ENERGY EFFICIENCY AND GREENHOUSE GAS EMISSIONS REDUCTIONS THROUGH STATE FREIGHT PLANNING

By Therese Langer and
Shruti Vaidyanathan

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About the Authors

Therese Langer is a senior fellow at ACEEE, where she is working on an initiative to reduce freight transportation emissions through applications of information and communications technology. She previously directed ACEEE's transportation program for 19 years and currently serves on the National Academy of Sciences, Engineering and Medicine Phase 3 committee on improving light-duty fuel economy. Therese holds a PhD in mathematics from the University of California, Berkeley.

Shruti Vaidyanathan oversees research on vehicle efficiency and systemwide transportation efficiency. Her work has most recently focused on passenger and freight mobility best practices at the state and local levels and the role of emerging mobility options and autonomous vehicles in sustainable urban transportation systems. Shruti holds a master of science in public policy and management from Heinz College at Carnegie Mellon University and a bachelor of arts in environmental science and economics from Grinnell College.

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Abstract

Some states view with increasing seriousness their role in addressing climate change and other societal imperatives, and they recognize the transportation sector's centrality to those efforts. Meanwhile, the transportation apparatus within the federal government has begun to emphasize freight as a key transportation issue and is using its role as transportation investor to disseminate and operationalize this priority throughout the transportation planning and funding processes. Together, these trends create an opportunity to integrate state freight planning into the broader context of state efforts to reduce greenhouse gas emissions, giving a new urgency and coherence to the freight planning process while expanding its audience.

This paper examines current state freight plans from the perspective of energy efficiency and greenhouse gas emissions. It reviews the implications of federal policy for these plans, provides examples of how states have begun to address energy efficiency and environmental issues within federal policy parameters, and offers recommendations of how state freight plans could advance broader goals while meeting freight system needs.

Introduction

This paper is about the role of state freight plans in creating a more efficient and sustainable freight system. Both public- and private-sector actors build and operate infrastructure for goods movement, and they will need to work together to reduce freight-sector emissions while maintaining or improving the essential economic services that the freight system provides. States are of particular importance because they have primary responsibility for programming public funds for freight investments.

Transportation has overtaken electricity generation as the largest source of greenhouse gas (GHG) emissions in the United States. Domestic freight transportation accounted for 30.2% of transportation-sector GHG emissions in 2018, up from 23.6% in 1990 (EPA 2020). This increase in emissions share is due largely to growth in truck miles traveled.

Trucks and rail carry roughly the same number of freight ton-miles annually in the United States, but freight trucks consume more than 10 times as much fuel as freight rail (EPA 2020; Davis and Boundy 2020). Federal fuel efficiency and GHG standards for heavy trucks, first adopted in 2011 and updated with "Phase 2" standards in 2016, will ensure fuel efficiency gains through vehicle technology improvements. New medium- and heavy-duty vehicles will be required to be 37% more fuel efficient on average in model year 2027 than they were in model year 2010 (Khan 2016).[1] In addition, prospects for medium- and heavy-duty battery electric trucks have greatly improved in recent years thanks to the decline of battery prices and expanding—though still limited—high-voltage charging infrastructure. The earliest commercial electric trucks have been shorter-distance vehicles operating in urban environments, such as pickup and delivery vans, buses, waste haulers, and utility vehicles. Even tractor trucks are increasingly perceived as possible battery electric vehicle (BEV) conquests; vehicles from several manufacturers are scheduled for release by 2021, initially targeting regional-haul markets (Nadel and Junga 2020). Fuel cell trucks remain a logical technology for long-haul applications, though the paucity of refueling infrastructure and the cost of hydrogen remain major challenges.

Yet freight-truck miles traveled continue to grow and are projected to increase at a rate of 1.1% per year for the next 30 years (EIA 2020). Absent further improvements in fuel efficiency beyond the Phase 2 standards, freight-truck fuel consumption is projected to bottom out in the mid-2030s and then resume climbing in 2039, as increasing miles traveled overtake efficiency gains (EIA 2020). Even with continued fuel efficiency gains and substantial electrification of the truck fleet, reductions in freight emissions consistent with transportation-sector sustainability will be very difficult to achieve without substantial changes in how goods travel.

[1] Two elements of the Phase 2 program, namely standards for trailers and standards for "glider" vehicles (new tractor bodies with older power trains), are in jeopardy due to legal challenges and/or actions of the EPA under the current administration. Trailer standards contribute about 7% of the 25% savings from Phase 2, and glider standards contribute roughly 5% (Khan 2019).

MAP-21 goals of the national freight policy (PL112-141):

- To invest in infrastructure improvements and to implement operational improvements that
  - Strengthen the contribution of the national freight network to the economic competitiveness of the United States
  - Reduce congestion
  - Increase productivity, particularly for domestic industries and businesses that create high-value jobs
- To improve the safety, security, and resilience of freight transportation
- To improve the state of good repair of the national freight network
- To use advanced technology to improve the safety and efficiency of the national freight network
- To incorporate concepts of performance, innovation, competition, and accountability into the operation and maintenance of the national freight network
- To improve the economic efficiency of the national freight network
- To reduce the environmental impacts of freight movement on the national freight network

There are major opportunities to save fuel, save money, and reduce emissions, not only through further improvements to the fuel efficiency of freight vehicles and the use of cleaner fuels but also through advances in the freight system. Such opportunities include greater use of intermodal services and multimodal networks, advanced logistics, load consolidation, collaborative shipping, and new approaches to urban freight delivery (Façanha et al. 2019). A shift in the trajectory of freight energy use will require that planning practices evolve to recognize and adopt new tools to reshape freight networks.

This review of state freight plan approaches to GHG emissions reduction is largely focused on system efficiency rather than vehicle efficiency. Greening of vehicles will be a huge factor in reducing the carbon footprint of goods movement. But this process will take decades, especially given the slow rate of vehicle turnover, and the grave environmental and societal impacts of freight movement will continue if the volume of truck traffic on our highways and city streets continues to grow.

Because the U.S. Department of Transportation (USDOT) strongly influences state transportation choices through its funding decisions, the paper begins with an overview of federal policy on freight investment.

Federal Freight Policy

Starting with the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), federal transportation funding authorization bills increasingly recognized the importance of freight transportation and the need for freight policy guidance. Moving Ahead for Progress in the 21st Century (MAP-21), the federal transportation law passed in 2012, contained substantial new freight-related provisions, including the outlines of a national freight policy.

MAP-21 set seven goals for a National Freight Policy (see box). MAP-21's freight provisions were focused almost exclusively on trucking, however. MAP-21 was followed by the Fixing America's Surface Transportation (FAST) Act. Signed into law in 2015, FAST built on the planning elements of MAP-21 and explicitly made U.S. freight policy multimodal.

TACKLING ENERGY USE AND GHG EMISSIONS

One of seven stated goals of national transportation policy overall is "[t]o enhance the performance of the transportation system while protecting and enhancing the natural

environment" (23 U.S. Code §150). While the FAST Act has no explicit requirements to improve energy efficiency or reduce GHG emissions, other key elements of the law could support an ambitious program of emissions reductions, helping to achieve the policy's environmental goal. One such element is a focus on performance-based investment to achieve national transportation goals. Another is the requirement that freight-sector planning be multimodal and take advantage of innovation and advanced technology. The next sections discuss these FAST Act elements and their relevance to saving energy and reducing GHG emissions.

Performance Management

MAP-21 and FAST are heavily focused on performance management as a tool to determine "the effectiveness of the Federal-aid highway program as a means to address surface transportation performance at a national level" (DOT 2017, 5972). These laws require USDOT to establish transportation performance measures. As recipients of federal funds, states must set performance targets for those measures as applied to their own transportation systems and report on their progress in meeting the targets. They can adopt additional performance measures as well. Having such measures is a crucial step toward ensuring that projects and policies adopted by states contribute to achieving public priorities such as emissions reduction.

USDOT adopted three performance management rules pursuant to MAP-21 and FAST. The third rule, issued in January 2017, established carbon dioxide (CO_2) emissions from vehicles on the National Highway System as a performance measure, meaning that states were required to track and set targets for those emissions. However, the Trump administration repealed the CO_2 performance measure requirement in May 2018 (DOT 2018).

The third rule nominally covers performance management for freight transportation as well. MAP-21 required development of performance measures only for freight movement on the interstate system (DOT 2016b), and the sole freight performance measure the rule requires is truck travel time on the interstate system. To shape the evolution of the U.S. freight system to meet transportation policy goals, federal and/or state DOTs will need to adopt a more comprehensive and balanced set of freight performance measures.

Multimodal System

The FAST Act responded to a broad critique of MAP-21's freight provisions as too focused on highways, in light of the multimodal nature and needs of the U.S. freight system. While non-highway freight infrastructure is frequently privately owned and operated, the public role in integrating these facilities into the larger freight system—to advance societal goals—is crucial (BouMjahed and Schofer 2019). FAST took several steps to remedy this shortcoming, including requiring USDOT to establish a national multimodal freight policy and a national multimodal freight network (49 U.S. Code Chapter 701).

FAST's treatment of the freight system as fundamentally multimodal is highly significant from the perspective of energy efficiency and the environment. Multimodality is a key strategy to reduce fuel consumption and emissions because trucking, the dominant mode, is much more fuel intensive and higher emitting than other freight modes, aside from aviation,

on a per ton-mile basis (see figure 1). Non-highway modes warrant special attention and investment due to the predominance of trucking and the shortage of public investments and planning procedures in most states to advance non-highway modes.

FAST added two dedicated freight funding programs: the National Highway Freight Program (NHFP) and the Nationally Significant Freight and Highway Projects program, currently known as INFRA but previously called FASTLANE (Boris and Murray 2018; Goldman 2019). The NHFP provides $6.3 billion in formula funding over five years, while INFRA is a discretionary grant program providing $4.5 billion over five years. FAST allows states to use modest amounts of this funding for eligible non-highway projects: up to 10% of NHFP funds and up to $500 million (11%) of INFRA grant funds can be used for projects to improve non-highway freight modes (Goldman 2019).

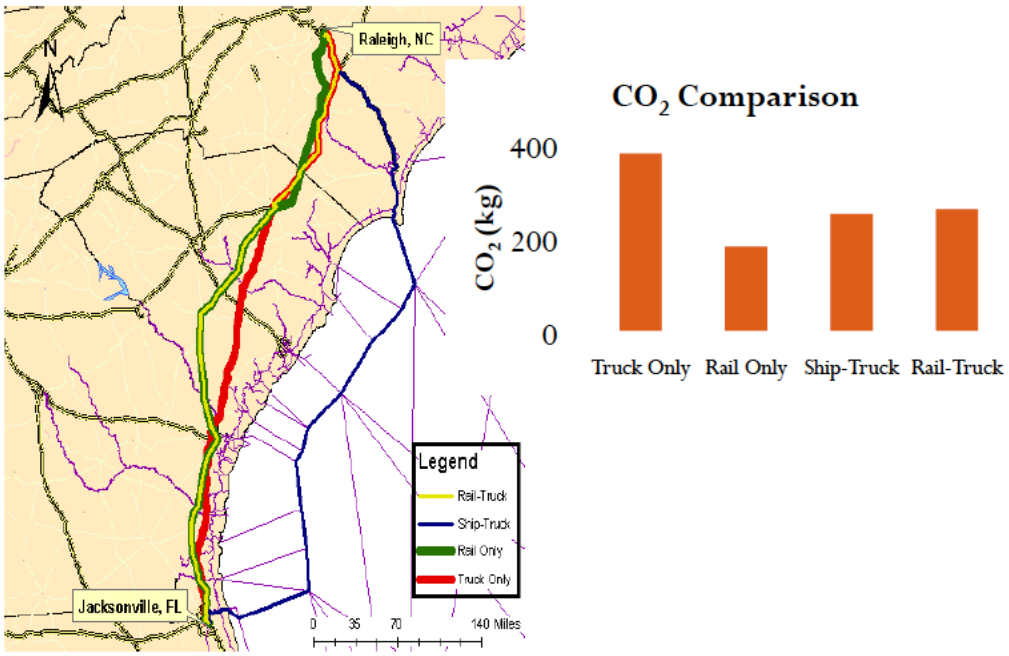

Figure 1: Comparison of CO_2 emissions across major freight modes for shipments between Jacksonville, Florida, and Raleigh, North Carolina. *Source:* Winebrake 2012.

Multimodal policies are not a substitute for GHG emissions reduction policies, but they do advance consideration of lower-emitting modes. In addition, the economic benefits of multimodality are widely acknowledged (Berman 2018), strengthening the case that economic efficiency and energy efficiency are aligned in the freight sector. Furthermore, the redundancy typical of multimodal systems contributes to system resiliency.

Innovative Technologies and Operational Strategies

The FAST Act requires state freight plans to include "[a] description of how innovative technologies and operational strategies, including freight intelligent transportation systems (ITS), that improve the safety and efficiency of the freight movement, were considered" (DOT 2016a).

The rapid technological advances occurring in the transportation sector apply fully to freight transportation. Information and communications technology (ICT) is facilitating major efficiency gains through such practices as real-time routing, load consolidation, shared use of warehousing and distribution facilities, and synchromodalism (i.e., multimodal transport in which mode assignments are made in real time). Automation of both vehicles and facilities is a growing trend, with ports and logistics facilities automating at an increasing rate globally while facing resistance at some locations due to potential job loss.

Such developments are driven primarily by their promise of greater efficiency and/or reliability. In many instances, they can result in energy efficiency and emissions reductions as well. This is because faster and more-direct routes, shared use of vehicles, dynamic use of warehousing, and direct access to the full array of transport options by small shippers can all reduce vehicle miles traveled in the transport of goods. In some instances, they result in greater use of high-efficiency modes like rail or ship.

ICT-based freight strategies, as well as successful implementation of performance-based freight planning, relies upon the collection, analysis, and use of high-quality data. But such data have been notoriously difficult to come by, partly due to the multitude of public and private entities that operate the freight network. Opportunities to dramatically improve data collection, sharing, and analysis through deployment of sensors and shared data protocols have the potential to address this problem.

Equity Issues

Transportation systems strongly affect communities, their economic prospects, and their quality of life. Freight activities in particular can bring severe health, safety, congestion, and noise impacts, often in lower-income or minority communities. Federal freight policy acknowledges such impacts but has yet to set an explicit goal of addressing them.

Low-income communities and minority communities also are expected to be disproportionately exposed to damage wrought by climate change. Fortunately, a variety of strategies to reduce freight GHG emissions could also reduce emissions of criteria pollutants and mitigate other adverse impacts of freight activities in those communities. For example, electrification of freight vehicles and equipment could dramatically reduce emissions near freight facilities and corridors. Reducing truck traffic through load consolidation and diverting truck traffic to cleaner freight modes also would reduce air pollution and noise while contributing to a low-GHG freight system more broadly.

All freight modes can bring adverse community impacts, however. Rail and marine freight facilities, for example, have historically been sources of health, safety, and noise problems. These can arise at poorly controlled and managed rail yards and rights of way, for example, or as a result of inadequate regulation of idling of locomotives and ocean-going vessels. Hence, steps to promote greater use of non-truck modes should be accompanied by safeguards against localized hazards from these modes and the associated facilities. Including community representation in state freight planning processes can help to avoid adverse local impacts from such projects.

FEDERAL POLICY ON STATE FREIGHT PLANS

As part of its heightened attention to freight transportation, MAP-21 underscored the importance of state freight planning by making a freight plan a prerequisite for states' eligibility for an increased federal share for freight project funding. FAST went further, requiring states to have such plans in place by December 4, 2017, to receive any NHFP funds.

States such as California and New Jersey, which host major freight gateways, have practiced freight planning in some form for many years. The objectives and structure of such planning efforts have been specific to the circumstances of each state. Other states have begun structured freight planning only recently, with the introduction of federal requirements for state freight plans. As of July 2019, all states had FAST-compliant freight plans in place.[2] Plans are to be updated every five years.

MAP-21 and FAST also specified certain components that state freight plans must include. Among the required contents of state freight plans are descriptions of

- The freight policies, strategies, and performance measures that will guide the freight-related transportation investment decisions of the state
- How the plan will improve the ability of the state to meet the national multimodal freight policy goals
- How innovative technologies and operational strategies that improve the safety and efficiency of freight movement were considered (49 U.S. Code §70202)

Pursuant to MAP-21 and FAST Act freight provisions, USDOT issued guidance regarding the content of state freight plans in 2016 (DOT 2016a). The guidance adds specifics on addressing environmental and community impacts. For example, regarding states' description of how they will meet freight goals, the guidance states that "strong consideration should be given to describing how the State plans to mitigate the effects of freight transportation on communities, particularly minority and low-income communities, and the environment" (DOT 2016a, 71194).

The guidance strongly recommends that states establish state freight advisory committees and that such committees include "cargo carriers and logistics companies, and safety, community, energy, and environmental stakeholders" (DOT 2016a, 71190). Including community representatives is essential in view of the impacts of freight movement on neighboring communities. Adequate participation of these communities can help to ensure that new facilities to accommodate multimodal freight, such as rail and intermodal yards, do not impose new environmental and safety burdens on residents.

[2] T. Julien, Federal Highway Administration, pers. comm., 2019.

The guidance also encourages states to coordinate their freight plans with neighboring states and nations (DOT 2016a, 71187). Multistate cooperation on freight is crucial given infrastructure needs for long-haul freight trips, especially those using non-truck modes.

LOOKING FORWARD

The FAST Act expires on September 30, 2020, and discussions of the reauthorization of transportation funding are underway. In August 2019, the Senate Environment and Public Works Committee reported by unanimous vote a bill entitled America's Transportation Infrastructure Act of 2019 (ATIA), which would authorize $287 billion in Highway Trust fund spending over five years (Senate 2020). Senate Banking and Commerce Committees would add provisions covering transit and finance issues, respectively, if ATIA were to advance as the Senate's overall transportation funding authorization bill in the coming months.

ATIA would increase NHFP funding to $8.5 billion over the five years. INFRA funding would increase to $5.5 billion, and up to 30% could to go to multimodal projects (this time including waterway corridor projects that are "likely to reduce on-road mobile source emissions"). Otherwise, the bill contains little on freight, lacking an update to the vision put forward in MAP-21 and the FAST Act. With regard to freight planning, new provisions are minor. The bill proposes no additions to the single, highway-based freight performance metric adopted in the third performance management rule. ATIA requires that members of state freight advisory committees have experience in business, transportation, or government, which could in effect exclude representatives of community or environmental groups, to the detriment of equity in freight system impacts.

A notable element of ATIA is its first-ever climate change subtitle in a transportation bill. The subtitle includes several significant climate provisions, including $700 million for a Carbon Reduction Incentive Program, which includes formula funding for state projects to reduce highway GHG emissions and grants for states that demonstrate success in reducing transportation carbon emissions. Freight-specific provisions under the climate subtitle include funding for a program to reduce truck emissions at port facilities, for example, "through the advancement of port electrification and improvements in efficiency" (Senate 2020, Section 1402).

On the House side, the chairman of the Committee on Transportation and Infrastructure released the INVEST in America Act, a five-year, $494 billion transportation funding bill, in June 2020. Like the Senate bill, INVEST seeks to address climate change, "[p]utting the U.S. on a path toward zero emissions from the transportation sector by prioritizing carbon pollution reduction…" (House Committee on Transportation & Infrastructure 2020a). INVEST climate-related provisions are much more extensive than those in ATIA. INVEST would require that USDOT adopt highway CO_2 emissions as a performance measure, as the agency did initially in the third federal performance management rule in 2017 before reversing itself in 2018.

Several provisions in INVEST would promote consideration of CO_2 emissions and related matters in freight programs and planning in particular. They include

- Specifying that the goals of the National Highway Freight Program and the National Multimodal Freight Policy include reducing emissions of GHG and local air pollution (as well as impacts to water and habitat) and reducing "any adverse impact of freight transportation on communities located near freight facilities or freight corridors"; requiring that state freight plans include strategies and goals to decrease those impacts
- Raising the cap on the amount of freight funding that can be used for non-highway projects
- Providing at least $125 million in fiscal year (FY) 2022 for freight projects in a "gridlock reduction grant program" that places "an emphasis on operational, technological, and mode shift strategies" (House Committee on Transportation & Infrastructure 2020c)

The bill was introduced without Republican cosponsors, and many provisions, including those relating to carbon reduction, can be expected to face opposition as it proceeds through Congress.

In addition to legislation, ongoing activity at USDOT provides important opportunities to advance freight planning and sustainability. MAP-21 and FAST mandated publication of a National Freight Strategic Plan (NFSP) and set requirements for the plan's content, including a process for addressing multistate projects and encouraging jurisdictions to collaborate, strategies to improve freight intermodal connectivity, and identification of best practices to mitigate the impacts of freight movement on communities.

FAST required that the NFSP be published by December 2017, but no such plan has been finalized. A draft NFSP released in the Obama administration includes a number of strategies to address the issues discussed in this paper (DOT 2015). More recently, the Trump administration began anew by soliciting public input on priorities for the NFSP; the timetable for finalizing the NFSP is unclear. The Senate's ATIA would require the NFSP to address resilience and local air pollution, while the House INVEST bill requires it to include best practices to reduce GHG emissions and local air pollution (Senate 2020; House Committee on Transportation & Infrastructure 2020b).

State Freight Plans

Energy and environmental elements of state freight plans are a work in progress. At this early stage, few plans contain provisions that would qualify as best practices in these areas. States by and large appear to have focused on meeting federal requirements for their freight plans, and those requirements address other aspects of planning, as discussed previously. In its *State Energy Efficiency Scorecard*, the American Council for an Energy-Efficient Economy (ACEEE) awards points to states for setting a quantitative energy efficiency, energy savings, or mode-split target for freight movement (Berg et al. 2019). Thus far, only California has earned this point.

Several states' plans do contain elements that could help to move toward a more sustainable and efficient freight system, however. Four such plans are discussed in the following sections. In addition to California, a clear leader in sustainable freight planning, we discuss

Massachusetts, which like California has made quantitative, economy-wide carbon reduction commitments; Minnesota, which has an established transportation performance management program; and Nevada, which has been cited elsewhere for its attention to meeting multimodal freight goals (Boris and Murray 2018). For each of these states, we summarize the plan's explicit commitment, if any, to reduce GHG emissions from goods movement. We then evaluate other plan elements that could support the development of a more effective approach to GHG reduction, focusing on performance management, multimodality, and innovative technologies and operational strategies. Appendix A lists noteworthy references to energy savings, GHG reduction, and related topics in other state freight plans.

CALIFORNIA

Highlights

- Freight GHG reduction target
- Focus on innovative technology
- Prioritization of equity

In December 2019, California released a draft update to the California Freight Mobility Plan (CFMP), first issued in 2014 (Caltrans 2019). The plan notes that freight equipment produces 10% of the state's GHG emissions, as well as 70% of diesel particulate matter, and 45% of NO_x emissions.

California's climate policy includes economy-wide GHG emissions reduction targets of 15% by 2020 and 40% by 2030. Having such targets in place supports state agencies in setting strong, specific emissions reduction goals for the transportation sector and for freight movement, specifically. The CFMP references the need to coordinate with these statewide GHG reduction requirements.

Importantly, the CFMP states a GHG emissions reduction target: a 25% increase in gross domestic product (GDP) per ton CO_2 from freight movement by 2030. This target comes from the California Sustainable Freight Action Plan (CSFAP) (California 2016).[3] The CFMP does not commit to achieving the target, however; in fact, the CSFAP states: "The Targets are not mandates, but rather aspirational measures of progress toward sustainability for the State to meet and try to exceed" (California 2016, 10). A plan appendix reports that there has been a 60–98% reduction of criteria pollutants and 13% reduction of CO_2 emissions at the San Pedro Bay ports (i.e., Port of Los Angeles and Port of Long Beach) but does not report statewide progress (Caltrans 2019, A6).

The plan does cite many emissions reduction opportunities. Among the objectives and strategies laid out in the plan to accomplish its environment-related goals are

- Strategy ES-3-E: incentivize freight projects that minimize GHG, criteria pollutants, and other emissions
- Strategy ES-2-D: explore decarbonization of last-mile delivery to decrease the freight system's impact on air quality in dense urban environments

[3] The CSFAP target is to "[i]mprove freight system efficiency 25 percent by increasing the value of goods and services produced from the freight sector, relative to the amount of carbon that it produces by 2030" (California 2016, 10).

- Strategy CA-1-A: freight plan priority for projects implementing state-of-the-art and demonstration technologies (Caltrans 2019, E.S.-6)

Also notable is that, as one of three components of the "guiding vision" for the CFMP, social equity has a prominent role in the plan. This manifests as a "healthy communities" goal to "[e]nhance community health and wellbeing by distributing the benefits and the negative externalities of the goods movement system equitably throughout California's communities" (Caltrans 2019, E.S.-3). The plan discusses environmental impacts on "freight affected" and disadvantaged communities and overlays those communities on a map of the Primary Freight Network, as defined by USDOT pursuant to MAP-21. CFMP outreach involved consultation with disadvantaged communities, and the state freight advisory committee includes community organizations.

Performance Management

Despite its extensive and often quantitative treatments of freight performance issues, the CFMP identifies a set of performance measures that barely exceeds those required by the USDOT performance management rules. The GHG emissions reduction target in the CFMP is not identified as a performance measure and thus is not subject to federal reporting requirements.

Multimodal System

Multimodal mobility is one of seven CFMP goals, described as "[s]trategic investments to maintain and modernize the multimodal freight transportation system with innovative approaches, including advanced technology to optimize integrated network efficiency, improved travel time reliability, and achieve sustainable congestion reduction" (Caltrans 2019, 1.B.-3). The plan contains extensive discussions of rail and marine modes as well as intermodal freight, and it highlights mode shift as an increasingly important means of reducing truck vehicle miles traveled (VMT) and GHG emissions. The state has identified marine corridors as a means of freeing up rail capacity, which in turn could remove more freight from highways. The plan proposes inland port and rail shuttle development. Many strategies, objectives, and specific investments together spell out an extensive program to expand options for all modes. No measure or target for freight mode split is stated, however, so it is not possible to quantify this multimodal program's contribution to achieving GHG emissions reduction targets.

Innovative Technologies and Operational Strategies

The CFMP highlights "technological trends and potentially disruptive trends such as e-commerce, autonomous trucks, and the greening of the freight industry" and their potential impacts on supply chains and the freight system (Caltrans 2019, E.S.-4). Many objectives and strategies are focused on development and deployment of innovative technologies, including a freight research center for technology innovations, pilot projects for autonomous truck platooning, freight data collection, and modeling-tool development.

A review of freight-plan best practices cites California's "aggressive" integration of ITS into its freight network and the tie-in of these tools to sustainability metrics (Boris and Murray 2018). Potential ITS projects include systems providing vehicle and container location and condition information in real time, eco-routing software using real-time, historical, and

predicted data to optimize routes for least fuel use and emissions, and using train management systems that improve rail service capacity and flexibility.

In summary, California is the only state with an explicit, quantitative target to reduce freight GHG emissions, although it stops short of committing to achieve that target. The freight plan references climate and equity considerations throughout, and it proposes multiple expansions of multimodal facilities and projects to use innovative technologies to make freight movement more sustainable.

MASSACHUSETTS

Highlights

- Commitment to contribute to achieving a 25% statewide reduction in GHG emissions by 2020
- Three of five strategies selected in the plan support GHG reduction

Like California, Massachusetts has in place a statewide climate plan. The Global Warming Solutions Act of 2008 requires a 25% reduction in GHG emissions across all sectors by 2020, relative to 1990 levels, and at least 80% reduction by 2050. The act requires reductions from each sector that sum to the total required; the state's 2010 Clean Energy Plan called for transportation to contribute 30.4% of the reductions toward the 2020 goal.

The Massachusetts freight plan states that the freight sector should contribute to the achievement of the 2020 target (MassDOT 2018). It notes that the state was making progress toward these goals as of 2013 and that the federal government has adopted GHG emissions standards for medium- and heavy-duty vehicles, but it does not further specify how much the freight sector has contributed to the reduction goals or must contribute in the future.

Mentions of strategies to reduce GHG emissions appear throughout the document. For example, an "immediate strategy" is to "support policies to reduce CO_2 emissions from all freight vehicles" (MassDOT 2018, 4–40). However, this is likely a reference to policies to improve truck fuel efficiency, not state freight planning. It does note that this strategy "may involve" continuing to track transportation emissions and "[c]onsidering additional measures to reduce GHG emissions should Federal policy not be projected to achieve the Commonwealth's objectives" (MassDOT 2018, 4–47). This comment underscores the risk that, absent further data and guidance, states may assume that advances in vehicle technology will be sufficient to decarbonize the freight sector.

For modernization and expansion projects, MassDOT selection criteria include the project's ability to reduce GHG and other emissions.

Performance Management

The Massachusetts plan does not consider performance measures beyond those required under MAP-21 and the FAST Act. The current plan has no framework to ensure measurable progress, and state climate commitments are not making their way into freight planning in a meaningful way. However, MassDOT commits to revising the agency's performance management processes to include freight in the future.

Multimodal System

The Massachusetts freight plan includes several strategies to improve the multimodal freight system. Near-term strategies include upgrading rail lines to carry cars loaded to 286,000 pounds, now the national norm, as well as maintaining access to intermodal facilities in urban areas and modernizing container terminals. Under "shaping and hedging strategies," the plan lists "[e]ncourage private industry to adopt short-sea shipping" (MassDOT 2018, 4–42 and 4–60).

Innovative Technologies and Operational Strategies

The plan cites the use of smartphones and GPS to provide real-time traffic and routing information for first- and last-mile shipments, but it also observes the adverse effects these approaches can have on roads not designed for truck traffic. It describes three "plausible futures," in which three-dimensional (3D) printing, automated driving, artificial intelligence (AI), and e-commerce drive a variety of outcomes for the state—not all beneficial—but describes them primarily in economic terms rather than in environmental terms (MassDOT 2018, 3–34). Among the strategies discussed are the development of ITS and active transportation and demand management. "Hedging and shaping" strategies also include "leverage connected vehicle technology to maximize en route efficiency" (MassDOT 2018, 4–57). This includes use of truck convoys and route optimization, but the plan does not mention load consolidation and reduction of empty backhauls. The idea of small-package drops such as Amazon Locker or DHL's Packstation is listed as a "deferred" strategy (MassDOT 2018, 4–60).

The freight plan ultimately selected five implementation strategies to pursue, three of which have been mentioned: upgrading rail-line weight capacity, improving access to intermodal facilities, and developing ITS. Furthermore, looking ahead to the challenges facing the freight system, the plan identifies the following primary strategies to meet those challenges: maintain the current system in a state of good repair, build a sustainable and resilient system in the face of climate change, and embrace ITS and new technologies. These strategies indicate a focus on issues closely related to addressing climate change.

In summary, while Massachusetts, like California, has ambitious statewide GHG emissions reduction targets, its freight plan does not specify how much the freight sector will contribute to meeting those targets. More generally, the plan does not yet employ performance management in a meaningful way. However, of the freight strategies the state has opted to pursue, a majority are likely to improve sustainability.

MINNESOTA

Highlights

- Performance measures beyond federal requirements
- Multimodal vision

Minnesota's current freight plan dates from 2017 (MnDOT 2018). One of five goals of the freight plan is to protect the state's environment and communities. The goal does not mention climate, although a section on freight trends makes a good case for GHG reduction and efficiency in the freight sector, noting that climate change

> highlights the need to develop alternative modes and routes that not only limit the environmental consequences of freight movement but also provide businesses with reliable options. Mode and route choice also reinforce an emerging trend in supply chain management, often referred to as "greening the supply chain." As companies look for ways to decrease costs, save money and reduce waste, the availability of more energy efficient freight modes, such as water or rail, may drive further need for freight system redundancy and thus increase overall system resiliency. Projects that support and develop system redundancy help protect the environment, increase capacity, and buffer the just-in-time supply chain model from disruptions. Finally, near-shoring (discussed on page 18) is partially a response to environmental challenges, as shorter supply chains reduce the risks associated with natural disasters (MnDOT 2018, 21–22).

The plan's performance measures contain no direct reference to saving energy or reducing emissions, although some measures are relevant to these topics, including measures of truck VMT, annual rail shipments in Minnesota, and container lifts in the Twin Cities.

The community protection aspect of the goal also receives spotty attention. The state aspires to ensure that freight is a "good neighbor" by encouraging idle reduction and the use of cleaner vehicles and modes (MnDOT 2018, 72). The plan includes an appendix on environmental justice issues, which shows the predominance of identified "environmental justice populations" (racial and ethnic minorities, households without vehicles, and persons who are low-income, are age 65 or older, are age 16 or younger, or who have limited English proficiency) within a quarter mile of freight facilities of various types, and provides a "general and qualitative" analysis of the impacts of freight plan strategies (MnDOT 2016, 106). How thoroughly these issues have been integrated into outreach activities is unclear, however. A Minnesota DOT (MnDOT) freight summit "fostered executive-level engagement between government and industry," and the summit's agenda included nothing on health or environmental topics (MnDOT 2018, 47). In addition, the working group charged with selecting the performance measures for the freight plan was composed entirely of personnel from MnDOT and other agencies.

Performance Management

MnDOT has an established performance management program, including a "well-developed" set of performance measures (MnDOT 2018, 39). The freight plan stands out in including performance measures, 21 in all, that go far beyond federal requirements. The measures' scope is limited, however, covering only safety, infrastructure condition, and mobility. In addition, the plan lacks targets for the performance measures, and the performance review consists of an analysis of "hot spots" (MnDOT 2018, 41).

MnDOT itself acknowledges that the approach to freight performance falls short of state planning standards: "[T]he lens through which freight is examined is not as robust as other areas (e.g., state highway operations)" (MnDOT 2018, 40). The observation that the quantity of freight is increasing in both weight and value leads to the "possible implications" that the need for rail handling facilities for long-haul rail freight and local connections for trucks making first- and last-mile deliveries will likewise increase. The plan does note the need to include freight measures in the annual performance measure reporting, and it

acknowledges the importance and difficulty of freight data collection. It recommends that MnDOT "continually evaluate innovative data collection technologies and sources" (MnDOT 2018, 78).

Multimodal System

In discussing the importance of freight movement to the state's economy, Minnesota's freight plan cites several multimodal priorities: better intermodal services, improved modal connectivity, and resolution of "systemic and multimodal problems"(MnDOT 2018, 49). The plan's list of project types to be considered for future support is highly multimodal, and multiple references are made to the need for redundancy across modes. Three mode-related performance measures are listed in the plan: freight by mode in tons, value, and ton-miles.

A profile of freight modes in Minnesota shows notable features. First, the truck share of freight is similar whether measured by weight or by value, and the same is true of rail. In other words, goods moved by truck are not much more valuable per pound than goods moved by rail (MnDOT 2018, 26). However, on a national level, truck freight (e.g., electronics) is worth much more than rail freight (e.g., coal). This may indicate a greater feasibility of modal shifts in Minnesota than elsewhere, in that the typical link between freight by value and mode is less pronounced there. Another important takeaway from the modal profile is that rail and truck shares of freight weight and value are quite stable in Minnesota between 2012 and 2040 according to projections using the Freight Analysis Framework of the Federal Highway Administration (FHWA). This also differs from national trends, which show truck share growing over the same period (BTS 2019). At the same time, MnDOT's industry interviews revealed in some cases a desire to shift heavy, bulky shipments to trucks due to a shortage of rail capacity caused by increased shipments of oil from North Dakota. This situation illustrates that modal flexibility does not always advance energy use and emissions reduction goals, underscoring the importance of a planning process that can overlay the full set of freight goals onto planning and project prioritization.

Innovative Technologies and Operational Strategies

The plan's asset management objective aims to "put technology and innovation to work to improve efficiency and performance" (MnDOT 2018, 5). The discussion of trends includes platooning, autonomous vehicles, e-commerce, and 3D printing as well as onshoring and nearshoring (i.e., moving overseas manufacturing to locations in or near the United States), which can bring net reductions in freight-ton miles. The plan notes that 92% of businesses responding to a survey said they will continue nearshoring. However, these discussions are generic and qualitative; how the state might take advantage of these trends to advance its freight goals is not indicated. Elsewhere, the plan lists limited uses of advanced technology, but the associated action item is simply to monitor their development and explore pilot programs for their use.

In summary, Minnesota's freight plan contains no direct commitment to GHG reduction. Minnesota's freight system and project planning are highly multimodal, however, and the state is working toward full inclusion of freight in its transportation performance management program.

NEVADA

Highlights

- Robust performance management
- Focus on intermodal rail
- Formation of the Western States Freight Coalition

Environmental sustainability and livability is one of eight strategic goals for Nevada's current freight plan. The objective for the environmental goal is to "[r]educe vehicular emissions by reducing congestion, deploying technologies that improve the fuel-efficiency of commercial vehicles, and providing better mode-choice and integration to encourage utilization of the most sustainable options"(NDOT 2017, 1–15). Like Minnesota, Nevada does not state that GHG emissions are included in the emissions reduction goal, although the plan contains multiple references to climate change as an important part of the context for freight planning.

Two performance measures are associated with the plan's environmental sustainability and livability goal, one relating to slow truck speeds (causing congestion and thus adversely affecting livability) and the second relating to truck age (which correlates with truck emissions rates). The target for the second performance measure is that each year at least 4% of registered trucks should be new trucks. The second measure seeks to ensure that the percentage of trucks registered in Nevada with model year 2010 or newer engines is increasing. The measure would result in the tracking of criteria pollutant emissions, and more broadly, it acknowledges the state's role in promoting cleaner freight vehicles. However, standards for model year 2010 engines do not include GHG emissions or fuel efficiency requirements. Hence, the performance measures for Nevada's environmental sustainability and livability goal do not at present reflect the emissions reduction strategies referenced in the objective.

Implementation actions identified for the environmental sustainability goal are more ambitious, including development of "a mode policy that encourages moving freight in the most sustainable manner" and "a compelling public benefits analysis and demonstration of potential market feasibility for new intermodal and/or bulk transload rail services from/to the State," as well as actions to promote cleaner vehicles (NDOT 2017, 1–25).

Nevada has promoted regional cooperation in freight planning by leading the formation of the 11-member Western States Freight Coalition, a forum for DOT freight leads in neighboring states to discuss planning and implementation issues and coordinate where possible.

Performance Management

Nevada is methodical and transparent in presenting goals, objectives, and performance measures and in explaining how the state will track and evaluate progress toward its goals for freight transportation. Notably, each performance measure has an associated target and plan. The American Transportation Research Institute (ATRI) states: "Nevada embraced data-driven goal setting in its freight plan and included a wide range of non-highway performance measures to reflect its multimodal freight goals"(Boris and Murray 2018, 29).

The plan also presents its performance management approach in a transparent and energetic fashion, showing performance measures and targets for the goals and objectives of

the plan. The measures do not come close to covering those goals and objectives, however, and the strategies and actions presented later in the plan bear no obvious relationship to what might be required to meet the performance targets. On balance, however, a plan with Nevada's level of ambition and logic is far above the typical plan, even with many gaps remaining in the first iteration.

In the case of the environmental sustainability goal discussed in the previous section, the proposed actions confirm the state's intent to meet the plan's objective. Yet without corresponding performance measures and targets, these actions may never occur. Across all states, more complete federal guidance and requirements for performance planning in freight plans would help to ensure that states follow through in delivering projects and policies that help to accomplish state and national freight goals.

Multimodal System

Nevada's plan contains a forward-looking, substantive discussion of multimodality, with an emphasis on intermodal freight transport. Expanding intermodalism is a pillar of the state's vision for freight logistics. In fact, "Nevada's best long-term economic results would come from a major change in the current logistics role within the Western trade pattern and a major improvement in its intermodal infrastructure to increase its distribution functions" (NDOT 2017, 1–3). Nevada envisions the transformation of the state's economy by turning Reno and Las Vegas, which are now simply stops on two major interstate corridors (I-80 and I-15), into nodes in a multidirectional, multimodal network that promotes value-add activity near these urban centers. The plan puts particular emphasis on rail, calling it "a sleeping giant" in the context of business development plans for distribution and manufacturing companies (NDOT 2017, 3–47). The plan notes the key role for west–east intermodal rail (figure 2), for which Nevada is currently a pass-through:

> The ability of Nevada rail yards to efficiently handle marine cargo and domestic intermodal containers would remove large volumes of containerized cargo from congested urban highways, thereby adding highway capacity and improving air quality along the service corridor. With large enough manufacturing logistics distribution bases at Reno and Las Vegas, intermodal rail would provide efficient lower cost services by splicing into larger intermodal trains moving between California and major inland ports to the east (NDOT 2017, 1–6).

The plan also makes a compelling case for converting a fragmented transportation system in an urban area into an integrated multimodal hub to minimize conflicts between passenger movement and freight movement while reducing cost and adverse environmental impacts. Strategies listed in the plan include facilitating private-sector development of freight villages to promote economic development. The plan notes the steady growth nationally of rail intermodal volumes and that the "next frontier" for intermodal is the under-500-mile market (NDOT 2017, 3–53).

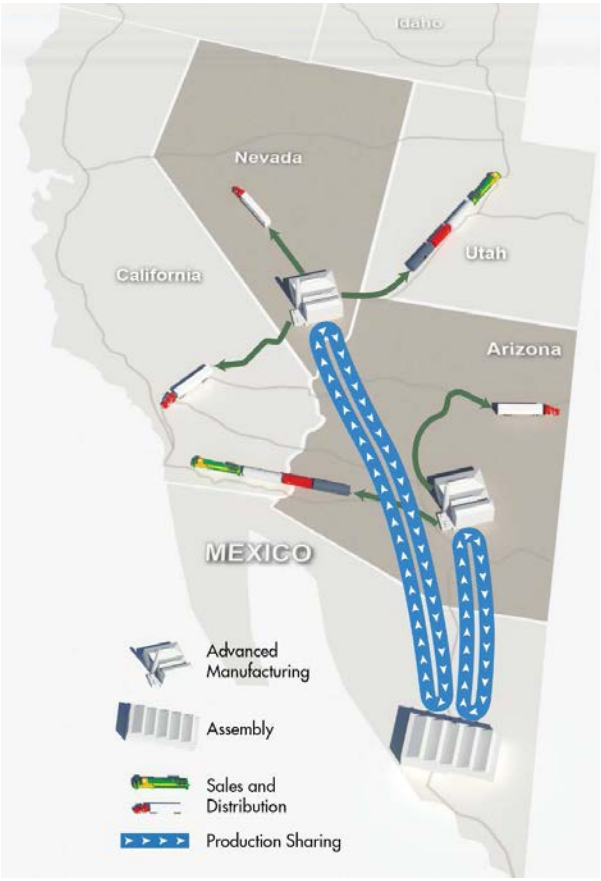

Figure 2: Nearshoring concept showing key intermodal routes. *Source:* NDOT 2017, 3–31.

Surprisingly, the state's goal to "maintain and improve essential multimodal infrastructure within the state" has associated objectives and performance measures that relate to pavement and bridge condition only (NDOT 2017, 1–14).

The ambition of Nevada's multimodal plan is impressive, particularly in its vision of rail expansion, integration of modes, and location of logistics centers and freight villages. The vision is not informed by emissions considerations, however; for example, it encompasses a major expansion of air freight as well. This is not surprising. Nevada is also eager to grow its air cargo activity, noting that increasing levels of passenger air travel means more opportunity for belly cargo and that reshoring is changing freight patterns in ways that may be conducive to more air shipping. Nevada's interest in multimodality is driven by economic development priorities, not climate concerns, as demonstrated by its desire in increase air freight. As in other states, freight planning in Nevada involves choosing a course of action that simultaneously advances the various goals set by the state, and Nevada's multimodal plan is likely to bring net environmental and economic benefits.

While multimodality is an essential strategy to reduce freight emissions, an explicit commitment to emissions reductions is necessary to ensure that outcome. Even Nevada's rail expansion plans envision a network carrying much more freight than today, supporting

a more dynamic and fast-growing economy for the state. Therefore, a realistic approach to emissions reduction may need to focus on (1) distributing the growing freight transportation demand to the extent possible to those states, corridors, and hubs with the cleanest and most efficient freight systems in place and (2) using system efficiency to reduce future freight emissions relative to a business-as-usual scenario, rather than in absolute terms.[4]

Innovative Technologies and Operational Strategies

Another goal of Nevada's freight plan is to "[u]se advanced technology, innovation, competition, and accountability in operating and maintaining the freight transportation system" (NDOT 2017, 1–13). The plan cites the trend of greater consolidation and collaboration among carriers, including "synergistic service match-ups, for example, between companies efficient at filling empty backhauls with firms that have large customer bases" (NDOT 2017, 3–32). It mentions efficient packaging, network optimization, sophisticated inventory and tracking technologies, and data-driven terminal management systems, all efficiency strategies that could be used to reduce emissions. It also includes a discussion of the advent of 3D printing, citing its low transport costs and low carbon footprint. The plan explains that Nevada's economic strategy for its metro areas and freight hubs relies to some extent on trends toward reshoring and nearshoring of manufacturing and other economic activity, which could offer opportunities to apply ICT to develop streamlined freight services to these new hubs.

Nevada is a demonstration state for truck platooning. It was the first state to grant a license for an autonomous commercial truck to operate on an open public highway and has authorized the testing of driverless vehicles. Researchers at the University of Nevada Las Vegas are working on an automated multimodal "land ferry" system that could reduce truck traffic in the east–west I-80 corridor serving California ports.

The performance measure for the use of advanced technology and innovation is the number of freight research projects NDOT completes annually, and the target is at least two research projects per year.

In summary, Nevada has the most robust freight performance management program of the states reviewed, though it has no explicit GHG reduction goal. Nevada is strongly focused on expanding intermodal rail and has been a leader in promoting multistate collaboration in freight planning.

Conclusions and Recommendations

Many states focus almost exclusively on economic issues in freight planning, which is not surprising given the central role of the freight system in keeping state economies moving. A critical role of the federal government is to provide a comprehensive context for freight

[4] Freight, like all economic sectors, will need to decarbonize. System efficiency alone will not be sufficient to bend the emissions curve downward in the face of robust economic growth, but absolute reductions can be achieved with the help of fuel-efficient and electric freight vehicles and equipment.

planning that highlights the impacts that freight movement may have on other societal priorities such as health, equity, and the environment and to help states factor those issues into their planning processes and project selection.

Federal disbursement of tens of billions of dollars annually in transportation funding puts USDOT in a position to impose extensive transportation planning requirements on states. At the same time, states, metropolitan planning organizations (MPOs), and cities, as the implementers of transportation plans and project selection processes, are crucial sources of input and feedback to the federal government as it develops legislation, rules, and guidance documents. Opportunities for further action on freight planning on the parts of both federal and state governments include reauthorization of the FAST Act, completion of the National Freight Strategic Plan, updates to state freight plans (every five years), and annual freight project selection, among others.

We present five general areas of opportunity for progress in freight planning and provide recommendations for action in each area by federal and state entities.

CONTINUE TO ADVANCE FREIGHT PLANNING

The federal transportation reauthorization bill due in 2020 will contain opportunities to include freight-related provisions that can make major contributions to addressing economic, energy, and environmental imperatives. The momentum established in MAP-21 and FAST on freight transportation needs to continue into the reauthorization.

Freight movement has large and growing implications for the economy and the environment. Improving freight-sector efficiency can bring benefits to both. Given the large impacts of freight facilities and operations on local communities, it is essential that these communities have opportunities to provide input throughout the freight-planning process.

Regional and multistate planning is especially important for long-haul freight. New forums such as the Western States Freight Coalition (11 western states) and the Transportation and Climate Initiative (12 northeastern and mid-Atlantic states and the District of Columbia) provide important opportunities to advance common transportation priorities, including emissions reduction.

Recommendations:

- (Congress) Renew and expand the federal funding programs for freight projects; refine criteria for NHFP, INFRA, and BUILD (the Better Utilizing Investments to Leverage Development transportation discretionary grants program) to ensure prioritization of projects that advance efficiency and environmental gains.
- (States) Provide input to improve the current federal framework for freight policy. States can help to ensure consideration of energy efficiency in the National Freight Strategic Plan, which will "rely significantly on the freight plans prepared by the States."
- (States) Incorporate performance measures into project prioritization by determining projects' contribution to meeting performance targets.
- (States) Ensure state freight advisory committees include representation from community and environmental organizations.

EXPAND THE SCOPE OF PERFORMANCE MANAGEMENT

A hallmark of MAP-21 was its emphasis on performance management to ensure that federal investment in surface transportation met the goals of federal transportation policy. While FAST addressed a critical shortcoming of MAP-21 by broadening the focus of national transportation policy from the highway system to the multimodal transportation system, the performance management system established through USDOT rulemakings fails to address this and many other key national transportation needs.

The crux of performance management is establishing performance measures that capture the policy goals and objectives at hand and setting and meeting targets for those measures over time. While MAP-21 and FAST include requirements for performance measures, neither those laws nor the implementing performance management regulations go far in addressing national freight goals. Freight transport provides a stark example of this disconnect. The single federal freight performance measure adopted, the Truck Travel Time Reliability Index, does not reflect the fundamental shift in FAST to a multimodal system. Moreover, even for the highway system, the measure captures only one of a host of performance issues key to meeting national goals and is limited to the interstate system.

The performance measures that DOT regulations now require conform closely to what was required by Congress, resulting in a federal performance management policy that barely begins to establish a trajectory to accomplish the stated goals of national freight policy or national transportation policy more generally. Compounding the problem, many states have chosen not to go beyond federally required measures, limiting their own freight performance measures to the single measure of truck travel-time reliability on the interstate system. As a recent survey of state freight plans notes, "[f]ew states reached beyond the most readily available, free data, measuring what is most easily measured, and focusing on the highway system" (BouMjahed and Schofer 2019). Lacking a more extensive set of required performance measures, few states put their discussions of freight system performance in a context that is amenable to quantification and analysis.

Robust data collection is a prerequisite for effective performance management. Recent advances in ICT can greatly facilitate and reduce the cost of data collection. Furthermore, these technologies can vastly expand the availability and utility of real-time data, which allows implementation of new strategies to improve efficiency and reduce emissions.

Recommendations:

- (Congress and USDOT) Clarify and strengthen required performance measures. These measures should capture the full range of goals and objectives of federal freight policy and help states establish and track quantitative targets for improvement.
- (States) Establish freight plan goals and targets beyond those required by USDOT, as needed; adopt targets fully covering the state's main priorities for the freight system. Translate and import targets from other planning processes (climate, economy, health, equity, and transportation) into freight plans.
- (USDOT) Produce a toolkit of freight emissions reduction strategies and help in collecting and using data to monitor and evaluate emissions. This could support and

add value to the freight planning processes that often-understaffed state DOTs are required to undertake.

SET FREIGHT-SPECIFIC GHG REDUCTION TARGETS

National transportation policy and freight policy both identify protection of the environment as a goal. Meeting this goal will require major reductions in GHG emissions. The climate provisions of the Senate and House transportation reauthorization bills represent an important step. This is the time to incorporate GHG emissions into the freight provisions as well, as the House bill begins to do.

Most states have adopted targets to reduce energy consumption and/or GHGs, and several have set targets for each sector, including the transportation sector. Given the distinct planning processes, stakeholders, and economic considerations that exist for the freight sector, states should set goals specifically for GHG emissions from freight, and they should chart pathways to reach those goals. GHG emissions from the freight sector constitute an essential performance measure, a crucial step toward ensuring that state freight investments address climate goals at both the state and national levels.

At present, state freight plans often discuss the federal fuel efficiency standards for medium and heavy trucks and/or the potential to electrify freight vehicles and equipment; they may assume that such advances will be sufficient to deliver the needed carbon reductions. Yet no structure or guidance requires or even encourages states to compare the GHG emissions reductions associated with those improvements with total reductions needed in a given year to meet state goals or provide benchmarks and thus determine what the roles of planning and system improvements should be in reducing freight emissions.

Filling this gap would also support the broader environmental sustainability goals of the national transportation policy. States can help to promote sound freight planning by engaging with the USDOT to help develop a federal freight policy that advances energy efficiency and related goals.

Recommendations:

- (Congress) Reinstate the requirement for a GHG performance measure, targets, and progress as initially established in the third performance management rule.
- (USDOT) Require that states assign to the freight sector a share of GHG reductions that contributes appropriately to the overall sectoral target. Provide tools and guidance for states on the data and methodology to track freight-sector emissions.
- (States) Quantify state freight emissions. Adopt freight GHG performance measures and reduction targets in state freight plans. Ensure these are reflected in transportation investment strategy and other aspects of the plan.
- (States) Provide input to the National Freight Strategic Plan and to the transportation reauthorization bill.

MAKE A CONSISTENT COMMITMENT TO MULTIMODAL SYSTEMS

The FAST Act began to establish a coherent national multimodal freight policy, but major gaps remain. Many freight programs, including funding programs, reside within highway-specific sections of transportation law, with the result that other freight modes are

disadvantaged. Regulations to implement the law, such as the performance management rules, often inherit this flaw. The House INVEST bill begins to address this issue.

State freight plans are similarly spotty in their attention to non-truck modes. A recent review of state freight plan performance measures evaluates the multimodality of those measures, finding that only 52% of the freight plans reviewed by the authors discuss performance measures from a multimodal perspective, and one-third measured performance from a multimodal perspective (BouMjahed and Schofer 2019). As the paper notes: "While rail or waterway performance falls outside the purview of most state DOTs, the state's interest in economic development and sustainability defines a public interest in non-highway freight services."

Recommendations:

- (Congress and USDOT) Complete the task of creating a fully multimodal freight policy through FAST Act reauthorization and regulatory updates.
- (States) Include mode split in freight plan goals and performance measures and incorporate in project prioritization to achieve the associated targets.

PROMOTE INNOVATIVE TECHNOLOGIES AND OPERATIONAL STRATEGIES TO IMPROVE FREIGHT EFFICIENCY AND REDUCE EMISSIONS

Federal policy contains repeated references to the importance of innovative technologies to the future of transportation but does little to guide the adoption of such technologies toward meeting transportation goals. Both efficiency and the environment stand to gain much from targeted application of ICT in transportation, as well as from the emergence of new vehicle technologies, and it is important that federal and state policy work toward that outcome through funding priorities and other means.

Federal research and data programs for freight transportation are also important to the development of new technologies and the understanding of how they could be applied most effectively, but these programs are chronically underfunded. For example, the National Cooperative Freight Research Program (NCFRP) was last authorized for funding in the 2005 federal surface transportation bill (SAFETEA-LU). Similarly, even basic data collection programs such as the Vehicle Inventory and Use Survey, last conducted in 2002, often fail to gain the modest resources required for their maintenance.

Recommendations:

- (Congress and states) Fund and pursue demonstration projects on uses of real-time data and collaborative use of freight and logistics resources to improve efficiency and reduce emissions.
- (Congress) Reinstate the NCFRP and fund comprehensive overhaul of freight data collection and dissemination.

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Appendix

Table A1. Summary of statewide freight plan elements related to energy efficiency or GHG reduction[5]

State	Year of publication	Energy efficiency/GHG-related elements
California	2018	Sets target of 25% increase in GDP per ton GHG emissions from freight by 2030 Contains a robust program of advanced technology strategies to advance plan goals Includes extensive consideration of freight-related equity issues
Colorado	2019	Promotes the growth of diverse modal and routing options for moving goods
Delaware	2017	Encourages modal competition for freight and goods movement Invests in intermodal connections between freight modes to promote seamless goods movement Adopts goods movement planning strategies compatible with DelDOT's Intelligent Transportation Systems (ITS) program
District of Columbia	2019	Recommends last-mile delivery/pick-up using bikes Addresses steps toward implementation of dynamic truck routing practices Cites freight efficiency as a means for lowering GHG emissions
Florida	2020	Cites ITS technology to improve efficiency and reliability
Illinois	2018	Reviews multimodal and intermodal freight options and services in detail Highlights modal shifts as a means for reducing GHG emissions tied to freight
Indiana	2018	Cites need to improve intermodal connectivity and promote multimodal freight
Iowa	2018	Details ITS information-sharing efforts via the Heartland Chapter of ITS America
Kansas	2017	Provides detailed discussion of potential Intelligent Vehicle Initiatives (IVIs) and ITS investments, including subjects such as e-commerce delivery, dedicated truck lanes, AV technologies, and more
Louisiana	2018	States a desire to lower GHG emissions, but no targets are in place
Maine	2017	Cites MaineDOT's Industrial Rail Access Program (IRAP) as a means for increasing rail mode share and lowering GHG emissions

[5] Freight plans of the 25 states not listed in table A1 contained no notable elements related to energy efficiency or GHG reduction beyond those required for federal approval.

State	Year of publication	Energy efficiency/GHG-related elements
Maryland	2017	Notes that Maryland's 2016 SB 323 mandates that the state's total GHG emissions must be reduced 40% from 2006 levels by 2040 and that freight will play an important role in accomplishing that goal Highlights ITS as a means for enhancing multimodal and intermodal freight
Massachusetts	2018	Cites the state's climate goals and need for freight contribution to achieving them Adopts several freight strategies that support GHG reduction
Michigan	2017	Cites the potential of an Internet of Things (IoT) system to facilitate real-time information sharing and ITS system efficiency and reduce GHG emissions Discusses the potential benefits of integrating various advanced freight technologies into the state's freight monitoring and physical infrastructure
Minnesota	2018	Promotes modal redundancy as a means to increase resiliency and protect the environment Includes three mode-related performance measures (tons, value, and ton-miles by mode)
Missouri	2017	Cites the need to identify, preserve, and expand critical multimodal freight-intensive development nodes and adjoining industrial land assets
Nevada	2017	Includes a strong focus on intermodal rail Discusses the state's initiative in forming an 11-state western-state coalition on freight planning and implementation
New Jersey	2017	Encourages use of maritime freight to increase the overall efficiency of the freight system and lower GHG emissions tied to freight Promotes moving road freight traffic away from peak travel hours to take advantage of off-peak period roadway capacity
New York	2019	Emphasizes importance of more-efficient modes of freight such as barge freight
Oregon	2017	Encourages development of consolidation facilities to increase modal alternatives on key freight corridors in the strategic system
Pennsylvania	2016	States a desire to lower GHG emissions, but no freight-specific targets are in place
Rhode Island	2017	Recommends investment in multimodal land use and development projects for improvement of areas with modal terminals
South Carolina	2018	Cites state multimodal environmental performance measures and goals Encourages availability of both rail and truck modes to major freight hubs (ports, airports, intermodal facilities)
Vermont	2012	Recommends performance measures for tons per mile, GHG emissions for road and rail freight Provides detailed descriptions of how particular ITS and advanced freight technologies are being implemented and used

State	Year of publication	Energy efficiency/GHG-related elements
Washington	2019	Promotes optimizing existing system capacity through better intermodal and multimodal connectivity
Wisconsin	2018	Extensively details intermodal and multimodal connectivity within the state and potential areas for expansion and investment

Source: ACEEE research