.
Implementing the action	• See if broad stakeholder groups currently exist and request to participate in the groups. The Resource List contains some PEV data and resources for existing groups. • Communicate through informal channels with legislators, local governments, private manufacturers, and others if the state does not already contain a broad stakeholder group. After it has gained knowledge on PEVs and cultivated an initial network, the DOT could take the lead in convening the relevant stakeholders in the state. **Spotlight**: The DOE's Clean Cities Coalitions are often local organizations that may be connected with other PEV stakeholders in the area. Ohio's Clean Cities Coalition contains over 100 diverse PEV and alternative fuel stakeholders from around the state. • Alternatively, issue a formal request for information to create a stakeholder group around a specific action, such as charging infrastructure siting. **Spotlight**: Oregon issued a Request for Information with the private sector and other stakeholders to learn more about what ODOT could do on charging infrastructure. • Use the broad stakeholder group as a source of institutional knowledge and base of support for PEV work. **Spotlight**: Ohio's business community continued to keep PEV deployment active and was a source of institutional knowledge through leadership change in the governor's office.
Outcomes	This action leads to more support and knowledge of the public value of PEVs. Participation in these dialogues should help DOTs understand why DOTs should do work on PEVs and lead to an action plan (see Action 1.4).
Related Actions	• Successor actions (building external support and legitimacy): 2.1 Share best practices by participating in national and regional dialogues; 2.4 Seek out and define PEV

	priorities with diverse, cross-sectoral stakeholders; 2.3 Support communications and outreach by other electric vehicle stakeholders in the state; 2.16 Communicate with private entities, other agencies, and local municipalities to maximize charging network effectiveness • Other relevant actions (required for progressing to the Learner profile): 1.3 Dedicate a staff member as the lead on PEVs; 1.4 Articulate public value Proposition, objectives, and a plan of action.

LEARNER	**1.2 EDUCATE DOT LEADERSHIP ON PEVS**
Reason for action	Interest from leadership (e.g., division head, deputy secretary, secretary) can catalyze work on PEVs. Leaders in relatively flexible offices (e.g., public-private partnerships, innovative delivery, sustainability, or economic development) are best positioned to catalyze work on PEVs. Staff can build institutional knowledge, but stronger PEV efforts (i.e. Actor and Leader actions) require the support of top leadership within the agency. **Spotlight**: Washington State's Transportation Partnerships Office and Ohio's Office of Jobs and Commerce are leading work on PEVs within DOTs.
Implementing the action	• Arrange briefing with top-level officials or high-level staff on PEV and charging technology. Leadership is most likely to conduct PEV work when the work can be tied with larger goals. For example, even if PEVs are not an executive priority, the governor may have a broader emissions reductions goal for transportation. Top leadership can then find that PEVs are an effective way of reducing transportation emissions. • Make the case for PEVs from different angles to attract interest from high-level leadership. Depending on leadership preferences, the staff may present the public value proposition of electric vehicles from several different angles: public health and air quality, greenhouse gas (GHG) emissions, energy security, jobs, and more (see Action 1.4). **Spotlight**: Some state DOT staff received support from leadership on PEVs by presenting PEV deployment as an opportunity to create jobs at the same time that the state business community requested more public support of PEVs.
Outcomes	DOT leadership and staff now have institutional knowledge that enables work on PEVs. The DOT staff could explore some of the other Learner actions and should eventually proceed to Action 1.4 Articulate public value Proposition, objectives, and a plan of action.
Related Actions	• Successor actions (increase internal operational capabilities): 1.3 Dedicate a staff member as the lead on PEVs; 2.5 Get buy-in from various DOT divisions and other state agencies for collaborating on PEV initiatives; 2.7 Identify funding sources for supporting PEV deployment • Other relevant actions (required for progressing to the Learner profile): 1.3 Dedicate a staff member as the lead on PEVs; 1.4 Articulate public value Proposition, objectives, and a plan of action.

LEARNER	1.3 DEDICATE A STAFF MEMBER AS THE LEAD ON PEVS
Reason for action	Major PEV projects such as building a charging station network require expertise and significant amounts of staff time. Designating a staff member as the lead on PEVs creates accountability for PEV knowledge and work. Some DOTs that have dedicated staff experts have been successful in attracting investments to their states. **Spotlight**: Oregon DOT's Office of Innovative Partnerships and Alternative Funding has developed staff expertise in PEVs, which has led to securing several million dollars from federal energy and transportation funding programs.
Implementing the action	Identify a staff member as the PEV lead, and involve several others in the department as stakeholders. The staff lead does not have to spend all his time on PEVs, but could work with others who each dedicate part of their time to PEVs.
Outcomes	With a staff member designated as the lead for PEVs, the department can move on to 1.4 Articulate public value Proposition, objectives, and a plan of action.
Related Actions	• Successor actions (enhance internal operations): Any of the early Actor actions, but particularly 2.5 Get buy-in from various DOT divisions and other state agencies for collaborating on PEV initiatives; 2.7 Identify funding sources for supporting PEV deployment. • Other relevant actions (required for progressing to the Learner profile): 1.4 Articulate public value Proposition, objectives, and a plan of action.

LEARNER	1.4 ARTICULATE PUBLIC VALUE PROPOSITION, OBJECTIVES, AND A PLAN OF ACTION
Reason for action	The DOT should know what it intends to accomplish by working on PEVs and why the work benefits the public.
Implementing the action	• Develop presentation slides and a memo that articulates the public value proposition and plan of action for working on PEVs. • Identify overall objective or forward-looking goal related to PEVs. • Create report that explains opportunities for PEVs tailored to state (e.g., jobs, environment, and energy security). Some states have commissioned a full study or report with recommendations. • Use different facets of the PEV public value proposition to find the best reason why PEV deployment benefits the state. For example, some states may see less public value in reducing GHG emissions than job creation. See Companion Brief: Public Benefits of PEVs and Resource List. • Consider building consensus and awareness around these actions from as many key stakeholders across departments as possible. This may be more difficult to accomplish, but may provide large payoffs in the long run (see Action 2.2 Publish PEV resources on website).

	• Develop clear objectives and a plan of action once leadership gives support to PEV work. Working with other PEV stakeholders (see Action 1.1) can help define the limits of PEV work. Objectives and the action plan may change and can be revisited over time.
Outcomes	DOT staff and leadership have a clear vision of what they want to do related to PEVs. This action may be continually revisited as conditions in the state change and new focuses and priorities regarding PEVs come up.
Related Actions	• Successor actions: any of the Actor actions • Other relevant actions (required for progressing to the Learner profile): 1.3 Dedicate a staff member as the lead on PEVs.

ACTOR

ACTOR	2.1 SHARE BEST PRACTICES BY PARTICIPATING IN NATIONAL AND REGIONAL DIALOGUES
Reason for action	These dialogues allow PEV work to follow best practices and avoid potential redundancy with the work of other groups. Examples include. **Spotlight**: Siting best practices have been compiled by several different organizations (including Advanced Energy, Oregon DOT, and Washington DOT) – instead of making a new report, DOTs can use the reports created by others. **Spotlight**: The West Coast Electric Highway network was the result of a multi-state collaboration among the public/private partnership offices at Oregon, Washington and California DOTs. **Spotlight**: This tool was the result of executive-level state DOT workshops, a pooled fund study involving eight different state DOTs, several local governments, and U.S. DOT.
Implementing the action	• Conduct research on the presence of national, regional, and local PEV deployment groups. **Spotlight**: Clean Cities Coalitions within the state are often active on PEV deployment and may know of key local and regional stakeholders. • Conduct research on national and regional dialogues. Participation in national and regional dialogues can include those just beginning work on PEVs as well as leaders in electric vehicle deployment. **Spotlight**: National dialogues include the pooled fund study for DOTs mentioned above, the Northeast Electric Vehicle Network, the PEV Dialogue Group, and more. **Spotlight**: Several in-state dialogues also exist, such as DriveOregon. • Alert leadership to the presence of dialogue groups and identify options for joining one or more groups. • Consider taking a proactive role in setting the agenda for these dialogues in order to set tangible goals for deployment. For example, one tangible goal for Learners is to issue a collective statement of support for PEVs that can spur other potential stakeholders to action.
Outcomes	The DOT can now find support from other PEV stakeholders, share information, and collaborate on initiatives.

Related Actions	• Successor actions: 2.4 Seek out and define PEV priorities with diverse, cross-sectoral stakeholders; 2.3 Support communications and outreach by other electric vehicle stakeholders in the state; 2.9 Use and publicize standardized PEV charging signage; 2.10 Create standard definition for PEVs; 2.16 Communicate with private entities, other agencies, and local municipalities to maximize charging network effectiveness • Other relevant actions (build external and internal support): 2.5 Get buy-in from various DOT divisions and other state agencies for collaborating on PEV initiatives.

ACTOR	**2.2 PUBLISH PEV RESOURCES ON WEBSITE**
Reason for action	Publishing content on the DOT website is a cost-effective way to support the deployment of PEVs.
Implementing the action	• Find an existing webpage to include PEV information or build a new PEV portal. • Coordinate with the DOT department that manages the website on content location and timing of the content's public launch. Website language on PEVs should focus on educational information and avoid advocacy. • Publish useful tools and resources on the site, such as links to websites like DOE's total cost of ownership calculator. Consider putting PEV links on all division websites to increase PEV web presence. • Keep the website up to date, potentially creating a blog to give the latest news on PEVs. Updates on the progress of DOT PEV work through a blog give consumers a way to learn about the DOT that is friendly and interactive. **Spotlight**: The U.S. DOT website has a transportation blog called FastLane that is frequently updated.
Outcomes	Consumers seeking to learn more about PEVs can go to the DOT website. Having a DOT landing page for PEV-related information opens the door for more innovative web work on PEVs (see Action 3.4).
Related Actions	• Successor actions: 2.3 Support communications and outreach by other electric vehicle stakeholders in the state; 3.4 Act as go-to source of PEV knowledge in the state; create an innovative PEV website that conveys up-to-date information on PEV purchases, charging behavior, FAQs, etc. • Other relevant actions (build external and internal support): 2.1 Share best practices by participating in national and regional dialogues; 2.5 Get buy-in from various DOT divisions and other state agencies for collaborating on PEV initiatives.

ACTOR	**2.3 SUPPORT COMMUNICATIONS AND OUTREACH BY OTHER ELECTRIC VEHICLE STAKEHOLDERS IN THE STATE**

Reason for action	A large barrier to electric vehicle growth is consumer unfamiliarity with PEVs.
Implementing the action	• Inform communications and outreach efforts by letting other stakeholders know about DOT policies and state and local incentives. • Ensure that messaging is consistent with how the DOT is talking about PEVs. For example, if the publicity campaign is primarily using emotional appeals to the driver, the DOT should be cautious about participating. • Recognize the line between advocacy or marketing, and communications and outreach. Other organizations already exist to market PEVs, such as automakers, charging infrastructure providers, local PEV advocacy groups, and industry associations. DOTs should focus on realizing the public benefits of PEVs and learning about the implications of PEVs on DOT operations.
Outcomes	The DOT better understands its role in future education and public awareness campaigns. The DOT is also a closer partner with state PEV stakeholders, opening the door to more collaborative work in the future.
Related Actions	• Successor actions (communications and outreach): 2.9 Use and publicize standardized PEV charging signage; 2.16 Communicate with private entities, other agencies, and local municipalities to maximize charging network effectiveness • Other relevant actions (external support building): 2.1 Share best practices by participating in national and regional dialogues; 2.2 Publish PEV resources on website; 2.4 Seek out and define PEV priorities with diverse, cross-sectoral stakeholders

ACTOR	**2.4 SEEK OUT AND DEFINE PEV PRIORITIES WITH DIVERSE, CROSS-SECTORAL STAKEHOLDERS**
Reason for action	After Action 1.1 Learn about PEVs from other PEV stakeholders, the DOT can begin to coordinate concrete actions with other stakeholders. This action involves not just meeting with other stakeholders, but also involves creating and capturing synergies in areas where the DOT may not have previous experience (e.g., working with trade association that promote clean technology). Coordinating with other stakeholders can strengthen a DOT's individual PEV efforts and help improve the overall success of PEV deployment. **Spotlight**: The California PEV Collaborative is a leading in-state PEV deployment groups that features a diverse range of stakeholders.
Implementing the action	• Build relationships and familiarity with other PEV stakeholders and their actions. PEV stakeholders must be able to trust one another when working together. Relationships can start off with aiding one another with research requests and gradually build up to implementing large initiatives such as charging infrastructure build-out. Past examples of collaborative work includes: o Working on education campaigns with other agencies and private entities to determine the most effective messaging. o Encouraging coordination leads to greater success in other Actor and Leader

	actions. o Action 2.16: Communicate with private entities, other agencies, and local municipalities to maximize charging network effectiveness • Encourage stakeholders to advance one another's work. People working in different sectors have different networks. Leveraging relationships for access to a wider stakeholder network can advance PEV work to a large degree. A DOT may not know of different contractors and rates for building charging stations, but building a relationship with regional/local agencies and automakers might allow access and communication with major charging network providers. • Action 3.6 Create PEV guidance for local governments/districts. If the DOT wishes to promote standardized signage, doing so through multiple points may increase success, from getting a dealership or automaker to know of this need to getting charging station providers to educate local municipalities.
Outcomes	Stakeholders know what other group members are doing, and can take opportunities to advance both individual work and the work of all stakeholders. Aligning actions saves time and money by having partners do work that one agency would have to do otherwise.
Related Actions	• Successor actions: 2.3 Support communications and outreach by other electric vehicle stakeholders in the state; 2.9 Use and publicize standardized PEV charging signage; 2.10 Create standard definition for PEVs; 2.16 Communicate with private entities, other agencies, and local municipalities to maximize charging network effectiveness • Other relevant actions: (external support building): 2.1 Share best practices by participating in national and regional dialogues; 2.2 Publish PEV resources on website; 2.3 Support communications and outreach by other electric vehicle stakeholders in the state

ACTOR	**2.5 GET BUY-IN FROM VARIOUS DOT DIVISIONS AND OTHER STATE AGENCIES FOR COLLABORATING ON PEV INITIATIVES**
Reason for action	State DOTs often place PEV work in a more flexible office within the DOT (e.g., jobs and commerce, public-private partnerships, innovative delivery), but flexible offices may also be isolated within the DOT. PEV deployment may require work across multiple offices. Examples include: • Obtaining the cooperation of the DMV is crucial for publishing sales data on PEVs, which is important to share with other PEV stakeholders in the state and the region. • Obtaining categorical exclusions for installing charging stations under the National Environmental Policy Act (NEPA) (see Action 2.15) requires cooperation with highway operations and maintenance. Determine early on who has jurisdiction over categorical exclusions. • Transportation finance staff could oppose PEVs because they do not pay any gasoline tax while operating in all-electric mode; a clear channel of communication with

	transportation finance staff could prevent opposition.
Implementing the action	• Circulate internal memo that articulates the public value of PEVs (citing report or presentation slides created in Action 1.4). • Hold department-wide stakeholder meeting to garner support for PEV-related initiatives. • Target DOT staff with many years of experience. Staff that have worked at the DOT for many years may have established informal networks across the department.
Outcomes	Getting buy-in from other departments allows for Actor and Leader actions to progress smoothly. Nearly all Actor and Leader actions require some degree of internal collaboration.
Related Actions	• Successor actions (enhance internal operations): 2.7 Identify funding sources for supporting PEV deployment. More generally, this action opens up many of the Research and Policy actions including 2.8; 2.9; 2.10; 2.11; and 2.12. • Other relevant actions (build external support): 2.1 Share best practices by participating in national and regional dialogues.

ACTOR	**2.6 ANALYZE AND REPORT ON PUBLIC VALUE OF DOT WORK ON PEVS IN STATE OR REGION**
Reason for action	Leadership may want in-depth description of the benefits of getting involved with PEVs and what the DOT can do. Alternatively, the DOT may be mandated to create a full study by an executive order or legislation. This action can be conducted in conjunction with a PEV action plan for the state. **Spotlight**: Although not a state DOT, FHWA has commissioned a comprehensive study that examines the public value of PEVs and their implications for the mission of the FHWA.
Implementing the action	• Find and coordinate with the appropriate partners. A full study might be part of a statewide effort to deploy PEVs and thus may involve stakeholders beyond those in the DOT. **Spotlight**: the Maryland EV Infrastructure Council and the Illinois EV Infrastructure Council detailed public benefits for the state in addition to recommendations for action in its report to their state's governor. • Conduct a review of existing literature to determine what studies have already been done. A large number of studies have already been conducted. C2ES's PEV Action Plan and recent Literature Review on the Northeast summarize much of the recent literature. The study can summarize past studies and attempt to answer outstanding or state-specific questions.
Outcomes	The study can enable more DOT work on PEVs and provide a firm, public justification for why this work is being conducted.
Related Actions	• Successor actions (Research and Policy): 2.8 Incorporate PEVs into DOT planning process; 2.9 Use and publicize standardized PEV charging signage; 2.10 Create standard definition for PEVs; 2.11 Implement PEV parking exemptions; 2.12 Implement PEV HOV/HOT lane exemptions.

	• Other relevant actions: 1.4 Articulate public value Proposition, objectives, and a plan of action.

ACTOR	2.7 IDENTIFY FUNDING SOURCES FOR SUPPORTING PEV DEPLOYMENT
Reason for action	Grants can enable financing for public fleet, charging infrastructure deployment, readiness studies, collaborative research with automakers, and more. Funding sources include federal agencies, state legislative authorization, public-private partnerships, private foundations, and non-profits.
Implementing the action	• Take steps to increase staff proficiency with applying for PEV grants. See Actions 1.3 Dedicate a staff member as the lead on PEVs and 2.1 Share best practices by participating in national and regional dialogues. • Find the right institutional funding sources. Funds from the federal Highway Trust Fund have rigid guidelines and are not easily spent on non-highway activities. However, federal Congestion Mitigation and Air Quality Funds (CMAQ) and Surface Transportation Funding (STP) allow for spending on charging infrastructure and public fleet PEVs (see Sections 1113 and 1108 of MAP-21, the most recent transportation reauthorization bill). States may also have special funds for PEV deployment. • Include the appropriate stakeholders necessary for securing funding. **Spotlight**: Several transportation departments noted that the department that controls CMAQ funds might be unfamiliar with PEV deployment. Securing CMAQ funds would require collaborative work and support from both the CMAQ representative at the state DOT as well as the FHWA field division office. • Monitor DOE and DOT websites and other communication mediums for funding opportunities. Charging infrastructure and electric vehicle deployment funding has been driven by the American Recovery and Reinvestment Act (Recovery Act). By now, much of the original appropriations from the 2009 Recovery Act have been spent, but some programs have continued to obtain funding. States may partner with or support local Clean Cities Coalitions to apply for U.S. DOE funds. **Spotlight**: Oregon built part of the West Coast Electric Highway by winning Transportation Investment Generating Economic Recovery (TIGER) grants. • Understand the provisions of different funding sources. Depending on the source of funding, there may be drastically different requirements. **Spotlight**: DOE funding may emphasize Davis-Bacon requirements whereas DOT may emphasize hazardous material requirements as part of the National Environmental Policy Act. • Contact other state DOTs, such as Oregon state DOT, that have applied for grants to obtain copies of successful past grants. • Explore innovative charging station finance options such as joint public-private financing. Public-private partnerships for financing charging infrastructure are becoming increasingly important as Recovery Act funds are spent. **Spotlight**: Volta Electric in Hawaii pays for the cost of charging by selling advertisements on charging

	stations. This way, the property hosting the charging station does not have to pay for electricity.
Outcomes	The DOT has identified funding sources for charging station installation, public fleet PEVs, research, and policy/planning studies. The DOT gains experience with grant applications.
Related Actions	• Successor actions (any specialized Actor and Leader action): policy and research (2.8; 2.9; 2.10; 2.11; 2.12; 3.4; 3.5; 3.6; 3.7), fleet deployment (2.13; 2.14; 3.1; 3.2), and charging infrastructure deployment (2.15; 2.16; 2.17; 2.18; 3.3). • Other relevant actions: 0.2 Act on legislation or legislative PEV request; 0.3 Act on Executive Order or gubernatorial PEV request, in order to see if the state legislature and the governor can authorize funding.

ACTOR	**2.8 INCORPORATE PEVS INTO DOT PLANNING PROCESS**
Reason for action	Each state DOT has a requirement in the Transportation Planning Regulations to develop a long-range transportation plan (LRTP). The LRTP sets forth a strategic and long-term (by law, a minimum of 20 years) vision for the future of transportation in the state. Many newer transportation plans include climate change issues (see the Georgetown Climate Center' report Summary of Climate Change Provisions in State Long-Range Transportation Plans and the FHWA study Trends in Statewide Long-Range Transportation Plans: Core and Emerging Topics for more information). Incorporating PEVs into the long-range transportation plan is an opportunity for the DOT to commit to a policy direction as well as a long-term plan for alternative fuel vehicles like PEVs.
Implementing the action	• Determine when the LRTP may be next updated. Some states have laws that require periodic updates. Many state DOTs also voluntarily update their plans. By aligning the right internal stakeholders (see Action 2.2), DOT staff and leadership can work to include PEVs in the LRTP. • Use a LRTP update as an opportunity to determine the long-term, strategic goals of PEV deployment and to partner with other key stakeholders. For example, metropolitan planning organizations (MPOs) as well as certain regions are also required to develop LRTPs. Bringing in local stakeholders and publicizing the state DOT LRTP's emphasis on electric vehicles could lead to the incorporation of electric vehicles into local LRTPs as well.
Outcomes	The state can use its incorporation of electric vehicles into its LRTP as a model for local entities as well as other agencies (see Actions 2.16 and 3.6).
Related Actions	• Successor actions: 3.6 Create PEV guidance for local governments/districts • Other relevant actions (other Research and Policy actions): 2.9 Use and publicize standardized PEV charging signage; 2.10 Create standard definition for PEVs; 2.11 Implement PEV parking exemptions; 2.12 Implement PEV HOV/HOT lane exemptions

ACTOR	2.9 USE AND PUBLICIZE STANDARDIZED PEV CHARGING SIGNAGE
Reason for action	Many states and municipalities are using different signage to indicate the presence of electric vehicle charging stations, even though the FHWA has adopted a standard guide sign for PEV charging. A non-standard sign confuses PEV drivers. DOTs can control the signage along roads that they manage.
Implementing the action	• Use the interim alternative electric vehicle charging general service symbol sign approved by the FHWA. This sign was developed by a Traffic Control Devices pooled fund study in response to a request by the Oregon and Washington Transportation Departments. Out of all other signs tested, this sign received the best ratings for clarity in signifying a charging station, as well as the distance from which it could be seen. • Publicize the sign to municipalities, private entities, and other agencies installing charging stations. A standardized sign increases recognition of charging station locations.
Outcomes	The DOT is prepared to include signage recommendations in Action 3.6 Create PEV guidance for local governments/districts.
Related Actions	• Successor actions: 2.16 Communicate with private entities, other agencies, and local municipalities to maximize charging network effectiveness; 3.4 Act as go-to source of PEV knowledge in the state; create an innovative PEV website that conveys up-to-date information on PEV purchases, charging behavior, FAQs, etc.; 3.6 Create PEV guidance for local governments/districts • Other relevant actions (other Research and Policy actions): 2.8 Incorporate PEVs into DOT planning process; 2.10 Create standard definition for PEVs; 2.11 Implement PEV parking exemptions; 2.12 Implement PEV HOV/HOT lane exemptions.

ACTOR	2.10 CREATE STANDARD DEFINITION FOR PEVS
Reason for action	Currently, many states have different definitions of PEVs. DMV collection of sales data for electric vehicles often includes legacy electric vehicles (retrofitted vehicles from the 1990s) as well as neighborhood electric vehicles, which makes sales data inconsistent across states. Moreover, different definitions of electric vehicles may pose problems in the future if, for example, neighboring states pass parking regulations, HOV lane exemptions, or charging regulations based on different definitions of electric vehicles.
Implementing the action	• Participate in multi-state or national dialogues to forge consensus on a standard definition of electric vehicles (see Action 2.1 Share best practices by participating in national and regional dialogues). As a starting point, states can base their definitions off what the federal government awards tax credits to, or what the EPA defines as all electric vehicles (EVs), extended range electric vehicles (EREVs), or plug-in hybrid electric vehicles (PHEVs). • Create a memorandum of understanding defining electric vehicles, and get other DOTs

	and local transportation authorities, if applicable, to agree to the definition. • Work with DMV to implement this definition and formalize a process for obtaining PEV data from the DMV.
Outcomes	DOTs can now more easily track trends in PEV ownership across state. These data can allow for cross-state comparison on the progress of PEV deployment as well as a regional understanding of PEV market penetration. The DOT can explore various Research and Policy actions: 2.8 Incorporate PEVs into DOT planning process; 2.9 Use and publicize standardized PEV charging signage; 2.10 Create standard definition for PEVs; 2.11 Implement PEV parking exemptions; 2.12 Implement PEV HOV/HOT lane exemptions.
Other actions	• Successor actions: 3.4 Act as go-to source of PEV knowledge in the state; create an innovative PEV website that conveys up-to-date information on PEV purchases, charging behavior, FAQs, etc.; 3.6 Create PEV guidance for local governments/districts • Other related actions (research and policy: 2.5 Get buy-in from various DOT divisions and other state agencies for collaborating on PEV initiatives; 2.8 Incorporate PEVs into DOT planning process; 2.9 Use and publicize standardized PEV charging signage; 2.12 Implement PEV HOV/HOT lane exemptions

ACTOR	**2.11 IMPLEMENT PEV PARKING EXEMPTIONS**
Reason for action	A parking exemption can be an effective incentive to purchase an electric vehicle depending on the cost and availability of parking in the area.
Implementing the action	• Research local parking incentives for PEVs as well as the ability of state law to preempt local ordinances. Parking ordinances are often passed on a local basis. **Spotlight**: the City of New Haven provides free parking to PEVs. • Inform local and state legislatures about proposed regulations and incentives if a state senator or representative requests information. **Spotlight**: California's AB 475 makes it illegal for any vehicle to park in an electric vehicle charging space unless it is physically connected to the charger. This law ended the practice of plug-sharing, in which a driver in a parking space adjacent to the charging space can share the plug with the person in the charging space; by unplugging the charger, the car in the charging space may be towed. However, proponents say that the law is necessary to assure electric car drivers that they can always get to a full charge at a station. • Consider providing guidance for PEV parking regulations to municipalities (see Action 3.6). • Consider the perception of parking exemptions for electric vehicles (see Companion Brief: Common Concerns About electric vehicle policy and Electric Vehicles). Parking exemptions may be perceived as inequitable and a subsidy to electric vehicle drivers, who usually have higher incomes than the average household at present. Parking exemptions could be phased out gradually.
Outcomes	Electric vehicle drivers can save money and time because of parking exemptions. DOTs and other

	stakeholders can learn about the benefits and drawbacks of incentives that are relatively inexpensive, but could have a noticeable effect on consumer behavior.
Other actions	• Successor actions: None. • Other relevant actions (Research and Policy): 2.5 Get buy-in from various DOT divisions and other state agencies for collaborating on PEV initiatives; 2.8 Incorporate PEVs into DOT planning process; 2.9 Use and publicize standardized PEV charging signage; 2.10 Create standard definition for PEVs; 2.12 Implement PEV HOV/HOT lane exemptions

ACTOR	**2.12 IMPLEMENT PEV HOV/HOT LANE EXEMPTIONS**
Reason for action	In highly congested roadways with HOV/HOT lanes, providing exemption for single-occupant electric vehicles is a strong incentive for electric vehicle purchase. For example, before California exemptions for hybrid electric vehicles expired, the resale value of a Prius with an exemption sticker was $1,200 to $1,500 more than a Prius without a sticker.
Implementing the action	• Confirm that a current HOV/HOT lane exemption statue exists. Before HOV/HOT lane exemption can be obtained on a highway funded by the federal Highway Trust Fund, the state must pass a law that allows for HOV/HOT lane exemptions. The state legislature can also revoke this statute. Many states with HOV lanes offered exemptions for inherently low emission vehicles (ILEVs) in the 1990s, which includes hybrid electric vehicles, although the statute may require updating for PEVs. By law, exempt vehicles must at the very least be ILEV, as defined by the U.S. EPA. The FHWA offers guidance on HOV lane exemption. • Check if the DOT has authority to extend HOV lane exemptions to electric vehicles. Sometimes, instead of passing a new law, the DOT has authority to extend the exemption to electric vehicles. States may allow for state DMVs, environmental agencies, or DOTs to determine exactly which vehicles qualify for exemption as well as the process of implementing the policy. • Determine which highways are eligible for exemption. For example, fewer HOT lane exemptions exist because HOT lanes are newer than HOV lanes. Moreover, if vehicles' speed on HOV lanes on federal highways become considerably slower, defined as "degradation," the state must implement measures to increases lane speed, including revoking electric vehicle HOV lane exemptions. Degradation may cause lane exemptions for electric vehicles to disappear faster than PEV drivers would expect. **Spotlight**: California's AB 2405 exempts electric vehicles from paying tolls on HOT lanes. **Spotlight**: Some Virginia HOV lanes have become degraded and no exemptions have been granted for PEVs. • Create a smooth and efficient process for getting HOV lane exemption. States have considerable flexibility in determining which vehicles within the ILEV classification qualify for HOV lane exemption and how to implement HOV lane exemption. **Spotlight**: The Utah Department of Transportation has the authority to set the fee for purchasing a HOV lane-exempt decal, although the fee has to abide by a budgetary

	procedure. **Spotlight**: California DMV administers the decals for HOV lane exemptions. • Consider raising the price of HOV lane exemption stickers or licenses. Higher prices could raise more revenue for the DOT and combat the perception that wealthier PEV and HEV drivers are able to use the HOV lane for only a small price. On the other hand, PEV drivers may perceive high prices for exemption stickers or licenses as unfair. • Consider the perception of HOV lane exemptions for electric vehicles. HOV lane exemption for electric vehicles may be perceived as inequitable because they give incentives to drivers of more expensive cars. • Monitor the HOV lane to see the effect of exemptions on congestion and air quality, a well as to prevent degradation of HOV lanes. Consider analyzing the effect of HOV lane exemption on HOV sales.
Outcomes	The DOT can publicize HOV/HOT lane exemptions to various PEV stakeholders and the public.
Other actions	• Successor actions: None • Other relevant actions: 2.5 Get buy-in from various DOT divisions and other state agencies for collaborating on PEV initiatives; 2.8 Incorporate PEVs into DOT planning process; 2.9 Use and publicize standardized PEV charging signage; 2.10 Create standard definition for PEVs; 2.11 Implement PEV parking exemptions

ACTOR	**2.13 CONDUCT AND PUBLISH TOTAL COST OF OWNERSHIP CALCULATIONS FOR PEVS**
Reason for action	Public and private fleet managers will have to conduct a total cost of ownership (TCO) analysis before electric vehicles can be considered for purchasing. Publicizing the methodology and assumptions behind calculating the TCO of PEVs is useful for anyone interested in purchasing an electric vehicle.
Implementing the action	• Start with national TCO calculators. The U.S. DOE has a TCO calculator that calculates local grid intensity and prices, but does not necessarily include time-variant electricity rates or local driving characteristics. The calculator also describes its methodology for calculating TCO. • Determine the values of the relevant variables for a TCO calculation. Consider including factors such as the following, many of which are already included in the DOE calculator: o Vehicle miles traveled, including daily travel patterns o Electricity prices with respect to time and location o Gasoline costs o Cost of installing infrastructure if necessary o Cost of electric and gasoline vehicles o Maintenance costs

	○ Resale value ○ Insurance costs ○ Assumed discount rate ○ Presence of incentives • Show ways to reduce cost. If expensive but unnecessary charging equipment is included, electric vehicle TCO can run especially high. **Spotlight**: The initial estimated cost of Arizona's electric vehicle fleet was especially high because DC fast-chargers and their associated infrastructure (more than $100,000 per fast charger) were included as part of the TCO. • Find other means for lowering the cost of purchasing PEVs (see 3.1 Deploy fleet vehicles). • Consider including societal benefits in TCO calculation. Total cost of ownership calculations from a public fleet manager could include the societal benefits of switching to PEVs from conventional vehicles, including air quality improvements and GHG emissions reductions. Including the societal benefits of electric vehicles may make them more competitive with conventional and hybrid vehicles. • Publish calculations on public-facing website and provide documentation and methodology behind the calculator. Explain why results may be different from other calculators. These calculations may help inform other public fleet managers. • Use online TCO calculations as an opportunity to educate consumers about different electricity rates by linking to electric utility websites. Consumers, even those that have already bought electric vehicles, may not know about special electricity rates or the opportunity to install a separate electricity meter for their electric vehicle.
Outcomes	The DOT can help justify PEV fleet purchases with cost analyses. Calculation methodologies can also be published online so consumers and other public fleet managers can use them (see 3.1 Deploy fleet vehicles).
Other actions	• Successor actions (purchase fleet PEVs): 2.14 Survey and educate agency staff ; 3.1 Deploy fleet vehicles; 3.2 Use public fleet to hold demonstration days and events for the public • Other relevant actions: 2.7 Identify funding sources for supporting PEV deployment; 2.2 Publish PEV resources on website; 3.4 Act as go-to source of PEV knowledge in the state; create an innovative PEV website that conveys up-to-date information on PEV purchases, charging behavior, FAQs, etc.

ACTOR	**2.14 SURVEY AND EDUCATE AGENCY STAFF ON PEVS**
Reason for action	A high level of staff interest in electric vehicles can help make the case for electric fleet vehicles to the fleet manager and DOT leadership. **Spotlight**: Arizona DOT surveyed its staff on its interest in electric vehicles and found that people were interested in electric vehicles but did not know

	very much about them. Educating staff on how to use public fleet electric vehicles may also be a catalyst for purchasing electric vehicles for personal use. Surveys of DOT staff can also reveal general consumer attitudes regarding electric vehicles. **Spotlight**: one state DOT found that staff did not use electric vehicles because they did not know how to use them.
Implementing the action	• Draft a survey to send to all staff, with questions on electric vehicle knowledge, attitudes, and current driving habits. • Consider holding focus groups and discussions afterwards to better understand survey responses. • Be clear that the survey is for informational purposes only. Staff may be against electric vehicles and the DOT must be careful to avoid unfair characterizations as advocates for electric vehicles. • Hold a DOT-wide webinar or presentation on electric vehicle use during lunchtime. **Spotlight**: the U.S. Department of Transportation's has invited experts to give talks on various transportation issues. • Respond to the needs from the survey by, for example, addressing range anxiety concerns by installing free charging stations at DOT offices.
Outcomes	Surveying and educating staff about electric vehicles leads to a better case for public fleet electric vehicles. It also allows for an internal "pilot testing" for electric vehicle messaging and education of the broader public. Finally, surveying and educating staff encourages staff purchase of electric vehicles for personal use.
Related Actions	• Successor actions (purchase fleet PEVs): 2.13 Conduct and publish total cost of ownership calculations for PEVs; 3.1 Deploy fleet vehicles; 3.2 Use public fleet to hold demonstration days and events for the public • Other relevant actions: 2.7 Identify funding sources for supporting PEV deployment; 2.2 Publish PEV resources on website; 3.4 Act as go-to source of PEV knowledge in the state; create an innovative PEV website that conveys up-to-date information on PEV purchases, charging behavior, FAQs, etc.

ACTOR	**2.15 SCOPE OUT WAYS TO INSTALL CHARGING INFRASTRUCTURE ON OR NEAR HIGHWAY RIGHTS-OF-WAY**
Reason for action	The DOT occupies an important role in deploying charging infrastructure. Without any funding, DOT expertise on road use and travel patterns, for example, can provide critical input to stakeholders developing best practices on charging station siting. In terms of building out charging infrastructure, many DOTs have focused on highway corridor charging. Although most charging occurs at home or at the workplace, consumers may want the opportunity to travel long distances; more research is needed on the importance of corridor charging. However, if the DOT determines that corridor charging is an effective investment, it has to overcome several obstacles. Because the Federal Aid Highway Act of 1956 prohibits commercialization of rest stops on all highways built with funds from the Highway Trust Fund, charging infrastructure cannot be built along highway right-of-way unless charging services are

	offered for free. Alternatively, the DOT can build at off-ramp locations.
Implementing the action	• Determine early on whether DOE or FHWA has NEPA jurisdiction. Some projects may require NEPA processes under both DOE and FHWA. If a categorical exclusion is not feasible, the DOT should work to streamline the NEPA process and avoid redundancy. **Spotlight**: Although both DOE and FHWA's NEPA requirements had jurisdiction over Oregon's solar highway project, Oregon followed the FHWA NEPA process after DOE agreed that the FHWA process was adequate for DOE, as long as certain DOE NEPA conditions were fulfilled. • Justify the installation of charging stations along highway rest stops. The agency should define the objective for installing charging stations at highway rest stops. The major reason for installing charging stations is to alleviate range anxiety. Moreover, although this has not been fully explored, free charging can potentially be justified on safety grounds, similar to the way state DOTs provide a small amount of gasoline for stranded motorists. • Arrange for the financing of electricity at rest stop charging stations. Charging stations along any federal highway rest stops are allowed if the charging is provided free. **Spotlight**: North Carolina DOT aided in installing charging stations at a rest stop, where electricity is provided for free. **Spotlight**: Washington is providing free Level 2 chargers along several rest stops. Although the cost of providing this electricity for free was considered negligible to the DOT, the cost of electricity is sponsored by a public non-profit (www.adoptacharger.com). • Identify a process for installing charging stations at off-ramp locations if the DOT prefers off-ramp installation. Convincing private businesses to host charging stations may be difficult, especially if the business has to pay for any of the installation and/or operating costs. However, installing charging stations may increase business at the location or brand the business as environmentally friendly. **Spotlight**: Oregon DOT installed charging stations at private off-ramp vendors including restaurants and hotels at no cost to the business. AeroVironment, the contractor, operates the charging stations and pays for the electricity. • Use ODOT and WSDOT's jointly developed Host Site Specifications for West Coast Green Highway EV Charging Stations as a resource and a potential starting point. • Consider coupling PEV charging station installations with additional alternative energy infrastructure for highway rights-of-way (e.g., solar panels, biomass crops, and wind turbines). See Action 3.5 Address Transportation Finance Concerns with PEVs. More information is available from the FHWA report on Alternative Uses of Highway Rights-of-Way (PDF version here). • Prioritize sites promoting both corridor travel and daily driving. **Spotlight**: the Puget Sound Regional Council, the City of Seattle, and ECOtality are deploying charging stations around Seattle that can serve various charging uses, including intercity travel and daily commuting. • Prepare for public scrutiny. Without good locations and careful siting, charging stations may go unused. Moreover, some of the best locations (i.e., public rest stops or popular

	businesses) may be unavailable. **Spotlight**: Newspapers in both Massachusetts and Tennessee have published stories on unused charging stations. See Action 2.17 for agency counterpoints to these articles.
Outcomes	The DOT has the necessary siting locations aligned in order to progress to Action 3.3 Deploy charging stations. The DOT also can educate local entities on its methods for finding charging station locations (see 3.6 Create PEV guidance for local governments/districts). Finally, the DOT has a list of locations that are prime spots for charging stations that it can publicize to charging station installers.
Related Actions	• Successor actions (charging infrastructure and research): 2.16 Communicate with private entities, other agencies, and local municipalities to maximize charging network effectiveness; 2.17 Clarify DOT's role in charging infrastructure and research charging network needs; 2.18 Collect and analyze data on consumer purchase data, and charging and driving behavior; 3.3 Deploy charging stations • Other relevant actions: 2.7 Identify funding sources for supporting PEV deployment; 2.8 Incorporate PEVs into DOT planning process; 2.9 Use and publicize standardized PEV charging signage

ACTOR	**2.16 COMMUNICATE WITH PRIVATE ENTITIES, OTHER AGENCIES, AND LOCAL MUNICIPALITIES TO MAXIMIZE CHARGING NETWORK EFFECTIVENESS**
Reason for action	Coordinating charging infrastructure installation with other entities can help avoid redundancy of charging stations within a location and maximize network reach and use.
Implementing the action	• Communicate with other potential charging station builders (e.g., private entities, local governments, other state agencies. See action 1.1) can help coordinate charging station deployment. Both cities and private businesses are installing charging stations. **Spotlight**: Walgreens is installing a high number of charging stations at its locations. **Spotlight**: ECOtality and Chargepoint are using U.S. Department of Energy grant funds from the Recovery Act to deploy charging stations across the country. • Encourage interoperability of charging networks. If the state has several different charging networks, the DOT can encourage streamlined use of all the different networks. The DOT can encourage interoperability by, for example, incorporating language on compatibility and interoperability in any grant funding opportunities. It can also convene charging infrastructure providers to discuss barriers to compatibility and interoperability. **Spotlight**: AeroVironment and ECOtality are building large charging networks in Oregon. Drivers without membership must submit their credit card information to ECOtality each time they charge. Drivers that are a part of the AeroVironment network get an AeroVironment key fob that cannot be used with other charging network providers, although AeroVironment also offers point-of-sale options.
Outcomes	Coordination and communication among stakeholders lead to a better-designed and user-friendly charging network.

Related Actions	• Successor actions (charging infrastructure): 2.15 Scope out ways to install charging infrastructure on or near highway rights-of-way; 3.3 Deploy charging stations • Other relevant actions: 2.4 Seek out and define PEV priorities with diverse, cross-sectoral stakeholders; 2.3 Support communications and outreach by other electric vehicle stakeholders in the state; 2.9 Use and publicize standardized PEV charging signage; 2.10 Create standard definition for PEVs

ACTOR	2.17 CLARIFY DOT'S ROLE IN CHARGING INFRASTRUCTURE AND RESEARCH CHARGING NETWORK NEEDS
Reason for action	The DOT may be interested in building charging infrastructure. As such, it will need to research the reasons as well as the best places for building infrastructure. Unlike cities and MPOs, DOTs are responsible for the entire state transportation system and must accommodate interregional and interstate travel, even if certain routes are relatively unused compared to others; for example, DOTs build and maintain rural routes despite the fact that dollar cost per passenger mile traveled is much more than densely populated areas. Similarly, PEV charging along highway corridors will be much less frequent than in urban areas, but DOTs must balance promoting regional travel with the consumer demand for corridor charging. Therefore, DOTs must coordinate with local entities to determine how it can best complement the local, state, and interstate charging network.
Implementing the action	• Determine the status of charger deployment in localities across the state (see Action 2.16). Governments, nonprofit foundations, and private entities may all be building charging networks in the state. Given that the DOT is responsible for state transportation, the DOT can coordinate build-out so that local charging networks also form a coherent regional charging network. • Identify key travel corridors where there are "dead spots" in the EV charging network. • Decide whether to focus on coordinating more local build-out in areas with high PEV densities, or connectivity. • Conduct a literature search and/or ask organizations that have previously conducted driver behavior and charging studies about charger siting. This action is tied with Action 2.1 Share best practices by participating in national and regional dialogues because some states and DOTs have already conducted their own charging station siting studies and developed best practices. Previous work on charger siting can be refined and modified to fit a state's unique situation. Spotlight: Washington State DOT and Puget Sound Regional Council have released a guide for installing charging infrastructure for local municipalities. Spotlight: Oregon DOT's charging station host site specifications for the West Coast Green Highway can be used for other states.
Outcomes	Knowledge of charging behavior helps charging station installers (including the DOT itself) and charging network providers optimize the location of equipment (see Action 3.3). Following the collection of this knowledge, publicizing charging behavior from PEV drivers can help assuage drivers with range anxiety.

Related Actions	• Successor actions (charging infrastructure and research): 2.18 Collect and analyze data on consumer purchase data, and charging and driving behavior; 2.15 Scope out ways to install charging infrastructure on or near highway rights-of-way; 3.3 Deploy charging stations; 3.4 Act as go-to source of PEV knowledge in the state; create an innovative PEV website that conveys up-to-date information on PEV purchases, charging behavior, FAQs, etc.; 3.6 Create PEV guidance for local governments/districts;3.7 Explore and pilot test new technologies, including V2G and wireless charging • Other relevant actions: 2.7 Identify funding sources for supporting PEV deployment; 2.1 Share best practices by participating in national and regional dialogues

ACTOR	**2.18 COLLECT AND ANALYZE DATA ON CONSUMER PURCHASE DATA, AND CHARGING AND DRIVING BEHAVIOR**
Reason for action	Understanding consumer behavior – from the point where a consumer is trying to decide what car to buy up to when a PEV driver is charging on a daily basis – is crucial for determining where and what kind of charging network should be built. Information can be shared on a national or multi-state level (see Action 2.1), within the state (see Action 2.4), and with local municipalities (see Action 3.6).
Implementing the action	• Collect and analyze information on consumer concerns regarding PEV purchase. In particular, consumer attitudes regarding charging may help the DOT build charging infrastructure in locations that would incentivize PEV purchase. For example, regarding highway corridor charging, no research exists as to what extent corridor charging would incent consumers to purchase PEVs. The DOT could partner with marketing firms to create surveys that help the DOT understand what kind of infrastructure and where would be most effective in encouraging new PEV purchases. **Spotlight**: Deloitte, McKinsey, and Zpryme have all created consumer surveys regarding PEVs. • Use internal staff or contract with a university or private entity to collect and analyze driver behavior data. Driver and charging behavior, in contrast to consumer surveys, yields important information about people who already own an electric car. **Spotlight**: UC-Davis, Idaho National Laboratory and ECOtality collect and analyze charging and driving data, although raw data is kept confidential. The National Cooperative Highway Research Program may also be a potential partner. • Build off Action 2.17 to identify outstanding research questions. Data may come from the DOT's charging stations. Data may also come from charging stations not financed by DOTs. Outstanding research topics include: o Frequency of Level 1 charging. o What trips a family takes in a conventional car versus a PEV. o The effect of different time-variant electricity rate schedules on charging times. • Account for privacy protections and concerns from participants.
Outcomes	Original data and study on driver behaviors would help stakeholders understand how to optimize

	charger deployment location and levels in addition to vehicle technologies and battery pack sizes. Knowledge from these studies will also better prepare all DOTs to install effective and sustainable charging stations (see Action 3.3)
Related Actions	• Successor action (charging infrastructure and research): 2.17 Clarify DOT's role in charging infrastructure and research charging network needs; 2.15 Scope out ways to install charging infrastructure on or near highway rights-of-way; 3.3 Deploy charging stations; 3.4 Act as go-to source of PEV knowledge in the state; create an innovative PEV website that conveys up-to-date information on PEV purchases, charging behavior, FAQs, etc.; 3.6 Create PEV guidance for local governments/districts;3.7 Explore and pilot test new technologies, including V2G and wireless charging • Other relevant actions: 2.7 Identify funding sources for supporting PEV deployment; 2.1 Share best practices by participating in national and regional dialogues

LEADERS

LEADER	**3.1 DEPLOY FLEET VEHICLES**
Reason for action	Fleet vehicles can drive early growth of PEVs and familiarizes DOT staff with PEVs.
Implementing the action	• Check the completion of prerequisite actions: 2.7 Identify funding sources for supporting PEV deployment; 2.13 Conduct and publish total cost of ownership calculations for PEVs; and 2.14 Survey and educate agency staff on PEVs. • Find the appropriate use for public fleet electric vehicles. Utility vehicles that travel less than 70 miles every day (i.e., vehicles that do not require multiple charges per day or the construction of new DC fast-chargers) may be best suited for replacement with battery electric vehicles. EREVs/PHEVs can run on a backup internal combustion engine when the battery runs out and are thus not limited by range. • Check if bulk purchasing discounts exist. Some states have joint/bulk purchasing and procurement programs for state agencies, local governments, and DOTs should check whether PEV bulk purchase discounts are available. Currently no known instances exist of manufacturers giving bulk discounts because of limited production volumes and the high cost of production, but bulk discounts may eventually be possible as manufacturing scales up. **Spotlight**: Most states, including Illinois, have joint purchasing programs in collaboration with local governments, state agencies, and non-profits. • Lower capital costs by exploring lease agreements. The separation of operating and capital budgets within DOT budgets makes it difficult to offset higher capital costs with lower operating costs because operations and capital are kept separate. Special vehicle leasing programs can overcome capital budget constraints and risks associated with battery longevity. Moreover, leasing a vehicle provides a hedge against perceived

	battery reliability risk. With respect to the type of leases available, a capital lease involves a transfer of ownership at the end of the contract whereas an operating lease does not. Financial officers sometimes prefer off-balance sheet financing to keep debt-to-equity ratios lower. However, new rules to be implemented in 2013 by the U.S. Financial Accounting Standards Board will consider many operating leases as on-balance sheet financing. • Find a way to take advantage of existing electric vehicle tax credits. The government as well as non-profits cannot take advantage of the existing electric vehicle tax credit because these entities do not pay taxes. However, the Internal Revenue Service (IRS) says an auto dealership may claim the PEV tax credit as long as it discloses to the tax-exempt entity purchasing the PEV that it will be claiming the credit. With this disclosure, the DOT can negotiate a lower price. However, a dealership must have a high enough tax liability (i.e., sufficient profits) in order to claim the tax credit. **Spotlight**: Nissan is building a turnkey municipal lease program that leases vehicles over several years or allows a one-payment, off-balance sheet purchase (a pre-paid lease). The tax credit is passed through to the lease because the tax credit is claimed by Nissan Motor Acceptance Corporation (NMAC). **Spotlight**: Oklahoma City successfully obtained the $7,500 tax credit for its electric vehicles. • Educate staff on how to use and drive PEVs after the fleet vehicles are purchased by holding a demonstration day. Staff may be wary of driving a car that uses an unfamiliar technology. For instance, a hybrid electric vehicle was not used by the staff of one DOT because they were unsure of how the vehicle worked. Educating staff can alleviate concerns about unfamiliar technology. • Use public fleet vehicles as an opportunity for education and awareness. See 3.2 Use public fleet to hold demonstration days and events for the public. For example, the DOT can clearly label the vehicles as electric vehicles so people gain awareness as the vehicles travel around the area. **Spotlight**: The City of Houston highlights its fleet at various community events. The fleet was acquired through the Climate Showcase Communities Program, which "helps local governments and tribal nations pilot innovative, cost-effective, and replicable greenhouse gas reduction programs." Additionally, the DOT can publicize the emissions abated and oil saved from using an electric vehicle by, for example, publishing that information on the DOT website.
Outcomes	The DOT uses its experience with fleet electric vehicles to guide future deployment efforts – for example, by going through the PEV procurement process, the DOT can advise other fleet operators interested in electric vehicles, especially those working for tax-exempt entities. Moreover, it can give DOT staff experience with driving PEVs. The DOT should continue to look for innovative, cost-effective ways of purchasing PEVs while staying up-to-date with the latest PEV and charging technologies.
Related Actions	• Successor actions (fleet vehicle deployment and education): 3.2 Use public fleet to hold demonstration days and events for the public; 3.4 Act as go-to source of PEV knowledge in the state; create an innovative PEV website that conveys up-to-date information on PEV purchases, charging behavior, FAQs, etc.; 3.6 Create PEV guidance for local governments/districts

	• Other related actions: 2.7 Identify funding sources for supporting PEV deployment; 2.13 Conduct and publish total cost of ownership calculations for PEVs; 2.14 Survey and educate agency staff on PEVs; 3.3 Deploy charging stations

LEADER	3.2 USE PUBLIC FLEET TO HOLD DEMONSTRATION DAYS AND EVENTS FOR THE PUBLIC
Reason for action	Getting consumers to drive or interact with an electric vehicle increases PEV awareness and is the best way to convey the unique driving experience that PEVs offer.
Implementing the action	• Identify feasibility of using the public fleet to demonstrate PEVs at special events. • Determine the legal processes and procedures for holding a demonstration event for the public with fleet vehicles. • Ensure that the purpose of the fleet demonstration is for education as opposed to selling vehicles. • Consider allowing automakers or dealerships to bring their own demonstration vehicles to reduce perception that the DOT is a PEV advocate. When other entities bring demonstrating fleets, the DOT could take on a supportive role explaining how the agency uses the vehicles. • Use larger events such as the opening of a new charging station to showcase the demonstration fleet. Demonstration events can also bring in VIPs to drive electric vehicles. **Spotlight**: Oregon used a Nissan LEAF to travel down the West Coast Green Highway when the first fast charging stations opened. The LEAF was present at various ribbon cutting ceremonies. Oregon Senator Jeff Merkley also completed an "oil free" road trip down Interstate 5 in an electric vehicle, stopping at various places to publicize PEVs. • Clearly label the public fleet PEVs as electric vehicles so consumers can see them as they are driven around the area.
Outcomes	DOTs gain valuable expertise on how to stage demonstration events for alternative fuel vehicles and new transportation technologies, thus branding itself as an innovative agency. Consumers can also go to the DOT for a reliable and balanced view on PEV
Related Actions	• Successor actions (fleet vehicle deployment and education): 3.1 Deploy fleet vehicles; 3.4 Act as go-to source of PEV knowledge in the state; create an innovative PEV website that conveys up-to-date information on PEV purchases, charging behavior, FAQs, etc.; 3.6 Create PEV guidance for local governments/districts • Other related actions: 2.7 Identify funding sources for supporting PEV deployment; 2.13 Conduct and publish total cost of ownership calculations for PEVs; 2.14 Survey and educate agency staff on PEVs; 3.3 Deploy charging stations

LEADER	3.3 DEPLOY CHARGING STATIONS
Reason for action	Range anxiety is one of the biggest barriers to electric vehicle adoption. The DOT can install charging stations to form a charging network if they have funding and the appropriate technical knowledge. As detailed in Action 2.15, some state DOTs have focused on corridor charging along highways because state DOTs are interested in facilitating statewide travel as opposed to focusing on one area or region.
Implementing the action	• Check whether the DOT has completed prerequisite actions 2.17 Clarify DOT's role in charging infrastructure and research charging network needs, 2.7 Identify funding sources for supporting PEV deployment, and 2.15 Scope out ways to install charging infrastructure on or near highway rights-of-way. Without funding for installing charging stations, the DOT can help other agencies or private entities site and install charging stations (see Actions 0.1; 2.15). • Explore project financing from multiple parties including banks, the government, and corporations. • Determine the most cost-effective and appropriate charging stations to install based on charging needs and available funding. AC Level 1 and Level 2 chargers can require many hours to fully charge a vehicle depending on the PEV type. While DC fast-charging takes much less time to charge, fast-charging standards for U.S. and European-manufactured PEVs have not yet been finalized. CHAdeMO-compliant fast-chargers today risk being incompatible with future PEVs. Additionally, fast-charging stations could incur demand charges from the electric utility, making the price of electricity expensive. Moreover, the location of the charger determines the suitability of various charging station types. For example, Level 1 and Level 2 chargers should be located in areas where the driver would be willing to spend at least a few hours, such as workplaces, shopping centers, etc. DC fast-charging can be located in areas where drivers spend less time, as fast-charging can charge a BEV with a 24 kWh battery pack to 80 percent in under a half-hour. • Consider offering a mix of various charging stations. **Spotlight**: Washington and Oregon combined DC fast-charging with AC Level 2 outlets in one charging station. Washington's request for proposal had contractors not only compete on lowest price but also best value. Oregon DOT incorporated this idea into their bid process for their TIGER grant. The contractor chosen, AeroVironment, offered both fast-chargers and AC Level 2 chargers in its bid to install charging stations. • Select the legal arrangement for project delivery, including organizing and financing charging station design, construction, operation, and maintenance. Project delivery of charging stations can follow the Design-Build-Operate-Maintain model, which is especially useful for charging stations funded by grants. In this model, the DOT develops the conceptual plan and contracts the design, construction, operation, and maintenance of the charging station. The contract can allow the private contractor to charge money for charging. **Spotlight**: ECOtality was awarded grant money for charging stations from the DOE. In Seattle, ECOtality hired McKinstry to install

	charging stations using a Design-Build-Operate-Maintain project delivery method. • Identify available contractors for siting and install equipment. Some charging station service providers have been consistently over budget and late. • Develop a long-term plan for charging station maintenance and legal contingencies in the case of the need for ownership transfer. The market outlook for charging infrastructure businesses is uncertain. The DOT should have contract terms for what happens if the contractor is unable to operate the charging station. Contractors that have a diversified business outside charging infrastructure may have a better chance of providing charging services for the long term. • Monitor and track the use of charging stations after they are built. In addition to collecting data on charging station use, the DOT should physically monitor the stations to prevent vandalism, or require the contractor to do so in the contract. • Be prepared for charging stations to have low use at first. Charging station usage may be infrequent so long as PEVs hold a very small market share. • Consider only installing the conduit for a charging station. The DOT could solicit bids for who gets to install and operate charging stations using this wiring. Only installing the conduit reduces project costs and allows for more time to select the appropriate charging station for that spot. Unused conduit is also less visible than an unused charging station. **Spotlight**: NRG Energy, in a $100 million settlement with the state of California, is installing charging stations and "pre-wiring" locations by laying conduits down. NRG has exclusive rights to installing a charging station on the conduits for the first 18 months.
Outcomes	Over time, the DOT is contributing to a popular, efficient, and cost-effective charging network. Moreover, with the experience of installing charging stations, the DOT can see future links between transportation and electricity, and is prepared to work more closely with entities like electric utilities and grid operators (see 3.7 Explore and pilot test new technologies, including V2G and wireless charging).
Related Actions	• Successor actions (fleet vehicle deployment and education): 3.1 Deploy fleet vehicles; 3.4 Act as go-to source of PEV knowledge in the state; create an innovative PEV website that conveys up-to-date information on PEV purchases, charging behavior, FAQs, etc.; 3.6 Create PEV guidance for local governments/districts • Other related actions: 2.7 Identify funding sources for supporting PEV deployment; 2.13 Conduct and publish total cost of ownership calculations for PEVs; 2.14 Survey and educate agency staff on PEVs

LEADER	**3.4 ACT AS GO-TO SOURCE OF PEV KNOWLEDGE IN THE STATE; CREATE AN INNOVATIVE PEV WEBSITE THAT CONVEYS UP-TO-DATE INFORMATION ON PEV PURCHASES, CHARGING BEHAVIOR, FAQS, ETC.**
Reason for action	A central location for PEV resources makes it easy for stakeholders to stay up-to-date on PEV deployment efforts and PEV technologies. Creating an interactive and innovative website that acts

	as a central resource hub can get consumers and stakeholders excited about PEVs.
Implementing the action	• Gather and synthesize all the information and resources that the DOT has collected or developed into an appealing web portal for PEVs. Resources include PEV data (e.g., DMV sales data), driver behavior, news clips, and more (e.g., see Action 3.3) as well as: o A guide on how to use charging stations from different service providers in the region. o A real-time ticker on air quality emissions and GHG emissions reduced by PEVs. • Include innovative and interactive resources on the website. Act with other groups to offer resources for PEV deployment needs, including: o Linking to maps locating all charging stations in the vicinity such as http://carstations.com/. o Working with educational institutions like UC-Berkeley's Renewable and Appropriate Energy Laboratory to recruit electric vehicle drivers to submit their driving behavior information and educate other drivers in the state. o Creating a charging station vote map, where consumers can vote for where they would like a charger. **Spotlight**: SeeClickFix, an innovative citizen engagement company, partners with municipal governments to offer citizens opportunities to report neighborhood issues and needs on an online map. This information is received directly by the government. • See the Resource List for additional links to the ones below: http://www.afdc.energy.gov/locator/stations, http://www.plugshare.com, http://www.electricdrive.org/, http://www.pluginamerica.org/ • Consider consulting or partnering with other organizations to create and maintain the website. Creating an innovative website may not be a core competency of the DOT. • Publicize the website and resources through the DOT's publicity mechanisms as well as through various stakeholder groups.
Outcomes	The website and the DOT are central resources for all PEV-related information in the state and the region. A well-maintained website can enhance the agency's effectiveness and ability to engage with other PEV leaders and encourage citizens to perceive the DOT as a valuable institution and resource.
Related Actions	• Successor actions: 3.6 Create PEV guidance for local governments/districts; 3.7 Explore and pilot test new technologies, including V2G and wireless charging • Other related actions: 2.7 Identify funding sources for supporting PEV deployment; 2.13 Conduct and publish total cost of ownership calculations for PEVs; 2.14 Survey and educate agency staff on PEVs; 3.1 Deploy fleet vehicles

LEADER	3.5 ADDRESS TRANSPORTATION FINANCE CONCERNS WITH PEVS
Reason for action	Electric vehicles operating in all-electric mode do not pay the motor fuels tax, which comprise a large share of DOT budgets. Many transportation budgets are facing significant revenue shortfalls due largely to inflation and increases in fuel economy. However, the motor fuel tax revenue lost from electric vehicles will remain negligible for the foreseeable future, and new taxes on electric vehicles could harm vehicle adoption. DOTs must identify finance policies and opportunities in piloting new financing mechanisms that encourage vehicle innovation while alleviating the criticism that PEV drivers do not pay their fair share.
Implementing the action	• Identify policies that balance the desire to encourage innovation and the need to maintain the transportation system. New taxes or registration fees make electric vehicles more expensive, and can slow vehicle adoption. Even after a fee or tax is imposed, publicity and debate around an electric vehicle's "fair share" may damage the public image of electric vehicles. Moreover, policies that impose taxes specific to electric vehicles run the risk of continually chasing the next vehicle technology (e.g., hydrogen fuel cell vehicles), and will not address the larger revenue shortfalls unrelated to PEVs. **Spotlight**: Oregon DOT is currently conducting a Road Usage Charge pilot program in lieu of a gas tax, and has conducted a similar program in the past. **Spotlight**: Washington is creating a policy analysis of a Road User Charge system, with an eye toward developing a feasible system to collect fees from drivers based on miles traveled. • Look for opportunities for electric vehicles to pilot new transportation finance mechanisms without damaging the PEV market. For example, advanced technology in PEVs may make it easier implement on-board finance mechanisms like a vehicle miles traveled fee. A state government could offer additional incentives for electric vehicle drivers if they agree to participate in a pilot program to demonstrate new finance mechanisms. • Explore innovative mechanisms for assuring a revenue stream to the government. For example, as first explained in Action 2.15, leasing highway rights-of-way and selling carbon offsets and renewable energy certificates from renewable energy projects can create a revenue stream to the DOT. **Spotlight**: Oregon's solar highway developed in partnership with Portland General Electric (PGE) produces solar renewable energy certificates, which are retired on behalf of PGE's customers. Under different ownership structures, these certificates could be sold to generate revenue for Oregon DOT.
Outcomes	Over time, different policies and pilot programs can inform how alternative fuel vehicles fit into the broader transportation finance picture, and more broadly, a national model for transportation finance.
Related Actions	• Successor actions (fleet vehicle deployment and education): 2.1 Share best practices by participating in national and regional dialogues • Other related actions: 0.2 Act on legislation or legislative PEV request

LEADER	3.6 CREATE PEV GUIDANCE FOR LOCAL GOVERNMENTS/DISTRICTS
Reason for action	Local municipalities and governments have the authority to pass different ordinances on PEVs, leading to consumer confusion. For example, local municipalities may pass their own ordinances on parking in front of public charging stations. Moreover, local municipalities that use their own signage for PEV charging may confuse consumers. The DOT can help local municipalities and governments by making them aware of other PEV-related activity across the state and offering guidance.
Implementing the action	• Get in contact with local municipalities and MPOs to find out what they are doing on PEVs and where guidance may be needed. **Spotlight**: the Puget Sound Regional Council and Washington State DOT offered guidance for local municipalities in Washington State. • Implement statewide legislation or an agency mandate. Agencies may have jurisdiction over a particular issue, which override all local ordinances. **Spotlight**: The Virginia EV Readiness plan recommends that the Virginia Board of Housing and Community Development mandate the pre-wiring of new homes with the conduits necessary for future installation of electric vehicle charging stations. British Columbia has implemented a similar rule. • Use district DOT offices for outreach if applicable. PEV may be more viable in certain parts of the state, and certain departments within state agencies may wish to focus on statewide transportation instead of a local area. As such, conducting work locally through, for example, the district DOT divisions may be the most effective way of working on PEVs. • Track local best practices and actions through the DOT website. Because the PEV market is evolving quickly, the state DOT should find a way to give updates on best practices. For example, the DOT website can summarize local ordinances and ongoing PEV-related activities. • Get in contact with the DOT's PEV stakeholder network to obtain best practices on how others have assisted local PEV efforts.
Outcomes	The DOT is a trusted source for PEV information for local governments. Moreover, because of the local guidance, the DOT has established relationships with local governments that can be leveraged for PEV deployment.
Related Actions	• Successor actions: 2.1 Share best practices by participating in national and regional dialogues • Other related actions: 2.9 Use and publicize standardized PEV charging signage; 2.16 Communicate with private entities, other agencies, and local municipalities to maximize charging network effectiveness

LEADER	3.7 EXPLORE AND PILOT TEST NEW TECHNOLOGIES, INCLUDING V2G AND WIRELESS CHARGING
Reason for action	Innovative technologies have the potential to increase the PEV value proposition, but are only in their infancy. The DOT could help companies and research labs commercialize new products. **Spotlight**: V2G, or vehicle-to-grid technologies, could be piloted on DOT fleet vehicles or DOT-financed charging stations. V2G allow electric vehicles to provide electrical grid services such as frequency regulation, which could improve a PEV's TCO. Leaders in V2G development include the University of Delaware and Lawrence Berkeley National Labs. **Spotlight**: Wireless charging could be implemented at curbside parking spaces or along stretches of highway. Leaders in the field include Siemens, Qualcomm, and Evatran. Wireless charging includes stationary wireless charging, which charges stationary vehicles, and mobile wireless charging, which can charge a vehicle as it moves.
Implementing the action	• Establish relationships with automaker research divisions, universities, national labs, and companies conducting innovative research on V2G and other PEV-related technology. • Revisit Action 1.4 Articulate public value Proposition, objectives, and a plan of action. There may not be a precedent for DOT to pilot new technologies. As such, articulating what public value comes from piloting new electrification technologies is crucial. **Spotlight**: California's DOT regularly works with automakers to test prototype vehicles and new vehicles because California has the largest vehicle market in the country. The DOT works on new technologies because California's transportation system must be equipped to handle them before new technologies can enter the national market. • Revisit Action 2.8 Incorporate PEVs into DOT planning process. Commercialization of these technologies may be within the timespan of long-range transportation plans, even if they may not be deployed on a mass scale in the near term. **Spotlight**: Connecticut DOT's Long Range Transportation Plan gave a vision of Connecticut's transportation system up to 2035. • Obtain an in-depth understanding of the electric utility and public utility commission's perspective on transportation electrification. By piloting new PEV technologies, transportation departments may have to understand more about the electrical grid. Transportation electrification is also becoming relevant across modes, making a closer working relationship with utilities even more important. **Spotlight**: States have actively worked to electrify truck rest stops so tractor-trailers can use electricity instead of running their engines overnight. • Build partnerships with utilities and public utility commissions. Transportation departments can stay ahead of the electrification curve by partnering with electric utilities to explore the challenges and opportunities associated with transportation electrification. The DOT can start relationships with utilities and public utility commissions by creating clear communication channels (see Action 2.1).
Outcomes	The DOT has the necessary communications channels with utilities and public utility commissions to see how developments in the electrical grid affect transportation and vice versa.

Related Actions	• Successor actions: 2.1 Share best practices by participating in national and regional dialogues • Other related actions: None.

COMPANION BRIEF: COMMON CONCERNS ABOUT ELECTRIC VEHICLE POLICY AND ELECTRIC VEHICLES

This companion brief contains common concerns regarding public involvement with electric vehicles as well as the vehicles themselves. For information about the public benefits and risks of public involvement with PEVs, please see Companion Brief: Public Benefits of PEVs and Companion Brief: Common Concerns About electric vehicle policy and Electric Vehicles.

PUBLIC POLICY AND ELECTRIC VEHICLES

Is the government picking winners among vehicle technologies? Is public policy supporting natural gas vehicles, fuel cell vehicles, and other alternative fuels?

There are many different public policies and programs for alternative fuel vehicles across federal, state, and local governments. All alternative fuel vehicles are receiving support from the federal government to some extent. For example, a number of alternative fuel vehicles are eligible for tax credits to lower their upfront cost. Any inherently low emission vehicle including natural gas vehicles and fuel cell vehicles are eligible for HOV lane exemptions. In addition, Congestion Mitigation and Air Quality funds have been spent on natural gas refueling infrastructure and natural gas vehicles.

However, electric vehicles have received a great deal of attention from policymakers recently for a number of reasons. To date, private investments in electric vehicles have helped jumpstart the market, far outweighing investments by government. For instance, General Motors committed to introducing an electric vehicle before there were government incentives to do so. Although public policy has spurred some automakers to introduce electric vehicles before they would otherwise, private manufacturers and consumers – not government – have been the primary driver behind electric vehicles. Almost every major automaker will have electric vehicles on the market within a year or two. Moreover, mass-produced electric vehicles are already widely available nationwide. Ultimately, consumers will determine what vehicle technology is successful. Many public policies and programs are not choosing a winner, but instead are aimed at leveling the playing field.

Numerous examples exist for government to help to enable the adoption of all alternative fuel vehicles, but the opportunity that electric vehicles offer, such as zero tailpipe emissions and the potential for significant oil savings, have made them more attractive to support than the others at present. Moreover, electric vehicles are more widely available than other alternative fuel technologies such as hydrogen fuel cell and natural gas vehicles.

Do electric vehicle incentives prioritize the transportation of a wealthy, tech-savvy minority over the vast majority of the public?

These incentives are part of a long-term strategy towards a more sustainable transportation system. Even as electric vehicles remain expensive today, everyone benefits as more of these vehicles hit the road. Encouraging electric vehicle adoption improves public health and air quality, reduces greenhouse gas emissions causing climate change, and stimulates our economy by allowing consumers to keep (and spend) more money locally. These public benefits will accrue as electric vehicle adoption grows (see Companion Brief: Public Benefits of PEVs for more information).

Electric and other alternative fuel vehicles can eventually vehicles that are suitable for consumer needs. Given time, electric vehicle manufacturers can learn how to achieve the cost-cutting measures associated with more efficient manufacturing processes while improving vehicle quality and electric driving range. Delivering an electric vehicles that are appropriate for all also depends on fostering an environment that will enable

technological breakthroughs in battery and other vehicle technology. Many of the advances that electric vehicles achieve will be applied to conventional and other electric drive vehicles, so investments in advanced vehicles can even help all consumers in the near term.

The early stages of the electric vehicle industry will rely on wealthier-than-average and tech-savvy consumers. However, as the industry grows, more consumers will be able to purchase these vehicles while public benefits accrue.

Should we be supporting a vehicle that has such low adoption rates?

Support for advanced vehicles like electric vehicles is warranted because they present a transformative opportunity for the transportation sector. Electric vehicles, in their first year of mass market availability, surpassed year one sales of hybrid electric vehicle by a large margin. For example, the Chevrolet Volt outsold the Toyota Prius in its first year on the U.S. market by more than 30 percent, or 2,000 cars. In 2012, electric vehicle sales will more than double 2011 sales. Much of the negativity in the media around electric vehicles is because of high expectations set by both manufacturers and government that in retrospect were unachievable. However, ambitious near-term goals helped spur investment in the industry that may not have occurred otherwise.

More importantly, electric vehicles are a long-term value proposition that will take decades to fully materialize. Year-to-year sales may vary greatly, and electric vehicles will remain a very small part of the overall vehicle market for years to come. However, electric vehicles present a rare opportunity to address critical energy and environmental issues.

Do electric vehicles pay their fair share of highway and road maintenance?

In fact, no vehicles currently pay their fair share. The Highway Trust Fund has deteriorated primarily due to inflation since federal gas taxes have not been raised since 1993. At present, nearly all states receive as much or more funding from the federal government for highway programs than they contribute from the federal motor fuels tax. A report by the Congressional Budget Office estimated that revenue to the Federal Highway Trust Fund, which helps fund many state transportation departments, would have a cumulative shortfall of $147 billion between 2012 and 2022 due to inflation and federal fuel economy standards.

Moreover, in 2007, user fees such as state and federal fuel taxes, vehicle registration fees, and tolls paid for only 51 percent of the $193 billion authorized to the federal-aid highway program. In contrast, forty years ago, user fees accounted for 71 percent of the amount spent on roads. The rest of highway funding comes from non-user fee sources, including income, sales, and local property taxes as well as debt financing from bond issues.[2]

As such, electric vehicles drivers contribute to highway and road maintenance because drivers often pay income, property, and vehicle sales tax, as well as tolls and vehicle license and registration fees. At the same time, no vehicle is actually contributing a “fair share” because of the diminishing role of user fees.

Because of these shortfalls, the current method to finance transportation is unsustainable. Funding shortfalls would persist even if special taxes and fees were imposed on electric vehicles, especially considering that electric vehicle market penetration is currently far below 1 percent. In sum, the highway financing shortfall existed long before electric vehicles were available, and reform efforts must be much broader than electric vehicles.

The transportation finance system is unsustainable regardless of PEV market growth, but PEVs offer an opportunity to pilot alternative mileage measurement and financing mechanisms while delivering many public benefits (see Companion Brief: Public Benefits of PEVs). For example, Oregon’s Office of Innovative Partnerships and Alternative Funding houses both electric vehicle infrastructure deployment and alternative transport finance mechanisms, which allows for the transportation finance team and the electric vehicle charging infrastructure deployment team to collaborate and keep each other informed. According to another DOT, one crucial reason to get involved with PEVs is that PEVs could be important players in the transportation system of the future.

If electricity comes from coal and natural gas, do electric vehicles actually reduce GHG emissions?

Currently, most studies show that even if electric vehicles charge completely on coal power, they still release fewer

GHG emissions than the average new 30-mpg conventional vehicle. Charging on natural gas makes electric vehicles comparable or better than the best hybrid electric vehicles in terms of both GHG and air pollutant emissions according to several studies (see Companion Brief: Public Benefits of PEVs). Moreover, unlike conventional cars, the emissions profile of electric vehicles will get cleaner as they get older because the electrical grid is becoming cleaner.

In the future, new federal vehicle standards will require new light-duty vehicles to achieve up to 54.5 mpg by 2025. These standards may diminish the relative advantage electric vehicles have over conventional vehicles for GHG and air pollutant emissions. On one hand, conventional and hybrid electric vehicles will get better fuel economy and thus emit less; on the other hand, new technologies and a cleaner grid will allow electric vehicles to emit less.

ELECTRIC VEHICLES

Are electric cars safe?

Electric vehicles are as safe or safer than their conventional counterparts. Electric vehicles are currently powered by lithium ion batteries, which can catch on fire in the worst circumstances similar to a conventional vehicle's fuel tank. The media has reported on isolated instances, usually after crash tests, where electric vehicles have caught on fire. These problems have either been resolved or misrepresented.

Most notably, after one such incident, the National Highway Traffic Safety Administration conducted an in-depth study to examine the safety risks of electric vehicles. NHTSA concluded that electric vehicles do not pose a greater risk of fire than gasoline-powered vehicles, which can also catch fire. Moreover, both the Chevrolet Volt and the Nissan LEAF received five-star crash test ratings from NHTSA, which are the highest safety ratings available.

However, the safety risks of electric vehicles are different from conventional vehicles. It is important that firefighters and other emergency aid responders understand these risks; for example, water should never be used to extinguish lithium ion battery fires. The National Fire Protection Association has created a website devoted to EV safety training at EVsafetytraining.org.

Where should electric vehicles be taken for maintenance and repair?

Service on components that electric vehicles share with conventional vehicles like tires, struts, etc., can be conducted by a standard repair shop. However, NHTSA recommends an automaker-authorized repair center handle the unique electrical and battery components of electric vehicles.

Broadly speaking, electric vehicles should require less maintenance than conventional vehicles because electric drive systems contain fewer moving parts. For example, pure battery electric vehicles do not require oil changes. Plug-in hybrid electric vehicles only use gasoline sparingly, thus requiring fewer oil changes than a vehicle that runs exclusively on gasoline.

How quickly do electric vehicle batteries degrade?

Ambient temperature and the presence of thermal management systems have the greatest effect on electric vehicle battery degradation. According to DOE, a lithium ion battery in Minneapolis, Minnesota theoretically should have 10 percent more capacity at the end of ten years than a battery in Phoenix, Arizona. The presence of liquid cooling can increase battery life by 15 percent after ten years compared to a battery without a thermal management system.

Automakers conduct exhaustive tests on electric vehicle batteries to ensure adequate range over the lifetime of the vehicles. General Motors, for example, has stated that it has accumulated more than 150,000 test miles. Another electric vehicle manufacturer estimated that degradation to 80 percent of the original battery capacity would not happen for at least five years. Electric vehicles also come with warranties, usually around 100,000 miles over eight years, although these warranties come with certain charging and temperature conditions. Finally, as a hedge against uncertainty regarding the battery, electric vehicles can be leased at low costs.

Real-life use of electric vehicles may vary from laboratory testing, especially for the earliest models. So far, one electric vehicle model that did not have a thermal management system has shown degradation at a much faster rate than expected, purportedly due to high ambient temperature as well as high mileage. The manufacturer has pledged to use a new battery design for all future models.

As automakers gain more experience with electric vehicles and thermal management systems, incidents of unexpected accelerated battery degradation are likely to diminish.

What is the residual value of electric vehicles and electric vehicle batteries?

It is too early to tell what the long-term residual value of electric vehicles will be. After one year, two electric vehicle models retained at least 90 percent of their post-$7,500 federal tax credit value. Over time, the first electric vehicle models are projected to have lower residual values than the average vehicle because of a shorter historical record as well as rapidly advancing powertrain technologies in newer models. Vincentric, a data compiler for the National Automotive Dealers Association, projected that the 2011 Volt will depreciate from the post-incentive manufacturer's suggested retail price (MSRP) by 69 percent while the LEAF will depreciate by 66 percent over the first five years. If battery capacity and electric range drop more than expected, the residual value will be even less. Future electric vehicle models are forecasted to retain more of their residual value if models do not incur issues earlier than anticipated.

If electric vehicle batteries can be reused by grid operators, the residual value of electric vehicles will increase. Specifically, batteries can retain 70 to 80 percent of their storage capacity after their useful life in vehicles is exhausted. Researchers at California Center for Sustainable Energy and UC-Davis are currently conducting experiments and estimate that proof of residual value in battery packs could reduce the cost of a Volt battery lease by as much as 20 percent; i.e., the lease payment can be lowered if the lessor can sell the car battery after the car's useful life. Progress on vehicle-to-grid development could allow for grid use of batteries during the useful life of a vehicle, further bringing down the total cost of ownership.

What is the payback period of an electric vehicle compared to a similarly priced conventional vehicle?

The payback period for an electric vehicle depends on a variety of factors, including characteristics of the reference vehicle, financing terms, mileage, electricity rates over time, oil prices over time, and more (see Action 2.7). The U.S. DOE has a calculator that can provide a preliminary cost comparison between different vehicles. Depending on how the calculation is made, payback periods can run as low as one year to as high as 26.6 years. For example, a study by GTM research assuming a higher-priced reference vehicle to the Volt as well as a lease payment plan found that the cost of payback was less than a year. A New York Times article assuming that a Volt owner did most of his driving on the combustion engine as opposed to electric mode found that the cost of payback was 26.6 years.

Several assumptions can shorten the payback period including: comparing electric vehicles to higher-priced conventional vehicles with – for example – comparable acceleration and handling as opposed to vehicles sharing the same chassis; driving a high number of miles in mostly all-electric mode; using electricity rate plans that lower electricity prices for off-peak (nighttime) charging; and comparing leases and installment plans as opposed to upfront cash payments.

What is the risk of charging station obsolescence?

Electric vehicle charging stations face the possibility of obsolescence. For example, current DC fast-chargers use a CHAdeMO connector, and are incompatible with all U.S. and European electric vehicles, which will use the J1772 connector from the Society of Automotive Engineers. Going further back, hundreds of chargers installed in California to charge first-generation electric vehicles (i.e., General Motor's EV1 and Toyota's original RAV4 EV) have become "stranded assets" as they are no longer compatible with today's vehicles; the state of California gave a grant of $1.9 million to convert old chargers so they could be made compatible with new electric vehicles. In the long term, advances in wireless charging, which are currently in very early stage development, could make existing charging stations and signage obsolete.

As such, although electric vehicles offer immense opportunities (see Companion Brief: Public Benefits of PEVs and Companion Brief: Common Concerns About electric vehicle policy and Electric Vehicles) and are gaining traction, transportation departments should be careful when spending public funds on electric vehicles. Existing incentives like the $7,500 federal tax credit and various state sales tax exemptions represent significant public incentives in electric vehicles.

With funding constraints, transportation agencies should seek out cost-effective paths to deploying electric vehicles. If a state transportation agency cannot fund its own charging stations, it can instead seek to help advertise and streamline private commitments to installing charging stations. Electric vehicle drivers mainly charge at home and studies have shown that electric vehicles charge less frequently as drivers become more experienced with electric vehicles. However, many PEV adopters may want public charging to assuage "range anxiety,"[3] even if drivers will not use them. Thus, making public charging recognizable via standardized signage and publicizing planned charging stations may be effective ways to showcase the existence of public charging. In general, the alternative fuel vehicle market is changing rapidly, and states should consider the effectiveness of actions in encouraging electric vehicle use, the cost of each action, as and the risk of failure of the PEV market.

COMPANION BRIEF: PUBLIC BENEFITS OF PEVS

PEVs offer several advantages to the public over conventional vehicles. For example, they consume no oil in all-electric mode, thus enhancing energy security while protecting consumers from oil price shocks. At the same time, building a homegrown electric vehicle industry can sustain U.S. jobs if electric vehicles become increasingly popular. Finally, they improve public health by releasing zero tailpipe emissions in all-electric mode and have the potential to reduce greenhouse gas (GHG) emissions.

ENERGY SECURITY AND OIL INDEPENDENCE

The transportation system and U.S. dependence on oil are fundamentally intertwined. In 2010, 95 percent of delivered energy to the U.S. transportation sector was from petroleum. Gasoline and diesel motor fuels also accounted for 64 percent of total U.S. liquid fuels consumption in 2010, making transportation the largest market for the oil industry.

The transportation sector's dependence on oil harms the U.S. economy in several ways. For example, our reliance on oil makes consuming oil necessary even at high prices. Oil prices are projected to rise from a nationwide average of $3.43 per gallon in 2011 to $3.71 per gallon in 2020. Average oil prices could rise to $5.12 per gallon by 2020 in a high oil price scenario. Between 1995 and 2010, median nominal household income grew an average of 2.7 percent annually while nominal oil prices grew an average of 7.3 percent. If oil prices continue to outpace household income growth, consumers will have to spend a growing share of their income on gasoline. In 2011, the average American household spent $4,155, or 8.4 percent of median family income, on gasoline, the highest share since 1981.

Not only does oil dependence lead to higher consumer expenditures on oil, the U.S. economy is harmed by the need to import nearly 48 percent of U.S. crude oil supply. Dollars spent on foreign oil no longer circulate in the U.S. economy. From 2005 onwards, wealth transfers to other countries to pay for imported oil accounted for a GDP loss of at least $200 billion per year. Moreover, the fact that oil is controlled by the Organization of Petroleum Exporting States (OPEC) allows OPEC to set prices to be higher than they would be if the international oil market was competitive. Finally, the U.S. military must take steps to ensure a secure supply of oil in the Persian Gulf; a 2009 RAND study estimated that the cost of securing the supply and transit of oil in the Persian Gulf ranges between $67.5 and $83 billion per year.

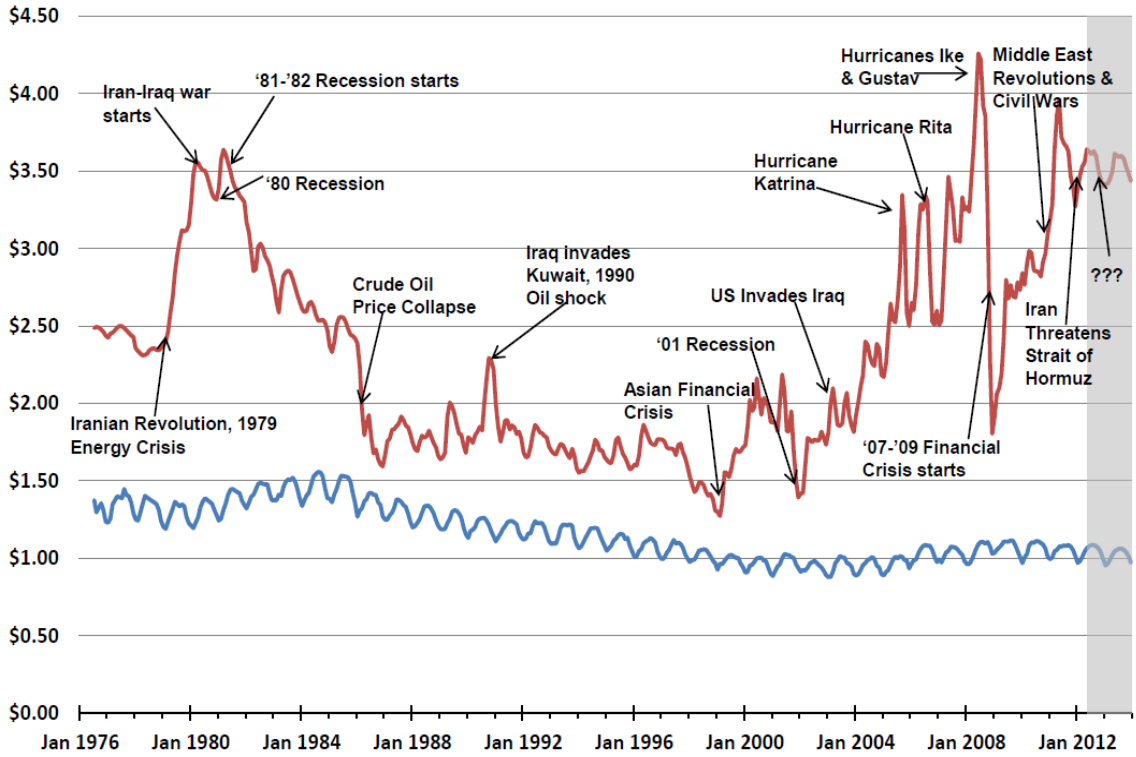
The volatility of oil prices also negatively affects the economy. For example, in 2008, Brent crude prices collapsed from a high of $143.95 per barrel in July to $33.73 per barrel in December because of the global financial crisis. This volatility makes it difficult for businesses and consumers to plan their expenditures. Between 2005 and 2010, Oak Ridge National Laboratory estimated that oil price shocks reduced U.S. GDP by more than $100 billion each year on average because of dislocation losses, defined as delays in adjusting price, wages, and interest rates in response to sudden price changes.

Without including the military-related costs to secure the supply and transit of oil, oil dependence has regularly cost the U.S. between $200 to $500 billion per year from 2005 onwards due to wealth transfer, dislocation losses, and the loss of potential GDP. In comparison, average spending from the Recovery Act stimulus was $165 billion

per year between FY 2009 to 2011 - the height of the stimulus.

In contrast, electric vehicles displace oil and draw electricity from the electrical grid, an almost entirely a domestic energy source. Electricity prices are also much less volatile than oil prices (see figure below from Edison Electric Institute). Moreover, the cost of a mile traveled on electricity can be three to five times less than a mile traveled on gasoline. Low operating costs allow consumers to spend more of their money on goods and services that can be more productive for the economy. The Resource List contains state-level data on oil prices, electricity prices, and other relevant information.

FIGURE 3: National Average Monthly Gasoline Retail Price vs. Monthly Residential Electricity Price.



Blue denotes residential electricity prices in Feb. 2012 dollars. Red denotes oil prices in Feb. 2012 dollars. Source: Energy Information Administration, Short-Term Energy Outlook, February 2012. Data compiled, converted, and presented by Edison Electric Institute.

ECONOMIC COMPETITIVENESS

The electric vehicle industry can benefit the U.S. economy in a number of ways. For instance, developing the industry can enhance American economic competiveness in the global auto market as consumers increase purchases of alternative fuel vehicles. Local and regional economies can also benefit if consumers spend gasoline savings locally. A study by the New York State Energy Research and Development Authority (NYSERDA) forecasted electricity and gasoline prices to 2025 and estimated that New York gained an extra $4.45 billion to $10.75 billion per year, assuming electric vehicles comprised 40 percent of new car sales. Those savings could indirectly sustain between 19,800 and 59,800 jobs in the state economy due to petroleum displacement, increased domestic electricity demand, and annual fuel cost savings. A study by the Blue-Green Alliance projected that EPA's and NHTSA's new GHG and corporate average fuel economy (CAFE) standards could help sustain 570,000 U.S. jobs as demand for more fuel-efficient vehicles increases.

As demand for alternative fuel and high efficiency

vehicles gradually increases in response to higher fuel prices, policymakers and auto manufacturers can work together to ensure a resilient automotive sector. Recently, government and private industry have invested in manufacturing capacity and infrastructure for electric vehicles. For example, the battery manufacturing and electric vehicle industry supported over 32,000 permanent jobs in 2010 according to the Brookings Institution. Moreover, Tesla Motors, a start-up electric vehicle manufacturer, currently employs more than 2,000 people. Charging station installation and service is projected to be nearly a $4 billion industry later in this decade, and vehicle-to-grid (V2G) development may require a number of jobs related to the smart grid. Policymakers can help sustain the initial manufacturing and demand base for electric vehicles so that the long-term benefits may materialize.

PUBLIC HEALTH AND AIR QUALITY

Ozone (commonly known as smog) and fine particulate emissions (known as $PM_{2.5}$) are two EPA-regulated pollutants with severe consequences to human health. Motor vehicles are a primary source of both these pollutants, especially in densely populated areas (see Table 1).

Ozone and $PM_{2.5}$ are linked to various heart and respiratory conditions including asthma, bronchitis, and heart attacks. A study examining 450,000 people in the United States showed that people living in cities with high ozone and $PM_{2.5}$ levels faced an increased relative risk of death from cardiopulmonary, cardiovascular, and respiratory causes. The EPA has estimated that ozone and particulate regulations prevented the premature deaths of 160,000 people, 130,000 heart attacks, and 1.7 million asthma attacks in 2010 alone. These regulations will save $2 trillion in the year 2020 alone while the cost of implementation will be $65 billion.

TABLE 1: Conventional air pollution for highway vehicles. NO_x and VOC are precursor chemicals to ozone.

POLLUTANT	SHARE OF U.S. TOTAL FROM 2010
CO	46%
NO_X	33%
Direct PM_{10}	9%
Direct $PM_{2.5}$	9%
SO_2	1%
VOC	23%
NH_3	7%
Pb (2008 Data)	0%

Source: http://www.epa.gov/airtrends/2010/dl_graph.html.

The effect of electric vehicles on regional air quality and public health is mixed and depends heavily on the source of electricity in the region. Electric Power Research Institute (EPRI) and Natural Resources Defense Council (NRDC) analyzed a scenario in which PHEVs comprised 40 percent of total on-road vehicles by 2030, and all additional electricity demand was assumed to be from coal generation. In this scenario, 61 percent of the U.S. population would experience decreased ozone levels and 1 percent of the population would experience increased ozone levels. However, the study also found that particulate matter would increase by 10 percent nationwide, primarily in areas around coal power plants. Notably, the study makes the conservative assumption that all PHEVs charge on coal generation. Generation sources have changed significantly since 2007 and the grid is likely to get cleaner. Natural gas, in particular, has displaced some of coal's share of power generation recently due to a variety of reasons, including record low natural gas prices, implementation of new EPA standards, and aging infrastructure. Coal's share of electricity generation is projected to decline through 2035. The decreasing emissions intensity of the grid over time may lead to smaller increases or even decreases in PM_{10} concentrations attributable to electric vehicle charging.

Because electric vehicles are primarily beneficial for air quality, especially over the long run, they may be incorporated into long range transportation plans and state implementation plans to improve air quality. If an area does not meet an air quality standard, it is designated as a "non-attainment area" under the Clean Air Act, which requires the state to submit a plan on how

non-attainment areas can lower air pollution levels to reach attainment standards. Plans must include control measures, means, and techniques for reaching attainment. For example, the Maryland Department of the Environment's State Implementation Plan for Baltimore $PM_{2.5}$ non-attainment highlighted the use of PEVs in public fleets. California has formally adopted a zero emission vehicles program. The ZEV program promotes a number of policies to accelerate adoption of zero emissions vehicles, which include electric vehicles.

CLIMATE CHANGE

According to the National Research Council, a "strong, credible body of evidence based on multiple lines of research" supports the assertion that climate is changing, and that climate change is in large part due to human activity. In a business-as-usual scenario, climate change would lead to weather pattern changes including drought and heavy rainfall, rising sea levels, and sea ice loss. These weather pattern changes would seriously diminish economic growth while threatening public health and ecosystems.

Reducing GHG emissions to lessen the impacts of climate change has become a key priority for many state governments. The transportation sector is the largest emitter out of any end-use sector (residential, industrial, commercial) and made up about 27 percent of total emissions in 2010 As such, reducing transportation emissions is a key strategy in reducing total GHG emissions.

Unlike gasoline-powered vehicles, electric vehicles deliver zero tailpipe emissions. However, if electric vehicles are charged with electricity generated by fossil fuels, driving electric vehicles still results in GHG emissions. The climate benefits of electric vehicles are determined by the actual GHG emissions resulting from plugging electric vehicles in the grid.

Calculating the GHG emissions from charging electric vehicles is complicated. One primary decision is whether to calculate emissions based on the average grid mix – the GHG emissions from electricity generation averaged across all sources including renewables and nuclear – or marginal grid mix – the GHG emissions from generating an additional kilowatt-hour from the next available dispatch source. Average grid mix can result in lower emissions than marginal grid mix because the average grid includes renewables and nuclear power. Marginal grid emissions will be higher than average grid emissions if additional load is met by fossil fuels. Average grid mix is often used for loads that electric utilities have planned to accommodate (i.e., loads that have been on the grid for some time), while marginal grid mix is used for loads that are new, unplanned, or infrequent.

TABLE 2: Well-to-wheels EV miles per gallon GHG equivalent (MPGGHG) by electricity source.

AN ELECTRIC VEHICLE CHARGING EXCLUSIVELY ON…	…EMITS GHGS EQUIVALENT TO A GASOLINE-POWERED VEHICLE WITH A FUEL ECONOMY OF
Coal	30 MPG
Oil	32 MPG
Natural gas	54 MPG
Solar	500 MPG
Nuclear	2,000 MPG
Wind	3,900 MPG
Hydro	5,800 MPG
Geothermal	7,600 MPG

Source: *State of Charge: Electric Vehicles' Global Warming and Fuel-Cost Savings across the United States*. UCS, 2012.

So far, most published studies show that PEVs emit less GHG emissions than conventional vehicles even in the worst-case scenario. A joint study by the EPRI and NRDC as well as a study by the Argonne National Laboratories (ANL) used marginal analysis and timing to show that PHEVs led to less GHG emissions than a 30 mpg conventional vehicle even when electricity came entirely from coal.

The EPRI-NRDC study forecasted business-as-usual scenarios dominated by coal and natural gas and alternative scenarios in which new technologies become the marginal mix, including coal with carbon capture and

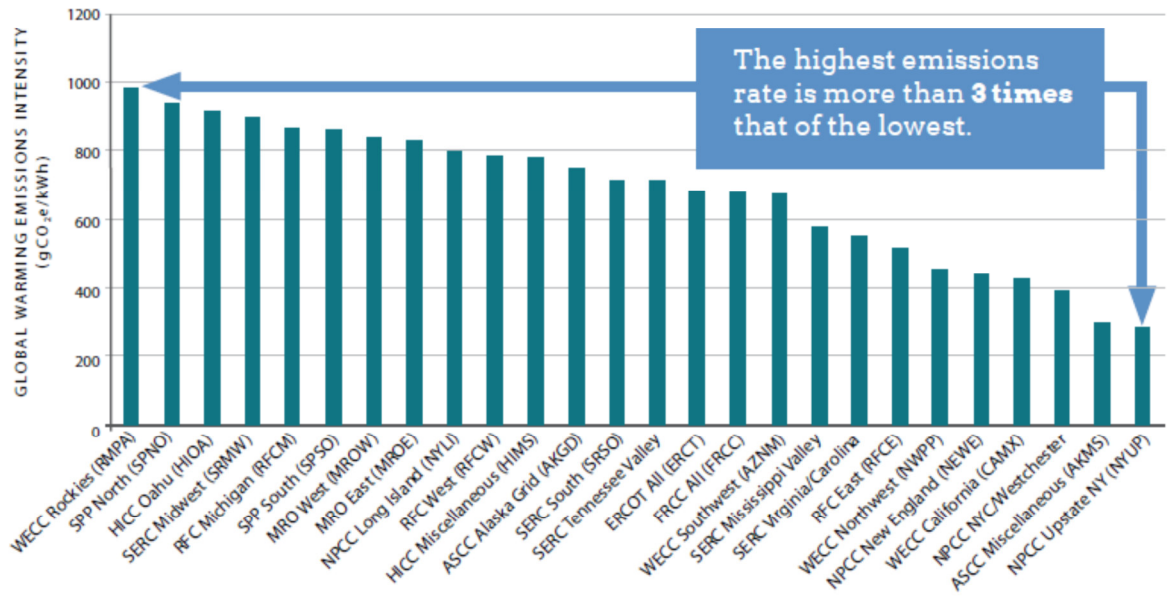
storage; natural gas peaker plants; neighborhood solar and microgrids; and advanced renewables with dispatch capabilities. Assuming a 0.5 percent fuel economy improvement per year in both hybrids and conventional vehicles, different penetrations of PHEVs always resulted in net GHG reductions. These reductions range from 163 in the business as usual case to 612 megatonnes of carbon dioxide equivalent (CO_2e) per year by 2050. However, with the new CAFE standard mandating an average fuel economy up to 54.5 mpg, actual fuel economy of hybrids and conventional vehicles should be higher than that estimated by the study, potentially resulting in diminished net GHG reductions from electric vehicle penetration. The EPRI-NRDC study assumes a 30.0 mpg fuel economy for conventional vehicles and a 46.3 mpg fuel economy for hybrid vehicles in 2050.

The ANL study reached similar conclusions. Plug-in hybrids with a 20-mile electric range had an emissions intensity of about 230 grams of CO_2e/mi using the marginal emissions profile of the national grid, while conventional vehicles with 30.5 mpg fuel economy had an emissions intensity of roughly 370 grams of CO_2e/mi. PHEVs were comparable to HEVs when natural gas was the marginal generation source. In contrast, the Oak Ridge National Laboratory found that efficient HEVs in 2020 and 2030 would have a lower emissions profile than electric vehicles charging from coal-based or oil-based electricity. However, the Oak Ridge scenario may be unlikely because natural gas has become much more widespread as a generation source.

Finally, a more recent study by the Union of Concerned Scientists justified using average grid mix emissions by saying that from the perspective of the individual purchasing an electric vehicle, the added load is indistinguishable from any other load. The results showed no regions in the United States in which electric vehicles would have higher emissions than the average 2011 conventional vehicle with a 27 mpg fuel economy. Moreover, 45 percent of Americans live in regions where a PEV will beat even the highest-performing hybrid vehicle (assumed to have a 41 to 50 mpg rating), 38 percent live in regions where a PEV compares favorably to hybrids, and the rest live in areas where a PEV beats a 27 mpg conventional vehicle. Considerable regional variations exist – as seen in the figure below, the emissions intensity of the highest intensity region is three times that of the lowest intensity region.

As such, electric vehicles hold great potential to reduce GHG emissions both currently and in the future. More data on state-level data are available in the Resource List.

FIGURE 4: GHG emissions intensity of charging electric vehicles across electrical grid sub-regions.



Source: *State of Charge: Electric Vehicles' Global Warming and Fuel-Cost Savings across the United States*. UCS, 2012.

RESOURCE LIST

This list contains useful links and resources. Within each category, the most relevant resources are listed at the top. Resources include reports, web portals, quantitative data, and significant news articles.

WEB PORTALS/GENERAL RESOURCES

C2ES: Plug-in Electric Vehicle Deployment Initiative: C2ES's PEV initiative brings automakers, electric utilities, policymakers, environmental groups, and others together to develop consensus approaches to accelerate PEV deployment.

DOE Alternative Fuels Data Center: resource for PEV-related initiatives nationwide. Contains database of current and future PEV models, frequently updated map of electric vehicle charging stations, state and local laws and incentives, total cost of ownership calculator, publications, and more.

DOE Clean Cities Coalitions: U.S. DOE-sponsored local coalitions for advancing alternative fuel use. Website is designed as a resource for Clean Cities Coalitions. Contains financial opportunities, publications and technical assistance, and literature from past conferences and workshops.

FHWA INVEST 1.0: The Infrastructure Voluntary Evaluation Sustainability Tool was developed by FHWA as a practical, web-based, collection of voluntary best practices designed to help transportation agencies at all levels integrate sustainability into their programs and projects.

Oregon DOT: Electric Vehicles and Infrastructure Program: details about Oregon's leading charging infrastructure deployment program

Sustainable Transportation Strategies: various studies about charging station siting and design, as well as case studies about electric vehicle readiness. Focuses on charging in Oregon.

West Coast Green Highway: details about corridor charging initiative by state DOTs along west coast highways

Advanced Energy: Transportation Initiatives: nonprofit focusing on energy efficiency. Transportation section includes handbooks for residential and commercial charging station installation as well as a community planning guide for PEVs.

Electric Drive Transportation Association: industry association dedicated to the promotion of electric drive. Runs GoElectricDrive.com, a leading consumer engagement website.

California Center for Sustainable Energy: contains resources on fleet education and consulting, private vehicle rebate programs, and vehicle technology demonstrations including the Second Life Battery Project.

Plug-in America: electric vehicle advocacy group. Contains database on charging station models/types, vehicle makes and models, webinars on various topics, and a YouTube channel offering resources for PEV deployment,

Bay Area Climate Collaborative: California electric vehicle collaborative including reports on readiness checklists, smart grid integration, and regional EV planning in the San Francisco Bay Area.

U.C. Davis Plug-in Hybrid and Electric Vehicle Research: hub of collaboration and research on plug-in hybrid and electric vehicles for the State of California. Leader in research on consumer and driver behavior, grid impacts, battery reuse, PHEV pick-up trucks, and more.

MARKET RESEARCH AND ACTION-ORIENTED REPORTS

C2ES: An Action Plan to Integrate Plug-in Electric Vehicles with the U.S. Electrical Grid: C2ES convened the PEV Dialogue Group in early 2011 to create an Action Plan that identifies many of the steps that would be necessary to integrate PEVs with the electrical grid nationwide.

C2ES and Georgetown Climate Center: PEV Deployment in the Northeast: comprehensive literature review of PEV deployment in the Northeast with nationwide applicability.

Carnegie Endowment for International Peace: Policy Priorities for Advancing the U.S. Electric Vehicle Market: policy recommendations for electric vehicles from leading transportation experts

Congressional Budget Office: Effects of federal tax credits for the purchase of electric vehicles: concludes that federal electric vehicle tax credits are an expensive means of reducing carbon emissions but acknowledges

Congressional Budget Office: Effects of Federal Tax Credits for the Purchase of Electric Vehicles

ECONOMIC COMPETITIVENESS RESEARCH

Brookings Metro Center: Sizing the Clean Economy: 2010 study giving rough estimates of the number of clean tech jobs in the nation, including battery manufacturing and electric cars

Blue-Green Alliance: Driving Growth: contains estimates of the economic benefits of new corporate average fuel economy standards

VEHICLE MARKET FORECASTS

Center for Automotive Research: Deployment Rollout Estimate of Electric Vehicles, 2011-2015: includes electric vehicle estimates by state. Methodology based on hybrid penetrations.

Table 5: Retail registration per 10,000 residents for top 20 states, 2007-2009

Table 6: U.S. Retail hybrid registrations by State: 2007-2009 (Percent of Total Hybrid Fleet)

Table 3: U.S. Retail Hybrid Registrations: 2007-2009 (Percent of Total Hybrid Fleet)

McKinsey Quarterly: Battery technology charges ahead: reviews developments in battery technology. Contains graphic that shows conditions required for BEVs and PHEVs to gain widespread adoption.

INCENTIVES AND INNOVATIVE PROGRAMS

University of Delaware: Vehicle-to-Grid Charging Research: details on V2G demonstration project and research from leaders in the space

Greening of Greenville: EV Ecosystem: innovative program supporting a charging network simultaneously with the introduction of vehicles into

the marketplace for users to drive, on both a short-term basis, and mid-term rentals, to see if an EV can meet the needs of their business or lifestyle.

California Air Resources Board: Air Quality Improvement Program: California program to fund clean vehicle and equipment projects with multi-million dollar annual budget

Pecan Street: Mueller Street: research program testing "integrated clean energy smart grid of tomorrow" within a residential neighborhood. Neighborhood currently has the highest density of PHEVs in the country.

PEV AND CHARGING STATION DEPLOYMENT

City of Atlanta: Electric Vehicle Deployment Municipal Best Practices Study: best practices on electric vehicle deployment from several different cities

City of New York: PLANYC Exploring Electric Vehicle Adoption in New York City: exploration of electric vehicle deployment strategies in New York City

Washington DOT, Department of Commerce, Puget Sound Regional Council: Electric Vehicle Infrastructure A Guide for Local Governments in Washington State: guidance for electric vehicle infrastructure, as mandated by House Bill 1481

Plug-in America: Hawaii EV Ready Guidebook for Commercial Electric Vehicle Charging Station Installations: guide for installing commercial charging stations; contains descriptions of innovative new financing models

FHWA: Interim Approval for Optional Use of an Alternative Electric Vehicle Charging General Service Symbol Sign (IA-13): charging station sign jointly developed by state DOTs

UCLA Luskin School of Public Affairs: Addressing Challenges to Electric Vehicle Charging in Multifamily Residential Buildings: study focuses on charging in multi-family dwellings

ECOtality: The EV Project and ChargePoint: largest private charging networks. Funded by the 2009 American Recovery and Reinvestment Act.

ENERGY, EMISSIONS, AND TRANSPORTATION STATISTICS

HybridCars.com: Market Dashboard: national PEV sales by year

U.S. DOE Transportation Energy Data Book:

- Chapter 1: Table 1.15-1.17: Highway/Non-highway Transportation Petroleum Consumption by Mode, 1970-2010
- Chapter 2: Tables 2.11-2.15: Energy Intensity by Mode (highway, non-highway passenger, freight, rail)
- Chapter 3: Tables 3.7 to 3.12: Share of Vehicle-Miles Traveled, Cars in Operation by Age, U.S. Average Vehicle Ages, New Retail Vehicle Sales, Shares
- Chapter 4: Tables 4.19 to 4.26: Light duty fuel economies, tax receipts, and carbon emissions over time
- Chapter 6: Alternative Fuel and Advanced Technology Vehicles and Characteristics
- Chapter 7: Fleet Vehicles and Characteristics
- Chapter 8: Household Vehicles and Characteristics
- Chapter 10: Tables 10.8 through 10.18: Motor fuels taxes, alternative fuel incentives, average price of a new car, car operating cost per mile, consumer price indices, transportation-related and auto parts manufacturing employment
- Chapter 11: Greenhouse gas emissions
- Chapter 12: Criteria air pollutants

U.S. Energy Information Administration: Annual Energy Outlook 2012 Table Browser

- Light-Duty Vehicle Sales by Technology Type and Region
- Petroleum Consumption in Transportation by Region
- Real and Nominal Energy Prices and Expenditures for Electricity and Motor Gasoline by Region
- Transportation Carbon Dioxide Emissions from Electricity and Petroleum by Region
- Generation by Fuel Type and Emissions per

kWh of electricity generation by Reliability Council Region

U.S. Energy Information Administration

- Monthly electricity sales prices
- Significant potential for plug-in vehicles exists in U.S. housing stock

The costs of oil dependence

U.S. DOT: Bureau of Transportation Statistics

- Table 3-11 - Sales Price of Transportation Fuel to End-Users (Updated April 2012)
- Table 3-12: Price Trends of Gasoline v. Other Consumer Goods and Services (Updated June 2009)
- Table 3-16: Personal Consumption Expenditures on Transportation by Subcategory (Updated October 2012)
- Table 3-17: Average Cost of Owning and Operating an Automobile (Updated July 2012)
- Table 3-29 - Federal, State, and Local Government Transportation-Related Revenues and Expenditures, Fiscal Year (Current $ millions) (Updated April 2010)
- Table 4-49: Estimated National Emissions of Particulate Matter (PM-2.5) (Updated July 2012)
- Table 4-51: Air Pollution Trends in Selected Metropolitan Statistical Areas (Updated January 2012)
- Table 4-53: U.S. Carbon Dioxide Emissions from Energy Use by Sector (Million metric tons of carbon) (Updated April 2012)

Federal Highway Administration: Highway Statistics Series

HDF Disposition Of Highway-User Revenues, All Levels Of Government - 2010

- HF-1: Revenues Used for Highways, All Levels of Government - 2010
- HF-2: Total Disbursements for Highways, All Levels of Government - 2010
- Highway Statistics Series: Table VM-1 Annual Vehicle Miles Traveled and Related Data

U.S. EPA: Counties designated "nonattainment": map of nonattainment areas in the nation

C2ES: Greenhouse gas emissions targets: map of states with GHG emissions targets

EPRI-NRDC: Environmental Assessment of Plug-in Electric Vehicles

- Table 2-8: 48-state Upstream Emissions and Percent Reductions from Base Case to PHEV Case in 2030
- Table 3-13 to 3-16: Electric-sector criteria pollutant emissions by NEMS EMM Region
- Table 4-1 to 4-6: Annual criteria pollutant emissions by state and source category (Base case and PHEV 2030 case)
- Table 3-2: Selected Results from Electric Sector Carbon Emissions Scenarios
- Table 5-3: GHG Emissions Reductions of PHEVs Compared to HEVs for MY2050
- Table 5-4: Annual CO_2 Reduction from PHEVs in the Year 2050
- Table 5-5: Cumulative 2010-2050 GHG Reductions from PHEVs

UCS: State of Charge: Electric Vehicles' Global Warming Emissions and Fuel-Cost Savings Across the United States: study showing the benefits of electric vehicles across different fuel sources

Environment America: Charging Forward: The Emergence of Electric Vehicles and Their Role in Reducing Oil Consumption

- Table 1: Annual Oil Savings if 469,000 Electric Vehicles Are Sold by 2015 (by State)
- Table 2: Metric Tons of Global Warming Pollution Prevented Annually by Electric Vehicles Sold 2012-2015 in Two Generation Scenarios

American Petroleum Institute: Gasoline Tax Map

PUBLIC FLEET DEPLOYMENT

IRS: Qualified plug-in electric and electric vehicle credit: IRS tax form. Explains how tax-exempt entities can receive the benefit of the tax credit through an auto dealership. Green fleet magazine gives a case study.

Energy Managers' Quarterly: Plug-In Electric Vehicles for Fleets

U.S. DOE: Plug-in Electric Vehicle Handbook for Fleet Managers

U.S. DOE: Electric vehicle maintenance: details how to maintain electric vehicles

PEV DEPLOYMENT GROUPS

PEV Dialogue Group

California PEV Collaborative

Plug-in Ready Michigan

North Carolina PEV Taskforce

Maryland Electric Vehicle Infrastructure Council

Illinois Electric Vehicle Advisory Council

Connecticut's Electric Vehicle Infrastructure Council

RMI's Project Get Ready (local)

DriveOregon

Plug-in Texas

Indiana's Project Plug-in

ENDNOTES

[1] PEVs refer to all electric vehicle types including all electric vehicles (e.g., Nissan LEAF), extended range electric vehicles (Chevrolet Volt), and plug-in hybrid electric vehicles (e.g., Toyota Prius Plug-in).

[2] Bond issues accounted for 16 percent of highway spending in 2007. Bond issues are in part financed by user fees.

[3] Consumer fear that a vehicle has insufficient range to reach desired destinations, thus stranding the vehicle's occupants.

CENTER FOR CLIMATE AND ENERGY SOLUTIONS

The Center for Climate and Energy Solutions (C2ES) is an independent nonprofit organization working to promote practical, effective policies and actions to address the twin challenges of energy and climate change.

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