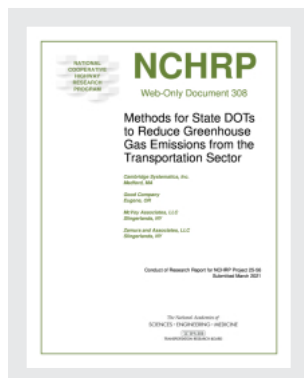


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NCHRP

Web-Only Document 308:

Methods for State DOTs to Reduce Greenhouse Gas Emissions from the Transportation Sector

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Conduct of Research Report for NCHRP Project 25-56
Submitted March 2021

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed, and implementable research is the most effective way to solve many problems facing state departments of transportation (DOTs) administrators and engineers. Often, highway problems are of local or regional interest and can best be studied by state DOTs individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation results in increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

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CHAPTER 1

Summary

Purpose of Project

The objectives of the National Cooperative Highway Research Program (NCHRP) Project 25-56 were to develop a guide to assist State departments of transportation (DOT) in evaluating ways to reduce transportation greenhouse gas (GHG) emissions through their activities and decision-making, and to pilot test and improve this guide by working with a select number of DOTs and their local partners. The guide is published as *NCHRP WebResource 1: Reducing Greenhouse Gas Emissions: A Guide for State DOTs*.

The guide aids DOTs by breaking down technical and institutional issues related to GHG estimation and reduction across the spectrum of an agency's activities. The guide can be used by individual functional areas in contributing to an integrated agency effort. Each of the guide's functional unit sections enables individuals to directly access the information they need in order to understand and affect GHG reduction strategies. The guide was not intended to duplicate existing materials on transportation GHG strategies and evaluation methods, but rather to cross-reference in-depth sources that already are available.

Project Approach

The project was scoped with eight tasks divided into three phases. At the conclusion of the first and second phase, an interim report was delivered to the Project Panel proposing a detailed timeline and workplan for the next phase.

The first phase of work, which took place between the summer of 2018 and the winter of 2019, included a review of practice; an assessment of needs, opportunities, and barriers; and development of an annotated guide outline and Phase 2 outreach plan. Research methods included a survey of State DOTs, interviews with selected DOT staff, and a review of State DOT documents related to GHG emissions estimation and reduction.

The second phase of work, which took place between the winter and summer of 2019, included the development of six initial sections of the draft guide; workshops with three State DOTs and partner agencies; an online briefing for a national State DOT audience; and development of a detailed Phase 3 workplan.

The third phase of work, which took place between the fall of 2019 and the winter of 2021, included development of the full guide; virtual workshops and other technical assistance with four State DOTs and partners to test and implement the draft guide; and finalization of the guide and project report.

Key Findings Regarding State DOTs and GHG Reduction

A “level of engagement” framework was used to characterize DOT activities related to GHG reduction, ranging from Level 1 (“just getting started”) to Level 4 (a comprehensive approach). As categorized based on survey responses, most State DOTs are at relatively early stages of addressing GHG emissions—“Level 1” or “Level 2” engagement. A few have been more active, categorized as “Level 3” or “Level 4,” and that number has been increasing as more State executives and legislative bodies set aggressive goals to address climate change and reduce emissions. Even the “Level 4” agencies, however, acknowledge that they still have much work to do in fully integrating GHG considerations into their activities, and taking many of the steps that would be needed to support more aggressive GHG reduction targets.

A common question from the workshops is, “what is the most effective thing we can do as an agency to reduce GHG emissions?” But a concurrent theme is, “how much will it cost, and how will it impact our other operations and priorities?” There is no silver bullet for a DOT. DOTs can lead by example, such as by electrifying their fleets and procuring low-carbon materials. These emissions sources, while under the direct control of the DOT, are relatively small compared to emissions from transportation system users. The project team developed estimates of transportation-related emissions for a “typical” State, based on composite data from multiple States. These estimates show that the great majority of emissions (about 94 percent) are from the operation of vehicles using the highway system. Emissions associated with construction, maintenance, and operations of the State’s highway system are about 6 percent of the total, and emissions from the DOT’s administration (buildings and light-duty fleets) are about 0.2 percent. The relative scale of these sources is illustrated in Figure 2.9 of the guide.

Transportation system user emissions are influenced by the DOT less directly through policy, planning, and operational decisions. Effective implementation of most of these strategies requires collaboration with other agencies and stakeholders, and the DOT may not always be the lead agency, especially for solutions such as clean vehicle technology.

Sample findings from GHG scenario analyses conducted by various agencies, as presented in Section 3.0 of the guide, provide some lessons learned about which strategies are likely to be most effective. First, a widespread transition to clean energy sources, most likely through electrification, will be needed to achieve the aggressive GHG targets being set by governments at all levels to mitigate the most severe effects of climate change. Mobility-focused solutions, such as travel demand management and traffic flow improvement, will be an important, but limited, part of an overall set of GHG reduction measures. Pricing strategies can be one of the most effective ways of managing mobility, but can be challenging to implement. Some choices that a DOT makes will align well with other imperatives, such as improving travel time and safety, reducing criteria air pollutant emissions, working towards energy independence, or achieving cost savings through fuel savings. Others may require difficult tradeoffs. For example, investing in new highway capacity may reduce emissions in the short term, but may be counterproductive in the long term if it leads to induced demand and increases automobile use. These are conversations to be had with stakeholders and the public.

Table 1-1 summarizes observations from past and ongoing State efforts to reduce GHG emissions and implications for State DOTs, as referenced in Section 3.0 of the guide.

Table 1-1. GHG reduction strategies: observations and implications for DOTs.

Observation	State DOT Implications
Most emission reductions will come from clean vehicle and fuel technologies.	Support electric and alternative fuel vehicle infrastructure for light and heavy vehicles, clean transit, and clean fleets.
Demand reduction and systems efficiency strategies can reduce emissions by up to 5 to 20 percent.	Implement intelligent transportation systems (ITS)/efficient traffic operations. Invest in and support low-carbon travel alternatives and incentives to manage demand for vehicle travel.
DOT construction materials, fuels/fleets, and buildings provide an additional reduction potential of 2 to 3 percent of total transportation system emissions.	Use low-carbon, recycled/reused materials, where feasible. Switch to clean fuel light and heavy vehicles.
GHG reduction targets of 75 to 80 percent or more by 2050 are challenging and will require widespread electrification <u>and</u> a clean grid.	Collaborate with other State, regional, and local agencies.

Observation	State DOT Implications
Most strategies require implementation at multiple levels (State, regional, and local).	

State DOTs have many moving parts that must be coordinated to address GHGs. First and foremost, strong direction from leadership is required for a concerted and sustained effort. Furthermore, if anything is going to be done to address any overarching issue within a DOT context, some organizational unit with motivated staff must lead and still others must deliver in cooperation with other parts of the agency. Complex operations like GHG reduction require many organizational units to operate in a concerted manner, and each must be trained, equipped, and directed to play its role within the constraints of competing priorities and available resources. Initial steps can include the development of an “executive charter” to establish objectives and use of a cross-agency working group that meets on a regular basis to report on progress and ensure accountability. The guide includes “self-assessment” tools that can help an agency plan out action items and assign responsibilities.

Significant GHG reductions will be the product of years of work involving a wide range of agency functions, which also will tend to evolve over time. Ideally, most GHG reduction efforts can be at least reasonably aligned with the department’s principal mission as the program matures.

Key Findings Regarding Conduct of Similar NCHRP Research and Implementation Projects

From a procedural standpoint, there were three noteworthy aspects of this project. The first was the extensive amount of outreach and engagement that took place as part of the development of the guide. Rather than waiting for a final product to engage the intended audience, NCHRP has been moving towards engagement as part of the development process. Experience in this project suggests that this is a successful means of building interest in the product, conveying technical information to the intended audience, and gaining feedback to shape the product to be as useful as possible. Three rounds of outreach were conducted: the first to establish a baseline of existing practices; the second to test preliminary material, including a subset of the guide; and the third to refine a draft version of the complete guide. Seven State DOTs hosted workshops, with two additional DOTs and numerous partner agencies participating. While the project team offered additional technical assistance to apply tools and methods presented in the guide, DOTs engaged mainly through the workshops for reasons discussed in this report.

The second was the evolution of the guide to focus less on technical resources (data and computational tools) and more on institutional procedures and practices. It became clear in the initial outreach that the existing resources describing available technical tools were reasonably good, but that resources did not exist to direct a State DOT on how to integrate GHG considerations across its spectrum of activities. Technical tools for estimating GHG emissions and evaluating mitigation strategies are still in need of development, but those needs are not the focus of this NCHRP project. The final guide contains significant technical resources, but is primarily focused on procedures and relationships; most notably, it includes a series of custom “self-assessment” tools designed for each functional area of the DOT.

The third noteworthy aspect was the development of the final guide in [webresource](#) format. While this publication format already has been used by the Airport Cooperative Research Program, it is the first application for an NCHRP project. This format allows for a more interactive engagement with the user, making it easier to navigate between sections and to link to material of interest. Development in this format required some additional resources on the part of the project team, compared to producing only a traditional printed or PDF document, but feedback from the workshops suggests that it improves the user experience.

CHAPTER 2

Project Approach

The objectives of NCHRP Project 25-56 were to develop a guide to assist State DOTs in reducing transportation GHG emissions and including GHG considerations in decision-making, and to pilot test this guide by working with a select number of DOTs and their local partners. The guide is designed to aid DOTs by breaking down technical and institutional issues across the spectrum of an agency's activities for independent use by individual functional areas in benchmarking their activities and contributing to an integrated agency effort. The guide is published as *NCHRP WebResource 1: Reducing Greenhouse Gas Emissions: A Guide for State DOTs*.

The project was scoped with eight tasks divided into three phases. At the conclusion of the first and second phase, an interim report was delivered to the Project Panel proposing a detailed timeline and workplan for the next phase. The tasks and their objectives are shown in Table 2-1.

Table 2-1. Description of tasks.

Task	Objectives
1. Review of Practice	Perform a review of GHG strategies considered for implementation by State DOTs, and tools and methods that State DOTs at various levels of engagement have used, or have available, to evaluate these strategies.
2. Assessment of Needs, Opportunities and Barriers	Conduct a more in-depth assessment, through structured conversations with State DOT staff on the extent to which GHG strategies and impacts are considered in planning, programming, and project development; methods for evaluating GHG impacts; and opportunities and barriers for introducing greater consideration of GHG reducing strategies. Summarize findings from the Task 1 and 2 reviews and resulting recommendations and a high-level outline for the guide with tools.
3. Annotated Guide Outline and Phase 2 Outreach Plan	Expand the guide outline into a first draft guide and to develop an outreach plan to guide further development and refinement of the guide in Phase 2.
4. Initial Outreach	Conduct outreach to obtain feedback on the guide tool and to help structure and shape the guide's contents to be most useful to practitioners at differing levels of engagement.
5. Additional Tool Development	Develop tools to help DOTs assess GHG planning capabilities, identify appropriate existing tools, methods, and resources to plan for GHG reduction, and/or evaluate GHG reduction strategies.
6. Complete Draft Guide	Develop a complete draft of the guide that reflects feedback from the Task 4 outreach and includes or references the additional Task 5 tools.
7. Testing/Implementation	Further refine and demonstrate the applicability of the guide by working with three to five State DOTs to pilot its implementation.
8. Final Documents and Outreach	Finalize the guide and tools, develop a report documenting the overall study effort, and conduct outreach to disseminate findings.

The initial planned duration of the project was 30 months, beginning in May 2018 and concluding in October 2020. For the most part, the project stayed on or close to schedule, with delays of 1 to 2 months in

some interim deliverables and additional time required for some Project Panel reviews. However, towards the conclusion of the project the schedule was disrupted by the COVID-19 pandemic, which began in March 2020. This initially required some agencies participating in Task 7 to turn their focus elsewhere, and also required rescheduling the workshops in “virtual” format. This resulted in delaying the draft final deliverables by about 3 months, and also extending the contract to cover a workshop for one State that needed to postpone its technical assistance involvement.

CHAPTER 3

Review of Practice and Assessment of Needs, Opportunities, and Barriers

Four background research tasks were undertaken for this project in the fall of 2018.

1. A review of literature on tools and methods that can be used by State DOTs to evaluate and reduce GHG emissions.
2. A survey of State DOTs to identify current and future activities and needs related to GHG evaluation.
3. A review of State DOT policy and planning documents related to GHG planning, implementation, and evaluation.
4. Interviews with staff from 14 State DOTs to gain a more in-depth understanding of opportunities, challenges, and information needs with respect to considering GHG emissions.

Literature Review

The literature review found 26 documents addressing at least 1 of 4 functions relevant to this project:

- Methods and data for transportation emissions inventory development.
- Overviews and assessments of GHG inventory and strategy evaluation tools.
- Guides to or syntheses of information on transportation GHG reduction strategies.
- Methods for incorporating GHG considerations into transportation planning processes.

Overall, there is a considerable amount of published information relevant to State DOT consideration of GHG emissions and reduction strategies. However, some documents are somewhat out of date and may not account for the latest developments in tools and State and Federal policies. In some cases, relevant information also is scattered across various sources and could benefit from being consolidated into a single resource document.

The project team also identified 35 transportation GHG evaluation tools and classified them into the following categories:

- Emission factor models.
- Inventory and forecast accounting/support tools.
- Tools to evaluate agency construction, maintenance, and operations activities.
- General GHG and vehicle-miles traveled (VMT) reduction strategy analysis tools.
- Limited focus/strategy-specific analysis tools.
- Other tools.

Despite the large number of tools, most have a very specific focus, and there are a limited number of tools with strategy analysis capabilities. Three sets of tools stand out as being well suited to State DOTs' transportation project and program GHG analysis at different scales:

- The VisionEval family of tools for program-level GHG policy analysis at statewide and metropolitan scales—relatively resource and data intensive, but the only tool designed for broad-based GHG policy analysis.

- The Federal Highway Administration (FHWA) Congestion Mitigation and Air Quality (CMAQ) Improvement Program Emissions Calculator Toolkit, a relatively simple set of project-level tools that include GHG emissions.
- The Infrastructure Carbon Estimator, which provides planning-level GHG estimates for construction and maintenance of transportation projects and mitigation activities.
- The universe of tools may still be missing significant functionalities to support State DOTs' GHG analysis activities, such as relatively simple planning-level evaluation tools, and tools that include certain policy levers that DOTs and other State agencies can directly influence, such as electric vehicle (EV) infrastructure.

A final annotated bibliography is published as Appendix A of the guide. This bibliography includes materials identified in the literature review, as well as additional documents referenced in the guide and identified following the initial literature review. A library of GHG evaluation tools is published as Appendix B of the guide.

State DOT Survey

A web-based survey was distributed to 52 State DOTs (including the District of Columbia and Puerto Rico) to identify recent and planned activities and needs with respect to GHG consideration. About 41 States completed the survey. Details on outreach methods and the survey results are included in Appendix A to this report.

The results were used to loosely classify States into four “levels of engagement” on GHG issues, considering dimensions of *policy*, *practice*, and *technology* (i.e., data and tools). The general engagement levels were defined as follows with the understanding that highly precise classifications are neither required nor desired.

- **Level 1:** “New to the topic.” Few or no formal actions to address GHG, although the agency might be involved in discussions regarding GHG activities or supporting another agency’s activities.
- **Level 2:** “We are developing our own policies or goals.” Policy—has established general policies, goals, and/or objectives related to GHG; practice—may apply qualitative project or program evaluation criteria; and technology—no or limited/partial GHG inventory.
- **Level 3:** “We are measuring and planning our actions and engaging others.” Policy—has established specific policies, goals, and/or objectives related to GHG; practice—apply quantitative project and/or program evaluation criteria; and technology—has developed GHG inventory and/or forecast, possibly limited use of assessment tools.
- **Level 4:** “We are taking action and tracking progress internally and with partners.” Policy—coordinated multiagency effort; practice—strategic planning has evaluated GHG reduction strategies, linked strategies to plans and programs, and conducted quantitative assessment; technology—has developed inventory, forecast, specific data and measurement methods, and established a range of specific policies, goals, and/or objectives related to targeted GHG reductions; tracks progress towards achieving targets; and addressing GHG from both agency operations and the transportation system.

The survey results indicate a few States had adopted a comprehensive set of policies and were implementing these through activities across functional areas. Most of the responding States had taken some action related to GHG, such as conducting an inventory, discussing GHG impacts qualitatively in environmental documents, or supporting another State agency’s efforts. Overall, the level of engagement varied by functional area, as shown in Figure 3-1.

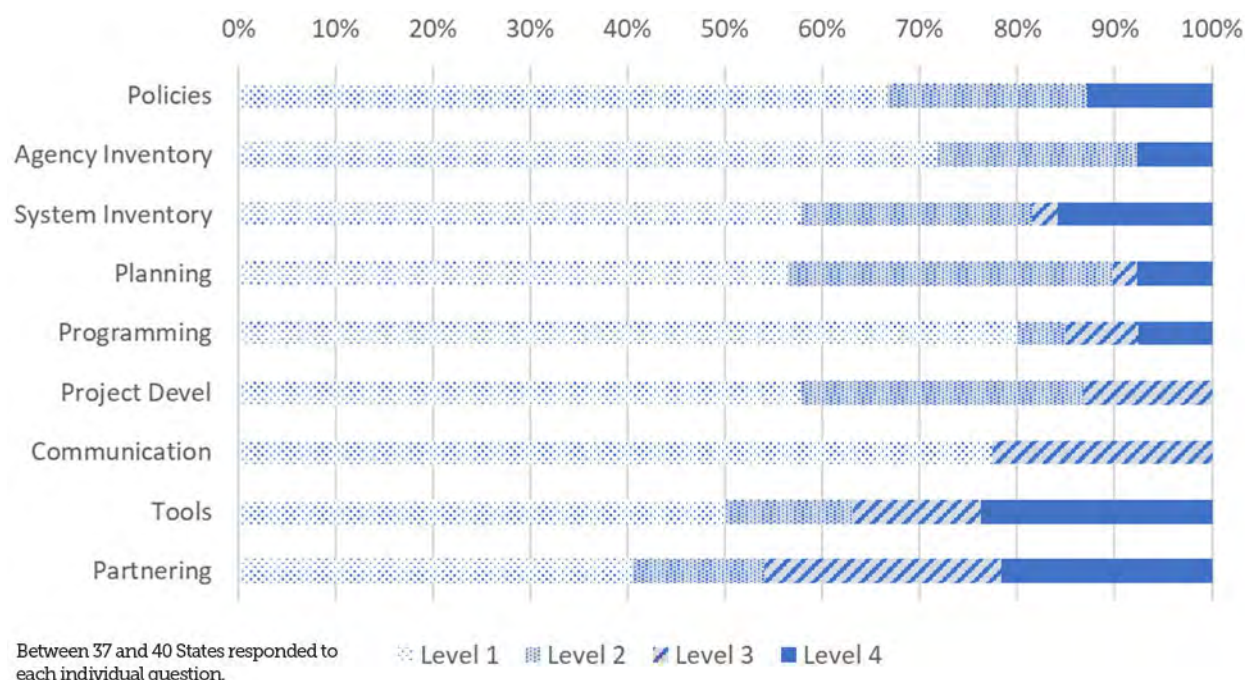


Figure 3-1. Percent of State DOTs by GHG level of engagement by functional area, as classified based on survey responses.

State Document Review

Published documents from State DOTs with higher degrees of GHG engagement were reviewed to examine in more detail how GHGs are considered in policy, planning, programming, project development, and agency operations. Most of the States had policies related to GHG, although in many cases this was a statewide policy affecting all agencies, in which the DOT was a participant (e.g., statewide GHG reduction goal or multiagency Climate Action Plan). GHG-related goals and strategies also commonly appeared in long-range plans, but only a few States explicitly considered GHG in capital program development. About half had some requirement (qualitative or quantitative) for consideration in project development and environmental documentation. Over half also had policies, and usually an inventory, to support GHG reduction from agency operations. Half also had engaged in GHG-specific planning efforts, such as an agencywide or statewide transportation GHG reduction plan.

The most comprehensive GHG emission reduction planning by a State DOT occurs when other related activities are occurring in the State. In these States, the range of State DOT activities and commitments can be quite broad. The State DOTs that are active in GHG emission reduction activities typically collaborate with other State agencies, most commonly with the State environmental agency or energy agency, and in some cases with metropolitan planning organizations (MPO) or regional planning agencies.

The findings of the State document review are attached as Appendix B to this report.

Interviews

Telephone interviews were conducted with staff from 14 State DOTs. The selection of States was based on the responses to the survey and included State DOTs at a range of engagement levels. Details on interview methods and findings are attached as Appendix C to this report.

Interview topics included:

- State context—leadership and policy support for GHG consideration (internal and external).
- GHG policies, goals, metrics—adopted, and under consideration by the DOT.
- GHG analysis tools and resources applied or considered by the agency (inventory, forecasting, strategy evaluation), strengths and limitations.
- Barriers to consideration of GHG emissions (technical/resource, policy, institutional, cultural) by stage—planning, programming, project development, operations.
- Partnering—with other State agencies (e.g., State Climate Action Plan); with MPOs/regional planning organizations (RPO); with local jurisdictions (requests/by whom and for what, what DOT has or has not been able to contribute, data/info needs, working relationships, success examples, barriers to collaboration, etc.).
- Potential future directions of the agency with respect to GHG.
- Data and information needs by stage of process—what advice, tools, and resources would the agency find most helpful from an NCHRP guide? From hands-on training or piloting efforts?
- Development of DOT policies/procedures?
- Leadership within the DOT.
- Lessons learned and advice for other DOTs.

The interviews found that State DOTs have adapted to undertaking GHG reduction efforts, depending upon the mandate and their organization's role in the effort and control of the transportation system, with varying degrees of success. Many of their efforts have been limited to reducing emissions from their own operations. Most often they have done this with no additional staffing. An emerging model of GHG reduction efforts is the umbrella of sustainability or “greening” work. Many of the State DOTs interviewed stressed the importance of good communications (internally and with outside groups) and the importance of good planning to undertake the effort.

DOTs value partnerships with other State agencies, local or regional agencies, or local and civic groups. The partnerships provide a common sense of purpose, spread the work around, and deflect potential negative reactions to the ongoing work. The confluence of air quality and GHG analysis techniques and tools offers an opportunity to better understand and report benefits of various transportation actions. For agencies that lack strong external direction, guide illustrations indicating how common agency initiatives such as mobility, safety, and energy savings are related to GHG performance could be of value in delivering on statewide or regional initiatives.

Some of the interviewees seemed to prefer the concept of webinars or pilot programs, rather than hands-on training, as something that would be most helpful as an outcome from this project. Whatever the format, training, report documents, and guides are expected to be clear and easy to understand.

The State DOTs did not find much internal resistance to undertaking GHG reduction work. With clear direction from the State DOT leadership, most staff understood the need for this work. At this point, the previously discussed communication and planning becomes important for keeping the effort ongoing in a unified and comprehensive manner. It also helps prioritize their efforts among many potential reduction strategies that could be pursued.

A few State DOTs mentioned the issue of a full life-cycle analysis. They would benefit from a definition of the term, guidance on how to perform the analysis, and how the results affect the selection of reduction strategies. Some felt that this analysis might preclude the selection of certain reduction strategies.

Some State DOTs noted the challenge of multiple conflicting priorities, in which other initiatives could distract, delay, or otherwise hinder GHG reduction efforts. Priority initiatives can change as State and agency leadership changes or other imperatives arise. This can sometimes result in reassignment of staff working on GHG reduction efforts to other efforts.

Background Research—Implications for Guide and Outreach Design

Together, the interviews, survey results, and literature review findings were examined for implications for the design and content of the guide that was to be produced. Key findings included:

- DOT staff want an easy-to-use reference with technical detail provided as accessory material that is not part of the main body of the guide.
- DOT staff are at different levels of understanding of GHG emissions and their significance. The guide needs to include some basic information to help educate users (and their managers) as well as more detailed information for technical staff.
- There is a considerable amount of information already published about GHG reduction strategies and their effectiveness. The guide may summarize, but should not repeat in depth, this information.
- There is a somewhat substantial amount of existing, published information on GHG assessment tools, although most sources are not entirely up to date. If agencies appear to lack information on appropriate tools and data to analyze GHG emissions and strategies, it may be as much a function of lack of tools meeting agencies' needs versus lack of knowledge of tools that do exist.
- Existing resources describe how GHGs can be considered in each phase of the planning process. However, there is less material discussing institutional/organizational best practices, or how GHGs can be integrated from top to bottom of a State DOT's operations. It would be helpful for the guide to address these institutional/procedural issues.
- The guide should include resources for internal GHG reduction along with resources for reducing transportation system GHGs. Internal actions give agencies a concrete and directly controllable place to start—one that can potentially support cost savings but will not elicit the challenges associated with strategies to affect travel patterns and consumer behavior.
- DOTs are in very different places with respect to the specific GHG issues they are concerned about and resources to address GHGs are limited. The guide should be modular so that DOTs can pick and choose based on their needs and priorities.
- Although State DOT experiences with GHG reduction are varied, most, if not all, would benefit from a comprehensive and systematic set of “best practices” across all facets of their operations.
- State policies and requirements with respect to GHG differ widely and there currently are no Federal policies. The guide needs to be flexible and general enough to provide useful information for States with different policies and priorities, and as Federal policies may evolve in the future.

CHAPTER 4

Outreach and Implementation Activities

Initial Outreach—Workshops and Online Briefing

The primary activity of Task 4 of this project was to conduct workshops with at least three State DOT to test an early draft of the guide. Workshops took place in three States in the spring of 2019, following the Phase 1 Interim Panel meeting held in March 2019 at which the initial draft guide material was reviewed. Two primary objectives were set for these Phase 2 workshops:

- To obtain feedback on the first draft of the guide, including content, organization, and presentation: Is this information helpful? Is it presented in a helpful manner? What more do staff need/want to know?
- To provide each State with some initial assistance in helping advance their GHG practices.

About six sample sections for the guide were developed as part of Phase 1. Feedback from the workshops generated overall direction and changes for completing the guide and conducting implementation support in Phase 3 of this project. A workshop report (Technical Memorandum #3: Task 4 Workshop Report) documented the development and key findings of the workshops. Subsequently, a Phase 2 Interim Report provided more detailed recommendations for completing the guide.

An online briefing provided updates on the project and presented and obtained feedback on the initial material, reaching more States than could be reached through the workshops.

Workshops

Workshops took place in Minnesota (May 7, 2019), Washington State (May 9, 2019), and Texas (June 4, 2019). Planning for the workshops began in February 2019 and invitations were issued six weeks to three months ahead of time. The project team worked with a primary host-State contact to identify a venue, confirm dates and times, develop logistical arrangements, issue invitations, and refine a draft agenda developed by the project team.

All workshop participants received a final agenda, as well as the first draft guide materials in PDF format a week in advance of the workshop. Handouts for the guide sections and self-assessments discussed in the breakout groups also were available at the workshop.

Each workshop ran from 9:00 a.m. to 2:30 p.m., and concluded no later than 2:45 p.m. Table 4-1 indicates the agenda for the Washington workshop. At the conclusion of each workshop, participants were asked to fill out an evaluation, either by hard copy or online.

Table 4-1. Washington workshop agenda.

Washington Workshop Agenda	
Welcome, introductions, and workshop objectives	9:00 a.m.
Greenhouse gas basics	9:20 a.m.
Overview of Washington State DOT's current policies and activities	9:35 a.m.
National state of the practice	9:45 a.m.
<i>Break</i>	9:55 a.m.
Overview of guidebook ¹	10:10 a.m.
Breakout groups	11:00 a.m.
Developing a State DOT GHG policy (including Executive self-assessment)	
GHG analysis in systems and corridor planning (including Planning self-assessment)	
GHG analysis in project development, design, and environmental analysis (including Design self-assessment)	
Report-back on review of draft guidebook material	12:00 p.m.
<i>Lunch</i>	12:15 p.m.
Institutional issues and partnerships—presentation	1:00 p.m.
Breakout groups	1:20 p.m.
Institutional, management, and program development issues	
Partnerships	
Report-back on breakouts	2:00 p.m.
Workshop summary, final comments, evaluation, and next steps	2:15 p.m.
Adjourn	2:30 p.m.

¹ The primary product of this research was referred to as a “guidebook” at the outset of the project, but the preferred terminology was later changed to “guide.” Agendas presented in this report retain the original term “guidebook” since that was the term used at the time of the workshop.

Participation included a mix of DOT and non-DOT staff:

- The Minnesota workshop included 22 participants. Half were Minnesota DOT (MnDOT) staff, representing a variety of functional areas—environment and sustainability, modeling, research, maintenance, controller’s office, and districts. Two staff from Iowa DOT also attended. Non-DOT partners included the MPO for the Twin Cities region, State commerce and environmental agencies, a university researcher, and a nongovernmental organization (NGO) representative.
- The Washington State workshop was held at the Washington DOT (WSDOT) headquarters building in Olympia, Washington. There were about 15 participants, 10 from WSDOT, 2 from Oregon DOT planning, 2 MPO/regional planning commission (RPC) staff, and 1 NGO representative. The DOT staff represented planning, environmental, construction/materials, and transportation systems management and operations (TSMO)/ITS functional areas as well as regions. This was a good cross section of DOT staff, as well as non-DOT representation to include outside perspectives.
- The Texas workshop took place in the Texas DOT (TxDOT) Riverside Drive training facility in Austin. There were 12 participants, including 6 TxDOT staff, 3 MPO/council of governments (COG) staff (2 from Houston and 1 from Dallas-Fort Worth), 2 university/research agency staff or contractors, and 2 other agency staff—1 each with the Austin regional transit agency and the City of Austin. The TxDOT staff from the Environmental unit also participated. Participants contributed actively to the discussions, and the MPO/COG and local agency planners helped fill in some perspectives to supplement those of the DOT attendees.

Some themes from each workshop included:

- Minnesota—MnDOT has recent strong leadership direction to address GHGs, but initiatives and knowledge are not yet fully integrated throughout the agency. Participants had many questions about what the DOT could do with regard to GHGs. For example, some discussion centered on asphalt versus concrete pavement, traffic flow improvements, and emerging technology vehicles. Participants also expressed a desire for information around the impacts of taking one course of action compared to the costs.
- Washington State—WSDOT is far along in terms of considering GHG emissions, especially at the project level, yet they have found GHG impacts of project-level decisions to be very modest. Much of the discussion focused on “moving the needle” on GHG emissions in the context of long-term goals and trends.
- Texas—TxDOT is in the early stages of addressing GHGs. There was much discussion about how the guide can be most relevant to a Level 1/2 agency that is working to change practice from the “bottom up” rather than in response to executive-level direction. DOT staff also need to be able to communicate the benefits of what they already are doing to build support for further action, especially when discussing climate change and GHGs publicly. The DOT should emphasize synergies with other more accepted initiatives, such as air quality, energy independence, sustainability, congestion relief, and resilience.

Overall considerations for finalizing the guide that were drawn from these workshops include:

- Overall guide organization/structure is generally good; materials presented in the sample sections were generally on the right track and mainly required tweaking/refinement rather than overhaul.
- Consider the title and how it presents the guide to newcomers and potential users.
- Self-assessment tools are generally helpful, but can use some tweaking and refinement as well as clear presentation of their intended use.
- Balance desires for brevity/ease of use versus detail by putting most technical detail and nonactionable information (e.g., state of national practice) in appendices, as well as providing links to existing documents/resources.
- Strongly consider a web-based/interactive publication format to make the guide more easily accessible and present layers of information.
- There is strong interest in seeing good examples of practice.
- There is strong interest in communication and partnerships. Consider how best to integrate communication—how much goes in its own section, versus integrating into other functional area sections.
- As guide development and implementation testing continues, make sure it is relevant to DOTs at all levels of engagement and something they can share with their partners.

Briefing

The project team conducted an online briefing in August 2019, provided an update on the project, and presented and obtained feedback on the initial material. The briefing provided an opportunity for States that did not participate in the workshops to offer input to the guide. The briefing was publicized via direct email to the same list of contacts assembled for the Task 1 survey, including State DOT environmental, planning, and executive leads. The briefing lasted just over an hour (45 minutes of presentation and up to 30 minutes for question and answer). In addition to presenting the guide outline and sample material, the briefing included polling questions on who is participating (type of agency), self-assessed level of engagement, GHG focus areas of greatest interest for technical support/guide resources, and relevance of proposed guide content.

As shown in Figure 4-1. Online briefing attendance by State. 69 staff from 36 State DOTs attended the briefing. The vast majority of the 53 respondents to the webinar polling were from the Planning, Environmental, or Project Development functional areas, with a small number from Executive or other

functional areas. Over 80 percent indicated that their agency were at Level 1 or Level 2 of GHG engagement (minimal activity or developing goals, policies, and tools).

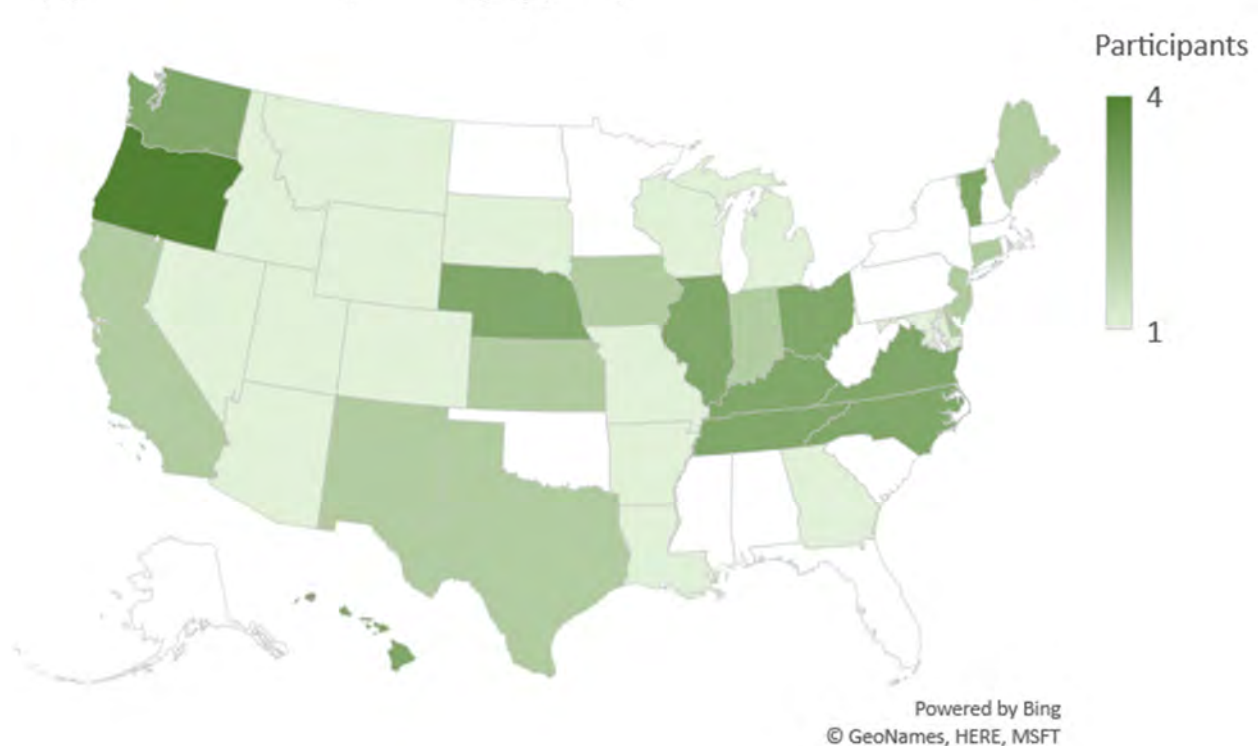


Figure 4-1. Online briefing attendance by State.

At the conclusion of the briefing, participants were asked which statement most closely reflected their view of their agency's current position on GHG issues and information needs. Of 43 respondents, about half stated that they needed help addressing GHG emissions. About two-thirds of those respondents indicated that the guide would probably meet their needs, with about one-third stating it probably would not. The other half either did not expect to address GHG emissions in the next 2 to 3 years or were not sure whether they would or not. A small percentage noted that they were addressing GHGs and had adequate resources (Figure 4-2).

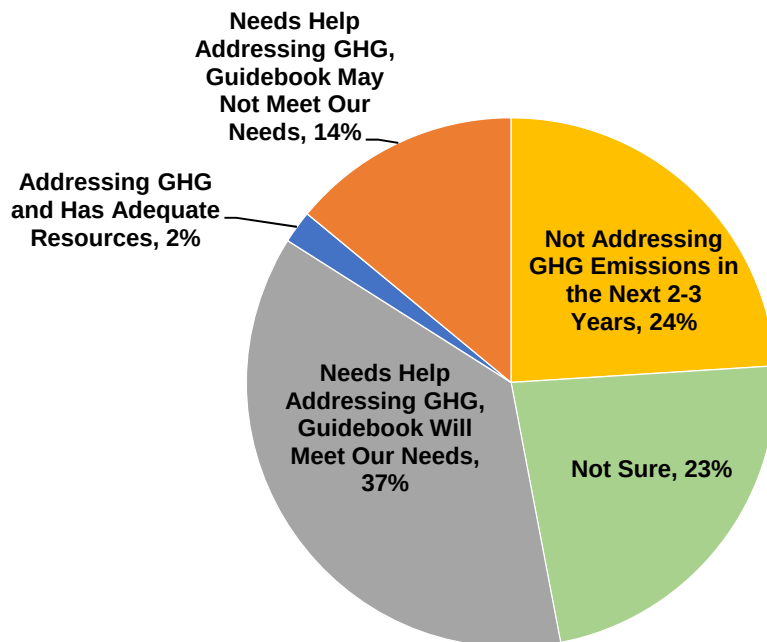


Figure 4-2. Participants' views on agency needs with respect to GHG.

Testing and Implementation—Workshops and Technical Assistance

The scope of work called for engaging three to five State DOTs in testing and implementation of the guide as part of Task 7 prior to completion of final products. The purpose of the technical assistance task was both to begin engaging the target audience in implementing the guide and for the research team to gather feedback on the guide prior to its final publication.

To recruit State partners for this task, the project team contacted the 27 State DOTs that had expressed potential interest in further assistance or support either in the fall of 2018 survey and interviews or in response to a poll question in the August 2019 briefing. State DOT staff contacts included those who responded to the survey and those who participated in the briefing. Nine States expressed potential interest, but a number of these States determined they were unable to participate due to factors such as timing, staff turnover, leadership support, or resource availability. Although two of the States participating in the first round of workshops also were potentially interested, the project team decided to prioritize engaging new States given the overlap in material between the 2 rounds of engagement. Ultimately, 4 States expressed strong interest in moving forward, which fit within the project team's scope for assistance.

Testing and implementation with these States included both workshops and additional technical assistance as requested by each State. Due to restrictions on travel and gatherings related to the ongoing COVID-19 pandemic, the four workshops took place virtually.

- Nevada—Virtual workshop held in four sessions of two hours each, May 2020.
- Colorado—Virtual workshop held in two sessions of two and a half hours each, June 2020.
- Delaware—Virtual workshop held in two sessions of two hours each and a one-hour follow-up call with Delaware DOT (DelDOT) staff, August 2020.
- Hawaii—Virtual workshop held in one session of three and a half hours, January 2021.

Individual reports were produced on each workshop; summaries are included as Appendix D to this report. Key findings from the workshops and follow-on technical assistance are provided below.

Participation

Each State had a very different approach to workshop participation, corresponding with different needs.

For Nevada, the DOT (NDOT) was at a very early stage of addressing GHGs and asked for more time on the guide overview. The Nevada workshop included 35 participants (attending at least 1 session), about half from NDOT and half from partner agencies (State agencies, utilities, MPOs, universities). Breakout groups were effective in this workshop at engaging participants, both from NDOT and from partner agencies. The involvement of NDOT and partner staff benefited from the strong endorsement of the NDOT director, who participated in the entire workshop.

Colorado DOT (CDOT) had more experience with GHGs, and was in the middle of a parallel, consultant-supported process as part of the development of a statewide GHG “roadmap” led by the Colorado Energy Office. (CDOT’s consultants organized a much larger GHG workshop the following month, including over 70 CDOT staff, at which the NCHRP guide also was briefly presented.) The Colorado workshop included a smaller group of 10 DOT staff, so there were no breakouts. Based on feedback from the Nevada workshop, the project team introduced the use of polling in the Colorado workshop to improve interactivity and to break up sections of longer presentation material.

DelDOT had more experience with GHGs—mainly at the operations level (e.g., agency fleets/electrification)—because the State had been addressing climate change for years, although primarily with a focus on adaptation. DelDOT was in the middle of a parallel process, led by the Department of Natural Resources and Environmental Control (DNREC) and supported by a separate consulting team, to develop a statewide Climate Action Plan. DelDOT had only a few agency staff participate (5 in the workshops plus 2 others in the debrief), as they felt that given the small size of their agency, these few staff were able to effectively communicate and set direction with others. The majority of the 22 DelDOT workshop participants were DelDOT partners (state agencies, transit, MPO, local government, advocacy).

Hawaii DOT (HDOT) also invited a number of partners to their workshop, as well as a cross section of agency staff from different functional units. The workshop included over 50 participants from HDOT, other state agencies, cities and counties, MPOs, and federal agencies. The workshop was structured as part of the quarterly convening of the Statewide Transportation Advisory Committee’s (STAC) staff-level arm, Sub-STAC, with additional invitees. (Sub-STAC facilitates a coordination committee between the State and counties.) HDOT also was in the process of updating its long-range transportation plan at the time of the workshop. As a result of the large number of local and regional agencies participating, the discussion at this workshop ranged broadly over GHG planning status and needs, in addition to State DOT status and needs. Breakouts and poll questions were effective at engaging participants.

Platform

Participating States and partners were able to view the draft guide in the form of a “hybrid” publication, which used the webresource platform for overall introduction and navigation pages and included links to PDFs of individual sections. The project team developed presentation slides for each workshop.

Workshops were convened using virtual platforms. The virtual format worked well for presenting information and reasonably well for discussions. Discussions are best suited to in-person settings, as people seem to feel freer to speak informally and can engage in side conversations. In-person events ensure that people are focusing most of their attention on the speaker or discussion, which did not always seem to be the case for the virtual events. As is common in virtual meetings, technical issues occasionally prevented people from speaking or hearing well. However, the virtual format was particularly advantageous in Hawaii and Nevada, where a number of participants was based at a considerable distance from the DOT headquarters.

Another advantage of the virtual format was that spreading the workshop over multiple days allowed the project team to adjust the agenda “on the fly,” and conduct and present additional research on key questions

that arose on the first day(s), such as examples of other States' policies or information on strategy and cost effectiveness.

Workshop Evaluation

A separate web-based evaluation survey (covering both the workshop and the guide) was distributed at all workshops. About 10 participants from Nevada, three from Colorado, and none from Delaware completed the survey. A follow-up survey was not distributed for the Hawaii workshop since the timing of this workshop precluded making use of any significant feedback on the guide. While the surveys captured some additional written feedback, most of the feedback from the surveys mirrored what was captured through discussion, chat comments, and polling in the workshops. Polls conducted during the Colorado and Delaware conveyed more quantitative responses than the follow-up survey, indicating that it is helpful to capture as much feedback as possible during the workshop.

Feedback on the guide was generally very positive and did not point to any major changes to the content or organization of the guide. Participants appreciated the modular structure, which allows DOT staff to navigate directly to the section corresponding to their functional area. They found the self-assessment tools helpful. Participants also liked the web portal interface and suggested the entire guide be placed in this format.

Some of the suggestions from the workshop participants for the final guide included adding additional State examples; adding additional content on a few items, such as strategy effectiveness and cost effectiveness; and some minor reorganization.

Post-Workshop Technical Assistance

Requests for post-workshop assistance beyond questions researched and presented during the workshop were more limited than anticipated. The project team provided the following assistance:

- Providing a written recap of questions raised by participants (via voice or chat) during the workshop and the project team's answers to these questions.
- Providing potential next steps for action as part of each workshop report, which was provided to host agency staff for review, and/or as a stand-alone memo.
- Participating in a 3-hour session of another consultant-led workshop on GHG strategies for CDOT staff. As part of this session, giving a 15-minute presentation on the draft NCHRP guide and answering questions in breakout groups.
- Holding a follow-up call with NDOT executives to discuss an executive charter and identify next steps for leadership.
- Providing CDOT staff with a consolidated list of possible GHG reduction strategies.
- Pointing participants to additional or key resources on particular topics. For example, a librarian from CDOT asked for a list of the team's top 5 to 10 resources.

Evaluation of the Testing and Implementation Task

All of the Task 7 host agencies felt that the workshops were a successful way of conveying the guide material to agency and partner staff and found them to be helpful in defining next steps. The project team also received useful feedback on the draft guide. The workshops were in many ways the most successful component of the testing and implementation task.

Follow-on requests were mainly related to overall agency direction and strategy, as well as identifying key resources and information. None of the agencies requested specific follow-up assistance with technical items (data, analysis, etc.). Possible reasons for this include:

- In some cases, technical staff needed direction from leadership before initiating their implementation of the guide. Agency timelines and priorities were sometimes not aligned with the timelines of the NCHRP project, making it difficult to plan and schedule technical assistance.
- In the case of two of the States, consultants were already on board through other contracts with the DOT or another State agency to perform technical analysis in support of GHG mitigation or climate action planning. Requesting assistance from the NCHRP project team could have risked overlapping with those ongoing efforts.
- The budget and time available to the NCHRP project team for technical assistance may not have been sufficient to support complete analysis as might have been requested by a participating State DOT; substantial DOT staff time and effort would have been required.
- Workshop participants noted that the guide provided useful resources. As such, they may not have felt the need for additional assistance, instead feeling that agency staff had the direction and resources that they needed to move forward.

In recent years, NCHRP has expanded the outreach and implementation aspects of its research projects. This project found both workshops conducted during early stages of guide or report development as well as prior to development of draft final materials to be excellent ways to: 1) ensure the product meets the needs of the target audience, and 2) to introduce the material to this audience and help jumpstart implementation. Online briefings and/or presentations at conferences and technical meetings are also an excellent way of engaging a larger audience, although with less depth than the State workshops. In contrast, the ability to provide effective “hands-on” technical assistance to individual States through this type of project was not clearly demonstrated, although it is possible that with a different subject matter and/or timing there might have been more interest in this type of assistance.

CHAPTER 5

Additional Implementation Steps

While executive and legislative support for State engagement in climate policies and GHG mitigation varies across the country, leadership priorities can change at any time. A State DOT can quickly be asked to prioritize a focus on this topic and take on additional responsibilities. The Task 7 workshops included States whose leadership had shifted within the past year or two to set aggressive GHG and reduction and/or clean energy goals, and to engage State agencies in developing plans and actions to work towards meeting those goals. Future policy direction also could come from the Federal level. This guide can help States prepare as needs arise.

With additional, dedicated resources, activities to support implementation of the guide could include:

- Workshops with additional State DOTs and partners (virtual and/or in person, as conditions permit) to walk through the guide and identify action items.
- A national webinar to present the guide to a national audience. This could be recorded.
- Presentations at conferences and technical meetings, such as the Transportation Research Board (TRB) Annual Meeting and meetings of the American Association of State Highway and Transportation Officials (AASHTO). Interim project updates were provided at workshops or lectern sessions in the 2018 and 2019 TRB Annual Meetings and for meetings of the AASHTO Air Quality, Climate Change, and Energy Subcommittee.
- Hands-on technical assistance with specific data, tools, or methods referenced in the guide. As presented in Appendix D, such assistance was piloted during the research project; other States may well find such assistance to be helpful.

APPENDIX A

State DOT Survey

Overview

A total of 52 State departments of transportation (DOT), including the District of Columbia and Puerto Rico, received a web-based survey that sought to identify recent and planned activities and needs with respect to greenhouse gas (GHG) consideration. The survey included 16 questions relating to GHG consideration in policy, inventory and forecasting, long-range planning, programming, project development, use of assessment tools, collaboration with other agencies, adequacy of existing tools/resources, and planned activities.

A request to complete the survey with a link to the survey site was distributed by email to agency directors and key planning and environment staff as identified from the American Association of State Highway and Transportation Officials (AASHTO) records in August 2018. The project team provided a PDF copy of the survey upon request, and followed up by email and/or phone with agencies that did not initially respond. A total of 41 States completed the survey. Five State DOTs began the survey without completing it, while 6 never began the survey. Three States completed multiple entries. Since the survey questions allow for multiple responses and only unique State responses in a category are reported below, this was not considered to be a problem.

Summary of Findings

Policy (Q2): About one-quarter (11) of the responding States had at least one policy in place related to GHG emissions. About five of these States (California; Washington, DC; Massachusetts; Vermont; and Washington) had a comprehensive set of policies addressing all three issues in the survey—GHG in planning activities, agency operations, and systemwide goals or targets. Several States noted that they were participants in a cross-agency statewide policy.

Agency inventory/footprint (Q3): About one-quarter (11) of the States had developed an agency GHG inventory/footprint; three of these agencies mentioned that they had used that information to identify GHG reduction measures. Several agencies had done partial assessments.

Statewide inventory/forecast (Q4): About two-fifths of respondents noted that they had developed, or partnered to develop, a statewide GHG inventory from the transportation system. This was not always up to date. Several noted that a comprehensive inventory, including transportation, was developed by another State agency.

Planning and performance measurement (Q5): About 13 States had established qualitative GHG goals/objectives in long-range planning; four had set quantitative measures, including three that had set reduction targets.

Programming (Q6): Use of GHG measures in State Transportation Improvement Program (STIP) development was very limited, with only three States noting that they considered GHG in the STIP at a program-wide or project level.

Project development (Q7): About 12 States indicated that they required qualitative consideration of GHGs in project development, typically as a part of environmental documentation. Five States required quantitative consideration for certain types of projects. No State required the identification of mitigation

measures. Two States commented that the difference between project alternatives has been too small to be a factor in decision-making.

Communication of progress (Q8): One-quarter of responding States noted that they reported on achievement of GHG goals or targets in some way. This reporting typically came as part of annual or infrequent published reports on performance measures more generally, though in several cases was specifically geared towards air quality or GHG emissions.

Assessment tools (Q9/Q10): About half the responding agencies had applied at least one assessment tool. These include a mix of inventory/footprinting tools (8 agencies), planning-level tools (11 agencies), and project-level tools (8 agencies). About 5 agencies reported having tools in regular use per agency guidance. Tools mentioned by at least 2 agencies included:

- Motor Vehicle Emission Simulator (MOVES) for project analysis or statewide inventories (10 agencies).
- Federal Highway Administration (FHWA) Intersection Control Evaluation (ICE) tool for project planning (3 agencies).
- Energy and Emissions Reduction Policy Analysis Tool (EERPAT), GreenSTEP, and/or other members of the VisionEval family (3 agencies).

Work with partner agencies (Q11): A majority of respondents (25) indicated that they had worked with State, regional, and/or local partner agencies to support GHG consideration. Half (20) had worked collaboratively on strategies, analysis, and/or reduction targets; others supplied data for other agency efforts. Partners were typically the State environmental agency and/or one or more metropolitan planning organizations (MPO) or regional planning agencies.

Adequacy of resources (Q12/13): About one-quarter of agencies noted that existing resources for GHG consideration were adequate. One-fifth to one-quarter noted a need for better analytical tools and/or better resources for addressing institutional/procedural issues. About 13 agencies indicated they were “not sure,” likely indicating lack of familiarity with existing tools and resources. Other needs or barriers noted were:

- Tools for project evaluation and prioritization (5 agencies).
- Desire for tools that translate GHG or air quality impacts into economic benefit terms (3 agencies) and quantify other related impacts (health, equity, etc.) (1 agency).
- Lack of trained/dedicated staff (3 agencies).
- Measuring GHG from agency activities/operations (2 agencies).
- Engaging stakeholders and public for long-range scenario planning (1 agency).
- Incorporating GHG reduction across department functions (one agency).

Additional steps (Q14): About half of respondents were undertaking additional steps related to GHG. These agencies identified those steps as additional policy development (9), agency inventory (5), program-level measures/targets (3), program/system analysis tools (5), project-level tools (4), and additional collaboration (9). Several mentioned related activities, such as alternative fuel corridor development.

Interest in additional activities (Q15): About 8 agencies were strongly interested in participating in follow-up project activities with 14 “possibly interested” and 11 asking to “please check back later.” Only seven indicated no interest in further participation in this project.

Detailed Results

Complete survey results are provided below. Note that multiple responses were allowed for every question, so the total of “unique State respondents” may be greater than the total number of survey respondents. “Other responses by State” are provided verbatim. Responses from New York were received after the deadline and are not reflected in the tabulations provided below.

Question 1: Which State DOT do you represent?

Surveys were completed by the following 41 States: Arizona, Arkansas, California, Colorado, Delaware, District of Columbia, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine,

Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, and Wyoming.

Question 2: Does your agency have a policy or policies related to GHG emissions reduction?

Table A-1. Question 2.

Answer	Unique State Respondents	States
No.	26	AR, AZ, GA, HI, IA, IL, IN, KS, KY, LA, ME, MI, MO, MS, MT, NE, NH, PA, RI, SC, SD, TN, TX, UT, WV, WY
Policy to consider GHG emissions in planning, programming, project development, and/or operations.	9	CA, DC, MA, MD, NC, OR, VA, VT, WA
Policy that sets reduction goals or targets for GHG emissions from the agency's operations.	6	CA, DC, MA, MN, VT, WA
Policy that sets transportation systemwide GHG reduction goals or targets.	6	CA, DC, MA, MN, VT, WA
Other.	7	CO, DC, DE, ID, MD, NJ, TX, WA

Other Responses by State:

Colorado: Policy Directive 1901.0 and its Air Quality Action Plan; CDOT statewide planning factors; Colorado Climate Plan (2018) Explanation: CDOT has Policy Directive (PD) 1901.0 (CDOT Policy on Air Quality) and the associated CDOT Air Quality Action Plan (Plan). The PD establishes goals and direction of CDOT in regard to air quality, including GHGs. The Plan summarizes CDOT activities that have a secondary benefit of improving air quality. Plan appendices are updated annually. Some of the activities may help reduce GHG emissions. A State law, 43-1-1103(5)(j), states that a statewide transportation plan shall address but shall not be limited to certain planning factors, including reduction of GHG emissions. In addition, CDOT wrote the transportation chapter of the 2018 Colorado Climate Plan: State-Level Policies and Strategies to Mitigate and Adapt. That climate plan has the following commitments from CDOT regarding GHG reduction: Support new technology, fiber optics, and planning.

DC: The District of Columbia DOT (DDOT) follows statewide policies through coordination with other State and regional agencies.

Delaware: Reviewing.

Idaho: 08-09 GHG Emission Reduction Action Plan.

Maryland: Maryland DOT (MDOT) supports statewide targets from 2006 levels of 25 percent by 2020 and 40 percent by 2030.

Massachusetts: Other agencies have set goals for on-road emissions and for our agency's emissions.

New Jersey: New Jersey enacted Global Warming Response Act 7/6/2007, New Jersey Department of Environmental Protection (NJDEP) Global Warming Response Act (GWRA) recommendations report released December 2009, New Jersey DOT (NJDOT) participated.

Texas: We have a best practice for project development.

Washington: Washington State DOT (WSDOT) is voluntarily establishing a performance measure and target for GHG emissions on the National Highways System under the Moving Ahead for Progress in the 21st Century Act (MAP-21) performance measure framework.

Question 3: Has your agency developed an inventory of GHG emissions (carbon footprint) for its own operations?

Table A-2. Question 3.

Answer	Unique State Respondents	States
No.	28	AR, AZ, DE, GA, IL, IN, KS, KY, LA, ME, MO, MS, MT, NC, NE, NH, NJ, PA, RI, SC, SD, TN, TX, UT, VA, WA, WV, WY
Yes, but have not yet used to identify and implement GHG reduction measures.	4	DC, IA, ID, MI
Yes, and have used to identify and implement GHG reduction measures.	3	CA, MN, VT
Other.	9	CO, DC, HI, MA, MD, OR, TX, WA

Other Responses by State:

Colorado: CDOT began quantifying its GHG emissions in 2016 per a Greening of State Government Executive Order (EO) (D 2015-013). The GHG emissions are calculated based on agency energy and petroleum consumption. The EO goal is to: "Reduce GHG emissions by a minimum of 1 percent annually and at least 5 percent below Fiscal Year (FY) 2015 levels by FY2020." Since this is a State EO, numbers are compiled from all executive State agencies and departments and reported on an annual basis in a Statewide Annual Report Card.

DC: DDOT developed a GHG inventory of its operations but have not used it specifically. However, DDOT has identify and implemented GHG reduction measures through cooperation and participation in statewide and regional GHG reduction efforts.

Hawaii: For Honolulu International Airport only.

Maryland: MDOT does not have an agencywide inventory. Individual Transportation Business Units (TBU) have developed GHG inventories, e.g., MAA and MPA.

Massachusetts: Have an inventory. Causal link to reductions is arguable as there are many drivers for these investments.

Oregon: Track energy use and fleet fuel emissions.

Texas: We have a statewide on-road emissions analysis as a best practice.

Washington: State statute sets GHG limits for State agency operations and requires reporting annual agency emissions.

Question 4: Has your agency developed a transportation-sector GHG inventory and/or forecast for the State, or worked with a partner agency to develop one?

Table A-3. Question 4.

Answer	Unique State Respondents	States
No.	22	AR, AZ, GA, IA, ID, IL, IN, KS, KY, LA, MD, ME, MI, MO, MS, MT, NC, NE, NH, SC, SD, WV
Yes, but have not used it for transportation planning.	7	CO, DC, MA, RI, TN, VA, WY
Yes, have used in transportation planning.	3	MA, OR, VT
Yes, have used to specifically support performance metrics.	4	CO, MN, UT, VT
Other.	7	CA, DE, HI, NJ, TN, TX, WA

Other Responses by State:

California: California DOT (Caltrans) has not completed a transportation sector (to include fuel consumption of use of the State highway system); however, California Air Resources Board (CARB) compiles and prepares statewide inventory and forecasts for all sectors under its agencies requirements related to AB32 and the Scoping Plan.

Delaware: Working with other State agencies to develop.

Hawaii: For Honolulu International Airport.

New Jersey: The NJDOT has worked with the NJDEP and NJ Board of Public Utilities (NJBPUP) to establish GHG Inventories for the GWRA in the past.

Tennessee: Inventory now several years old.

Texas: As mentioned, we have a statewide analysis that includes a base year and projects 30 years in the future.

Washington: The Washington State Department of Ecology updates the statewide GHG emissions inventory every two years.

Question 5: Has your agency established long-range transportation plan (LRTP) goals, objectives, and/or performance measures related to GHGs?

Table A-4. Question 5.

Answer	Unique State Respondents	States
No.	22	AZ, DE, HI, ID, KS, KY, LA, ME, MI, MO, MS, MT, NE, NH, PA, SC, SD, TN, TX, UT, WV, WY
Qualitative goals/objectives.	13	CA, CO, DC, IA, IL, IN, MD, NC, NJ, OR, VA, VT, WA
Quantitative measures.	1	GA
Quantitative measures with reduction targets.	3	DC, MN, RI
Other.	4	AR, CO, DC, WA

Other Responses by State:

Arkansas: The Statewide Long-Range Intermodal Transportation Plan mentioned the GHG rule. It does not establish GHG goals, objectives, or measures. The rule was rescinded.

Colorado: CDOT's last published Statewide Plan (SWP), Transportation Matters: Statewide Transportation Plan 2040, has a list of strategies intended to address the four goals of the SWP: safety, mobility, economic vitality, and maintaining the system. It also has Strategic Policy Actions that address more than one goal. One such Strategic Policy Action deals with Sustainability and the Environment. That one states: Sustainability and the Environment: Continue to implement CDOT's Sustainability Plan and other environmental initiatives. Ensure all projects undergo timely and proper environmental review and compliance under the National Environmental Policy Act (NEPA) and other State and Federal statutes. Grouped under this Strategic Policy Action are six key initiatives: CDOT's Sustainability Program and Plan, Alternative Fuels Program, Environmental Compliance, Innovation, Storm Water Management, and C--Plan. The one that has the most bearing on GHG emissions is the Alternatives Fuels Program, focused on developing a statewide market for compressed natural gas and other alternate fuel vehicles.

DC: The DDOT's moveDC plan has set qualitative goals/objectives as related to our contributions to climate change impacts. In the District's Climate Action Plan and SustainableDC plan, there are specific targets to reduce emissions from the transportation sector.

Washington: WSDOT's annual Corridor Capacity Report includes GHG emissions on key commuter corridors.

Question 6: Does your agency consider GHG impacts in transportation improvement program (TIP), State TIP, and/or other capital programming evaluation?

Table A-5. Question 6.

Answer	Unique State Respondents	States
No.	32	AR, AZ, CO, DE, GA, HI, IA, IL, IN, KS, KY, LA, ME, MI, MN, MO, MS, MT, NC, NE, NH, NJ, OR, PA, SC, SD, TN, TX, UT, WA, WV, WY
Yes, measure for the overall TIP/STIP.	1	MA
Yes, quantitative project assessment, where feasible.	3	ID, MA, MD
Other.	8	CA, DE, HI, MA, NJ, TN, TX, WA

Other Responses by State:

California: The California 2018 STIP guidelines mirror the requirements of Executive Order B-30-15, to consider climate preparedness and reduction of GHG emissions when approving programming recommendations.

DC: DDOT does not do a quantitative project assessment; however, DDOT works with the regional MPO to quantify the GHG impacts in the regional long-range plan.

Rhode Island: Overall, GHG plan for the State is mentioned in the STIP.

Question 7: Does your agency consider GHG impacts in project development and alternatives analysis?

Table A-6. Question 7.

Answer	Unique State Respondents	States
No.	21	AR, AZ, CO, HI, IA, IL, KS, KY, LA, MI, MN, MO, MS, NH, NJ, SC, SD, TN, UT, WV, WY
Qualitative consideration (e.g., increase/decrease, high/medium/low).	11	CA, DC, MA, MD, NC, NE, PA, RI, VA, VT, WA
Quantitative consideration, where feasible (e.g., tons GHG).	5	CA, GA, ID, IN, WA
Quantitative consideration with mitigation strategies identified.	0	
Other.	7	CA, IA, ME, MT, OR, TX, WA

Other Responses by State:

California: Greenhouse gas emissions analysis is required by California Environmental Quality Act (CEQA). Qualitative or Quantitative analysis completed at the Project Approval and Environmental Document (PA&ED) stage dependent on project type.

Iowa: No, but GHG impacts have been considered from a qualitative standpoint in the past.

Maine: They may be a minimal component when conducting a NEPA Environmental Assessment (EA) or Environmental Impact Statement (EIS) study.

Montana: Qualitative analysis on limited projects involving an EA or EIS.

Oregon: No GHG impacts are considered for categorically excluded projects under 23.771.117, Qualitative consideration may be done for EA under NEPA, Quantitative consideration may be done for EA and must be done for EIS under NEPA.

Oregon: GHG considered in Congestion Mitigation and Air Quality (CMAQ) process.

Texas: We provide a statewide analysis, but it is not used in alternatives analysis (the difference between alternatives is too small).

Washington: Projects being reviewed at the NEPA EA or EIS level typically include a GHG analysis. To date, analysis has not led to making different project decisions. Typically, project alternatives have relatively the same emissions, with some differences between existing or no build conditions.

Question 8: Does your agency externally communicate progress regarding plans or projects which contribute to achieving GHG targets or goals?

Table A-7. Question 8.

Answer	Unique State Respondents	States
No.	30	AR, AZ, DC, GA, HI, IA, ID, IL, IN, KS, KY, ME, MI, MO, MS, MT, NC, NE, NH, NJ, PA, RI, SC, SD, TN, TX, UT, VA, WV, WY
Yes.	9	CA, CO, DE, MA, MD, MN, OR, VT, WA

If Yes: How, how often, and to whom does your agency publish and circulate these results?

Colorado: CDOT's Air Quality Action Plan Appendices A and B contain information about plans and projects that contribute to reducing GHGs; Appendix C contains data that shows if GHGs are being reduced from year to year.

Delaware: As needed for projects.

Maryland: Annually, Governor, General Assembly, Maryland Commission on Climate Change, and the public.

Massachusetts: STIP appendix, annually, the public.

Minnesota: Annual Sustainability Report.

Oregon: Publicly available monitoring report on agency's progress towards achieving State reduction goal. Five-year monitoring report for stakeholders.

Vermont: Vermont Agency of Transportation (VTrans) completes a biennial Transportation Energy Profile. In addition, VTrans participates in a variety of workgroups, including the Vermont Climate Action Commission, relating to reducing GHGs from the transportation sector. Further, VTrans contributes to annual reporting under the State's Comprehensive Energy Plan.

Washington: Biennial Office of Financial Management (OFM) Attainment Report address transportation-sector emissions, annual Corridor Capacity Report.

Question 9: What GHG assessment tools or methods (if any) have been applied by your agency?

Table A-8. Question 9.

Answer	Unique State Respondents	States
None.	19	AR, AZ, HI, IA, IL, KS, KY, LA, ME, MI, MO, MS, MT, NE, NH, SC, SD, TN, WV
Agency inventory/carbon footprinting.	9	CO, DC, ID, MA, MD, MN, RI, VT, WA
Planning-level tools.	10	AR, CO, IN, MA, OR, PA, UT, VA, VT, WA
Project-level tools.	9	GA, ID, IN, MA, OR, PA, VA, VT, WA
Planning- and project-level tools in regular use per agency guidance.	5	CA, MA, MD, NC, VT
Other.	8	AR, CO, DE, IA, NJ, RI, TX, WY

Other Responses by State:

Colorado: Statewide GHG inventories are calculated using two methods and reported in Appendix C of the CDOT Air Quality Action Plan. These performance measure calculations are updated annually. The rest of this answer is more for the future than about what CDOT is applying today. CDOT has been approved for a \$30,000 pilot project with EERPAT, an update to the MOVES model that will estimate air pollution improvements from various strategies and assess CDOT's own contribution to carbon dioxide in the atmosphere. If used in concert with the statewide travel model, currently under development, EERPAT could eventually help CDOT choose among competing projects.

Delaware: Working with partners.

Iowa: None, but we have used planning-level tools on a trial basis.

Massachusetts: Note: environmental agencies are responsible for compiling the statewide GHG inventory.

New Jersey: Developed a tool to assess Department activities/operations, but practical considerations (data, usability) have prevented implementation.

Rhode Island: Setting up Portfolio manager for our buildings to track GHG reductions.

Texas: The statewide on-road analysis and projections.

Wyoming: Wyoming Department of Environmental Quality (DEQ) coordination.

Question 10: Which specific tools or methods have you applied and for what purpose?

Arkansas: We use MOVES and other spreadsheet tools to quantify GHG changes for discretionary grant applications.

California: CARB VISION tool used for scenario planning in the California Transportation Plan 2040. FHWA ICE tool used for broad overview of GHG emissions related to projects at the planning stage. CARB Emission Factor (EMFAC) model used for project-specific GHG emissions estimates at the PA&ED phase for analysis in CEQA documents. Sacramento Metropolitan Air Quality Management District (SMAQMD) Road Construction Emissions Model (RCEM)—used for estimating construction-related GHG emissions at the project level.

Colorado: Appendix C of CDOT's Air Quality Action Plan uses two methods of GHG inventory calculation to determine if statewide GHG emissions are increasing or decreasing from year to year. One method is based on vehicle-miles traveled; the other is based on fuel consumption.

DC: DDOT used the AASHTO GHG accounting procedures guidance that incorporates the Local Government Operations protocol.

Georgia: FHWA Spreadsheet MOVES for project-level analysis.

Idaho: We use the economic benefits of GHG reduction that are included in emissions reduction when performing benefit/cost analysis.

Indiana: Coordination with applicable MPOs on MOVES emissions modeling, use of the State's Major Corridor Investment Benefit and Analysis (MCIBAS) tool for alternatives testing for major capacity adding projects direct use of the MOVES model analysis for affected areas not represented by an MPO; and TREDIS/REMI Econometric modeling for major corridor investments and improvement strategies.

Iowa: FHWA Sensitivity Matrix for vulnerability assessment.

Maryland: Environmental Planning Agency (EPA) MOVES model (including nonroad) inventory, planning- and project-level, spreadsheet-based and proprietary tools/software inventory, planning and project level.

Massachusetts: Travel demand model and MOVES model for projecting total on-road emissions under build and no build packages of projects. Fuel sales data and emission factors for estimating and reporting historical on-road GHG emissions. A range of project-level GHG estimation tools for project categories that cannot be reflected in the travel demand model analysis. Project selection methodology that includes GHG impact for scoring projects. Levelized cost of carbon methodology for evaluating cost effectiveness of GHG reductions. Guidance on GHG quantification and reporting for MPOs and Regional Transit Authorities (RTA).

Michigan: None.

Montana: None.

New Hampshire: None.

North Carolina: NCDOT has used EPA's MOVES model when Mobile Source Air Toxic (MSAT) analyses have been required.

Oregon: GreenSTEP for statewide GHG scenario planning. Regional Strategic Planning Model (RSPM) for regional GHG scenario planning. Transitioning to the VisionEVAL suite.

Oregon: Planning-level tools include GreenSTEP for statewide scenario planning, and Regional Strategic Planning Model for MPO-level scenario planning. Project-level tools for GHG assessment include EPA MOVES for operational emissions and the ICE model for construction and maintenance emissions and the application of FHWA fuel factor of 27 percent to account for emissions released during fuel extraction, refining, and transport prior to use by vehicles.

Pennsylvania: Qualitative analyses for EAs and EISs.

Rhode Island: Using Portfolio manager to begin tracking energy usage in our buildings and measure the difference as buildings are upgraded for energy efficiency.

Texas: We compare statewide on-road, to total statewide emissions, total national emissions, and total global emissions. MOVES, with county specifics and county vehicle-miles traveled (VMT) projections are summed to estimate statewide on-road emissions.

Vermont: The Transportation Energy Profile tracks progress toward meeting the transportation-sector goals of the State's Comprehensive Energy Plan (CEP). VTrans considers the goals of the CEP in planning. In addition, VTrans works with other agencies to accelerate vehicle electrification in Vermont.

Virginia: MOVES, for evaluating carbon dioxide (CO₂) emissions.

Washington: WSDOT completed a pilot analysis using EERPAT in about 2014 Lynwood Strategic Highway Research Program (SHRP) 2 case study project-level analyses for NEPA EA and EIS documents are conducted using EPA's MOVES. Construction emissions for projects evaluated in EAs and EISs are calculated using FHWA's ICE tool.

Wyoming: Worked with the Wyoming DEQ on GHG use in Sublette County and surrounding areas.

Question 11: In the past five years, has your agency worked with a partner agency (State, MPO, or local agency) to support their consideration of transportation GHG emissions?

Table A-9. Question 11.

Answer	Unique State Respondents	States
No.	14	AR, AZ, DE, ID, KS, LA, MI, MO, MS, NH, PA, SD, TN, WV
Supplied data.	8	CA, DC, IA, MA, MT, NJ, WA, WY
Worked collaboratively on strategies and analysis.	13	CO, GA, IL, IN, MA, MN, NC, NE, OR, RI, UT, VT, WA
Worked collaboratively on strategies, analysis, and reduction targets.	8	CA, DC, MA, MD, MN, RI, VA, WA
Other.	7	HI, IA, KY, ME, SC, TX, WA

Other Responses by State:

Hawaii: State has established Climate Change Commission which has begun considering impact of GHG.

Iowa: Supplied information in the form of survey responses.

Maine: We work with the Maine Department of Environmental Protection (DEP) who conduct our Air Conformity Analysis.

South Carolina: We've had discussions with our State Air Quality Agency, but nothing developed.

Texas: We provide data for the State DEQ to use for VMT and county emission projections for multiple pollutants, including GHG emissions.

Washington: WSDOT contributes to multiagency resources to help local governments develop transportation-efficient communities.

Question 11a: Which agencies?

Colorado: Colorado Department of Natural Resources, City and County of Denver, Colorado Department of Public Health and Environment.

Colorado: Collaboration includes Colorado Department of Natural Resources on the 2018 Colorado Climate Plan City and County of Denver on its "80 by 50" plan to reduce the City's GHG emissions by 80 percent by 2050. The Colorado Department of Public Health and Environment on annual updates to one of the Air Quality Action Plan's appendices, Appendix D: Statewide Motor Vehicle Performance Measure Emissions Methodology: Colorado Air Pollution Control Division Report.

DC: District Department of Energy and Environment, Metropolitan Washington Council of Government, District Office of Planning.

Georgia: Atlanta Regional Commission (ARC).

Wyoming: Wyoming DEQ.

Illinois: Chicago Metropolitan Agency for Planning.

Indiana: MPOs (Indianapolis, South Bend, Fort Wayne, Evansville, Louisville KY, NW Indiana), Indiana Department of Energy Management (IDEM).

Maryland: State agencies, MPOs, and others through the Maryland Commission on Climate Change.

Massachusetts: All MA MPOs, All MA Regional Transit Authorities, MA Department of Environmental Protection, MA Executive Agency of Energy and Environmental Affairs.

Minnesota: MN Pollution Control Agency (State environmental agency).

Montana: MPO.

Nebraska: MAPA MPO in the Omaha area.

New Jersey: NJDEP and NJBPU.

North Carolina: NC Department of Environmental Quality—Air Quality Division.

Oregon: State energy, environmental quality, and health agencies, MPOs, local jurisdictions.

Oregon: States Department of Energy, Department of Environmental Quality, Department of Land Conservation and Development, MPOs, and local jurisdictions.

Rhode Island: Worked with all the Rhode Island (RI) State agencies on the overall State goals for GHG emission reduction targets and GHG reduction plan.

Vermont: Regional planning commissions, municipalities, Department of Buildings and General Services, Department of Public Service, Department of Environmental Conservation, Department of Housing and Community Development, Department of Health, and Agency of Agriculture Food and Markets.

Utah: Wasatch Front Regional Council (WFRC) and Mountainland Association of Governments (MAG).

Virginia: Metropolitan Washington Council of Governments.

Washington: Department of Ecology, Department of Commerce, Department of Health, MPOs, especially Puget Sound Regional Council.

Question 12: How adequate are existing resources for supporting your agency's current and expected consideration of GHG issues?

Table A-10. Question 12.

Answer	Unique State Respondents	States
Resources are adequate.	10	DE, ID, ME, MA, NC, NH, TN, UT, VA, WV
Need better analytical tools (or information about tools).	8	CO, DC, HI, MN, NJ, OR, RI, WY
Need better resources for addressing institutional/procedural issues.	9	CA, CO, DC, HI, LA, MN, NJ, RI, WA
Not sure.	13	AZ, GA, IA, IN, KS, KY, MI, MO, MT, NE, OR, PA, SC
Other.	8	AR, HI, MD, ME, MS, SD, TX, VT

Other Responses by State:

Arkansas: It would be beneficial to have clear guidance on monetizing local (as opposed to global) impacts of air quality.

Hawaii: Need technically knowledgeable staff.

Maine: Working with Maine DEP.

Maryland: Emissions tools can always be improved at Federal level, i.e., moves, but have been adequate for our purposes. Could use better integration with economic tools.

Mississippi: Very limited resources related to GHG issues.

South Dakota: South Dakota has no nonattainment areas and is a very rural State and do not have issues with air quality.

Texas: Resources are adequate at the moment. That could change depending upon Federal or State policy changes.

Vermont: All agencies are thinly staffed.

Question 13: How would better tools facilitate additional consideration of GHG issues by your agency?

Arkansas: The ability to monetize air quality impacts would allow for a quantitative treatment in benefit/cost analyses.

California: Need better information on how to efficiently and cost effectively incorporate GHG emissions reduction measures at the project level. Case studies of incorporating GHG reduction across department functions.

Colorado: Better tools would provide better data. Criteria could be established and considered as part of the project selection process.

DC: In prioritizing projects for implementation during planning, programming, and project development.

Georgia: Comparison Data (i.e., building roads cause and effect). More Guidance on how to analyze the data.

Idaho: If they can calculate economic or safety benefits.

Illinois: With better GHG analyze tools the agency would be in a greater position to analysis projects and predict impacts in programming documents like the TIP and STIP.

Iowa: Not sure at this time.

Kansas: In the long term, this agency may begin to consider GHG issues, but we have not begun work in this area. For the short term, this likely will remain the case, but we will coordinate with our Transportation Management Areas (TMA) should they begin work on GHG issues.

Maryland: Economic impacts, positive and negative externalities (workforce impacts, opportunity cost of focus on GHG, public health, multipollutant impacts, equity, and environmental justice).

Massachusetts: Our existing GHG quantification tools and practices have been reviewed by air quality experts and best practices of other agencies considered under a recent SHRP 2 project. These appear fit for purpose. It is always possible to improve, but a range of research projects and analysis completed for our agency and results from estimating GHG outcomes from several hundred projects all point towards transportation infrastructure investments being ineffective and/or inefficient at reducing GHG emissions, so arguably we have reached or passed the point of diminishing returns for GHG consideration at least as far as planning and project selection are concerned. With respect to systemwide GHG reduction goals or targets, it is important to be realistic about the obligations of State DOTs. There might be an understandable misconception that transportation agencies should bear responsibility for reducing transportation-sector emissions, but the effective policy levers typically rest with other agencies. It is important to align responsibilities with the authority to pursue affordable solutions and to avoid pursuing costly GHG reductions in one sector at the expense of low-cost abatement elsewhere in the economy.

Minnesota: Currently, we have no dedicated staff or staff with portion of their position officially dedicated to this work.

Mississippi: To be determined.

New Jersey: Would enable us to better understand the GHG impacts of our activities and projects.

North Carolina: Not sure. This would be dependent on the tools and their application. We look forward to receiving future guidance on the consideration of transportation-related GHG emissions.

Wyoming: Better collaboration with the DEQ on high-ozone/GHG emissions areas.

Oregon: The tools (MOVES, ICE, Fuel factor) we use sufficiently define emissions for project impacts. A guidance document for best practices would be helpful for GHG with MOVES. Need a more cost-effective method to engage stakeholders and the general public in long-range scenario planning for GHG reduction.

Rhode Island: Tools and support are needed for GHG measurements of our operations.

South Carolina: No plans.

South Dakota: Air quality is not an issue in South Dakota.

Tennessee: It seems unlikely that additional tools would have a significant impact on the status quo.

Vermont: Marginally. VTrans is pursuing a variety of means to reduce GHG emissions from the transportation sector, but one essential tool, which is to accelerate vehicle electrification, depends on part on regional, national, and global policies.

Washington: WSDOT has good support from our Governor's office on reducing GHG emissions and we have a Senior Policy Specialist for Air Quality and Energy who works primarily on GHG emissions (agency, sector, and project levels). The agency has a strong focus on multimodal transportation solutions, and supports other approaches to reducing emissions in our State. We are working to modernize our ferry fleet; initial steps include operational improvements to reduce fuel use and work to convert three vessels to electric hybrid. Recently upgraded rail engines are more efficient than previous equipment and support increased passenger rail service between Seattle and Portland. One staff person dedicated to expanding EV charging infrastructure in the State and an initial \$1 M funding provided in grants. WSDOT is working closely with State partners on Volkswagen funding for additional electric vehicle (EV) charging. We do not have analytical standards or procedures incorporated into agency processes to understand the effects of the decisions we make.

Question 14: Is your agency considering taking additional steps to address GHG emissions in the near future? (check all that apply)

Table A-11. Question 14.

Answer	Unique State Respondents	States
Not at this time.	21	AZ, GA, ID, IN, KS, KY, LA, MI, MN, MO, MS, MT, NE, NJ, PA, SC, SD, TN, UT, WV, WY
Additional policies.	9	DC, DE, HI, IL, NC, OR, RI, VA, VT
Agency inventory/carbon footprinting.	4	DC, DE, MA, RI
Program-level performance measures or targets.	3	DC, DE, RI
Develop/improve/apply program- or systems-level analysis tool.	5	CA, CO, DC, OR, RI
Develop/improve/apply project-level analysis tools.	4	CA, DC, MA, RI
Additional collaboration/coordination with partners on data and tool development.	9	CO, DC, HI, IL, MA, MD, OR, RI, VT
Other.	8	AR, CO, HI, IA, NH, NJ, TX, WA

Other Responses by State:

Arkansas: While not directly addressing GHG emissions, the Department is working with the State environmental agency to achieve Alternative Fuel Corridor Designations along several corridors. The Department also works closely with two of the State's TMAs to program CMAQ funds for planning activities related to emission reductions. Additional partnerships include participation in the Ozone Actions Days program in central Arkansas.

Colorado: Systems-level planning will be performed along with scenario planning in development of the 2045 Statewide Transportation Plan. CDOT's Statewide Travel Model will be one of the tools that will be utilized. In conjunction with the Statewide Travel Model, the EERPAT model will be used as a

complementary tool to determine GHG emissions on various types of improvements. As we use these tools, will be coordinate with our planning partners to define areas of collaboration and coordination.

Hawaii: Participating in State Climate Change Commission that is initiated discussions on GHC.

Iowa: Possibly vulnerability assessment.

Massachusetts: A range of activities relevant to GHG reduction but they serve multiple objectives. GHG reduction policy is not lead by our agency but we participate in discussions with the lead agencies.

New Hampshire: New Hampshire DOT (NHDOT) would seek to cooperate with other agencies to comply with any GHG-related laws, rules, or guidance, should it be developed in the future.

New Jersey: New Governor’s administration is more active on climate change than the previous administration. How this will translate to specific Department policies and actions is not yet determined.

Texas: We will be participating in the pooled fund for refining the FHWA ICE tool.

Washington: We are developing a metric and target to track GHGs on the NHS, as was described in the January 2017 version of the Performance Measure rule 3 (PM3).

Question 15: Would your agency be interested in participating in additional activities of this research project, including workshops to develop and review GHG resources, and/or implementation support of GHG analysis methods?

Table A-12. Question 15.

Answer	Unique State Respondents	States
Not interested.	7	LA, ME, MO, MT, TN, WV, WY
Please check back later.	11	AZ, ID, IN, KS, KY, MA, MI, MS, NH, SC, SD
Possibly interested.	14	AR, CA, GA, HI, IA, MD, NC, NE, NJ, PA, TX, UT, VA, VT
Strongly Interested.	8	CO, DC, DE, IL, MN, OR, RI, WA

Level of Engagement

The survey and literature review findings were used to initially classify States into an “engagement model” framework, considering dimensions of *policy*, *practice*, and *technology*. Four general “levels of engagement” were established to help differentiate State needs and provide context for ultimate development of the guide to assist State DOTs in evaluating transportation GHG emissions and including GHG considerations in decision-making.

The general engagement levels were defined as follows with the understanding that highly precise classifications are neither required nor desired. Note that the levels currently are being used to gain a better understanding of how States currently are addressing GHG issues and that guide topics may need to include attributes beyond Level 4 to be useful for that particular audience.

- **Level 1:** “New to the topic.” Few or no formal actions to address GHG, although the agency might be involved in discussions regarding GHG activities or supporting another agency’s activities.
- **Level 2:** “We are developing our own policies or goals.” Policy—has established general policies, goals, and/or objectives related to GHG; Practice—may apply qualitative project or program evaluation criteria; Technology—no or limited/partial GHG inventory.
- **Level 3:** “We are measuring and planning our actions and engaging others.” Policy—has established specific policies, goals, and/or objectives related to GHG; Practice—apply quantitative project and/or

program evaluation criteria; Technology—has developed GHG inventory and/or forecast, possibly limited use of assessment tools.

- **Level 4:** “We are taking action and tracking progress internally and with partners.” Policy—serious multiagency effort; Practice—strategic planning: has evaluated GHG reduction strategies, linked strategies to plans and programs, and conducted quantitative assessment; Technology—has developed inventory, forecast, specific data and measurement methods, and established a range of specific policies, goals, and/or objectives related to targeted GHG reductions; tracks progress towards achieving targets; addressing GHG from both agency operations and the transportation system.

Agencies were classified into levels for responses to individual survey questions. Table A-13 shows the rules used to generally classify the responses. In some cases, agencies responded using the “other” option with a free-response note; in these cases, judgment was used to assign a response to a given level. Agencies that did not respond to a question were not classified for that question. For each agency, the total number of responses by level was then determined, and a “score” calculated as the average value of the number of responses by level multiplied by the level (1–4). Agencies were then assigned an overall score with the following cutoffs: Level 1 = < 1.3; Level 2 = 1.3–1.99; Level 3 = 2.0–2.49; Level 4 = 2.5 or greater. The overall distribution of States by classification, as assigned based on the survey responses, is shown in Figure 3-1.

This taxonomy is inherently subjective, and agencies with scores close to the cutoff could be reasonably categorized into either level. The scoring also is primarily based on self-reported actions, and the accuracy of the reported activities was not verified. However, document review of States at higher levels of engagement helped to provide more insights into specific policies and actions referenced in published documents (see Section 4.0). This document review suggested the need for minor revision of a couple of categorizations. As more States move to Level 4, this level might be further differentiated based on how extensively GHG considerations are integrated throughout the agency’s planning and operations. The issue of what it means to comprehensively consider GHG was further explored as part of guide development and is discussed in Section 19.0 of the guide.

Table A-13. Rules used to assign levels.

Question	Dimension and Level
2. Does your agency have a policy related to GHG emissions reduction?	Policy
a. No.	L1
b. Policy to consider GHG emissions in planning, programming, project development, and/or operations.	L2
c. Policy that sets reduction goals or targets for GHG emissions from the agency’s operations.	L3
d. Policy that sets transportation systemwide GHG reduction goals or targets.	L4
3. Has your agency developed an inventory of GHG emissions (carbon footprint) for its own operations?	Practice
a. No.	L1
b. Yes, but have not yet used to identify and implement GHG reduction measures.	L2
c. Yes, and have used to identify and implement GHG reduction measures.	L4

Question	Dimension and Level
4. Has your agency developed a transportation-sector GHG inventory and/or forecast for the State, or worked with a partner agency to develop one?	Practice
a. No.	L1
b. Yes, but have not used it for transportation planning.	L2
c. Yes, have used in transportation planning.	L3
d. Yes, have used to specifically to support performance metrics.	L4
5. Has your agency established LRTP goals, objectives, and/or performance measures related to GHGs?	Practice
a. No.	L1
b. Qualitative goals/objectives.	L2
c. Quantitative measures.	L3
d. Quantitative measures with reduction targets.	L4
6. Does your agency consider GHG impacts in TIP and/or STIP evaluation?	Practice
a. No.	L1
b. Yes, measure for the overall TIP/STIP.	L2
c. Yes, qualitative project assessment.	L3
d. Yes, quantitative project assessment where feasible.	L4
7. Does your agency consider GHG impacts in project development and alternatives analysis?	Practice
a. No.	L1
b. Qualitative consideration (e.g., increase/decrease, high/medium/low).	L2
c. Quantitative consideration, where feasible (e.g., tons GHG).	L3
d. Quantitative consideration with mitigation strategies identified.	L4
8. Does your agency externally communicate progress regarding plans or projects which contribute to achieving GHG targets or goals?	Practice
a. Yes.	L3
b. No.	L1
9. What GHG assessment tools or methods (if any) have been applied by your agency?	Technology
a. None.	L1
b. Agency inventory/carbon footprinting.	L2
c. Planning-level tools.	L3
d. Project-level tools.	L3
e. Planning and project-level tools in regular use per agency guidance.	L4
11. Has your agency worked with a partner agency (State, MPO, or local) to support their consideration of transportation GHG emissions?	Practice
a. No.	L1
b. Supplied data.	L2
c. Worked collaboratively on strategies and analysis.	L3
d. Worked collaboratively on strategies, analysis, and reduction targets.	L4

APPENDIX B

State DOT Document Review

Overview

This section reviews policy, planning, and other documents developed by State departments of transportation (DOT) that address the quantification and/or mitigation of greenhouse gas (GHG) emissions as posted on their websites. It also describes State-level policies when they directly reference transportation emissions and require inventory and/or mitigation actions in the transportation sector. Though the project team thoroughly search the websites, this was a website review and was not vetted with the subject DOTs.

Documents from 11 State DOTs are included in the review. These agencies were identified from the survey as State DOTs with higher levels of GHG engagement. For those State DOTs wanting to become more active in reducing GHG emissions, these documents may be useful examples of GHG policy and planning actions. The team reviewed documents from several other States with moderate levels of engagement, but these yielded little information.

After examining State DOT websites for climate change-related items, those items were reviewed for policy or activity related to GHG emission reductions. In many cases, these documents were Long-Range Transportation Plans (LRTP); State Transportation Improvement Program (STIP) analyses; planning for various transportation modes (e.g., State rail plans); air quality analysis procedures; or sustainability plans. In cases in which State DOT documents indicated reliance on, or outgrowth from, other State documents prepared by other State agencies, or in collaboration with other State agencies, the review included those items (e.g., State Climate Action Plans), as well for their impact on the transportation sector and the State DOT. Since this project relates to GHG emission reduction activities, State DOT climate change documents related to adaptation or resilience were not subject to review. In cases in which multiple versions of documents existed, the review focused on the most recent version. Many documents that State DOTs publish describe activities that by their nature also would reduce GHG emissions, such as bicycle/pedestrian plans. However, these documents were not subject to review if they did not mention GHG emission reduction as a goal, objective, or outcome.

The following section discusses policies, studies, and actions addressing GHG emissions as posted on State DOT websites in each of the following categories:

- **Policy.** State-level policies (adopted by the DOT, the State legislature, or Governor's office) that include references to GHG reduction in the transportation sector.
- **Long-Range Planning.** Goals, objectives, strategies, measures, or projects to reduce GHG emissions referenced in the State's LRTP.
- **Programming.** Inclusion of GHG as a consideration in the development of the STIP.
- **Project Development/Environmental Analysis.** Consideration of GHG in project development and/or environmental review (e.g., requirements to quantify GHG emissions associated with project alternatives and/or develop mitigation measures).
- **Transportation System Management and Operations (TSMO).** Policies or actions to reduce GHG emissions from vehicles using the State's transportation system through operational measures such as traffic efficiency improvements.

- **Agency Operations.** Policies or actions to quantify and/or reduce GHG emissions from facilities and vehicles under the agency’s direct control, including agency- and contractor-operated fleets, traffic controls, DOT buildings, materials, and maintenance activities.
- **GHG-Specific Planning.** Development of a transportation-sector GHG inventory, forecast, and/or mitigation plan for the State. This category also includes plans or studies focused on specific GHG reduction strategies such as electric vehicles.

If a category is not included, no documents were identified relevant to that particular category. However, it is possible that the DOT may have developed a document that was not easily located on their website. Also, documents listed in some categories may be relevant to other categories. For example, GHG-specific plan activities often inform the development of other plans and policies (such as the LRTP) even if GHGs are not explicitly referenced in those locations. Table B-1 summarizes the categories in which documents for each State were identified.

Table B-1. Summary of categories addressed in State DOT published documents.

State	Policy	Long-Range Planning	Programming	Project Dev/Env Analysis	TSMO	Agency Operations	GHG-Specific Planning
California	✓	✓		✓		✓	
Colorado	✓	✓				✓	
District of Columbia	✓			✓		✓	
Maryland	✓		✓				✓
Massachusetts	✓		✓	✓	✓	✓	✓
Minnesota	✓	✓				✓	
Oregon		✓			✓		✓
Rhode Island	✓	✓	✓			✓	✓
Vermont	✓	✓				✓	✓
Virginia			✓	✓			
Washington	✓			✓		✓	✓

State Policies and Documents

California

Policy

Starting with the California Global Warming Solutions Act of 2006, the State’s policy framework places a strong emphasis on GHG reduction. Senate Bill 375 (2008) requires regional transportation and land use planning to reduce GHG emissions; Executive Order 8-30-15 establishes a GHG reduction target of 40 percent below 1990 levels by 2030, in addition to the State’s emission reduction goal of 80 percent by 2050.

California’s 2017 *Climate Change Scoping Plan*, developed by the California Air Resources Board (CARB), adopts GHG emission reduction targets for transportation. The plan alters building, planning, and development methods for urban areas. Other transportation measures include more efficient delivery trucks,

heavy-duty trucks, and goods movement. The plan establishes transportation sustainability actions, including goals for vehicle-miles traveled (VMT) reduction, vehicle technology, clean fuels and sustainable freight and provides a detailed list of specific measures. The plan notes that while most of the GHG reductions from the transportation sector will come from technologies and low-carbon fuels, a reduction in the growth of VMT also is needed. The plan sets a goal of a 15 percent reduction in VMT from expected levels in 2050.

The *Caltrans Strategic Management Plan 2015–2020* sets strategic objectives and performance metrics for the agency. The plan establishes performance measures and targets for transportation system GHG and for the California DOT (Caltrans) design, construction, operation, and maintenance activities. Under Goal 3 (Sustainability, Livability, and Economy), the plan sets a strategic objective to support a statewide reduction of GHG emissions to achieve 80 percent below 1990 levels by 2050. The plan sets a target of a 15 percent reduction (from 2010 levels) of GHG to achieve 1990 levels by 2020.

Long-Range Planning

The *California Transportation Plan 2040* (2016) vision references meeting the State’s GHG emission reduction goals and includes GHG reduction as a basis for the plan. The plan includes a policy to “reduce GHG emissions and other air pollutants.” The plan makes recommendations to meet regional GHG goals by managing transportation and land use; implement project development and review requirements; deploy mobile source control technology; and support efforts to implement clean vehicles, fuels and technology, and alternative modes of transportation. The plan includes estimates of GHG emissions from the transportation sector between 2010 and 2050 under three scenarios with different levels of transportation investment and alternative fuel vehicle technology. The plan includes an economic analysis of GHG reduction strategies.

Project Development/Environmental Analysis

Caltrans is developing draft guidance to implement California Environmental Quality Act (CEQA) guidelines. The guidance will establish a process for Caltrans District staff to make project-level significance determinations, and identify mitigation measures as necessary, under CEQA GHG emissions.

Agency Operations

In addition to setting systemwide GHG reduction objectives and targets, the *Caltrans Strategic Management Plan 2015–2020* sets targets of a 15 percent reduction by 2015 and 20 percent reduction by 2020 of Caltrans’ internal operational GHG emissions.

The *Caltrans 2-Year Plan* (2016) is a short-term strategic management plan for the agency. It establishes uses of Tier 4 construction equipment on pilot projects to reduce pollution, including GHGs. It also prioritizes zero-emissions vehicle (ZEV) implementation actions by installing fast-charging electric vehicle (EV) stations, increasing employee EV charging stations, and installing three hydrogen fueling stations.

Caltrans annually calculates GHG emissions produced by Department facilities and operations and reports these to the Climate Registry.

Colorado

Policy

The Colorado Climate Plan (2015) is a multiagency collaboration between the Colorado DOT (CDOT) and six other State agencies to promote State policy recommendations and actions to adapt to future climate change impacts and identify opportunities to mitigate GHG emissions. This plan was developed to meet the

requirements of Colorado House Bill 13-1293. The plan commits CDOT to work with the State Transportation Advisory Commission to develop a stakeholder engagement process. The plan adopts broad strategies to reduce GHG emissions, including:

- Promoting and encouraging fuel-efficient vehicle technologies and programs to reduce vehicle emissions.
- Continuing to support strategies and develop new strategies to reduce GHG emissions, reduce the growth of VMT, and alleviate congestion.
- Providing guidance to local governments on land use planning strategies to promote efficient use of public resources and reduce GHG emissions through compact, transit-oriented development that utilizes smart growth practices and complete streets.

Long-Range Planning

The *Colorado Statewide Transit Plan* (2015) includes reducing VMT and GHG emissions among its goal and objectives. The plan adopts performance measures that relate to percentage of statewide fleet using compressed natural gas, hybrid electric, or clean diesel vehicles or other low-emission vehicles and passenger miles traveled on fixed-route transit.

The *Colorado State Highway Freight Plan* (2015) includes an objective to improve the energy efficiency of freight movement and reduce associated levels of GHG emissions. The plan includes strategies related to truck electrified parking at rest areas and other locations and promote vehicle efficiency by promoting and disseminating information on strategies and programs to improve freight vehicle efficiency.

The *Statewide Bicycle and Pedestrian Plan* (2015) discusses the connection between biking and walking with lower emissions with emphasis on high emissions associated with short trips and cold starting vehicles. The plan adopts a goal and investment decision criterion of reducing carbon-based VMT through increased bicycling and walking and a performance measure of mode shift.

Agency Operations

The *CDOT Sustainability Program and Action Plan* (Fiscal Year 2016) identifies a number of actions CDOT has taken to reduce GHG emissions as part of its stewardship program, including fleet management, roadside sand cleanup program, engines off in school areas, diesel idling reduction, compressed natural gas (CNG) and EV roadway signs, reclaiming asphalt, etc.

District of Columbia

Policy

Climate of Opportunity: A Climate Action Plan for the District of Columbia (2010, Draft) proposes various transportation measures to meet GHG emission reduction targets for both Government and the public. Some example measures are flexible work schedules, car sharing, EV infrastructure support, downsize police cruiser vehicles, street lighting retrofits, promote anti-idling, expand and enhance alternative transportation mode options, etc. The plan includes an inventory of emissions forecasts by sector, with transportation including vehicles and transit (Metro). The plan sets targets to reduce emissions by 20 percent below 2006 levels by 2012, 30 percent below 2006 levels by 2020, and 80 percent below 2006 levels by 2050.

Project Development/Environmental Analysis

The District of Columbia DOT (DDOT) *Environmental Policy and Process Manual, Second Edition* (2012) requires qualitative discussion of direct and indirect effects GHG associated with a transportation project as part of the air quality analysis in environmental review documents.

Agency Operations

The *DDOT Greenhouse Gas Emission Inventory* (2012) includes emissions from DDOT fleets, the DC Circulator Bus, facilities, streetlights, traffic signals, and roadway network (VMT by vehicles traveling on all roadways within the District). The inventory was developed with a base year of 2009 and a forecast year of 2040.

Maryland

Policy

Maryland's Greenhouse Gas Emissions Reduction Act Plan (last updated 2015) includes a multisector inventory and forecast and plan for reducing GHG emissions within a multipollutant framework. The plan implements the Maryland Greenhouse Gas Emissions Reduction Act of 2009, which requires Maryland to achieve a 25 percent reduction in 2006 GHG emissions by 2020 (the target was expanded in 2016 to a 40 percent reduction by 2030 levels from a 2006 baseline). The plan references GHG analysis and strategy development by MDOT and lists a range of transportation-related programs and associated potential emission reductions to help achieve overall reduction goals. The plan proposes setting emission targets for the Baltimore- and Washington-area transportation sectors.

Programming

Maryland DOT's (MDOT) GHG planning activities reference GHG-beneficial investments in the State's Consolidated Transportation Plan (reducing single-occupant vehicle travel, shifting to lower energy intensity modes, and improving travel efficiency and vehicle technology) and estimate that these represent 44 to 50 percent of MDOT's six-year (2017–2022) program.

Source: MDOT—2018 GGRA Draft Plan Status, Presentation to the Mitigation Working Group, MCCC, April 5, 2018 by Colleen Turner.

Agency Operations

MDOT's GHG planning activities (as described in the same presentation) reference annually reported performance measures that relate to GHG, including VMT, agency fuel consumption, and conventional and renewable energy generation, among others.

GHG-Specific Planning

The *Maryland Climate Action Plan: Maryland Department of Transportation Draft 2012 Implementation Plan* (2011) focuses on the transportation sector in Maryland. It develops baseline and future GHG emission levels. The plan identifies funded, unfunded, and additional transportation programs to meet GHG emission reduction targets. The plan implements the Maryland Greenhouse Gas Emissions Reduction Act of 2009, which requires Maryland to achieve a 25 percent reduction in 2006 GHG emissions by 2020 in the transportation sector.

MDOT's *Maryland 2015 Greenhouse Gas Reduction Act Plan* updates the baseline forecast and identifies specific actions being implemented or planned for implementation through 2020, as well as these actions' GHG reduction benefits. These include on-road, airport, port, and freight rail policy options; electric and low-emitting vehicle initiatives; public transportation initiatives; and consideration of evaluating GHG emissions through the National Environmental Policy Act (NEPA) and/or regional planning processes. The plan identifies costs for various options.

Charting the Path Forward: A Transportation Strategy for Meeting Long-term Air Quality and Greenhouse Gas Emissions Goals and Enhancing Maryland's Economy and Quality of Life (2016) is a joint strategy document of the MDOT and Maryland Department of the Environment. This document adopts a strategic vision for:

- Cleaner Vehicles and Fuels—Providing incentives, policies, and infrastructure support to expand the market for vehicles that produce low or zero emissions.
- Increasing Travel Choices—Supporting mobility improvements and livable communities that facilitate use of transit, bicycling, and walking options.
- Enhancing Travel Efficiency—Optimizing system operations to reduce traffic congestion, improve travel time reliability, and reduce fuel consumption.
- Spurring Innovation—Advancing clean energy technologies in transportation.
- Strategic Highway Capacity Enhancements—Reducing traffic congestion in critical transportation corridors to positively impact air quality.
-

The document supports increasing ZEV deployment and supporting plug-in electric vehicle (PEV) deployment; port-related initiatives; retrofitting and replacing aging fleet vehicles to reduce GHG emissions and improve air quality; transit improvements and transit-oriented development; reduced vehicle idling; and energy-efficient lighting.

Massachusetts

Policy

The Massachusetts *Clean Energy and Climate Plan for 2020* (2015) updates the 2010 plan, as required under the Massachusetts Global Warming Solutions Act of 2008. The plan sets forth strategies to reduce emissions to at least 25 percent below 1990 levels by 2020. Transportation strategies in the plan include smart growth, electric vehicle market development, and continuation of Massachusetts DOT's (MassDOT) GreenDOT program. The plan requires MassDOT to achieve its GHG reduction goal and to focus on three related goals: reduce GHG emissions; promote the healthy transportation modes of walking, bicycling, and public transit; and support smart growth development.

MassDOT's *GreenDOT Policy Directive* (2010) and *GreenDOT Implementation Plan* (2012) establish policy related to activities ranging from strategic planning to construction and system operations. Long-range planning documents, including statewide planning documents, as well as long-range metropolitan planning organization (MPO) plans, must address MassDOT's three sustainability goals and evaluate, track, and plan for reducing GHG emissions over time. Similarly, the shorter-range Transportation Improvement Programs (TIP) and State Transportation Improvement Programs (STIP) must be consistent with the State's GHG reduction target. This will require that the MPOs and MassDOT minimize highway system expansion projects and balance their impact with other projects that support smart growth development and promote public transit, walking, and bicycling. In addition, the project programming mix included in the Regional Transportation Plans (RTP), TIPs, and STIPs can contribute to GHG reduction through prioritizing roadway projects that enable improved system operational efficiency without expanding overall roadway system capacity.

Programming

MassDOT's *Transportation Improvement Program Greenhouse Gas Assessment and Reporting Guidance* (2017) establishes that all TIP projects are subject to a GHG assessment; should assess whether the project results in an increase, decrease or no impact on GHG emissions; and should be considered for a quantitative evaluation. GHG estimates must be reported during each TIP/STIP cycle. Analyses are performed through a Congestion Mitigation and Air Quality (CMAQ) spreadsheet calculation. Regional TIP and STIP will include an evaluation of overall GHG emissions from the program of projects, and will need to be developed in a manner that fits into an overall State GHG reduction target. This will require that the MPOs and MassDOT balance highway system expansion projects with other projects that support smart growth development and promote public transit, walking, and bicycling.

Project Development/Environmental Analysis

MassDOT's *Healthy Transportation Policy Directive* (2013) calls for healthy transportation modes to be considered equally as potential solutions within project designs. It further states that all MassDOT projects must include accommodation of pedestrians and bicycles per the MassDOT Highway Division Project Development and Design Guide and that recipients of highway access permits and recipients of State discretionary funding will be required to adhere to Highway Division Project Development and Design Guide standards on Complete Streets design.

Transportation System Management and Operations

GHG reduction strategies identified in the GreenDOT Implementation Plan and the *Clean Energy and Climate Plan* (CECP) include continuing to promote and deliver transportation demand management (TDM) information and services; promoting ecodriving; and using intelligent transportation systems (ITS) and other noncapacity bottleneck relief measures to manage roadway capacity to reduce congestion, idling, and GHG emissions. MassDOT will undergo a Truck Stop Electrification procurement to reduce emissions from idling trucks and fund a Shore Side Power at the Port of New Bedford to reduce emissions from idling ships.

Agency Operations

GHG reduction strategies identified in the GreenDOT Implementation Plan and the CECP include installing high-efficiency light-emitting diode (LED) traffic signals, replacing red bulbs with LEDs on a systematic basis, designing and building resource-efficient buildings, and pursuing Leadership in Energy and Environmental Design (LEED) certification for new or rehabilitated buildings. MassDOT project design and construction also will reduce GHG impacts through measures such as the use of recycled content in paving materials, use of warm mix asphalt paving, and requirements for diesel engine retrofits for construction contractor vehicles. The Massachusetts Bay Transportation Authority (MBTA) will continue to evaluate vehicle technology and life-cycle costs, including the on-road and maintenance performance of its new diesel-electric hybrid buses, and work with bus manufacturers to improve bus technology. MassDOT is pursuing several renewable power generation projects along State highways and other MassDOT property, and will work with municipalities and stakeholders to increase implementation. MassDOT has conducted energy audits and is pursuing energy conservation programs at a number of facilities. Sustainability measures will be embedded in all aspects of the MassDOT performance management system, based on best practices.

GHG-Specific Planning

MassDOT conducted the study *Application of the EERPAT Greenhouse Gas Analysis Tool in Massachusetts* (2016) to provide information about the potential GHG reduction benefits of a variety of transportation emission reduction measures, as well as the potential costs of implementing these measures. The study applies the Federal Highway Administration (FHWA) Energy and Emissions Reduction Policy Analysis Tool (EERPAT) model to evaluate statewide policy impacts.

Minnesota

Policy

The *Annual Minnesota Performance Measure Report* (2015) reports petroleum fuel use as a measure that relates to GHG and other emission reduction goals.

The *Minnesota Department of Transportation Sustainability Report: Establishing a Baseline* (2016) (2017) describes Minnesota DOT's (MnDOT) role in reducing GHG emissions. The report includes an inventory and forecast of Minnesota GHG emissions by transportation source and identifies year 2025 GHG targets for the transportation sector that are based on statewide reduction targets.

Long-Range Planning

The *Statewide Multimodal Transportation Plan* (2017) commits MnDOT to making transportation decisions that minimize and reduce total GHG emissions so that Minnesota's transportation systems do their part in combating global climate change. Chapter 5 of the plan sets a Healthy Communities performance measure of annual GHG emissions from the transportation sector. The plan notes the GHG reduction targets set in the Minnesota Next Generation Energy Act of 2007, which include 30 percent below 2005 levels by 2025, and 80 percent below 2005 levels by 2050. The plan states that MnDOT will work internally and with transportation stakeholders to identify and implement strategies to reduce GHG emissions from the transportation sector.

The *Greater Minnesota Transit Investment Plan 2017–2037* (2017) recognizes that transit reduces the reliance on single-occupant vehicles and reduces GHG emissions.

Agency Operations

The *MnDOT Office of Environmental Stewardship CY 2017 Workplan* identifies reducing GHG emissions as a potential emerging issue.

The *Minnesota Department of Transportation Sustainability Report* identifies year 2025 GHG reduction target from MnDOT's facilities and fleet, and identifies actions the agency is taking or plans to take to reduce GHG emissions from its operations.

Oregon

Long-Range Planning

The *Oregon Transportation Plan* (2006) adopts a strategy to encourage the development and use of technologies that reduce GHGs. The plan supports the conversion of passenger vehicles and public transportation fleets to more fuel-efficient and alternative fuel vehicles.

Transportation System Management and Operations

EcoDrive is a toolbox that allows local jurisdictions, businesses, or community groups to create their own community-based campaign to promote ecodriving. It is available at: <https://www.oregon.gov/ODOT/Programs/Pages/EcoDrive.aspx>.

GHG-Specific Planning

The Oregon Sustainable Transportation Initiative, as described on the State's website (<https://www.oregon.gov/odot/programs/pages/osti.aspx>), is an integrated statewide effort launched in 2010 to reduce GHG emissions from the transportation sector. Designed to help Oregon meet its long-range goals to reduce GHG emissions 75 percent by 2050, it encompasses five focus areas:

1. Development of a Statewide Transportation Strategy.
2. Adoption of GHG emission reduction targets for metropolitan areas by the Land Conservation and Development Commission.
3. Development of land use and transportation scenario planning guidelines for GHG emissions reduction.
4. Outreach to the public on climate change.
5. Development of the GHG Transportation Emissions Reduction Toolkit, including tools that support local governments in reaching their emissions reduction goals.

The *Oregon Statewide Transportation Strategy* (Oregon DOT, 2013) (STS) charts a potential broad path for reducing emissions from transportation and land use strategies. These strategies are those that modeling and analysis indicate have measurable GHG reduction results and will help Oregon meet its 2050 GHG emission reduction goal. The document contains 18 strategies that fall into the following categories: vehicle and engine technology advancements; fuel technology advancements; enhanced system and operations performance; freight transportation options; efficient land use; and pricing and funding mechanisms. It also includes a short-term implementation plan (2014) and a monitoring report to chart progress on implementation. The STS identifies a target of a 60 percent reduction in GHG emissions from the transportation sector from 1990 levels by 2050.

Rhode Island

Policy

The Resilient Rhode Island Act of 2014 requested a general assembly plan to meet the statewide targets for GHG emission reductions by December 31, 2017. The plan includes strategies, programs, and actions to control GHG emissions to meet the following targets: 10 percent below 1990 levels by 2020; 45 percent below 1990 levels by 2035; and 80 percent below 1990 levels by 2050. The plan also specifies periodic reporting procedures.

Long-Range Planning

In its Trends Report of the *Rhode Island Moving Forward, Long-Range Transportation Plan* 2018 draft, Rhode Island DOT (RIDOT) notes that transportation is “the largest factor producing GHG in Rhode Island...” In this report, the State compares how its GHG emissions compare to the U.S. as a whole, and emphasizes that the transportation sector in Rhode Island is a greater contributor (by 10 percent) of GHG emissions than it is for the national average. It also discusses the State's *Greenhouse Gas Emissions Reduction Plan* in order to emphasize the importance of the transportation sector in practicing the strategies and techniques listed. The report advises that approaches to decreasing and stabilizing GHG emissions should be within the following three parameters:

1. Efficiencies and reductions: Working to decrease the demand for modes that rely on fossil fuels and reduce overall VMT.
2. Clean energy sources.
3. New technologies.

Programming

Rhode Island's STIP considered impacts of climate change as part of its Transportation Equity Benefit Analysis. The STIP discusses the impact the transportation sector has on carbon dioxide emissions in Rhode Island and how reducing VMT is one of the best strategies to diminish and control GHG emissions. The STIP states that reducing GHG emissions is crucial for climate control mitigation, which is critical for the coastal State.

Agency Operations

RIDOT's July 30, 2018 Quarterly Report indicates that RIDOT is working with Rhode Island's Office of Energy Resources and the National Grid on a project to promote and provide energy efficiently upgrades at six Maintenance Division District Facility buildings. The agencies are aiming to improve energy efficiencies, reduce operating costs and GHG emissions, and streamline inventories across the division's buildings.

GHG-Specific Planning

The State of Rhode Island published the *Rhode Island Greenhouse Gas Emissions Reduction Plan* in 2016. This plan identified the advantages and disadvantages of various techniques and practices to reduce GHG emissions, including alternative fuel strategies, increasing public transportation, and some VMT reduction techniques. The plan indicates that Rhode Island's vulnerable coastal location is a clear need for the State to take action in reducing GHG emissions. As such, it recommends three areas of opportunity: build on State success, enable markets and communities, and leverage regional collaboration.

In 2016, RIDOT, the Office of Energy Resources (OER), the Department of Environmental Management (DEM), and the Ocean State Clean Cities (OSCC) worked together with State and quasi-State agencies, private and nonprofit companies, auto dealers, and utility providers to promote a ZEV Action Plan for the State. The plan was published in 2016 and promotes the application of ZEV as one of the most promising technologies to reduce GHG emissions and control global warming. According to the plan, pushing for ZEVs is imperative to meet Rhode Island's climate and energy goals.

Vermont

Policy

The *Vermont Comprehensive Energy Plan* (2016), developed by the Vermont Department of Public Service, sets targets to achieve reductions in statewide energy consumption as well as obtaining most of its energy from renewable sources. The plan sets the State on a path to obtain 90 percent of its total energy from renewable sources by 2050. Many of the strategies are transportation related, including the electrification of the passenger fleet. The plan also includes interim goals to reduce transportation energy consumption by 20 percent and power 10 percent of transportation energy from renewable sources by 2025.

Long-Range Planning

The *Draft 2040 Vermont Long-Range Transportation Plan* (2018) sets objectives of reducing air pollution associated with fossil fuels used in transportation, as well as reducing the overall level of energy

use by the transportation system. The plan calls for implementing the transportation recommendations included in the 2016 *Comprehensive Energy Plan*, including supporting efficient land use, reduction in single occupancy vehicles, electrification of the light-duty vehicle fleet, and alternative fuels for the heavy/commercial fleet. The plan calls for working with other agencies to advocate for competitive electric rates to support electrification of the transportation sector and participating in build-out of Vermont’s EV charging network. It also calls for increasing the use of walking, biking, transit, rail, and travel demand management options.

Agency Operations

As a strategy related to the goal of environmental stewardship, the draft Long-Range Transportation Plan “encourage[s] the development and use of transportation construction and operations technologies that reduce emission of GHG.”

GHG-Specific Planning

Vermont was a participant in pilot testing the FHWA EERPAT GHG evaluation tool. VTrans used the tool to test the impact of both individual and combined strategies, including parking costs, TDM, transit, land use, pricing, and EV and CNG market penetration.

Virginia

Programming

Smart Scale is a project selection process used by Virginia DOT (VDOT). Among other factors, it considers GHG emissions as part of the environmental consideration for project selection. See: <http://dashboard.vasmartscale.org/about>.

Project Development/Environmental Analysis

The VDOT Project-Level Air Quality Analysis Resource Document (2016 version) requires a qualitative GHG analysis for environmental impact statement (EIS) projects.

Washington

Policy

The Washington State Agency Climate Leadership Act of 2009 established GHG reduction targets for agencies in Washington State. By 2020, it requires reductions in GHG emissions to 1990 levels; by 2035, reductions to 25 percent below 1990 levels; and by 2050, reductions to 50 percent below 1990 levels.

The *Washington State Energy Strategy* (2012), prepared under the leadership of the State’s Commerce Department, is a comprehensive energy strategy for the State that is driven in part by concerns about climate change. It contains a “transportation policy package” that identifies nine near-term recommendations and eight long-term policy recommendations under the broad categories of vehicles and fuels, travel efficiency, and pricing.

Project Development/Environmental Analysis

WSDOT Guidance—Project-Level Greenhouse Gas Evaluations under NEPA and SEPA (2018) requires a project-level quantitative GHG analysis for all projects that are progressed as Environmental Assessments

and EIS under NEPA and/or the State Environmental Policy Act (SEPA) and a qualitative evaluation for some smaller-scale projects.

Agency Operations

The *2007 WSDOT Greenhouse Gas Emissions Inventory* (2009) reports the agency's GHG emissions from 2007. GHG emissions inventories are required by State legislation for agencies that surpass threshold levels. The inventory generally follows the Climate Registry's General Reporting Protocol and includes GHG emissions from the ferry system, the highway system (traffic services), agency buildings, and the agency's vehicle fleet.

The *Sustainable Transportation Action Plan: 2015–2017* (2016) describes major Washington State DOT (WSDOT) activities that promote sustainable practices and clean transportation in Washington State. The plan encourages WSDOT employees to support reductions in vehicle VMT and GHG emissions, encourage more cost-effective and sustainable practices for construction and operations, and promote alternative fuels and electric vehicle infrastructure. The plan proposes various actions, including annually developing a GHG inventory and developing an agency GHG reduction plan. Other proposed actions relate to reducing land and water fleet and freight emissions, improving energy efficiency and reducing construction material waste and energy consumption, improving and expanding TDM, promoting bike and pedestrian travel, and promoting transit sustainability.

GHG-Specific Planning

The *Washington State Electric Vehicle Action Plan 2015–2020* (2015) is a plan to increase plug-in electric vehicle penetration in Washington State with a goal of 50,000 plug-in vehicles by 2020. The plan includes 13 action items to meet State targets.

Conclusions

Some commonalities emerged from the document review, as well as some unique aspects for some State DOTs:

- Generally, the most comprehensive GHG emission reduction planning by a State DOT occurs when other related activities are occurring in the State. Typically, climate change planning and activity is most intense when there are overarching GHG emission reduction and/or energy policy requirements in the State, whether through State legislation or a Governor's Executive Order or Directive. In these cases, State DOTs participate in the State's activities to reduce GHG emissions, usually to meet a statewide emission reduction target of a certain percentage from a base year.
- For DOTs participating in State GHG reduction activities, the range of activities and commitments can be quite broad. In a few States, the State DOT commits to a small number of actions, such as assisting in the planning and installation of electric vehicle charging stations. In several other States, such as Massachusetts, there is a more thorough review and consideration of all aspects of the State DOT's planning, programming, project design, funding, and internal operations.
- For some State documents such as Climate Action Plans and/or State Energy Plans, the State DOT is relied upon to provide VMT forecasts. With limited additional activity from the transportation sector, the State then uses regulations under the Federal Motor Vehicle Control Program to predict GHG emission reductions from the transportation sector. Some plans also combine the progress in meeting National Ambient Air Quality Standards with the need to reduce GHG emissions.
- Few States consider GHG emissions in project-level analysis. For those who do, there is a range of approaches. Washington State, for example, requires a quantitative GHG analysis for many projects. Massachusetts requires a quantitative or qualitative analysis for each project at the TIP stage. The District of Columbia requires a qualitative analysis. Some State DOTs recognize that this may be an issue that

should be addressed in the future and some are in the process of revising their air quality analysis procedures to consider GHG.

- The State DOTs that are active in GHG emission reduction activities typically collaborate with other State agencies, most commonly with the State environmental agency or energy agency. In some cases, they also collaborate with MPOs or regional planning agencies.

APPENDIX C

Interviews

The project team conducted telephone interviews with several States. The States were selected for interviews on the basis of responses to the survey, and included State departments of transportation (DOT) across a range of engagement levels. The state DOTs responding either “yes” or “possibly” to survey question 15 (“Would your agency be interested in participating in additional activities of this research project, including workshops to develop and review greenhouse gas (GHG) resources, and/or implementation support of GHG analysis methods?”) were contacted for an interview. In addition, the project team contacted a small number of other State DOTs known to the team to be active in activities to reduce GHG emissions from the transportation sector.

Staff at 16 State DOTs were invited to participate in a phone interview. Of those 16, 2 declined. The 14 States where staff were interviewed were as follows: Arkansas, California, Colorado, District of Columbia, Delaware, Georgia, Hawaii, Massachusetts, Minnesota, North Carolina, Oregon, Rhode Island, Texas, and Washington.

In order to allow for sufficient consideration prior to the interview, the team provided a State DOT staff contact with the interview questions prior to scheduled interviews. Interviews ranged in duration from 30 minutes to an hour, depending on the nature of the State’s involvement with GHG reduction activities. The Colorado interview was the only one to take place with several staff participating; others limited to just the survey respondent. A number of interviewees indicated they had discussed the interview questions with other DOT staff prior to the interview. The interview was conducted as a conversation. Depending on the State DOT’s level of engagement in GHG activities and the interviewee’s experience, longevity, and placement within the organization, not all questions were discussed. The interview topics were as follows:

- State context—leadership and policy support for GHG consideration (internal and external).
 - How long has leadership been in place—longer than one Commissioner/Secretary and/or Governor?
 - How long have statewide policies been in place?
 - Are adopted policies still being actively followed or are they “dormant”?
- GHG policies, goals, metrics—adopted, and under consideration by the DOT.
 - How adopted?—Legislation? Executive Order? Commissioner/Secretary Directive? Other?
 - How have they been institutionalized within DOT? Incorporated into departmental workplans? Individual review cycles?
 - Do you expect institutional responsibilities to change?
- GHG analysis tools and resources applied or considered by the agency (inventory, forecasting, strategy evaluation), strengths and limitations.
 - What tools or methods have you applied or considered applying? (Quantitative or qualitative).
 - What information sources on GHGs (data, strategies, impacts, analysis methods) have you used? (e.g., Federal Highway Administration (FHWA) reports, National Cooperative Highway Research Program (NCHRP) reports, Strategic Highway Research Program (SHRP) reports, another report such as Moving Cooler or U.S. DOT Report to Congress, Annual Energy Outlook (AEO), State Energy Consumption, Price, and Expenditure Estimates (SEDS), or Environmental Planning Agency (EPA) data, other State agency resources, university research)
 - Accomplished in house or with consultant help?
 - How much staff time was required to gather needed data?

- Have you leveraged tools or methods you’ve used for other purposes (e.g., Motor Vehicle Emission Simulator (MOVES))?
- What decisions are the tools being used for?
- Do the tools provide the right type of information you need for decision-making?
- How confident are you in results?
- What information on tools and resources would have been helpful?
- Barriers to consideration of GHG emissions (technical/resource, policy, institutional, cultural) by stage—planning, programming, project development, operations.
 - DOT staff reaction?—Level of buy-in? Any resistance?
 - Sufficient staff resources/capacity?
 - Adequacy of information/data/tools?
 - Which stage of the effort has been easier/harder to implement? Why?
 - Any steps taken to reduce/consolidate effort with other ongoing work (e.g., coordinate with conformity analyses)?
 - If your agency has a GHG policy- and/or planning-level assessment, but does not consider GHGs at the programming or project level, why not?
- Partnering—with other State agencies (e.g., State Climate Action Plan); with metropolitan planning organizations (MPO)/regional planning organizations (RPO); with local jurisdictions (requests/by whom and for what, what DOT has or has not been able to contribute, data/info needs, working relationships, success examples, barriers to collaboration, etc.).
 - Who initiated the partnerships and why?
 - Any new working relationships established? If yes, what agency(ies)?
 - Roles for DOT within effort (e.g., State CAP)—Lead? Support?
- Potential future directions of the agency with respect to GHG.
 - Planning and programming—transportation system GHG.
 - Agency operations, e.g., carbon footprinting, sustainability initiatives.
 - Leading or supporting specific initiatives, such as EVSE planning and deployment, Alternative Fuel Corridor nominations, generation of renewables in ROW.
- Data and information needs by stage of process—what advice, tools, and resources would the agency find most helpful from an NCHRP guidebook? From hands-on training or piloting efforts?
- How were DOT policies/procedures developed?
 - One functional unit? Collaborative effort among several functional units? Copy other agencies?
 - Peer review process?
- How is effort led within DOT?
 - Roles/titles and functional units
 - How is communication and collaboration across DOT divisions accomplished?
- Lessons learned? Advice for other DOTs.

The discussions were open, and the responses reflected the respondent’s views on their agency’s role in efforts to reduce GHG emissions. Although the level of engagement for the DOTs varied, some common views emerged. Some valuable insights were gained from the interviews and are detailed below.

Summary of Findings

External Drivers

Perhaps the most significant driver for State DOT involvement in efforts to reduce transportation GHG emissions is an external requirement imposed upon the agency, typically by Governor’s Executive Order (EO) or State legislation. Notably, the State DOTs with the highest levels of GHG engagement are in States with rigorous EOs or legislation requiring stringent GHG reductions.

The scope and language of the EO or legislation also is important. The external drivers whose language is more active (i.e., will act or implement) rather than passive (i.e., will consider or study) also help determine the State DOT activity level. The active language in the external drivers seems to compel all the relevant State agencies (including the DOT) to work on strategies to reduce GHG emissions from their sector of the economy.

Taken together, a combination of not having any specific requirements, public sensitivities, limited available data, and perceived limited influence over GHG may begin to explain why many agencies have chosen not to focus their attention on GHG reduction efforts in favor of more pressing and less politically sensitive initiatives. Illustrations of how complementary agency initiatives such as mobility, safety, and energy savings also can improve GHG performance could be useful in this context.

State DOT Jurisdiction

The scopes of State DOT's jurisdictions vary across the country. Some DOTs are primarily highway agencies while others oversee rail, commuter transit, freight, air, and/or motor vehicle registration. DOTs vary as to the modes of transportation over which they have control or influence. Based on conversations with the respondents, it seemed that if a State DOT had jurisdiction over more than the roadway network, the DOT was more involved in multimodal activities to reduce GHG emissions and more willing to tackle the transportation sector's emissions. Some of the States that controlled only the roadway network seemed to feel there was less the State DOT could do to reduce emissions because emissions were being driven by other factors beyond their control (i.e., they only took care of the infrastructure).

Partnerships

All State DOTs that are active in GHG reduction efforts have established collaborative partnerships with other agencies and stress the value of the partnerships. Some partnerships were established as a result of having to work together to meet requirements of legislation or EOs. For some State DOTs, work on GHGs serves to strengthen and reinforce existing relationships. The number of partners varies with the State, depending on the requirements of the EO or legislation, but the most common partners were the State environmental agency and the State energy agency. At the regional and local levels, MPOs also are common partners. Many State DOTs suggested that the earlier partnerships are established, the more successful the relationship and work products will be.

Transportation Sector versus Internal Operations

To varying degrees, many State DOTs have taken steps to reduce GHG emissions from their own internal operations. Some are tracking and reducing energy use from their buildings, such as installing light-emitting diodes (LED) and more efficient heating, ventilation, and air conditioning (HVAC) systems. Many are purchasing cleaner vehicles (including electric vehicles (EV) for their fleets. Some are calculating and seeking ways to reduce GHG emissions from their construction and maintenance operations. Others are installing or experimenting with solar panels. Many have inventoried their internal GHG emissions to varying extents, with some tracking and reporting those emissions. These DOTs seem happy and eager to undergo these efforts. However, many State DOTs, even those at high levels of engagement, have difficulty with the concept of effectively reducing GHG emissions from the transportation sector as a whole. Some indicate they do not have sufficient influence over how and who uses the roadway network. While many can quantify the GHG emissions emanating from the transportation system, there is underlying concern that they will not be able to demonstrate sufficient reductions from the transportation sector to meet GHG reduction targets or goals, leading to negative consequences and publicity for their agencies. They suggest that expectations be realistically set.

Organizational Setting and Leadership

There does not appear to be one clear organizational arrangement within State DOTs for working on GHG emission reductions. Aside from the ideal of having committed, interested, and accessible executives nominally leading this work, there are several organizational settings that work for different States. A common arrangement, especially among State DOTs at high levels of GHG engagement, is to house GHG reduction work under the umbrella of a sustainability initiative. In this arrangement, staff working on GHG reduction from the transportation sector also are working on reducing GHG emissions from internal operations and other sustainability activities. In this arrangement, staff seem to be most knowledgeable about all GHG-related activity within their DOT and State.

Some States house GHG reduction work in the planning division and some in the environmental division. Generally, State DOTs that are more focused on project-level GHG activity have the staff lead in the environmental division, while State DOTs focused on GHG planning-level issues have the staff lead in the planning division. In few cases do agencies have staff dedicated full-time to GHG emission reduction, much less staff dedicated full-time to GHG emission reductions from the transportation sector specifically. In most cases, there are multiple staff working on GHG issues, but this activity has been added to their existing responsibilities.

Tools and Data

There are several available tools to measure and quantify different aspects of GHG emissions. There are tools for transportation system-level planning, emissions from construction activities, emissions by vehicle type and age, emissions from buildings, etc. State DOTs prefer tools that are designed for the intended purpose and as simple to use as possible. However, over time and lacking specific training, DOTs have self-taught and learned to adapt various tools to their needs. Many felt prepared to continue to do the same as needed. Many felt that guidance directing them to the appropriate tool and information on how to use that tool would be helpful.

The main challenges DOTs face are data availability and usefulness. The array of data needs for the various tools is daunting. DOTs that have used Energy and Emissions Reduction Policy Analysis Tool (EERPAT) found the data needs to be extensive and difficult to collect. Some DOTs found it challenging to obtain the data required to inventory their emissions if the emission sources (e.g., vehicles used by DOT staff, building in which the DOT is housed) were owned by entities whose data were collected differently. It would be helpful to develop a standard for data collection and/or a conversion method from the form and units of collected data to the form and units of needed data for tool manipulation. Additionally, it would be helpful to indicate the significance and sensitivity of inputs of various tools; this information would help DOTs guide data collection efforts towards the most significant variables.

A few State DOTs mentioned the issue of a full life-cycle analysis. DOTs would benefit from a definition of the term, guidance on how to perform the analysis, and guidance on how looking at life-cycle impacts could affect the selection of GHG reduction strategies.

Greenhouse Gases and Air Quality

Some State DOTs, especially those with less experience and engagement in GHG emissions reduction, consider GHG emissions in the same context as criteria air pollutants. Some believe that because they are not in nonattainment, they have no air quality issues and thus do not need to consider GHGs. Some only report GHG emissions for information purposes when performing project-level air quality analysis for a transportation project. Some believe that because there is no air quality standard for GHGs, a given project would not have a significant air quality impact. For these situations, guidance on scales of air quality analysis and differences in scope, effect, and impact between GHGs and criteria pollutants would be useful.

Nevertheless, the confluence of air quality and GHG analysis techniques and tools offers an opportunity to better understand and report benefits of various transportation actions. In addition to documenting that a project improves air quality by improving traffic flow, for example, agencies could also document that the project also reduces GHGs. Similarly, actions at a program level that might reduce criteria pollutant emissions, such as installation of Intelligent Transportation Systems (ITS), also would likely reduce GHG emissions. Since both efforts would use the same tool (e.g., MOVES) that already models criteria pollutants, the additional effort to model GHGs would be minimal. It is useful to highlight these synergies.

Documents

Consumers of reports and guidebooks expect them to be clear and easy to understand. Most State DOTs want report titles to be short and indicative of the work contained in the report. The body of the report should be written in a style that is easy to read and conveys the meaning and finding of the study. Technical and/or complex material is often understood to be necessary, but DOTs noted that it would be helpful to keep that type of material to an appendix or other subordinate document.

Sustainability and “Greening”

An emerging model of efforts to reduce GHG emissions from the transportation sector is the umbrella of sustainability or “greening” work. Some DOTs include GHG reductions, both internal and from the transportation sector, in their sustainability initiatives. Depending on the specific initiative, metrics, guidance, or procedures could be established to ensure that GHG reduction considerations are included as part of good sustainable practice. This model also may serve those States where discussions on climate change may be challenging.

Consultant Use

State DOTs interviewed varied in their use of consultants versus in-house staff. Some States use consultants, including academics, frequently, while others primarily rely on in-house staff. Depending on the need or application, those activities that require considerable effort, such as data collection or complex model runs, are usually performed by consultants. The most common model is that in-house staff develop the guidance and procedures while relying on consultants to perform the model runs and/or application of the guidance and procedures. In some cases, in-house staff perform the first model runs or applications and when satisfied on the outcomes and validity of the process, turn over subsequent work to consultants. In cases where the initial run of the model requires a substantial amount of data (e.g., EERPAT), consultants have been asked to help in collecting the needed input data.

GHG Reduction versus Adaptation

Practically all the State DOTs interviewed recognize and are dealing with the impacts of climate change through various resiliency and/or sustainability efforts. There is a sense of criticality for adaptation, especially for the coastal States. For some State DOTs, the terms “climate change” or “greenhouse gases” brings about discussion about adaptation, rather than emission reduction. This is probably an indication of those States’ involvement with GHG mitigation efforts. At least one State DOT recognized the relationship between transportation GHG emissions and issues with sea-level rise and, therefore, thought it appropriate to try to reduce their State’s transportation emissions. This thinking may be a model for State DOTs seeking to increase their efforts toward GHG emission reduction. It also builds on generally accepted “greening” efforts and environmental “stewardship”—especially when combined with the synergies of actions focused on mobility, air quality, etc.

Federal versus State

Several States cited the variable nature of Federal requirements as a confounding effect for their climate change work. The revocation of project-level National Environmental Policy Act (NEPA) guidance and the proposed revision to fuel economy standards were mentioned specifically. At least one State DOT indicated that since these changes in Federal requirements, they no longer mention GHG reduction in their planning and project documents.

Technical versus Executive

By the nature of the issue and the potential strategies involved to reduce GHG emissions from the transportation sector, the ongoing work is highly visible internally within the State DOT and with the public using the transportation system. The model that seems to work best within the DOTs is a high-level executive in charge of the overall effort with technical staff in charge of the day-to-day effort. The technical staff could be the point of contact for inquires/requests, both internal and external, and be technically knowledgeable about climate science, tools, and the transportation system. The technical staff also should have access to all relevant program areas of the State DOT. Many of the State DOTs interviewed stressed that those working on the issue should have a personal interest, enthusiasm, and commitment to the subject. They also felt that continuity in staff and interest was important. Some felt that too many “initiatives” within the agency could dilute the effort and cause unnecessary distractions. That said, the State DOTs generally did not find much internal resistance to undertaking GHG reduction work. With clear direction from leadership, most staff understood the need for this work.

Conclusions

State DOTs have adapted to undertaking GHG reduction efforts, depending upon the mandate and their organization’s role in the effort and control of the transportation system, with varying degrees of success. Many of their efforts have been limited to reducing emissions from their own operations. Most often they have done this with no additional staffing. An emerging model of GHG reduction efforts is the umbrella of sustainability or “greening” work. Many of the State DOTs interviewed stressed the importance of good communications, both internally and with outside groups, and the importance of good planning to undertake the effort.

DOTs value partnerships with other State agencies, local or regional agencies, or local and civic groups. The partnerships provide a common sense of purpose, spread the workload, and deflect potential negative reactions to the ongoing work. The confluence of air quality and GHG analysis techniques and tools offers an opportunity to better understand and report benefits of various transportation actions. For agencies that lack strong external direction, illustrations of how common agency initiatives such as mobility, safety and energy savings are related to GHG performance could be of value in delivering on statewide or regional initiatives.

Some interviewees preferred webinars or pilot programs to hands-on training as the most helpful outcomes of this project. Whatever the format, training, report documents, and guidebooks are expected to be clear and easy to understand.

The State DOTs did not find much internal resistance to undertaking GHG reduction work. With clear direction from the State DOT leadership, most staff understood the need for this work. At this point, to keep the effort ongoing in a unified and comprehensive manner is where the communication and planning discussed previously becomes important. It also helps prioritize their efforts among many potential reduction strategies that could be pursued.

A few State DOTs mentioned the issue of a full life-cycle analysis. They would benefit from a definition of the term, guidance on how to perform the analysis, and how the results affect the selection of reduction strategies. Some felt that this analysis might preclude the selection of certain reduction strategies.

Some State DOTs noted the challenge of multiple conflicting priorities, in which other initiatives could distract, delay, or otherwise hinder GHG reduction efforts. Priority initiatives can change as State and agency leadership changes or other imperatives arise. This can sometimes result in reassignment of staff working on GHG reduction efforts to other efforts.

APPENDIX D

Task 7 Workshop Report Summaries

Nevada

Format of Workshop and Agenda

Due to restrictions on gatherings and travel resulting from the COVID-19 pandemic, the Nevada workshop was held virtually using a platform capable of videoconferencing and breakout groups.

The workshop spanned three days during May 2020 and was divided into four sessions originally timed for two hours each (Table D-1). During Sessions 1 and 2, the team walked participants through the content of the guide; Session 2 concluded with a discussion of the guide in breakout groups. Session 3 again split participants into breakout groups to walk through the guide's self-assessment and action planning tools. Session 4 was originally planned to include additional small-group discussion centered on continued development of action plans, as well as specific technical and institutional issues identified in Session 3. However, the discussion in Session 3 identified that Nevada Department of Transportation (NDOT) needed to do further internal policy and institutional development work before spending more time on action plans specific to functional areas. As a result, Session 4 ended up being a shorter plenary session (about an hour) to cover additional questions, next steps, and wrap up.

Throughout the workshop, participants were able to contribute feedback, ask questions, and find links to resources in the chat box. Workshop evaluation surveys were distributed at the end of Sessions 3 and 4.

Table D-1. Nevada workshop agenda.

Date and Time	Topic	Contents
Monday 5/4 10:00–12:00 PDT	Session 1— Orientation and Guidebook Walk- Through Part 1	Introductions, Overview of Workshop, Objectives Current Status of Addressing Greenhouse Gas (GHG) at NDOT Guidebook Walk-Through Part 1: Sections 1–8
Monday 5/4 1:00–3:00 PDT	Session 2— Guidebook Walk- Through Part 2	Guidebook Walk-Through Part 2: Sections 9–18 and Appendices Overall Guidebook Feedback (breakouts)
Wednesday 5/6 1:00–3:00 PDT	Session 3— Breakouts for Self- Assessment and Action Planning	Breakouts by functional area to review guidebook materials, complete self-assessments, and develop action items. 1. Executive, State Partners (Sections 5–8, 17, and 18) 2. Planning, Environmental (Sections 10–12) 3. Construction, Operations, Maintenance, Operations, Districts, and Administration (Sections 9, 13–16)
Thursday 5/14 1:30–2:30 PDT	Session 4—Plenary Discussion and Wrap Up	Additional Questions, Wrap Up, Next Steps, and Evaluation

Because there was not time to explore all content of the guide in detail, it was recommended that participants review relevant sections independently. Participants were asked to review the entire guide before Session 1 and to explore specific portions of interest in more detail and complete at least two self-assessments prior to Session 3. The project team asked participants to consider the following questions in their review:

1. Does the guide contain information that is useful to you in your job?
2. How is the amount of information presented—too much? Not enough? Or just about right?
3. If “not enough,” what is missing that you would like to see added?
4. Is the organization of the guide logical? Can I easily find what I am looking for?
5. Is the visual presentation and layout of the guide attractive and easy to use?
6. How would you prefer to access the guide—download a single PDF? Access PDF sections through a web portal? Or access all material directly via webpages?
7. What organization, formatting, or other presentation changes would you suggest?

Policy Context

Recent policy developments at the State level have provided the impetus for NDOT to take a more active role in estimating and reducing GHG emissions. Senate Bill 254, signed into law in June 2019, directs the State’s Department of Conservation and Natural Resources to issue an annual report on greenhouse gas (GHG) emissions in Nevada, as well as a statement of policy options needed to reach the economy-wide GHG emission reduction goals called for in the bill. Executive Order 2019-22 builds on the initial climate report and calls for the completion of a State Climate Strategy by December 1, 2020. The order also called for cross-departmental coordination, directing the Department of Transportation to coordinate with other State agencies.

Current NDOT Activities

At the Executive level, participants reported ongoing processes to create a group, led by NDOT Division Chief of Environmental Programs, to pen policies and strategies around GHGs. This group’s meetings already had been scheduled. Environmental Programs sees itself as responsible for being compliant with Federal environmental regulations. The program plans to move forward in including GHG considerations in project development and design.

Considering the level of engagement of NDOT in addressing GHG, participants from NDOT’s Planning Division placed NDOT at Level 2 and working towards Level 3 on the planning level. Planners are in the process of merging long-range planning projects and are involved in several efforts, such as electric charging, alternative fuels, and ride sharing incentives, that will impact GHGs. Though the Planning Division relies on other agencies’ annual reports for reporting GHGs, the division is considering how reporting could be improved. Planning reports a strong working relationship with the State’s MPOs, which they leverage to “educate the rest of the group.” The division plans to continue working with metropolitan planning organizations (MPO), Federal highway partners, American Association of State Highway and Transportation Officials (AASHTO), and others.

NDOT’s Maintenance and Asset Management Division plans to approach GHG reduction through several strategies: continuing to change lighting fixtures to light-emitting diodes (LED) and promoting solar usage; continuing to upgrade windows and doors; continue upgrading systems for snow; and looking to reduce unnecessary travel.

In some sections and divisions, activities are not yet explicitly tied to GHGs. The Construction Division has not started to work on GHG reduction but expressed openness to future efforts. NDOT reports that it is utilizing the full range of transportation system management and operations (TSMO) strategies available and plans to begin taking measurements of delay reductions to translate into GHG reductions. NDOT

estimates, though, that it is two to four years away from quantifying GHG reductions in this way. The Chief Equipment Superintendent noted that NDOT is replacing vehicles every year, an effort not explicitly intended to reduce GHGs, but that generates GHG emission reductions.

Desired Status and Activities

NDOT workshop participants recognize that the agency is at Level 1 overall; participants discussed several planned steps that would move the agency towards Level 2, in close coordination with its partners. Agencywide, policy recommendations consistent with the Governor's Executive Order are needed by December 1.

The Planning Division's priority is to continue to work with the State environmental agency to acquire the data needed to improve accuracy of GHG reporting. The division also hopes to develop system-level strategies and policies. Specific strategies include identification of data needs; identification, evaluation, and selection of GHGs in plans; development of better understanding of what measures and forecasts include; and the convening of a statewide working group.

The Environmental Division aims to undertake a formal evaluation of GHG reduction at the project level; implement qualitative and quantitative GHG assessment in environmental review; and convene an intra-agency team to develop a strategy to improve traffic operations, safety, and travel time reliability. They also hope to participate in interagency partnerships to increase alternative transit use and other approaches. The Environmental Division also hopes to increase material efficiency use to decrease its carbon footprint, collaborate with the Operations Division to increase energy efficiency in fleet and facilities, and implement vegetation in the NDOT right-of-way in order to reduce emissions.

In Construction, participants identified two feasible approaches moving forward: reconsideration of materials and vehicles used in construction and looking to reduce idle times.

The Maintenance Division aims to develop baseline GHG emissions for facilities and operations; baselines already have been developed for some facilities, but not for maintenance ones. The division also would like to establish a policy that sets GHG reduction goals and targets and monitors regions and districts. This would help them better measure reduction achieved. There also is an appetite for route optimization efforts.

Though NDOT sees itself as active in TSMO, there has not been a push to tie those metrics and functionalities explicitly to the reduction of GHGs; this is a step NDOT could take in the future.

The Division of Administration sees the biggest opportunity moving forward as electrification of NDOT's light-duty fleet. To reduce emissions from other vehicles, the agency also could consider implementing idling policies. The group also discussed potential gains related to switching fuels.

Actions to Increase Engagement

NDOT has taken important steps at the executive level by assigning lead responsibilities to coordinate the agency's GHG efforts. Several next steps were proposed to help move these activities forward:

- Write an executive charter establishing a working group or task force comprised of leads from each functional area, and outlining meeting and reporting expectations and deliverables for the working group.
- Hold an internal "get started" meeting with the working group.
- Complete self-assessments from the guide for each functional area, identifying strategies the agency is prepared to undertake and assigning specific action items and timeframes to initiate or complete those strategies.
- Develop a GHG inventory for the agency to help identify the greatest opportunities for potential reductions from administration, planning, design, construction, maintenance, and operations activities.
- Develop a list of partner agencies and entities for statewide cross-sector effort and transportation-sector effort. Start with lists from Governor's Executive Order and State legislation and add as appropriate, especially for transportation-sector effort. Share with involved NDOT staff.

Key Questions and Needs

Across functional areas, participants asked questions about where to begin and what priority actions should be. Questions raised during discussion included:

- How can NDOT GHG emission inventories be coordinated with Nevada’s other statewide inventories, and with other western States?
- Where should NDOT start in the construction and administration areas?
- How should NDOT develop a baseline for emissions reduced in the maintenance area?
- How have other agencies translated TSMO measures, such as reduction in delay, into GHG emission reductions?
- What is the role of planning versus project-level evaluation of GHG reductions?

Feedback on Guide

In workshop Session 2, participants discussed what worked and what could be improved or added to the guide. In addition, facilitators solicited feedback on the level of detail and presentation.

What Works?

As anticipated, the extent to which certain sections were highlighted as particularly useful was related to participants’ functional area. Different participants highlighted Section 5 (policy), Section 12 (project development and design), and Section 18 (“putting it all together”) as useful, and environmental staff expressed that they found new ways to support other functions. Below are several key reactions that spanned functional areas.

- **Level of depth and detail.** Participants across all breakout groups noted that although the guide was long, the comprehensiveness and level of detail was appropriate; the level of depth was appreciated.
- **Layout and presentation.** The organization of the guide also struck participants as intuitive and thus easy to read and follow. Participants liked the layout of the guide as well as the presentation, including visuals.
- **Group charter and agenda.** Participants liked the idea of establishing a charter and a monthly meeting, and appreciated the sample meeting agenda. From a performance management perspective, the group understood that this kind of structure helps ensure that everyone is doing what they are supposed to be doing.
- **Self-assessment tools.** Participants anticipated that the self-assessment tools would be very helpful. The presentation of steps, rather than just high-level actions, would provide a solid groundwork. Organizations outside of NDOT also found the tools instructive; representatives from the Office of Energy and Public Utilities reported that they found them useful and might use them.
- **Partnerships.** Participants appreciated learning about available partnership agencies, considering how other agencies might support DOTs, and learning about how components of the DOT are relevant to other agencies. One participant noted that, “Everything provides a good foundation that can be applied across governments and agencies.”

Areas for Improvement

- **Address induced demand.** Participants would like the guide to more explicitly address induced demand—How can agencies balance the need to keep traffic moving to reduce emissions, but compensate for the increased demand, and thus vehicle-miles traveled (VMT), as a result of better traffic flow? The guide could delve into broader policy and behavioral aspects of travel in terms of mode shift and GHGs. What can DOTs do to influence the inputs of a travel demand model?

- **More examples.** Participants appreciate concrete examples that already existed in the guide and would like more of them. With additional examples, it could be helpful to bring in more “boots on the ground” and geographically diverse examples. Other participants discussed a desire for more examples around processes for consensus on inventory policies and processes.
- **More content on electric vehicles (EV) and alternative fuel vehicles.** Participants would like more information on what the State—and in particular, the Public Utilities Commission—can do to encourage adoption of EVs and alternative fuel vehicles. And though the guide frequently mentions EVs, participants voiced a desire for more information about alternative fuels such as hydrogen.
- **Expand geography covered.** Participants noticed that the guide tended to focus more on the East Coast, particularly with EV examples. In Nevada, the long driving distances present other challenges to adoption; considering rural geography is important. The guide could address this, a participant suggested, by providing detail specific to each State.
- **Focus on funding.** The guide is more focused on external funding. For example, some areas do not receive Congestion Mitigation and Air Quality Improvement Program (CMAQ) funding. A participant noted that EV infrastructure is expensive and wondered how it could be funded. This also could include examples of the price tags of what’s been successful so far and timelines associated with those projects. The DOT’s funding system does not really support getting 80 to 90 percent of people in electric vehicles. How can DOTs motivate people to switch to electric vehicles?

Attendees

Workshop participants included approximately 17 staff from NDOT, as well as another 17 staff from State and regional agency partners, although not everyone participated in every session. The consultant team included 4 presenters/facilitators/technical experts, 1 primary support staff to manage technology, and 3 staff to assist with note-taking in breakout groups.

The following positions were represented within NDOT:

- Assistant Director, Administrative Services.
- Assistant Director, Operations
- Assistant Director, Planning and Program Development
- Chief Equipment Superintendent
- Chief Maintenance Engineer
- Chief Materials Engineer
- Chief Performance Analysis Engineer
- Deputy Director, Transportation
- Director, Transportation
- Division Chief, Environmental Programs
- Division Chief, NV2X Innovation
- Environmental Services Support
- Transportation Planner

The following partner agencies and staff positions were also represented at the workshop:

- Governor’s Office of Energy: Deputy Director
- Nevada Department of Administration: Administrator of Fleet Services
- Nevada Department of Administration: Director
- Nevada Department of Motor Vehicles: Manager of Emissions Control Program
- Nevada Department of Conservation and Natural Resources: Deputy Administrator, Regulation Agency CNR
- Public Utilities Commission of Nevada: Manager, Policy Analysis
- Public Utilities Commission of Nevada: Economist
- NV Energy: Electrification Programs Director

- Carson Area Metropolitan Planning Organization (MPO): Senior Transportation Planner
- Clark County: Assistant Director, Department of Environment and Sustainability
- Regional Transportation Commission of Northern Nevada: Planning Manager
- Regional Transportation Commission of Northern Nevada: Transportation Modeling Program Manager
- Regional Transportation Commission of Southern Nevada: Director, Las Vegas Regions Metropolitan Planning
- Regional Transportation Commission of Washoe County
- Tahoe Regional Planning Agency: Transportation Division Manager
- University of Nevada Las Vegas: Office of Executive VP and Provost
- University of Nevada Las Vegas: Senior Fellow, Boyd School of Law, Climate and Sustainability Law Project

Colorado

Format of Workshop and Agenda

Due to restrictions on gatherings and travel resulting from the COVID-19 pandemic, the Colorado workshop was held virtually using a software platform capable of polling and breakout groups.

The workshop spanned two days during June 2020 and was divided into two sessions of two and a half hours each (Table D-2). Due to the relatively small size of the participant group, the project team decided that breakout groups were not a necessary element; all sessions involved the participants as a single group. During Session 1, the team walked participants through approximately half of the guide content; Session 2 concluded by covering the rest of the guide and discussing next steps.

Table D-2. Colorado workshop agenda.

Date and Time	Topic	Contents
Tuesday 6/2 10:00–12:30 MDT	Session 1—Guidebook Walk-Through and Self-Assessments	Introductions, Overview of Workshop, Objectives Current Status of Addressing GHG at Colorado DOT (CDOT) Guidebook Walk-Through with Feedback/Discussion by Functional Area to Identify: • Current Level of Engagement • Current and Desired Strategies • Questions
Thursday 6/4 10:00–12:30 MDT	Session 2—Topical Discussions	Continuation of Guidebook Walk-Through with Feedback/Discussion by Functional Area Additional Topics based on Day 1 Questions

Throughout the workshop, participants were able to contribute feedback, ask questions, and find links to resources in the chat box. A workshop evaluation survey was distributed at the end of Session 2.

For the guide walk-through, presentations on Sections 1 to 4 included limited question and answer. The following sections were grouped into modules with more time for interactivity, including poll questions and discussion:

- Sections 5 to 8—Policy, Institutional Alignment, Partnerships, and Communications.
- Sections 10 to 12—Planning, Programming, Project Development/Environmental.
- Sections 9, 13, and 14—Final Design/Construction, Maintenance, Central Administration.

Sections 15, 16, 17, and 18 also were presented in a less formal manner. These sections were covered on day 2 of the workshop, after the project team presented information addressing some questions raised on day 1.

Because there was not time to explore all guide content in detail, it was recommended that participants review relevant guide sections independently, with the same questions provided for consideration as for the Nevada workshop.

Policy Context and Current Activities

Colorado House Bill (HB) 19-1261: Climate Action Plan to Reduce Pollution, was passed and signed into law in 2019 by then newly elected Governor Jared Polis. The legislation outlines GHG emission reduction goals for Colorado from 2005 levels. The act mandates statewide goals to reduce 2025 GHG emissions by at least 26 percent, 2030 GHG emissions by at least 50 percent, and 2050 GHG emissions by at least 90 percent from 2005 levels. In addition, Governor Polis has expressed a goal to achieve 100 percent renewable energy by 2040. These goals implicate major emission reductions in Colorado's transportation sector, which is second only to electricity in emissions statewide.

CDOT sits with several other State agencies—including the Department of Public Health and Environment, the Department of Agriculture, the Colorado Energy Office, and the Department of Natural Resources—on the Energy and Renewables Working Cabinet Group. The group operates under the direction of the Governor's Climate Cabinet. The group's aims are threefold:

1. Support the growth of renewable energy by increasing the number of utilities with an adopted plan to increase renewable consumption, resulting in at least an 80 percent reduction in GHG pollution by 2030, as measured by an increase of State renewable generation from 53 percent to 71 percent by June 30, 2021.
2. By September 30, 2020 finish development of the GHG roadmap, and by June 30, 2021, achieve completion of provisions articulated in the State's GHG roadmap and the Ozone State Implementation Plan (SIP). As part of this goal, CDOT is working with the Colorado Energy Office and the Department of Public Health and Environment.
3. Ensure all potential Goal Transition Communities have the capacity, expertise, and resources to begin to implement comprehensive, locally driven economic transition strategies designed to sustain their economic vitality.

The group's GHG Pollution Reduction Roadmap will evaluate the anticipated outcomes of the participating agencies' current policies and approaches and begin the process of determining required reduction measures across sectors. This roadmap will help CDOT better understand its role in State climate goals and begin to establish targets.

In addition to its participation in the Working Cabinet Group, CDOT is undertaking outreach with additional stakeholder groups. In the realm of vehicle energy, for example, the agency has partnered with both private and public entities to form the Freight Advisory Panel, and is supporting electrification efforts. CDOT also is working with the Denver Regional Council of Governments (DRCOG) as part of its GHG roadmap efforts.

Of Colorado's three "Wildly Important Goals," or "WIGs," for transportation for 2021, one is explicitly geared towards GHG reduction:

- **Clean Transportation:** Reduce pollution in our air and congestion on our roads by reducing VMT, GHGs, and ozone-causing emissions from the transportation sector, through multimodal options, by 1 percent per capita by June 30, 2021, from the pre-COVID-19 estimated calendar year 2019 baseline of 9,300 VMT per capita, 4.2 tons of carbon dioxide equivalent (CO₂e) per capita, 2.0 pounds of Volatile organic compounds (VOC) per capita, and 9.5 pounds of nitrogen oxides (NO_x) per capita.

CDOT submits reports on measures for each of its WIGs to the Governor's Office, and metrics are tracked and publicly accessible on the Governor's website.

Desired Status and Activities

CDOT recognizes several opportunities. First, it may be possible to leverage work addressing ozone precursor emissions to address GHGs in the future. One mechanism for this could be through the statewide transportation improvement plan (STIP), which CDOT is drafting during the summer of 2020. Though the STIP currently does not consider tools that co-benefit GHGs, CDOT sees an opportunity to more explicitly leverage ozone work in the plan.

Colorado also sees an opportunity in NEPA decision-making process, perhaps in incorporating secondary goals and objectives under broader environmental stewardship directives. As part of its current NEPA assessment process, CDOT runs the Motor Vehicle Emission Simulator (MOVES) model to obtain existing, no-action, and design year emissions of methane, NO_x, and CO₂ for environmental impact statement (EIS) project alternatives. There may be opportunities to expand the scope of this analysis.

In addition to the agency's existing partnerships and coordination efforts, CDOT understands there to be additional existing relationships to be "tapped" in its GHG work.

Key Questions and Needs

CDOT recognizes that elevating the GHG discussion will involve substantial cultural shift, and workshop participants discussed how to approach this transition. The project team recommended a focus on establishing processes that would sustain the system in the longer term. For example, a task force with monthly meetings and reporting expectations could help guide this process. Participants expressed interest in a model executive charter and model policies. They also seemed to feel that the guide's functional unit-based approach would be an asset in organizing their activities.

CDOT staff also solicited advice on interacting with political leadership, which ultimately establishes the agency's direction. One participant asked about how to prepare for changes at the executive level, particularly in the case that a new executive establishes a new set of priorities. Participants also discussed the extent to which the GHG roadmap would involve CDOT and how much specific guidance would emerge from the process. The project team recommended a proactive and collaborative approach in order to convey to leadership what the agency can reasonably accomplish; proactive engagement now can help ensure better GHG outcomes for everyone involved.

Some discussion also centered on how to integrate GHGs into the planning process. There may be conflicts, participants noted, between bold action on GHGs and local preferences. Colorado's collaborative approach towards planning can at times amplify these tensions; there are many stakeholders the agency must "bring along" in the decision-making process. The project team recommended clear messaging that would convey to the public and to other stakeholders which projects would help reduce GHGs and what the tradeoffs would be. The team also recommended bringing scale to these conversations, framing the discussion in terms of how the broader GHG benefits of various approaches can synergistically reinforce other objectives.

The following questions were asked by participants and followed up on by the project team either at the second workshop session or via a subsequent memorandum.

- What is the #1 thing CDOT could do to reduce emissions?
- Benefit/cost—what strategies are most cost effective?
- How can we change agency culture to seriously address an issue that has only recently been on our radar screen?
- How do induced demand effects affect the benefits of TSMO strategies?
- What is the best way to couple tools, e.g., planning-level tools such as EERPAT and project-level tools?
- What is the appropriate balance of quantitative versus qualitative analysis in project-level analysis?
- What are the long-term GHG impacts of telework/work from home?
- What are the GHG benefits of concrete versus asphalt?

Feedback on Guide and Workshop

Feedback on the guide was obtained in workshop discussion. Participants felt the presentations were helpful, clearly identified potential levers and tools, and that the material was comprehensive and organized well. The guide structure seems to work well, and the self-assessments were useful in focusing on potential actions during the workshop discussion. The examples presented and discussions of synergies were helpful. Participants seemed to find the guide to be comprehensive and useful in its current form.

Three participants completed the evaluation survey distributed to respondents after the workshop. The survey solicited feedback on the structure and flow of both the workshop itself and the draft guide content. The results are described below.

Survey responses tended to echo comments offered in the larger group discussion. All three respondents found that the overall workshop length and sequencing was “About right” in length, the presentation materials were helpful, and that the project team seemed knowledgeable. Two comments indicated the breakout groups or the overall workshop were “Too short.”

There were mixed responses to the prompt asking whether participants “had sufficient opportunity to engage and provide feedback”; one participant responded “neutral” with the others agreeing. There were mixed responses to the self-assessment tool; asked whether the tool was helpful, there was one each “disagree,” “neutral,” and “agree” response. The respondent who disagreed wrote in part that, “Self-assessment tools are not written as one size fits all. It was rare that a choice was the ‘correct’ choice because only part of it would be true for this DOT. Perhaps that is why there was usually so much variation in how different people assigned levels.”

Asked what could be added, one respondent asked for “additional case studies, model policies, etc.” Another asked that more of the type of “advice” conveyed by the project team in the workshop be included in the text of the guide.

The survey allowed respondents to choose sections on which to comment. The most responses to these prompts characterized the selected sections as “About right” in length, with some respondents adding comments on specific figures.

Attendees

Workshop participants included 12 CDOT staff, as well as 1 participant from a consultant to CDOT assisting the agency with related GHG planning activities. Five members of the project team facilitated discussion, managed technology, and took notes. CDOT participants represented the following positions:

- Air Quality and Noise Program Manager, Division of Transportation Development
- Chief of Innovative Mobility
- Director of Electrification and Energy, Office of Innovative Mobility
- Director, Division of Transportation Development
- Environmental Policy and Biological Resources Section Manager
- Environmental Programs Branch Manager
- Information Management Branch Manager
- Local Government Liaison
- Manager, Applied Research and Innovation Branch
- Manager, Multimodal Planning Branch
- Senior Transportation Advisor, Multimodal Planning Branch

Delaware

Format of Workshop and Agenda

Due to restrictions on gatherings and travel resulting from the COVID-19 pandemic, the Delaware workshop was held virtually using a software platform capable of polling and breakout groups (ultimately not used). The workshop was originally planned to take place over three days in three sessions of two hours each (Table D-3). During Session 1, the team walked participants through approximately half of the guide content; Session 2 concluded by covering the rest of the guide and discussing next steps. At the conclusion of Session 2, it was determined that a third session with the entire group was not needed, and instead a 1-hour debrief was held with key Delaware DOT (DelDOT) staff.

Throughout the workshop, participants were able to contribute feedback, ask questions, and find links to resources in the chat box. A workshop evaluation survey was distributed at the end of Session 2.

Table D-3. Delaware workshop agenda.

Date and Time	Topic	Contents
Monday 8/10, 1:00–3:00 p.m. EDT	Session 1—Introductions, Guidebook Walk-Through	Introductions, Overview of Workshop, Objectives Current Status of Addressing GHG at DelDOT Guidebook Walk-Through: Sections 1–8, 10–12, 15
Wed. 8/12, 1:00– 3:00 p.m. EDT	Session 2—Topical Discussions	Guidebook Walk-Through: Sections 9, 13–14, 16– 18, Appendices Breakout Groups by Functional Area Guidebook Evaluation
Monday 8/24, 1:00–2:00 p.m. EDT	Session 3—Leadership Debrief	Workshop Evaluation Recommended Next Steps

For the guide walk-through, presentations on Sections 1 to 4 included limited question and answer. The following sections were grouped into modules with more time for interactivity, including poll questions and discussion:

- Sections 5–8: Policy, Institutional Alignment, Partnerships, and Communications.
- Sections 10–12: Planning, Programming, Project Development/Environmental.
- Sections 9, 13, and 14: Final Design/Construction, Maintenance, Central Administration.
- Sections 16–18: Districts, Monitoring, Putting it All Together.

Because there was not time to explore all guide content in detail, it was recommended that participants review relevant guide sections independently, with the same questions provided for consideration as for the Nevada workshop.

Policy Context and Current Activities

DelDOT is coordinating with a range of State agencies, including the Delaware Department of Natural Resources and Environmental Control (DNREC), as the State develops its Delaware Climate Action Plan. Over the course of the spring and fall of 2020, the State engaged Delaware residents in a series of public workshops to shape the plan. The plan aims to minimize GHG emissions and maximize the State's resilience to the climate change impacts the State already is experiencing. In doing so, the document considers energy demand as one of three major impacts and adopts economy-wide modeling strategies and emissions. The plan considers solutions in a variety of areas, including renewable energy, clean

transportation (public transit, electric vehicles), support for local communities (technical and planning assistance, grant funding), and partnerships with other States, among others.

The plan's first draft will be submitted in December 2020, with the final document slated for release early 2021.

DelDOT sees its ongoing activities as aligned with these clean transportation goals, though its long-range planning is not yet formally coordinated with the Climate Action Plan process. The agency has some electric vehicles (EV) and looks for opportunities where possible to expand its EV fleet. Delaware's transit system is run as a transit corporation (DART) within the DelDOT group, and DelDOT recognizes that higher-quality transit service encourages mode shift and reduces emissions. Overall, the agency's three primary approaches towards reducing GHGs in transportation are:

- Electric charging station installation at facilities.
- Provision of alternative fuel transit vehicles.
- Work with industry partners (DNREC) on statewide initiatives, including the Climate Action Plan.

Actions to Increase Engagement

In the leadership debrief held on day 3, the project team suggested a number of next steps for the agency and offered assistance with these, as needed. Next steps for consideration are shown in Table D-4. The DelDOT leadership team meets bimonthly, and expected to develop a more specific roadmap of next steps for the agency at these meetings.

Table D-4. Potential next steps for Delaware DOT.

Functional Area	Description of Activity
Executive	Develop an Executive Charter expressing the agency's priority for addressing GHG emissions and assigning responsibilities.
All	Have functional units perform self-assessments and suggest specific actions they could take, along with interim check-ins/milestones.
Executive	Create master list of who is doing what, and check in on progress regularly.
Planning, Programming, Project Development, Environmental	Develop policy for considering GHG in planning and programming, starting with project-level analysis, moving to STIP project and program-level assessment, and finally at the planning level.
Executive/Administrative, working with Construction, Maintenance, Operations	Develop order-of-magnitude inventory of agency-generated emissions and identify potential low-hanging fruit for emission reductions and reasonable reduction targets.

Guide Feedback

Several poll questions posed during the workshop solicited general feedback on the structure and organization of the document. Unanimously, participants reported that the guide material was "about right" in length (7/7), agreed that the "organization and presentation of the guidebook work well" (5/5), and that "the self-assessment tools are useful to me and/or my staff" (4/4). One participant added that organizing the guide around a combination of self-evaluation, text, and examples provided helpful variety and made the document more useful. Other participants echoed that examples from other States were particularly helpful.

Attendees

The workshop included 22 participants across a range of organizations, including DelDOT, other State agencies, MPOs, County/City staff, a university, and nonprofits. Five members of the NCHRP project team facilitated discussion, managed technology, and took notes.

The following positions were represented within DelDOT:

- Assistant Director, Maintenance and Operations
- Assistant Director, Planning
- Assistant Director, Traffic Operations and Management
- Deputy Director, Operations and Support
- Director, Planning
- Planner

The following partner agencies and staff positions also were represented at the workshop:

- Delaware Department of Natural Resources and Environmental Control: Climate Adaptation Project Manager, Principal Planner
- Delaware Department of Natural Resources and Environmental Control: Environmental Engineer
- Delaware Department of Natural Resources and Environmental Control: Clean Transportation Planner
- Delaware Office of Management and Budget: Deputy Director, Government Support Services
- Delaware Office of Management and Budget: Fleet
- Delaware River and Bay Authority: Director of Environmental, Health, and Safety
- DART: Chief Innovation Officer
- DART: Planning and Development Manager
- AECOM/RideShare DE: Outreach Coordinator
- AECOM/RideShare DE: Project Manager
- City of Newark: Planner
- Dover-Kent County MPO: Public Outreach Manager
- New Castle County: Planner
- Wilmington Area Planning Council: Principal Planner
- University of Delaware: Professor and Director of the Center for Fuel Cell Research
- Delaware Greenways: Executive Director.

Hawaii

Format of Workshop and Agenda

Due to restrictions on gatherings and travel resulting from the COVID-19 pandemic, the Hawaii workshop was held virtually using a software platform with capacity to support breakout rooms and polling questions. The workshop was structured as part of the quarterly convening of the Statewide Transportation Advisory Committee's (STAC) staff-level arm, Sub-STAC. Sub-STAC facilitates a coordination committee between the State of Hawaii and the Counties of Honolulu, Hawaii, Maui, and Kauai in the development of the STIP policies and programs.

The workshop took place over the course of a single three and a half half-hour session (Table D-5). During the first half of the workshop, the team walked participants through about half of the guide content. The second portion of the day covered the remainder of the guide. Participants split into breakout groups organized by functional area for discussion, sharing topics of discussion and takeaways upon reconvening.

Throughout the workshop, participants were able to contribute feedback, ask questions, and find links to resources in the chat box.

Table D-5. Hawaii workshop agenda.

Date and Time	Topic	Contents
Thursday 1/21 8:00–10:35 HAST	Guide Walk-Through and Self-Assessments	Introductions, Overview of Workshop, Objectives Current Status of Addressing GHG at Hawaii DOT (HDOT) Guide Walk-Through with Feedback/Discussion by Functional Area to Identify: • Current Level of Engagement • Current and Desired Strategies • Questions
Thursday 1/21 10:35–11:05 HAST	Session 3 – Breakouts for Self-Assessment and Action Planning	Self-Assessment Discussion - Breakouts by Functional Area: 1. Policy and institutional issues 2. Planning, programming, project development, and traffic operations 3. Design, construction, maintenance, facilities & administration Report-Backs
Thursday 1/21 11:05–11:30 HAST	Workshop Evaluation and Wrap Up	Wrap up, Next Steps, and Evaluation

Because there was not enough time to explore all guide content in detail, it was recommended that participants review relevant guide sections independently. Participants were asked to review the guide, explore specific portions of interest in more detail, and complete a self-assessment worksheet for at least two functional areas that are most closely related to their responsibilities.

Policy Context

In 2007, Hawaii became the second State to set a binding cap on GHG emissions through Act 234, which declared a policy to reduce GHG emissions statewide to 1990 levels by the year 2020. Act 234 established the GHG Emissions Reduction Task Force within the Department of Business, Economic Development, and Tourism, and directed the Task Force to prepare a work plan and regulatory framework for the effort. Act 234 directed the State to adopt rules focused on the “maximum practically and technically feasible and cost-effective reductions in GHG emissions.”¹

The Department of Health now serves as the primary agency with regard to GHG emissions with its Air Pollution Control Permit process regulating emissions. Act 234 also directed the DOH to adopt rules specifying how the State could effectively achieve the required “real, permanent, quantifiable, verifiable, and enforceable” reduction in GHG pollution. The rules focus on large existing stationary sources; emissions of GHGs from biogenic, transportation, and smaller sources are not included in these rules.²

Another effort is the Hawaii Clean Energy Initiative (HCEI), launched in 2008 through a memorandum of understanding between the U.S. Department of Energy and the Governor of Hawaii. This initiative aims to transform Hawaii’s economy to 70 percent clean energy by 2030. HCEI formed several working groups

¹ State of Hawaii, Department of Health. “Hawaii Greenhouse Gas Program.” 2020. <https://health.hawaii.gov/cab/hawaii-greenhouse-gas-program/>.

² Hawaii State Energy Office. “Hawaii Greenhouse Gas Program Update.” 2016. <https://energy.hawaii.gov/wp-content/uploads/2016/03/2015-greenhouse-gas-program.pdf>

composed of government, nongovernmental organization, university, and business leaders; and is on track to meet interim renewable portfolio and energy efficiency portfolio standard targets by 2020.

Current Activities

Unlike most States, Hawaii allocates transportation GHG emissions within the energy sector. Consequently, the vast majority of carbon emissions fall under this category; in 2016, the energy sector accounted for 86.5 percent of total emissions. Within the energy sector, transportation represents the category with the highest portion of emissions. HDOT anticipates that, without concerted action, the percent of net emissions in Hawaii attributed to the transportation sector will only continue to rise (Table D-6). In particular, the 2019 Hawaii GHG Emission Report anticipates ground transportation's portion of emissions to rise from 59 percent to 69 percent between 2020 and 2025.

Table D-6. Hawaii GHG total and transportation emissions.

Source	Hawaii GHG Emission Projections (MMT CO ₂ Eq)					
	1990	2007	2010	2015	2020	2025
Transportation	11.26	12.19	10.16	9.79	10.22	10.32
	59%	56%	51%	55%	59%	69%
Ground	3.4	4.97	5.28	5.64	5.84	5.73
Domestic Marine	1.82	1.79	0.91	0.39	0.39	0.39
Domestic Aviation	4.66	4.42	2.87	3.23	3.46	3.67
Military	1.38	1.02	1.1	0.53	0.53	0.53
Net Emissions (Including sinks)	19.08	21.71	19.77	17.75	17.34	14.86

Source: Hawaii Greenhouse Gas Emission Report for 2015 and 2019.

In response, one area of focus for HDOT has been promoting electric vehicles and electric vehicle charging stations. HDOT currently maintains 286 public EV charging stations, and the agency hosted an electric bus demonstration in 2018 for airport passenger shuttles. Other reduction activities include solar panel installation at airport parking garages; energy-efficient lighting; indices for environmental aspects in the STIP process; and EV exemptions for use of high-occupancy vehicle (HOV) lanes. After the State enacted a law allowing agencies to contract for vehicle procurement or associated capital investments in charging or fueling infrastructure similar to facility-based energy services contracts in 2019, HDOT Highways entered into a service contract and was replacing 43 internal combustion engine (ICE) light-duty vehicles with EVs in 2021. While not specifically addressing GHG emissions, the HDOT Practical Solutions Action Plan (2016) outlines an outcome-focused approach to decision-making for transportation project development and delivery that supports multimodal solutions and Complete Streets practices that could help reduce vehicle travel over time.

HDOT also has taken steps to advance low-carbon materials. The agency is testing a concrete mix injected with waste CO₂. To produce this concrete, CO₂ is mixed into the concrete, generating a product that traps CO₂ in mineral form within the concrete and improves the comprehensive strength of the material. Depending on the final specifications, the use of carbon-injected concrete could reduce embodied carbon by 25 pounds per cubic yard, representing a 6 percent improvement.³

³ Hawaii Department of Transportation. "HDOT Tests Sustainable Concrete Mix Designed to Reduce Carbon Footprint of Road Construction." 2019. <https://hidot.hawaii.gov/blog/2019/05/16/hdot-tests-sustainable-concrete-mix-designed-to-reduce-carbon-footprint-of-road-construction/>.

The draft Hawaii Statewide Transportation Plan (HSTP) update includes an environmental goal to support a transportation system that protects and enhances Hawaii’s unique natural and cultural resources. Reduction of transportation GHG emissions to support the statewide goal of carbon neutrality by 2045 is one of the environmental objectives in the proposed HSTP.

Overall, much of the current work in Hawaii is happening in adaptation rather than mitigation. One participant offered the Harbor Division’s resiliency plan as an example of this approach.

Key Questions and Needs

In response to poll questions, a majority or plurality of workshop participants generally their agency (HDOT or partners) as Level 2 for GHG engagement, having taken some actions, but still with much more that could be done. The exception was for partnerships, where the majority rated HDOT as Level 3, working collaboratively with one or more agencies.

HDOT considers itself committed to generating further cuts to its GHG emissions. The agency sees the collection and use of data as the most important next challenge, as this information will help to determine where to focus its efforts. Examples of data needs include vehicle fleets (age and composition) to support replacement programs, as well as GHG and other benefits and impacts of mode shift strategies. HDOT wants to be able to quantify the GHG impacts of its actions, indicating a need to comprehensively review the data the agency already collects and understand how that might translate into GHG benefits. Clear communication of this data, and use of the data in decision-making, also are important needs.

Some workshop participants had questions about roles and responsibilities of the various agencies involved in GHG emission reduction efforts and the number of “cooks in the kitchen.” There were questions about the extent to which HDOT should be expected to “lead the charge” versus being seen more as a player within a larger effort. Concern over roles and responsibilities can be managed by breaking activity down into a spreadsheet identifying the expected players, deadlines, and deliverables. Conversations at the staff level can support a larger, more formal process of meetings with report-backs on progress and help focus all involved. These regular reports also can help identify which parts of the process are underperforming so that agencies can improve coordination as they go.

An example of an issue on which roles could be clarified is the development of specifications. If a county wants to use GHG-friendly pavements, HDOT may need to provide leadership and technical assistance in this area. Enhanced communications procedures could help improve HDOT’s understanding of the needs of local agencies.

The dispersed nature of the State creates additional challenges around communication and coordination that need to be addressed across all aspects of a GHG program. However, this dispersed nature also creates opportunities; for example, smaller municipalities or localities often bundle roads and construction projects, allowing for bulk buying of low-carbon materials and fuels.

Actions to Increase Engagement

HDOT considers itself committed to generating further cuts to its GHG emissions. The agency sees the collection of data as the most important next challenge, as this information will help to determine where to focus its efforts.

Following the workshop, actions proposed to increase HDOT’s engagement included:

- **Action 1.** Create an executive charter that establishes a task force or working group that meets regularly (e.g., monthly) to identify action items and report on progress. This group should be charged with investigating, assessing, reporting on, and implementing GHG emission reduction measures for all direct and indirect DOT-related GHG emissions. This group should include key staff representing all of the agency’s divisions/functional areas. (See model charter and meeting agenda in Section 19 of the guide.)

- *Responsibility*: Executive leadership.
- *Timeframe*: One month.
- **Action 2.** Functional area leads should work with their staff to complete the self-assessment(s) included at the end of their area’s relevant section(s) of the guide. Share recommended actions with GHG task force; get executive buy-in where needed; and set a process/timeline for checking in on progress.
 - *Responsibility*: Functional area leads included in GHG task force.
 - *Timeframe*: Two months.
- **Action 3.** Continue working with the Statewide Climate Coordinator and other agencies to develop a roadmap for the State to achieve the State’s goal of a zero-carbon economy by 2045. To the extent it is not being done already, representatives(s) of HDOT should meet regularly with the Statewide Climate Commission and other agencies to communicate what HDOT is doing and can do to estimate and reduce GHGs from the transportation sector. Identify how HDOT and other State agencies can work together and support each other to get to the 2045 goal.
 - *Responsibility*: Statewide Climate Commission and HDOT climate or other designated lead per task force.
 - *Timeframe*: Ongoing.
- **Action 4.** Develop an inventory of existing data collected by HDOT and analysis tools that can support: a quantification of GHG emission effects of ongoing and to-be implemented HDOT programs and projects; a more detailed inventory and forecast of GHG emissions from transportation sources and sources; and future analysis of GHG reduction strategies. Develop a plan and timeline for quantifying and reporting on emissions. Coordinate with partner agencies (e.g., MPOs) as needed for sharing of data and tools.
 - *Responsibility*: Planning lead, working with environment and with support from other functional areas, including sustainability coordinator for operations, construction, and maintenance, or other designated lead per task force. This could be examined further to be included in the ongoing Hawaii Statewide Transportation Plan update.
 - *Timeframe*: Four months.

Guide Feedback

Two poll questions were offered to gauge the usefulness of both the guide and the workshop.

Participants generally expressed that the workshop and guide would prove somewhat (53 percent) or very useful (35 percent) to them and/or their staff. That over half the respondents found the guide to be only “somewhat useful” may be due to the relatively low portion of participants from HDOT compared to counties/cities, MPOs, and other agencies, who are not the primary audience of the guide.

Similarly, 31 percent of respondents reported that the guide’s self-assessment tools would be “very useful” to them and/or their staff, with 62 percent reporting that the self-assessments would be “somewhat useful.” This result may again reflect the intended audience for the assessments versus the composition of this particular workshop.

Attendees

Five members of the NCHRP project team facilitated the meeting. The project team participation included staff for one facilitator for each breakout group and one person managing note-taking and live polling.

The Sub-STAC includes members from a range of departments, agencies, and localities, including DOTs, Business, Economic Development, and Tourism, and Planning at the county level, as well as State-level representatives. There were 52 total workshop participants, including 22 HDOT staff. Participants included representatives of the following agencies and organizations:

- State of Hawaii Department of Transportation. Office of the Deputy Director, Airports Division Engineering Branch Planning Section, Harbors Division Engineering Branch Planning Section, and

various sections and districts of the Division of Highways, including the Planning Branch, Construction and Maintenance Branch, Project Coordination and Technical Services Office, Traffic Branch, Design Branch, Oahu District, Hawaii District, as well as Statewide Transportation Planning Office.

- Other State Agencies. Office of Planning, Department of Business, Economic Development and Tourism, Department of Health, Department of Land and Natural Resources Office of Conservation and Coastal Lands.
- Cities/Counties:
 - Hawaii County: Departments of Public Works (DPW), Transit, Planning.
 - City and County of Honolulu: DOT Services Planning and Transit, Department of Planning and Permitting, Office of Climate Change, Sustainability and Resiliency.
 - Kauai County: DPW, Transit, and Planning.
 - Maui County: DPW, DOT, Planning.
- MPOs:
 - Maui MPO.
 - Oahu MPO.
- Federal Agencies:
 - U.S. Environmental Protection Agency.
 - Federal Aviation Administration.
 - Federal Highway Administration.
 - Federal Transit Administration.
- Other:
 - Consultant to HDOT.