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New Strategies for Reducing Transportation Emissions and Preparing for Climate Impacts

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NEW STRATEGIES FOR REDUCING TRANSPORTATION EMISSIONS AND PREPARING FOR CLIMATE IMPACTS

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INTRODUCTION

The transportation sector is becoming the largest source of greenhouse gas ("GHG") emissions in the United States.[1] This is already the case in many states, including those along the East and West Coasts.[2] The Obama Administration put in place federal vehicle and fuel standards that are significantly reducing emissions. However, these regulations will be insufficient to put the United States on track to achieve needed reductions needed long-term, per scientific findings and the Paris Agreement, which call for significant medium-term reductions and a long-term goal of decarbonizing our energy system before the end of the century.[3] This is especially true if the 2025 standards announced by the Obama Administration are rolled back by the new Trump Administration.[4]

Because current federal standards alone will not attain ambitious climate goals and may be rolled back, state and local activity is essential to make progress towards meeting emissions reduction goals. For example, financial and other incentives for adoption of clean vehicles can encourage more consumers to purchase electric

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1. *See* U.S. ENERGY INFO. ADMIN., *Power Sector Carbon Dioxide Emissions Fall Below Transportation Sector Emissions* (Jan. 19, 2017), http://www.eia.gov/todayinenergy/detail.php?id=29612 [https://perma.cc/TKL2-SUUM].

2. *See, e.g.*, Gabe Pacyniak et al., *Reducing Greenhouse Gas Emissions from Transportation: Opportunities in the Northeast and Mid-Atlantic*, GEO. CLIMATE CTR. 8 (2015), http://www.georgetownclimate.org/files/report/GCC-Reducing_GHG_Emissions_from_Transportation-11.24.15.pdf [https://perma.cc/S458-E4SJ] [hereinafter GEO. CLIMATE CTR. TRANSP. REP.] ("In the northeast and mid-Atlantic states, direct emissions from the transportation sector represent the largest source of greenhouse gas emissions."); *see also* U.S. ENERGY INFO. ADMIN., *State Carbon Dioxide Emissions* (Nov. 3, 2016), https://www.eia.gov/environment/emissions/state/ [https://perma.cc/PM2G-JP7Q] (select "California" and compare "Transportation Sector" total emissions to "Electric Power Sector" total emissions); *id.* (select "Oregon" and compare "Transportation Sector" total emissions to "Electric Power Sector" total emissions); *id.* (select "Washington" and compare "Transportation Sector" total emissions to "Electric Power Sector" total emissions).

3. *See* John Larsen et al., *Rhodium Group, Taking Stock: Progress Toward Meeting US Climate Goals* 15 (2016), http://rhg.com/reports/progress-toward-meeting-us-climate-goals [https://perma.cc/F86R-QGPH] (finding that U.S. policies, including vehicle standards, will achieve significant emission cuts but will ultimately be insufficient to meet U.S. Paris Agreement targets); *see also* GEO. CLIMATE CTR. TRANSP. REP., *supra* note 2, at 17-19 (finding that federal GHG and fuel economy standards for vehicles will achieve significant reductions but are not sufficient to put states on track to meet long-term GHG targets).

4. *See* Coral Davenport, *Trump to Undo Vehicle Rules That Curb Global Warming*, N.Y. TIMES (Mar. 3, 2017), https://www.nytimes.com/2017/03/03/us/politics/trump-vehicle-emissions-regulation.html [https://perma.cc/2KCN-YTU3].

vehicles.[5] Electrification of the transportation system, combined with a move to lower-carbon sources of electricity, can bring about the transformative change needed to curb climate change.[6]

In addition, transportation infrastructure (including roads, bridges, transit, ports, airports, and rail) is already compromised by climate change impacts such as increased heat, and more extreme weather events such as floods, storms, and rising seas.[7] Investments in infrastructure are generally based on past, static conditions and do not take into account current and future projections of climate change impacts. As a result, trillions of dollars in assets are vulnerable to the changes the United States is already experiencing and anticipating.[8] The news is not all grim. This Article highlights efforts—some already underway and some still needed—to promote strategies for a more sustainable, low-carbon future that also accounts for impacts to transportation infrastructure.

This Article focuses on four underappreciated strategies that will be critical to catalyzing a shift to a low-carbon, resilient transportation sector in the United States. First, federal vehicle and fuel standards should be complemented by federal and state strategies to promote the adoption of lower-emission and zero-emission vehicles. Second, it will be critical to develop tools and practices that integrate GHG reduction planning into transportation decision-making. Third,

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5. *See* Yan Zhou et al., *Plug-in Electric Vehicle Policy Effectiveness: Literature Review*, ARGONNE NAT'L LAB. 13-14, 29 (2016), https://energy.gov/sites/prod/files/2017/01/f34/Plug-In%20Electric%20Vehicle%20Policy%20Effectiveness%20Literature%20Review.pdf [https://perma.cc/E29H-GGTT] (finding that financial and other incentives will be necessary to build a strong PEV market).

6. WHITE HOUSE, *United States Mid-Century Strategy for Deep Decarbonization* 7-9 (2016), http://unfccc.int/files/focus/long-term_strategies/application/pdf/us_mid_century_strategy.pdf [https://perma.cc/8MWL-SP63] (U.S. analysis showing that increased electrification of the transportation sector, combined with decarbonization of the power sector, is a key component of achieving deep decarbonization).

7. EPA, *Climate Impacts on Transportation*, https://www.epa.gov/climate-impacts/climate-impacts-transportation [https://perma.cc/H8FZ-E8J3] (last updated Dec. 22, 2016) (describing the impact of climate change on transportation infrastructure as including higher temperatures creating ruts and potholes on roads through softening and expanding pavement; concentrated rainfall from more intense storms resulting in flooding that weakens or washes out the support for roads; possibly raising harbor facilities due to rising sea levels; and damaged airstrips that are near sea level).

8. *See* GLOBALCHANGE.GOV, *Transportation* (2014), http://nca2014.globalchange.gov/report/sectors/transportation [https://perma.cc/2MX9-MQ23] ("The estimated value of U.S. transportation facilities in 2010 was $4.1 trillion. As climatic conditions shift, portions of this infrastructure will increasingly be subject to climatic stress that will reduce the reliability and capacity of transportation systems.").

resilience to climate impacts should be incorporated into transportation planning and investments. Finally, to achieve these goals and make the necessary investments, the broken transportation funding system should be replaced or complemented by new mechanisms that can sustainably fund our transportation system during this period of transition and beyond. This Article highlights existing models and emerging approaches for all of these strategies, but argues that broad implementation must accelerate to meet GHG emission reduction goals and prepare for climate impacts.

I. BACKGROUND

Existing federal fuel and vehicle standards—combined with efforts at the state level—will make a significant contribution to emissions reduction goals in the transportation sector, assuming that they are not weakened or repealed.

Following years of legal challenges, the 2007 Supreme Court decision in *Massachusetts v. EPA*, and leadership by the California Air Resources Board ("CARB"), an agreement was reached in May 2009 between California, the U.S. Environmental Protection Agency ("EPA"), the U.S. Department of Transportation ("DOT") and automakers.[9] This agreement led to the adoption of nationwide standards for fuel economy and GHGs for light-duty vehicles such as automobiles, SUVs, and pickup trucks produced in model years ("MY") 2012-2016—achieving the first significant improvements in fuel efficiency and vehicle emissions in decades.[10] In 2012, this rule was followed by another, which further reduced GHGs and improved fuel economy for light-duty vehicles for MY 2017-2025.[11] These standards will achieve an average GHG emissions-per-mile for the light-duty vehicle fleet in MY 2025 that is equivalent to 54.5 miles per gallon—representing an annual fuel efficiency increase of between four and five percent from MY 2011.[12] Combined with MY 2012-2016 standards, this will result in MY 2025 vehicles emitting one half of the GHGs that MY 2010 vehicles emitted.[13]

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9. 549 U.S. 497 (2007). *See* Notice of Upcoming Joint Rulemaking to Establish Vehicle GHG Emissions and CAFE Standards, 74 Fed. Reg. 24,007-24,012 (proposed May 22, 2009), http://www.gpo.gov/fdsys/pkg/FR-2009-05-22/html/E9-12009.htm [https://perma.cc/4Q9R-S864].

10. *See* 74 Fed. Reg. 24,007-24,012, *supra* note 9.

11. 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624 (Oct. 15, 2012).

12. *Id.* at 62,770.

13. *Id.*

There have likewise been two rounds of standards for medium and heavy-duty trucks and other work vehicles. First, in 2011, the EPA and the National Highway Traffic Safety Administration ("NHTSA") released the Phase 1 standards for MY 2014-2018 medium- and heavy-duty vehicles—the first regulation of GHG emissions from these sources.[14] Then, in August 2016, the EPA and NHTSA promulgated Phase 2 standards for MY 2019-2027 vehicles.[15]

Taken together, these federal vehicle standards will achieve significant GHG emission reductions. The MY 2012-2016 light duty vehicle standards are projected to reduce emissions by 960 million metric tons,[16] and the MY 2017-2025 standards are projected to reduce emissions by two billion metric tons over the life of the vehicles.[17] Similarly, the Phase 2 standards for trucks are projected to reduce emissions by approximately 1.1 billion metric tons over the life of the vehicles.[18]

The election of President Donald Trump in 2016, along with Republican control of both houses of Congress, has brought uncertainty to these federal vehicle standards. Some auto manufacturers have called for weakening the light duty vehicle standards for MY 2022-2025.[19] Under the Clean Air Act, states are

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14. Medium- and Heavy-Duty Vehicle Fuel Efficiency Program Standards, 49 C.F.R. § 535.5 (2011).

15. Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles-Phase 2, 81 Fed. Reg. 73,478 (Oct. 25, 2016).

16. *See* 75 Fed. Reg. 25,323, 25,328 (May 7, 2010).

17. *See* 77 Fed. Reg. 62,623, 62,627 (Oct. 15, 2012).

18. Press Release, National Highway Traffic Safety Administration, EPA and DOT Finalize Greenhouse Gas and Fuel Efficiency Standards for Heavy-Duty Trucks (Aug. 16, 2016), https://www.nhtsa.gov/press-releases/epa-and-dot-finalize-greenhouse-gas-and-fuel-efficiency-standards-heavy-duty-trucks [https://perma.cc/ZU93-KD7A].

19. Juliet Eilperin & Steven Overly, *Automakers Ask EPA to Overturn Recent Review of Fuel-Efficiency Standards*, WASH. POST (Feb. 22, 2017), https://www.washingtonpost.com/national/health-science/automakers-ask-epa-to-overturn-recent-review-of-fuel-efficiency-standards/2017/02/22/81ad1398-f920-11e6-9845-576c69081518_story.html [https://perma.cc/4SLK-QNSY]. Due to the differences in the statutes that authorize fuel economy and GHG regulations, the EPA and NHTSA's second round of joint fuel economy and GHG standards did not both reach the same final model years. The EPA's GHG standards for light duty vehicle were promulgated through model year 2025, while NHTSA's fuel economy regulations were only promulgated through model year 2021. The EPA and NHTSA committed to undertake a joint mid-term program review to be completed by 2018 to assess whether the EPA's GHG regulations continued to be appropriate and to inform a *de novo* rulemaking for NHTSA's fuel economy standards for MY 2022-2025. 77 Fed. Reg. 62,623, 62,627 (Oct. 15, 2012). After the publication and request for comment on a mid-term technical assessment report, the EPA determined in January 2017 that its final MY 2022-2025 regulations were appropriate. EPA, FINAL

generally preempted from setting their own vehicle emission standards.[20] However, because of its historic leadership in this area, California has been given special authority to enact stricter standards via a waiver of this preemption by the EPA, and other states may choose to adopt California's standard.[21] On March 3, 2017, the Trump Administration was reported to be considering a rollback or change in timing of the review of the federal vehicle standards, as well as a potential withdrawal of California's waiver authority.[22] More generally, Speaker of the House Paul Ryan has called for eliminating EPA's authority to regulate GHG emissions under the Clean Air Act, although it is not clear that such a measure could obtain the sixty votes required to break a filibuster in the Senate.[23] Should the EPA

DETERMINATION ON THE APPROPRIATENESS OF THE MODEL YEAR 2022-2025 LIGHT-DUTY VEHICLE GREENHOUSE GAS EMISSIONS STANDARDS UNDER THE MIDTERM EVALUATION (2017), https://www.epa.gov/sites/production/files/2017-01/documents/420r17001.pdf [https://perma.cc/ZA8Y-5K84]. Under President Trump, the EPA could potentially weaken GHG standards for these model years (although it would need to show a non-arbitrary reason as to why such weakening was justified under the Clean Air Act under *FCC v. Fox Television Stations, Inc.*, 556 U.S. 502 (2009) given the record compiled in the original rulemaking) and NHTSA could potentially finalize weaker fuel economy standards than anticipated for these model years.

20. Clean Air Act 42 U.S.C. § 7543(a); CAA § 209 (a).

21. Under CAA Section 209(b), the EPA must grant California a waiver of preemption for standards that are at least as strict as federal standards unless the EPA Administrator determines that the state's standards are arbitrary and capricious, not required to meet compelling and extraordinary conditions, or not consistent with requirements of the Clean Air Act. 42 U.S.C. § 7543(b); CAA § 209 (b). Other states may then adopt these standards under CAA Sec. 177. 42 U.S.C. § 7507; CAA § 177. *See also* Vicki Arroyo et al., *State Innovation on Climate Change: Reducing Emissions from Key Sectors While Preparing for a "New Normal"*, 10 HARV. L. & POL'Y 385, 389-90 (2016). Historically, the EPA has approved every California waiver petition, with the singular exception that the EPA initially denied California's waiver petition to establish first-ever GHG standards for new motor vehicles toward the end of President George W. Bush's final term in office. Decision Denying Clean Air Act Preemption Waiver for California's 2009 and Subsequent Model Year Greenhouse Gas Emission Standards for New Motor Vehicles, 73 Fed. Reg. 12,156 (Mar. 6, 2008). The EPA subsequently granted this waiver petition under President Barack Obama. *See* Decision Granting Clean Air Act Preemption Waiver for California's 2009 and Subsequent Model Year Greenhouse Gas Emission Standards for New Motor Vehicles, 74 Fed. Reg. 32,744 (July 8, 2009). President Donald Trump's nominee for EPA Administrator, Scott Pruitt, declined to say during Congressional hearings on his nomination whether he would grant such waivers in the future. *See* Stuart Leavenworth, *Trump's EPA Pick Won't Guarantee California's Right to Tougher Auto Emission Rules*, MCCLATCHY D.C. (Jan. 18, 2017), http://www.mcclatchydc.com/news/politics-government/congress/article127330159.html [https://perma.cc/W8PN-87KB].

22. *See* Davenport, *supra* note 4.

23. In October 2016, Speaker of the House Paul Ryan released his "A Better Way" policy proposal, which promised that a Republican-led Congress would seek to repeal "all climate-change regulations under the Clean Air Act." The proposal also

be stripped of this authority, or should the EPA roll back the federal standards or California's waiver, these would be major setbacks for efforts to reduce GHG emissions, including emissions from transportation.[24]

In addition to informing the development of these federal standards, California and other states are supporting the development of, and the market for, low- and zero-emission vehicles such as electric and fuel cell cars.[25] California has implemented a zero-emission vehicle standard—under another waiver of Clean Air Act preemption—requiring automakers to produce and sell non-emitting vehicles within the state.[26] Nine states have joined California in enacting that standard,[27] and in 2013, the governors of California and seven of these states agreed to work together to put 3.3 million zero-emission vehicles on the road by 2025.[28]

Those same eight U.S. states—California, Connecticut, Maryland, Massachusetts, New York, Oregon, Rhode Island, and Vermont—joined the International Zero-Emission Vehicle Alliance ("International ZEV Alliance") launched in August 2015 to promote awareness and increase adoption of zero-emission vehicles.[29] Along with Germany, the Netherlands, Norway, the United Kingdom, and the Canadian provinces of British Columbia and Québec, the International ZEV Alliance members made a commitment that all

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specifically endorsed H.R. 3880, a 2015 bill that would have eliminated the EPA's authority to regulate greenhouse gas emissions under the Clean Air Act by excluding greenhouse gas emissions from the definition of an "air pollutant" under the Act. SPEAKER.GOV, A BETTER WAY: OUR VISION FOR A CONFIDENT AMERICA 31 (2016), http://abetterway.speaker.gov/_assets/pdf/ABetterWay-Economy-PolicyPaper.pdf [https://perma.cc/F5Q5-D4SL]; H.R. 3880, 114th Cong. (1st Sess. 2015*).*

24. NHTSA would still maintain its separate statutory authority to set fuel economy standards. Increasing fuel economy standards also reduce GHG emissions. *See* discussion *supra* note 19.

25. Arroyo et al. *supra* note 21, at 386-90.

26. *See Final Reg. Orders (Parts 1-5) of Zero Emission Vehicle Regulation*, CAL. AIR RES. BD., codified in CAL. CODE OF REGS. § 1962, title 13 (adopted 2012), http://www.arb.ca.gov/regact/2012/zev2012/zev2012.htm [https://perma.cc/8ESE-B2PY]; *see also Advanced Clean Car Program*, CAL. AIR RES. BD. (2012), https://www.arb.ca.gov/msprog/acc/acc.htm [https://perma.cc/JP69-27SA].

27. *See ZEV Program*, CTR. FOR CLIMATE AND ENERGY SOLUTIONS, http://www.c2es.org/us-states-regions/policy-maps/zev-program [https://perma.cc/832V-RQEW] (last updated Jan. 18, 2017).

28. *See Memorandum of Understanding, State Zero-Emission Vehicle Programs* (Oct. 24, 2013), http://www.nescaum.org/documents/zev-mou-8-governors-signed-20131024.pdf [https://perma.cc/GW3M-HUUF].

29. *See* CAL. ENVTL. PROT. AGENCY, GLOBAL ALLIANCE ACCELERATES TRANSITION TO ZERO-EMISSION VEHICLES (2015), https://www.calepa.ca.gov/2015/09/29/alliance/ [https://perma.cc/AU4A-CRA7].

new passenger vehicles in their jurisdictions will be zero-emission vehicles by 2050.[30]

As described in more detail in Part III, state and local jurisdictions are also providing incentives designed to boost purchases, including tax credits and rebates, access to high-occupancy lanes on highways, and preferential parking.[31] States and cities are also developing electric vehicle charging and natural gas and hydrogen fueling networks, and are working to remove regulatory barriers, such as complicated permitting processes for installing stations.[32] States and regions are also collaborating to promote seamless long-distance travel in electric vehicles by providing accessible and clearly marked charging stations. Existing collaborations include the Transportation and Climate Initiative ("TCI"), a regional collaboration of energy, environment, and transportation agencies from eleven northeast and mid-Atlantic states and the District of Columbia,[33] and the West Coast Electric Highway, an initiative of California, Oregon, and Washington.[34]

In addition to policies to promote low- and zero-emission vehicles, states are crafting policies to support the production of cleaner transportation fuels. As it has done with vehicles, California has pioneered regulation of the carbon content of transportation fuels, providing lessons for similar programs in other states and at the federal level. California's low carbon fuel standard ("LCFS") was established by CARB in 2010, pursuant to state legislation in 2006

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30. *See* INT'L. ZERO-EMISSION VEHICLE ALL. (2016), http://www.zevalliance.org/members/ [https://perma.cc/46J4-HX8P].

31. *See, e.g., Mass. Offers Rebates for Elec. Vehicles*, MOR-EV, https://mor-ev.org/ [https://perma.cc/4QFU-STWJ] (the Massachusetts Offers Rebates for Electric Vehicles ("MOR-EV") program provides up-front consumer rebates up to $2500 for plug-in hybrid electric vehicles and electric vehicles.); CAL. AIR RES. BD., *Eligible Vehicle List*, https://www.arb.ca.gov/msprog/carpool/carpool.htm [https://perma.cc/SP72-W39Z] (last updated Apr. 24, 2017) (California's White Clean Air Vehicle decals permit single-occupant use of HOV lanes.); Hawaii Revised Statutes, Act 168 (2012) (Hawaii's exemption of electric vehicles from payment of parking fees).

32. *See, e.g., Residential EVSE Permit Process Best Practices*, ENERGETICS INC. FOR N.Y. ST. ENERGY RES. AND DEV. AUTH. (Apr. 2013), https://www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/Permit-Process-Streamlining.pdf [https://perma.cc/5T9D-U3NV].

33. *See Northeast Electric Vehicle Network*, TRANSP. & CLIMATE INITIATIVE, http://www.transportationandclimate.org/node/30 [https://perma.cc/KB8B-TGHL] (last updated Nov. 3, 2016).

34. *See West Coast Electric Highway*, WEST COAST GREEN HIGHWAY (2014), http://www.westcoastgreenhighway.com/electrichighway.htm [https://perma.cc/BN4E-TCWB].

and a governor's executive order in 2007.[35] California's LCFS has been operating since January 2013 and will reduce the carbon intensity of transportation fuels used in California by an average of ten percent by 2020 from 2010 levels.[36]

In 2015, Oregon's legislature followed in California's footsteps by authorizing that state's Clean Fuels Program,[37] requiring a ten percent reduction in the carbon intensity in fuel by 2025 from 2010 levels.[38] This program began in January 2016, with over seventy fuel providers reporting to the Oregon Department of Environmental Quality.[39]

These state fuel standards continue to move forward despite legal challenges to both states' programs on both procedural and substantive grounds. In September 2015, CARB re-adopted the state's LCFS regulations[40] in order to remedy procedural issues that a state court of appeals found violated the California Administrative Procedures Act and the California Environmental Quality Act. In 2013, the Ninth Circuit vacated a preliminary injunction by the lower court in *Rocky Mountain Farmers Union v. Corey*, and the program continues to operate although a portion of the litigation continues as of this writing.[41] The lower court originally granted the injunction based on claims that the LCFS violated the dormant Commerce Clause doctrine and was preempted by the Clean Air Act.[42] Upon remand from the Ninth Circuit, the district court dismissed most claims, although it allowed litigation to proceed on a claim that the LCFS ethanol provisions illegally discriminate in purpose or effect.[43] As of March 2017, the United States District Court for the Eastern

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35. *See Low Carbon Fuel Standard Program Background*, CAL. AIR RES. BD., http://www.arb.ca.gov/fuels/lcfs/lcfs-background.htm [https://perma.cc/GB6Z-JME3] (last updated Feb. 2, 2016).

36. *Id.*

37. S.B. 324-A, 2015 Reg. Sess. (Or. 2015).

38. *Id.*

39. *See Clean Fuels Program Basics and Update*, OR. DEP'T OF ENVTL QUALITY (Sept. 2016), http://www.deq.state.or.us/aq/cleanFuel/docs/cf0916bulletin.pdf [https://perma.cc/P7AM-ZN99].

40. *See Notice of Decision, Re-Adoption of the Low Carbon Fuel Standard*, CAL. AIR RES. BD. (Oct. 2, 2015), http://www.arb.ca.gov/regact/2015/lcfs2015/nodlcfs.pdf [https://perma.cc/E8JD-KEY5].

41. *See* Rocky Mt. Farmers Union v. Corey, 730 F.3d 1070 (9th Cir. 2013).

42. *Id.*

43. *See* Am. Fuels & Petrochemical Mfrs. Ass'n v. Corey, 2015 U.S. Dist. LEXIS 106901 (E.D. Cal. Aug. 13, 2015).

District of California was considering CARB's motion to dismiss the remaining LCFS ethanol claim.[44]

In Oregon a federal district court dismissed similar challenges to the Oregon program, largely relying in the decision on the California *Corey* case.[45] The Oregon federal district court decision is being appealed in the Ninth Circuit.[46]

There is no federal low-carbon fuel policy, although some policy experts have recommended this approach.[47] Instead, the federal Renewable Fuel Standard created by the Energy Policy Act of 2005 and expanded in the Energy Independence and Security Act of 2007 focuses on increasing the production of renewable fuels.[48] These fuels can vary widely in their GHG emissions reduction benefits.[49] The program has succeeded in promoting production of corn ethanol—a biofuel that is typically found to have marginally lower greenhouse gas benefits on a life-cycle basis than petroleum—but has not succeeded in promoting production of large quantities of "second generation" renewable fuels that have significantly lower GHG emissions.[50] For these reasons the program is not expected to drive significant additional reductions of GHG emissions from transportation.[51]

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44. A hearing was scheduled to be held on the motion on February 24, 2017. Minute Order, Docket Item No. 388, Rocky Mt. Farmers Union v. Corey, Case No. 1:09-cv-02234-LJO-BAM (E.D. Cal.).

45. *See* Am. Fuel & Petrochemical Mfrs. v. O'Keeffe, 2015 U.S. Dist. LEXIS 128277 (D.Or. Sept. 23, 2015).

46. Briefing took place in Spring of 2016. Am. Fuel & Petrochemical Mfrs. v. O'Keeffe, No. 15-35834 (9th Cir. Apr. 29, 2016).

47. In 2012 scientists from six leading institutions released reports urging a federal low carbon fuel standard. NAT'L LOW CARBON FUEL STANDARD PROJECT, *Final Reports of the National LCFS Project* (July 19, 2012), http://nationallcfsproject.ucdavis.edu/?page=final_reports [https://perma.cc/M3HT-M42A].

48. *See* EPA, *Renewable Fuel Standard Program*, http://www.epa.gov/renewable-fuel-standard-program [https://perma.cc/36JP-Q337] (last updated Jan. 19, 2017).

49. *See* Jeremy Martin, *Fueling a Clean Transportation Future: Smart Fuel Choices for a Warming World*, UNION OF CONCERNED SCIENTISTS 25-35 (2016), http://www.ucsusa.org/clean-vehicles/clean-fuels/transportation-fuels-future#.WJ492TvafmE [https://perma.cc/ZJN7-KY43].

50. Final Renewable Fuel Standards for 2014, 2015, and 2016, and the Biomass-Based Diesel Volume for 2017, 80 Fed. Reg. 77,420, 77,422 (Dec. 14, 2015) (noting the shortfalls in production of cellulosic and other advanced biofuels); *see also* Martin, supra note 49.

51. *See Uncertainty Surrounds Ethanol's Impact on GHG Emissions*, INST. FOR ENERGY RES. (June 30, 2014), http://instituteforenergyresearch.org/analysis/uncertainty-surrounds-ethanols-impact-ghg-emissions/ [https://perma.cc/WU4C-SD5X].

Finally, some states have begun to consider opportunities to shift land use planning to reduce GHG emissions by reducing the amount of vehicle-miles traveled ("VMT"), the "third leg" of the "transportation stool" alongside the first two legs of vehicle efficiency and fuel content.[52] Such strategies involve using state and local planning processes, incentives, and sometimes regulatory tools to promote compact land use patterns that reduce driving. One of the signature policies in this area has been California's SB 375, which establishes GHG targets for metropolitan planning organizations that make transportation infrastructure investment decisions.[53]

The state efforts described above demonstrate that while federal policy is vital, it is not the only opportunity to reduce emissions and promote alternative, lower-emitting vehicles and fuels. Together, these state and federal programs are having a significant effect on emissions. An analysis of transportation emissions in the northeast and mid-Atlantic United States published by the Georgetown Climate Center indicates that state and federal fuel and vehicle standards will achieve a twenty-nine percent reduction in transportation-sector GHG emissions in this region by 2030, compared to 2011 levels.[54]

Unfortunately, while these reductions are significant, they are not sufficient to achieve the emission targets that are likely needed from the transportation sector to meet long-term economy-wide goals necessary to avoid the worst consequences of climate change.[55] In

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52. For examples of state policies of this type in northeast and mid-Atlantic states see Gabriel Pacyniak, *State-Level Programs and Policies Supporting Sustainable Communities within Transportation & Climate Initiative (TCI) Jurisdictions*, GEO. CLIMATE CTR. (2012), http://www.georgetownclimate.org/files/report/report-tci-state-level-programs-policies-supporting-sustainable-communities.pdf [https://perma.cc/UN3E-UK27]. For a more general discussion of the potential of land use strategies to reduce GHG emissions, see URB. LAND INST., LAND USE AND DRIVING: THE ROLE COMPACT DEVELOPMENT CAN PLAY IN REDUCING GREENHOUSE GAS EMISSIONS (2010), http://uli.org/wp-content/uploads/ULI-Documents/Land-Use-and-Driving-Low-Res.pdf [https://perma.cc/EXP6-GPPZ].

53. *See* discussion *infra* in Section III.D.

54. Pacyniak et al., *supra* note 2, at 4.

55. The 2015 Twenty-first Conference of the Parties (COP 21) Paris Agreement set a goal of keeping global temperature rise to 1.5 degrees above pre-industrial levels, a level that is a "significantly safer defense line against the worst impacts of a changing climate." Press Release, United Nations Framework Convention on Climate Change, Historic Agreement on Climate Change (Dec. 12, 2015), http://newsroom.unfccc.int/unfccc-newsroom/finale-cop21/ [https://perma.cc/F6NP-L9A2]. The 2014 Fifth Report of the Intergovernmental Panel on Climate Change states that a forty to seventy percent reduction in global GHG emissions from 2010 levels will be necessary by 2050 for all countries. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: SYNTHESIS REPORT 22 (2014),

order to reach an eighty percent reduction by 2050 as the United States and Paris commitments aim to achieve, transportation emissions will have to move toward zero—a very ambitious goal that is difficult to achieve without compromising the mobility of people and goods.[56]

As a consequence, it will be critical as a first step to maintain current policies—including federal GHG standards for vehicles that are in danger of being weakened or repealed. It is also clear that much more will need to be done to curb emissions from the U.S. transportation sector.

The rest of this Article outlines additional strategies that can be employed to further the transition to a low-carbon and resilient transportation system. Part II outlines expanded efforts required to promote zero-emission vehicles, Part III discusses opportunities to incorporate GHG planning into transportation decision-making, and Parts IV and V discuss opportunities to integrate emissions-reduction and transportation funding strategies and support adaptation of the transportation system to climate impacts.

II. FEDERAL AND STATE POLICIES THAT PROMOTE ZERO-EMISSION VEHICLES

While increasing the fuel economy of vehicles significantly reduces GHG emissions, simply using less fossil fuel in conventional or even hybrid-electric vehicles will not achieve the scale of reductions needed over the long term.[57] Zero-emission vehicles, including electric and fuel cell vehicles, produce no emissions from the tailpipe, and can therefore dramatically reduce emissions from this sector.[58] Emissions produced during the production of electricity or hydrogen to power the vehicles must also be considered, and electrification of the transportation system must therefore be combined with a move to lower-carbon sources of electricity. This process is already underway due to reductions in the price of natural gas and renewable power, as well as to state and federal regulations.[59] In addition, studies have shown that even with the current electricity mix, electric vehicles still

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https://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_INAL_full.pdf [https://perma.cc/Q9P7-DKKR].

56. *See generally* Pacyniak et al., *supra* note 2, at Appendix Emission Reduction Strategy Analysis section 2.3; *see also* Elizabeth A. Stanton et al., *The RGGI Opportunity*, SYNAPSE ENERGY ECON., INC. (Feb. 5, 2016).

57. Pacyniak et al., *supra* note 2, at 18-19.

58. *See* WHITE HOUSE, *supra* note 6, at 7-9.

59. *See* Arroyo et al., *supra* note 21, at 395-406.

provide an emission benefit relative to internal combustion engine vehicles.[60]

The need for public policy action to rapidly accelerate the adoption of ZEVs was made even clearer with the finding in 2016 that the transportation sector surpassed the electric generation sector as the largest source of carbon dioxide emissions in the United States for the first time since the 1970s.[61] While the number of electric vehicles sold in the United States has increased steadily since 2011, the rate of adoption has not accelerated sufficiently to meet the urgent need for emission reductions in the near- and medium-term. In California, for example, electric vehicles have increased to three percent of sales for light-duty vehicles in 2015; however, CARB projects that one hundred percent of new vehicles will need to be ZEVs or plug-in hybrid electric vehicles by 2050.[62]

A. Barriers to ZEV Deployment

Unfortunately, several barriers currently stand in the way of widespread ZEV deployment. These barriers include incremental vehicle costs relative to the cost of traditional vehicles, lack of consumer awareness about these vehicles, and the need for changes in infrastructure and "refueling" behavior in drivers.[63] However as more vehicles come into the market, and dealers and customers "learn by doing," these barriers can be overcome. Policies can ease the transition to widespread ZEV adoption.

Automakers argue that sales requirements do not address a primary barrier to greater ZEV adoption—a lack of consumer

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60. *See, e.g.*, Rachael Nealer et al., *Cleaner Cars from Cradle to Grave: How Electric Cars Beat Gasoline Cars on Lifetime Global Warming Emissions*, UNION OF CONCERNED SCIENTISTS 9-12 (2015); Joyce McLaren et al., *Emissions Associated with Electric Vehicle Charging: Impact of Electricity Generation Mix, Charging Infrastructure Availability, and Vehicle Type*, NAT'L RENEWABLE ENERGY LAB. 16-19 (2016).

61. U.S. ENERGY INFO. ADMIN., POWER SECTOR CARBON DIOXIDE EMISSIONS FALL BELOW TRANSPORTATION SECTOR EMISSIONS (Jan. 19, 2017), http://www.eia.gov/todayinenergy/detail.php?id=29612# [https://perma.cc/G596-VTZJ].

62. CAL. AIR RES. BD., CALIFORNIA'S ADVANCED CLEAN CARS MIDTERM REVIEW ES-34 (Jan. 18, 2017), https://www.arb.ca.gov/msprog/acc/mtr/acc_mtr_finalreport_full.pdf [https://perma.cc/4FMT-MWHY].

63. *Overcoming Barriers to Deployment of Plug-In Electric Vehicles*, COMM. ON OVERCOMING BARRIERS TO ELEC.-VEHICLE DEPLOYMENT, BD. ON ENERGY & ENVTL. SYS., DIV. ON ENG'G & PHYSICAL SCI., NAT'L RES. COUNCIL OF THE NAT'L ACADS. 47-51 (2015).

demand for the cars.[64] However, recent consumer surveys have shown that demand for electric vehicles is significant in many states, and increasing.[65] Additionally, analyses have found that the availability of vehicles at dealerships is lacking[66]—particularly outside of California—and that consumer purchasing experiences of electric vehicles are worse than for conventional vehicles.[67] However, a potential inflection point for electric vehicle adoption is within reach. More vehicle models—including models with significantly increased electric range—will be available beginning in 2017, offering greater choice to consumers and satisfying more driver requirements.[68] States, automakers, and advocates are engaging dealerships and educating consumers to increase familiarity with electric vehicles.[69] The popularity of electric vehicles and potential for widespread consumer adoption over the coming years was recently on display when over 400,000 people placed deposits to purchase the new Tesla Model 3, a moderately priced extended-range electric vehicle, nearly two years before the vehicle will be available.[70]

Research indicates that part of the challenge of increased ZEV adoption is the higher upfront cost of the vehicles. The cost differential has been decreasing, however, particularly for electric vehicles as battery technology improves and production volumes grow.[71] Additionally, estimates of life-cycle costs show that electric

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64. *See* Letter from Mitch Bainwol, President and CEO of the All. of Automobile Mfrs., to President-Elect Donald J. Trump Transition Team (Nov. 10, 2016).

65. UNION OF CONCERNED SCIENTISTS, INFOGRAPHIC: NORTHEAST DRIVERS WANT ELECTRIC CARS (2016), http://www.ucsusa.org/clean-vehicles/electric-vehicles/northeast-electric-cars#.V-wLgfArKUk [https://perma.cc/A2QB-9LVU].

66. Mary Lunetta & Gina Coplon-Newfield, *Multi-State Study of the Electric Vehicle Shopping Experience*, SIERRA CLUB (2016), https://www.sierraclub.org/sites/www.sierraclub.org/files/uploads-wysiwig/1371%20Rev%20Up%20EVs%20Report_09_web%20FINAL.pdf [https://perma.cc/67Y7-MP44].

67. A study by the University of California Davis found that PEV purchasers show less customer satisfaction with auto dealers than conventional car buyers. Eric Cahill et al., *New Car Dealers and Retail Innovation in California's Plug-In Electric Vehicle Market* (Inst. of Transp. Stud., Univ. of Cal. Davis, Working Paper UCD-ITS-WP-14-04, 2014).

68. Charles Fleming, *Chevy Bolt EV Range is 238 Miles: Prime Time for the Electric Car?*, L.A. TIMES (Sept. 12, 2016), http://www.latimes.com/business/autos/la-fi-hy-bolt-ev-range-20160912-snap-story.html [https://perma.cc/4FZW-AZ5W].

69. *See, e.g.*, Press Release, Drive Oregon, Drive Oregon Awarded Nearly $1 Million for Regional Electric Vehicle Showcase (Aug. 29, 2016) (on file with author).

70. Katie Fehrenbacher, *Tesla's Model 3 Reservations Rise to Almost 400,000*, FORTUNE (Apr. 15, 2016), http://fortune.com/2016/04/15/tesla-model-3-reservations-400000/ [https://perma.cc/ZU6K-KFX4].

71. Björn Nykvist & Måns Nilsson, *Rapidly Falling Costs of Battery Packs for Electric Vehicles*, 5 NATURE CLIMATE CHANGE 329, 329-332 (2015).

vehicles are cost-competitive or can even result in cost savings once reduced fuel and maintenance costs are factored in.[72] Until costs are further reduced, federal and state subsidies to help defray the upfront costs of ZEVs have proved effective at increasing rates of adoption.[73] Studies also find that public policy can be valuable to address the lack of consumer information about how to charge and operate the vehicles, and to support the installation of charging and fueling infrastructure that allows ZEVs to be as easy to operate and reliable as traditional internal combustion vehicles.[74] Successful policies can promote the production and sale of ZEVs and stimulate consumer demand—while ensuring that the infrastructure is there to support large-scale deployment.

The adoption of electric vehicles is also impeded by a market failure caused by imperfect consumer information. For example, an analysis of consumer behavior shows that consumers significantly undervalue the fuel economy of vehicles when making purchase decisions.[75] Recent consumer surveys have also found that drivers are less familiar with alternative fuel vehicles such as electric vehicles and fuel cell vehicles than they are with conventional internal combustion engine vehicles.[76]

Market intervention may be particularly necessary to promote electric vehicles due to the significant infrastructure requirements of a national charging station buildout and the chicken-and-egg problem that consumers will not purchase electric vehicles until sufficient infrastructure exists, but infrastructure is not financially viable in many circumstances until a critical mass of electric vehicles is on the road. While some public policy researchers have cautioned against technology-forcing policy mandates, such as the ZEV program, the

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72. *See* U.C. DAVIS, *Electric Vehicle Explorer*, http://gis.its.ucdavis.edu/evexplorer/#!/locations/start [https://perma.cc/8FQP-DS36].

73. Lingzhi Jin et al., *Evaluation of State-Level U.S. Electric Vehicle Incentives*, INT'L COUNCIL ON CLEAN TRANSP., 26 (2014).

74. U.S. DEP'T OF ENERGY, NON-COST BARRIERS TO CONSUMER ADOPTION OF NEW LIGHT-DUTY VEHICLE TECHNOLOGIES (Mar. 2013), http://www.nrel.gov/docs/fy13osti/55639.pdf [https://perma.cc/LNE9-G6XJ].

75. David Green, *Why the Market for New Passenger Cars Generally Undervalues Fuel Economy*, OAK RIDGE NAT'L LAB. TRANSP. RES. CTR. (2010).

76. *A Survey of Electric Vehicle Awareness & Preferences in Vermont*, VT. ENERGY INV. CORP. 14 (2014), https://www.veic.org/documents/default-source/resources/reports/veic-a-survey-of-electric-vehicle-awareness-and-preferences-in-vermont.pdf [https://perma.cc/K6TL-FCHF]; Jon LeSage, *Surveys Show Challenges OEMs Face Selling Electric and Self-Driving*, HYBRID CARS (May 27, 2016), http://www.hybridcars.com/surveys-show-challenges-oems-face-selling-electric-and-self-driving-cars/ [https://perma.cc/KF7B-843C].

magnitude of the problem of climate change and the urgent need for action necessitate market intervention.[77]

B. Vehicle Standards Are Critical But Insufficient

Federal fuel economy and GHG emissions standards provide some incentive to manufacturers for the sale of ZEVs, but this approach has limited benefits. The federal standards are designed as average standards for fleets primarily comprised of internal combustion engine vehicles, and the standards are not intended to drive a wholesale shift to ZEVs.[78] The fleet emissions and efficiency requirements are sales-weighted and vary according to the type of vehicles consumers buy, and do not require manufacturers to shift production to ZEVs or provide incentives for the installation of needed charging or fueling infrastructure. In addition, incentives for lower-emitting vehicles in the federal standards decline over time. ZEVs receive favorable treatment in the vehicle standard compliance calculations—an "incentive multiplier" allows automakers to count electric vehicles and fuel cell vehicles as more than one vehicle for the calculation of fleet averages,[79] and automakers can treat electric vehicles, plug-in hybrid vehicles, and fuel cell vehicles as though they have zero emissions when calculating fleet emission averages under the MY 2017-2021 standards.[80] However, the multiplier decreases from 2.0 for MY 2017 vehicles to 1.5 for MY 2021 vehicles, and there is no multiplier for vehicle model years 2022-2025.[81] In addition, for

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77. *See* Gary E. Marchant, *Complexity and Anticipatory Socio-Behavioral Assessment of Government Attempts to Induce Clean Technologies*, 61 UCLA L. REV. 1858, 1865 (2014). While Marchant argues that CARB did not successfully anticipate the technological and economic challenges of the first ZEV program, Marchant's concerns about battery capacity and costs have proven to be less founded in recent years, as electric vehicle battery costs have decreased significantly per kilowatt-hour and mid-price, long-range electric vehicles will be offered by several manufactures over the next two years. *See* discussion accompanying *supra* notes 71-76.

78. In their Draft Technical Assessment Report, the EPA and NHTSA project that "only a very small fraction of the fleet will need to be PEVs to meet the MY2025 standards." EPA & NHTSA, DRAFT TECHNICAL ASSESSMENT REPORT: MIDTERM EVALUATION OF LIGHT-DUTY VEHICLE GREENHOUSE GAS EMISSION STANDARDS AND CORPORATE AVERAGE FUEL ECONOMY STANDARDS FOR MODEL YEARS 2022-2025 9-1 (July 2016).

79. EPA, REGULATORY ANNOUNCEMENT, EPA AND NHTSA SET STANDARDS TO REDUCE GREENHOUSE GASES AND IMPROVE FUEL ECONOMY FOR MODEL YEARS 2017-2025 CARS AND LIGHT TRUCKS (Aug. 2012), https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100EZ7C.txt [https://perma.cc/5WQ4-NNRH].

80. For electric miles driven. *Id.*

81. The EPA and NHTSA are currently conducting a mid-term assessment of the model year 2022-2025 standards. *See* EPA, MIDTERM EVALUATION OF LIGHT-DUTY

MY 2022-2025 standards, manufacturers must account for upstream vehicle GHG emissions after reaching a sales cap.[82]

States, therefore, have stepped in to supplement these policies. To encourage consumer adoption and increase automaker sales of electric and fuel cell vehicles, the state of California included a zero-emission vehicle sales requirement (i.e., the ZEV standards introduced above) in its Advanced Clean Cars program, which was adopted in 2012.[83] The California ZEV regulations require automobile manufacturers to sell a specified percentage of ZEVs relative to total vehicle sales each year.[84] California and the nine states that have adopted its ZEV program (called "Section 177 states" because of the Clean Air Act provision that allows them to choose to follow federal vehicle standards or to adopt California's)[85] are working to address the barriers to deployment of zero-emission vehicles.

However, there are limitations to the likely success of these efforts as well. First, the ZEV regulations apply only in California and the nine Section 177 states. Second, the ZEV program's "travel provision" currently allows vehicles sold in any state that adopts California's ZEV program to count as being sold in all ZEV states.[86] This provision results in most ZEVs being sold in California (and

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VEHICLE GREENHOUSE GAS (GHG) EMISSIONS STANDARDS FOR MODEL YEARS 2022-2025 (Mar. 15, 2017), https://www.epa.gov/regulations-emissions-vehicles-and-engines/midterm-evaluation-light-duty-vehicle-greenhouse-gas-ghg [https://perma.cc/R6E9-TXN3].

82. For MY 2022-2025 standards, automakers can use the zero g/mi tailpipe compliance value for (a) 600,000 vehicles if the companies sell at least 300,000 electric vehicles, plug-in hybrid electric vehicles, or fuel cell vehicles in MY 2019-2021; or (b) 200,000 vehicles for manufacturers who do not sell at least 300,000 electric vehicles, plug-in hybrid electric vehicles, or fuel cell vehicles in MY 2019-2021. *See* 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,623-63,200 (proposed Oct. 15, 2012), https://www.gpo.gov/fdsys/pkg/FR-2012-10-15/pdf/2012-21972.pdf [https://perma.cc/Z5ZP-6U4U].

83. *See* CAL. AIR RES. BD., MIDTERM REVIEW (Jan. 18, 2017), https://www.arb.ca.gov/msprog/acc/acc-mtr.htm [https://perma.cc/V2EM-YJZU].

84. *See* CAL. AIR RES. BD., ZERO EMISSION VEHICLE (ZEV) PROGRAM, https://www.arb.ca.gov/msprog/zevprog/zevprog.htm [https://perma.cc/377X-RDSV] (last updated Jan. 18, 2017); CAL. AIR RES. BD., ZERO-EMISSION VEHICLE LEGAL AND REGULATORY ACTIVITIES AND BACKGROUND, https://www.arb.ca.gov/msprog/zevprog/zevregs/zevregs.htm#background [https://perma.cc/U8TR-3Y7W] (last updated Oct 27, 2014).

85. 42 U.S.C § 7507(1) (1990).

86. UNION OF CONCERNED SCIENTISTS, WHAT IS ZEV?, http://www.ucsusa.org/clean-vehicles/california-and-western-states/californias-zev-program#.V-vwAfArKUk [https://perma.cc/YRX3-8P5D] (last updated Oct. 31, 2016).

automatically meeting other states' requirements without increasing sales in those other states), limiting the effectiveness of the policy in the Section 177 states.[87] The travel provision is scheduled to sunset in 2018, and the sunset is strongly supported by leaders in Section 177 states.[88] Third, recent analysis has shown that the increase in battery range of new plug-in electric vehicle ("PEV") models has resulted in an excess of ZEV compliance credits for automakers, which may result in automakers meeting the regulation's requirements but not selling the number of ZEVs necessary to meet other state goals or GHG emission reduction requirements.[89] CARB is currently conducting a midterm review of the Advanced Clean Cars Program, including the ZEV regulation, to ensure that it is strong enough to have an effect but not more ambitious than automakers are able to achieve.[90] Some stakeholders are encouraging CARB to strengthen the ZEV program, while others are arguing that the program is already too ambitious.[91]

C. Opportunities for Additional Policy Support

Several policy models to supplement vehicle and fuel standards are already in place at the federal or state level, and could be strengthened or expanded to other parts of the country. These include purchase incentives like rebates or tax credits, and other buyer incentives like access to high-occupancy vehicle lanes for drivers of ZEVs.[92]

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87. Letter from Robert Klee et al., Commissioner Conn. Dep't of Energy & Envtl. Prot., to Mary Nichols, Cal. Air Res. Bd. (July 20, 2016), http://www.nescaum.org/documents/joint-177-state-letter-to-mary-nichols-re-zev-regulation_072016.pdf [https://perma.cc/J4X9-EZXS].

88. *Id.*; CAL. AIR RES. BD., CALIFORNIA'S ADVANCED CLEAN CARS MIDTERM REVIEW, A-8 (Jan. 18, 2017); *see also* CAL. CODE REGS. tit. 13, § 1962.1(d)(5)(E)(2).

89. *See* Chuck Shulock, *Manufacturer Sales Under the Zero Emission Vehicle Regulation: 2012 Expectations and Governor's Commitments Versus Today's Likely Outcomes*, NAT. RES. DEF. COUNCIL 2 (2016), https://www.nrdc.org/sites/default/files/media-uploads/nrdc_commissioned_zev_report_july_2016_0.pdf [https://perma.cc/A9CW-JXTG].

90. *See* CAL. AIR RES. BD., *supra* note 83.

91. *Compare* Shulock, *supra* note 89, *with ZEV AND CAFE/GHGS*, ALL. OF AUTOMOBILE MFS., http://m.autoalliance.org/cafe/zev-and-cafe/ghgs [https://perma.cc/NQN6-FGQT].

92. *See ZEV Program*, CTR. FOR CLIMATE AND ENERGY SOLUTIONS (2013), http://www.c2es.org/us-states-regions/policy-maps/zev-program [https://perma.cc/6JMD-25RX]; *see also* J.R. DeShazo et al., *State of the States' Plug-in Electric Vehicle Policies*, UCLA LUSKIN CTR. FOR INNOVATION (2015), http://innovation.luskin.ucla.edu/sites/default/files/EV_State_Policy.pdf [https://perma.cc/958W-SY4H].

The federal government offers a federal income tax credit of up to $7500 for the purchase of new electric and plug-in hybrid electric vehicles.[93] States across the country offer a range of tax rebates and financial and other incentives to consumers and public fleets. For example, the Massachusetts Offers Rebates for Electric Vehicles ("MOR-EV") program provides rebates up to $2500 for purchasing or leasing ZEVs or plug-in hybrid vehicles;[94] the Pennsylvania Alternative Fuels Incentive Grant ("AFIG") program provides fifty percent of the incremental purchase cost for electric vehicles or plug-in hybrid electric vehicles ("PHEV") vehicles, as well as the purchase and installation of charging equipment, for school districts, municipalities, businesses, and non-profit organizations; and Maryland provides access to high-occupancy vehicle ("HOV") lanes for all electric vehicles registered in the state.[95]

Some states have designed incentive programs to promote ZEV adoption by lower-income drivers. For example, California established an income cap on rebates to limit the incentives provided to high-income individuals, and provides additional incentives to low-income residents who purchase or lease a ZEV.[96] Additionally, studies have found that the delayed benefit of tax credits weakens the incentive that policy provides; buyers do not receive the value of the credit until they pay their income taxes, so may have to wait as long as a year after buying the vehicle to get this refund.[97] Some states are therefore shifting to a rebate available to buyers immediately, which results in a lower out-of-pocket cost of the vehicle at the time of

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93. The federal tax credit is available for the first 200,000 vehicles sold by each manufacturer. After 200,000 vehicles are sold, the credit is phased out. PLUG-IN ELECTRIC DRIVE VEHICLE CREDIT (IRC 30D), https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d [https://perma.cc/7225-7XX9] (last updated Feb. 8, 2017).

94. MOR-EV, *supra* note 31.

95. *High Occupancy Vehicle (HOV) Lanes Frequently Asked Questions*, ST. HIGHWAY ADMIN., MD. DEP'T OF TRANSP., http://www.roads.maryland.gov/index.aspx?PageId=249 [https://perma.cc/DEK3-DM8Z].

96. For example, The Fiscal Year 2015-16 Low Carbon Transportation Investments and AQIP Funding Plan approved by the California Air Resources Board continued a cap on high-income resident (gross annual income above $250,000 for individuals) eligibility for consumer rebates and increased rebate levels for low-income residents. *See Income Eligibility*, CAL. CLEAN VEHICLE REBATE PROJECT (Mar. 29, 2016), https://cleanvehiclerebate.org/eng/income-eligibility [https://perma.cc/HRD2-MXK3].

97. Zifei Yang et al., *Principles for Effective Electric Vehicle Incentive Design*, INT'L COUNCIL ON CLEAN TRANSP. 5 (2016).

purchase.[98] Federal policy could shift the federal tax credit in the same way to increase its effect. This change would also allow entities that do not pay federal taxes (like state and city governments and universities) to more readily benefit from the incentive.

Some state, federal, and local policies are also focused on building the infrastructure needed to charge (or, in the case of fuel cell vehicles, fuel) the cars. In some cases, a public agency directly invests in installing charging stations available to the public. For example, the California Energy Commission recently provided nearly nine million dollars in grant funding for the installation of direct-current ("DC") fast chargers at strategic locations along highway corridors in the state.[99] Other policies provide incentives or financing support for residents or businesses to install stations for their own use, or for use by employees or customers.[100] In July 2016, the U.S. Department of Energy announced the expansion of its $4.5 billion Renewable Energy and Efficient Energy loan program to provide financing for electric vehicle charging equipment, although the status of this program within the Trump Administration's priorities is unclear.[101] Many states provide incentives for the installation of charging infrastructure through grants or tax rebates, such as the New Jersey It Pay$ to Plug In Electric Vehicle Workplace Charging Grant program, which offers employers up to $250 for the installation of a Level 1 charging station and up to $5000 for a Level 2 charging station,[102] and

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98. Colorado recently passed new legislation to amend its electric vehicle incentive to now offer the $5000 tax credit to individuals at the time of purchase. COLO. SESS. LAWS 955 (2016), http://www.leg.state.co.us/clics/clics2016a/csl.nsf/fsbillcont2/D29A1044569D6D5987257F2400642E3F/$FILE/1332_rer.pdf [https://perma.cc/W73S-7GCN].

99. Press Release, California Energy Commission, Energy Commission Funds Electric Vehicle Chargers along Major State Routes (Apr. 13, 2016), http://www.energy.ca.gov/releases/2016_releases/2016-04-13_ev_chargers.html [https://perma.cc/P3KU-Y87V].

100. *See, e.g., Electric Vehicle Supply Equipment Tax Credit Program*, MD. ENERGY ADMIN., http://energy.maryland.gov/transportation/Pages/incentives_evserebate.aspx [https://perma.cc/9NSV-GBZC]; *EV Connecticut Charger Incentives* DEP'T OF ENERGY & ENV'T, ST. OF CONN., http://www.ct.gov/deep/cwp/view.asp?a=2684&q=561884&deepNav_GID=2183 [https://perma.cc/4QG7-XM7G] (last updated July 13, 2016).

101. Press Release, White House Off. of the Press Sec'y, FACT SHEET: Obama Administration Announces Federal and Private Sector Actions to Accelerate Electric Vehicle Adoption in the United States (July 21, 2016), https://www.whitehouse.gov/the-press-office/2016/07/21/fact-sheet-obama-administration-announces-federal-and-private-sector [https://perma.cc/PD62-JB82].

102. *Programs*, BUREAU OF MOBILE SOURCES, ST. OF N.J. DEP'T OF ENVTL. PROT., http://www.drivegreen.nj.gov/programs.html [https://perma.cc/P93T-4AAN] (last updated May 18, 2017).

Oregon's Alternative Fuel Vehicle Infrastructure Program, which offers a business tax credit of up to thirty-five percent of the cost of charging infrastructure.[103] Wider adoption of policies like these can help develop the scale of infrastructure needed to make a wholesale shift in the type of vehicles people purchase.

Research also shows a strong potential role for electric utilities in building out the charging infrastructure for plug-in electric vehicles, and utilities have increasingly begun to embrace this role.[104] The electric industry is heavily regulated, with revenue opportunities largely determined by state utility commissions, yet state utility regulators are only beginning to address the policy issues raised by the electrification of transportation.[105] Clarity in the rules regarding utilities' role in providing charging infrastructure, and in the prices that vehicle-charging providers can charge for electricity, would help demonstrate to the electric power industry the business opportunity that transportation electrification can offer. In many states, utilities have enacted time-of-use rates for electric vehicle owners that encourage charging during off-peak hours[106] and are taking other actions to reduce regulatory barriers to electric vehicle adoption.[107] In addition to offering special electric vehicle charging rates, some electric utilities have started investing in electric vehicle charging infrastructure—particularly for multi-unit dwellings such as apartment buildings and workplaces.[108] The California Public Utility Commission has already approved proposals by San Diego Gas and

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103. *Alternative Fuel Vehicle Fueling and Charging*, OR. DEP'T OF ENERGY, http://www.oregon.gov/energy/TRANS/Pages/hybridcr.aspx [https://perma.cc/THD4-5S6S].

104. *MOU with U.S. Department of Energy*, EDISON ELEC. INST. (June 8, 2015), http://www.eei.org/resourcesandmedia/newsroom/Documents/MOU.pdf [https://perma.cc/HT4R-Z87F].

105. *See generally* Kathryn A. Zyla, *Charging Ahead: Options for Policymakers Regarding the Regulation of Electric Vehicle Charging Markets*, GEO. CLIMATE CTR. (June 2014).

106. *See, e.g.*, *PEV Rates,* CONSUMER ENERGY, https://old.consumersenergy.com/content.aspx?id=3367 [https://perma.cc/52GZ-28X5] (listing Consumer Energy's residential home and plug-in electric vehicle time-of-day rates for customers in its Michigan service territory).

107. *See generally* Max Baumhefner, Roland Hwang & Pierre Bull, *Driving Out Pollution: How Utilities Can Accelerate the Market for Electric Vehicles*, NAT. RES. DEF. COUNCIL (2016), https://www.nrdc.org/sites/default/files/driving-out-pollution-report.pdf [https://perma.cc/F798-QS6E].

108. *See, e.g.*, *KCP&L Clean Charge Network*, KAN. CITY POWER & LIGHT CO., http://www.kcpl.com/about-kcpl/environmental-focus/clean-charge-network [https://perma.cc/BM3X-LP5A].

Electric,[109] Southern California Edison,[110] and Pacific Gas and Electric[111] to invest in charging infrastructure and incorporate the cost of those investments in the rates that customers pay the utilities.[112]

Some state and local governments are taking a more direct role in developing the ZEV market, leading by example with fleet procurement initiatives, which focus on vehicles owned or leased by a government agency,[113] and consumer education programs.[114] States have set fleet electrification goals through executive orders or as aspirational targets. For example, Executive Order 2016-03 in New Hampshire requires that the state reduce GHG emissions from its passenger vehicle fleet by thirty percent by 2030, as compared to a 2010 baseline.[115] Additionally, states and cities are collaborating to achieve fleet electrification goals. The governors of California, Oregon, Washington, and the premier of British Columbia joined with municipal partners to launch the West Coast Electric Fleets initiative to accelerate fleet electrification on the West Coast.[116] As the incremental cost of electric vehicles continues to decrease and increased battery range allows more electric vehicle models to meet fleet needs, more public and private fleet managers will have opportunities to pursue fleet electrification.

Despite these policy efforts, GHG emissions from combustion of transportation fuels remain an externality that is not incorporated

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109. *In re San Diego Gas & Elec. Co.* (2016) Cal. P.U.C. Dec. No. 16-01-045.

110. Press Release, Cal. Pub. Util. Comm'n, CPUC Supports State's Zero Emission Vehicle Goal with Approval of Program for Edison (Jan. 14, 2016), http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M157/K724/157724767.PDF [https://perma.cc/2KKR-75UK].

111. *In re Pacific Gas & Elec. Co.* (U39E) (2016) Cal. P.U.C. Dec. A.15-02-009. *See also California PUC approves PG&E electric vehicle infrastructure plan,* UTILITY DIVE (Dec. 20, 2016), http://www.utilitydive.com/news/california-puc-approves-pge-electric-vehicle-infrastructure-plan/432710/ [https://perma.cc/XV6Y-A5X9].

112. The rate base is the value of assets on which a utility can earn a profit. *See generally* SCOTT HEMPLING, REGULATING PUBLIC UTILITY PERFORMANCE: THE LAW OF MARKET STRUCTURE, PRICING AND JURISDICTION (2013).

113. *See, e.g., Washington State Electric Fleets Initiative*, WASH. ST. OFF. OF THE GOVERNOR (2015) http://www.governor.wa.gov/sites/default/files/documents/ElectricFleetsInitiative12_07_2015.pdf [https://perma.cc/3D8R-97KT].

114. *See, e.g., EV Connecticut,* DEP'T OF ENERGY AND ENV'T., ST. OF CONN., http://www.ct.gov/deep/cwp/view.asp?a=2684&q=525224&deepNav_GID=1619 [https://perma.cc/C3WQ-QQ8N] (last updated Mar. 28, 2017).

115. N.H. Exec. Order No. 2016-03 (May 6, 2016), http://governor.nh.gov/media/orders/documents/eo-2016-03.pdf [https://perma.cc/9MTR-DSJP].

116. *See, e.g.*, *About West Coast Electric Fleets*, W. COAST ELEC. FLEETS, http://www.westcoastelectricfleets.com/about/ [https://perma.cc/F4KH-6XPP].

into the price of vehicles or fuels. A carbon pricing policy as described in Part V below is a valuable way to incorporate the GHG benefits of EVs into the market and potentially to help fund investments into the market supports described above.

As ZEVs become more affordable and consumers become more aware of their benefits, public incentives should become less necessary. However, in the early years of new vehicle technology and charging and refueling infrastructure availability, public support is critical to achieve scale.[117] While many state, local, and federal programs (as well as efforts by automakers and electric vehicle advocates) have made significant progress in promoting vehicle adoption and infrastructure installation, there is still more work to be done across all jurisdictions.

III. INCORPORATING GHG PLANNING INTO TRANSPORTATION AND LAND USE DECISION-MAKING

A second key strategy for reducing emissions from the transportation sector is to establish GHG planning processes that assess needed emission reductions from the transportation sector, evaluate the effectiveness of different transportation strategies to reduce emissions, and track progress toward emission reduction goals; these processes must be ongoing to secure continued improvements. This Part begins by describing why reducing emissions from transportation is essential to meeting mid-term economy-wide emission reduction targets that are being set at both the federal and state levels. It then describes the existing climate, transportation, and land use planning processes at different levels of government, and how they intersect. Finally, it identifies potential processes and tools that can be used to integrate GHG planning into transportation and land use decision-making.

A. The Importance of the Transportation Sector for Meeting Economy-Wide GHG Targets

Many states have set mid-term, economy-wide GHG emission targets and are actively engaged in planning processes to meet those targets.[118] Reducing emissions from the transportation sector will be critical to these efforts—particularly given the significant reductions

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117. *See generally* John Paul Helveston et al., *Will subsidies drive electric vehicle adoption? Measuring consumer preferences in the U.S. and China*, TRANSP. RES. Part A 73, 96-112 (2015).

118. *See* CLIMATE CHANGE, SUSTAINABLE DEV. & ECOSYSTEMS, 2015 ANNUAL REPORT 313-16 (Shannon Martin Dilley et al. eds., 2015).

achieved in the power sector—but GHG planning practices for transportation will need to be further developed and implemented to successfully meet targets.

Across the U.S. and within many states, power sector emissions have dropped, driven by a combination of both state and federal policies as well as market shifts. The United States has seen a reduction of fifteen percent in GHG emissions in the power sector since 2005.[119] Leading states have seen even greater reductions in power sector emissions. For example, the nine states that participate in the Regional Greenhouse Gas Initiative, a cap-and-trade program for the power sector in the northeast, reduced carbon dioxide ("CO_2") emissions by forty percent since 2012.[120]

In contrast, transportation sector emissions have seen significantly smaller reductions, even during the recent economic downturn. The transportation sector as a whole reduced emissions nine percent since 2005.[121] As the economy improves, transportation sector emissions are trending upward while power sector emissions are continuing to decline.[122] In August 2016, the U.S. Energy Information Administration reported that transportation-sector CO_2 emissions have surpassed power sector emissions for the first time.[123]

Setting and meeting GHG targets also becomes more challenging over time. When states initially set GHG emission reduction targets, they often set a near-term target (e.g., 2010, 2020) that captured "low-hanging fruit"—relatively easy emission reductions, including some already expected to take place. States often set ambitious long-term targets at the same time, usually for 2050, which represent the level of

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119. EPA, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS 1990-2015 (2017), https://www.epa.gov/sites/production/files/2017-02/documents/2017_complete_report.pdf [https://perma.cc/FDK9-722E] (discussing change in electric power sector emissions).

120. Regional Greenhouse Gas Initiative State Agency Officials' Comments to EPA on Proposed Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units 4 (2014), http://www.rggi.org/docs/PressReleases/PR110714_CPP_Joint_Comments.pdf [https://perma.cc/F3ME-7DYJ]. The nine states in the Regional Greenhouse Gas Initiative are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. *Welcome*, REG'L GREENHOUSE GAS INITIATIVE, http://rggi.org/ [https://perma.cc/E5DW-BDUU].

121. *See* EPA, *supra* note 119 (discussing change in electric power sector emissions).

122. U.S. ENERGY INFO. ADMIN., AUGUST 2016 MONTHLY ENERGY REVIEW 184-85 (2016), https://www.eia.gov/totalenergy/data/monthly/archive/00351608.pdf [https://perma.cc/2SVV-PFD8] (comparing emissions for 2014, 2015, and first five months of 2016).

123. *Id.*

emission reduction needed in the then-distant future according to scientific estimates.[124] Setting mid-term targets (e.g., around 2030 or 2035) is more difficult, because it requires governments to set targets in the not-too-distant future that will require new and more ambitious policies to meet.[125]

For example, Massachusetts passed legislation requiring the state to set GHG limits every ten years, beginning with a 2020 target.[126] In 2016, Governor Charlie Baker issued an executive order that emphasized reducing emissions from transportation. He directed that the state set declining annual aggregate emission limits for the Department of Transportation and work regionally to develop regional policies to reduce GHG emission limits from transportation.[127] Similarly, the states of California, Maryland, and New York, which have all recently established ambitious mid-term GHG reduction goals, have emphasized achieving emission reductions from the transportation sector in their efforts.[128]

As described above, federal vehicle and fuel standards will drive significant reductions in the sector, but these reductions will not

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124. For more detail on states that have recently set mid-term goals, see GEO. CLIMATE CTR., MEMORANDUM: POLICY CONSIDERATIONS FOR THE MARYLAND CLIMATE CHANGE COMMISSION 12-23 (2015), http://www.georgetownclimate.org/files/report/GCC_MDClimateCommissionMemo_FinalMemo_Nov2015_clean_1.pdf [https://perma.cc/Y93A-JB35].

125. *Id.*

126. 2008 Global Warming Solutions Act, ch. 298.

127. Exec. Order No. 569, Mass. Governor Charles D. Baker (Sept. 16, 2016), http://www.mass.gov/eea/docs/executive-order-climate-change-strategy.pdf [https://perma.cc/K2NB-2K8U]. The Executive Order followed a 2016 Massachusetts Supreme Judicial Court decision, *Kain v. Massachusetts Department of Environmental Protection*, that found that the legislation required the state to set mass-based declining emission limits for more than one sector of the economy. 49 N.E.3d 1124 (Mass. 2016).

128. The Maryland Greenhouse Gas Reduction Act of 2016 set a mid-term target to reduce GHG emissions forty percent below 2006 levels by 2030. *See* H.R. 610, 2016 Leg., 436th Sess. (Md. 2016), http://mgaleg.maryland.gov/webmga/frmMain.aspx?id=HB0610&stab=01&pid=billpage&tab=subject3&ys=2016RS [https://perma.cc/2DP3-VQ34]. New York established an (aspirational) goal of reducing emissions forty percent below 1990 levels by 2030 (goal set in 2015 State Energy Plan released in June 2015). *See* N.Y. ST. ENERGY PLAN. BD., THE ENERGY TO LEAD: 2015 NEW YORK STATE ENERGY PLAN (Dec. 2015), http://energyplan.ny.gov/Plans/2015 [https://perma.cc/9CEQ-PVLG]. California Senate Bill 32, signed in September 2016, put into law the requirement to reduce emissions forty percent below 1990 levels by 2030 (a target which had previously been set by Gov. Brown through executive order). S.B. 32, 2015-16 Leg., Reg. Sess. (Cal. 2016), https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32 [https://perma.cc/R72T-YCMB].

sufficiently reduce the largest sector of U.S. emissions.[129] It is difficult to see how economy-wide targets can be met without setting and meeting meaningful transportation goals.

GHG planning for the transportation sector is critical to these efforts because it helps jurisdictions identify the anticipated gap between projected emission reductions from existing policies and emission reduction targets. GHG planning also helps states evaluate different strategies for achieving reductions from the transportation sector, and establishes a baseline for measuring progress.[130]

A number of reports have evaluated the potential emission reductions from various low-carbon transportation strategies. Reports such as Moving Cooler, the federal Department of Transportation's Report to Congress on Transportation's Role in Reducing U.S. Greenhouse Gas Emissions, and the Transportation Research Board's Special Report on Policy Options for Reducing Energy Use and Greenhouse Gas Emissions from U.S. Transportation provide insights into what a wide variety of approaches—from eco-driving to land use change to pricing strategies to technology and fuel shifts—can achieve.[131] While such reports

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129. *See* discussion accompanying *supra* notes 61-62.

130. For examples of states that have specifically evaluated emission reductions options for the transportation sector, see CAL. AIR RES. BD., 2017 CLIMATE CHANGE SCOPING PLAN UPDATE: THE PROPOSED STRATEGY FOR ACHIEVING CALIFORNIA'S 2030 GREENHOUSE GAS TARGET, https://www.arb.ca.gov/cc/scopingplan/scoping plan.htm [https://perma.cc/F4A7-94CR] (last updated Feb. 24, 2017); MD. DEP'T OF THE ENV'T, 2015 GREENHOUSE GAS EMISSIONS REDUCTION ACT PLAN UPDATE (Oct. 2015), http://climatechange.maryland.gov/wp-content/uploads/sites/16/2014/11/GGR A_Report_Final_11-2-15.pdf [https://perma.cc/G6Z4-HKBK]; EXEC. OFF. OF ENERGY & ENVTL. AFF., MASSACHUSETTS CLEAN ENERGY AND CLIMATE PLAN FOR 2020 25-26 (2015), http://www.mass.gov/eea/pr-2016/pr-massachusetts-clean-energy-and-climate-plan-for-2020.html [https://perma.cc/CQ4R-QCWV]; N.Y. ST. ENERGY PLAN. BD., *supra* note 128.

131. CAMBRIDGE SYSTEMATICS, INC., MOVING COOLER: AN ANALYSIS OF TRANSPORTATION STRATEGIES FOR REDUCING GREENHOUSE GAS EMISSIONS (2009); VT. DEP'T OF PUB. SERV., COMPREHENSIVE ENERGY PLAN 2016 9 (2016), https://outside.vermont.gov/sov/webservices/Shared%20Documents/2016CEP_Final.pdf [https://perma.cc/9M63-RNEQ]; CAL. ENVTL. PROT. AGENCY AIR RES. BD., FIRST UPDATE TO THE CLIMATE CHANGE SCOPING PLAN (2014), https://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf [https://perma.cc/B3B6-TH6J]; EXEC. OFF. OF ENERGY & ENVTL. AFF., *supra* note 130; NORTH JERSEY TRANSP. PLAN. AUTH., NJTPA REGIONAL GREENHOUSE GAS MITIGATION PLAN (Mar. 1, 2013), http://www.njtpa.org/planning/regional-studies/completed-studies/greenhouse-gas-(ghg)-mitigation-plan/njtpa-regional-greenhouse-gas-mitigation-plan/njtpa-regional-greenhouse-gas-mitigation-plan_fina.aspx [https://perma.cc/4ALU-QYAD]; N.Y. ST. ENERGY PLAN. BD., *supra* note 128; U.S. DEP'T OF TRANSP., REPORT TO CONGRESS, TRANSPORTATION'S ROLE IN REDUCING U.S. GREENHOUSE GAS EMISSIONS (2010); TRANSP. RES. BD. COMM. FOR A STUDY OF

have been valuable in identifying a range of opportunities to reduce transport emissions, they do not constitute a systematic, iterative process for analyzing the emission reduction potential, benefits, and costs of various strategies that can reduce GHG emissions as part of an ongoing planning and decision-making process.

B. Existing Transportation, Land Use, and Air Quality Planning Frameworks

Over the past fifty years, federal regulatory and funding frameworks have expanded planning requirements for transportation, land use, and air quality, and have improved understanding of policy levers and responses in these areas. Federal transportation funding laws, beginning with the Federal-Aid Highway Act in 1962, require state and metropolitan area transportation planning, and have continued to evolve with each transportation reauthorization.[132] At the metropolitan region and local level, this transportation planning is often linked with land use planning requirements and processes established under state and local authorities.[133]

On the environmental side, the Clean Air Act Amendments of 1977 required for the first time that state transportation plans and investments conform to air pollution standards, giving rise to new techniques and tools for evaluating the air pollution effects of transportation policies.[134] The 1969 National Environmental Policy Act similarly required federal agencies and contractors to use a "systematic, interdisciplinary" process to evaluate environmental impacts at the project level—including on transportation investments—and dozens of states have passed similar state-level laws.[135] Much of this planning takes place in states, metropolitan

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POTENTIAL ENERGY, SAVINGS AND GREENHOUSE GAS REDUCTIONS FROM TRANSP., POLICY OPTIONS FOR REDUCING ENERGY USE AND GREENHOUSE GAS EMISSIONS FROM U.S. TRANSPORTATION (2011), http://www.nap.edu/catalog.php?record_id=13194 [https://perma.cc/UAR8-WYY8].

132. *See generally* ROBERT DILGER, AMERICAN TRANSPORTATION POLICY (2003); *see also* EDWARD WEINER, URBAN TRANSPORTATION PLANNING IN THE UNITED STATES: AN HISTORICAL OVERVIEW 31 (1999), http://site.ebrary.com/lib/alltitles/docDetail.action?docID=5007019 [https://perma.cc/66S5-X3Q6].

133. *See generally* Pacyniak, *supra* note 52.

134. *See generally* JAMES E. MCCARTHY, CONG. RES. SERV., TRANSPORTATION CONFORMITY UNDER THE CLEAN AIR ACT NO. R44050 (2015), https://www.hsdl.org/?view&did=766518 [https://perma.cc/U5LY-4B8R]; *see also* Arnold W. Reitze, Jr., *Air Quality Protection Using State Implementation Plans–Thirty-Seven Years of Increasing Complexity*, 15 VILL. ENVTL. L.J. 209, 209-366 (2004).

135. Paul J. Culhane, *NEPA's Impacts on Federal Agencies, Anticipated and Unanticipated*, 20 ENVTL. L. 681, 681-702 (1990); Bradley C. Karkkainen, *Toward a*

regions, and municipalities, and a number of jurisdictions have become national leaders in these fields.[136]

While there is a rich academic literature identifying shortcomings and opportunities for improvement, these laws have advanced systematic planning processes that inform decision-making in these related fields. It will be similarly necessary to integrate GHG planning considerations into future government policy and investment decisions. Such planning will need to consider emission reduction opportunities from all "three legs of the stool"—strategies to promote cleaner vehicles, cleaner fuels, and cleaner modes of transportation and land use.

C. Challenges for Transportation Sector GHG Planning

Implementing such planning processes will require confronting a number of challenges, including challenges related to the jurisdictional complexity of the sector and the maturity of analytic tools.

The first challenge is that there are many different levels of government, and many different agencies, that play a role in funding, planning, and implementing transportation strategies.[137] All must play a role in truly decarbonizing the sector. Not all are fully committed to reduction of GHG emissions as a priority and even where they are, efforts to reduce emissions are often not well coordinated across bureaucratic silos.

At the federal level, congressional transportation funding authorizations direct transportation funds and condition funding on state planning requirements and performance. The DOT and its sub-agencies administer this funding, including through promulgation of regulations and administration of competitive funding programs.[138]

Smarter NEPA: Monitoring and Managing Government's Environmental Performance, 102 COLUM. L. REV. 903, 903-72 (2002).

136. *See, e.g.*, U.S. DEP'T OF TRANSP., BEST PLANNING PRACTICES: METROPOLITAN TRANSPORTATION PLANS (2012), https://www.planning.dot.gov/documents/BestPlanningPractices_MTP.pdf [https://perma.cc/9GPA-XWBZ].

137. *See* Peter Plumeau & Stephen Lawe, *Meeting the Challenge of Institutional Fragmentation in Addressing Climate Change in Transportation Planning and Investment*, 2139 TRANSP. RES. REC.: J. OF THE TRANSP. RES. BD. 81-87 (2009).

138. The federal government plays a dominant role in shaping state transportation policies through federal aid programs that provide funding for highway, transit, and other transportation programs. These programs are funded by federal fuel taxes and other user fees. Funding to states is conditioned on successfully meeting federal requirements for planning and project selection at the state and regional levels. Federal transportation funding laws also create funding incentives for pursuing certain projects. This combination of federal aid, requirements, and incentives is

The Department of Energy leads investment and research into clean vehicle programs.[139] The EPA and NHTSA together develop joint federal fuel economy and GHG standards.[140] The EPA administers the Renewable Fuel Standard and assesses state transportation conformity plans as part of the National Ambient Air Quality Standard program.[141]

At the state level, transportation agencies are required, as a condition of receiving federal funds, to engage in long-term state transportation planning and direct state-level transportation capital investment through state transportation improvement programs ("STIPs").[142] State transportation agencies also oversee highway operations that offer opportunities to reduce congestion and related emissions, plan and invest in freight infrastructure, and establish statewide "complete streets" policies that promote bicycle and pedestrian facilities. State environmental agencies are often designated by state statute or by the state's executive as the lead agency for economy-wide GHG planning. They also conduct transportation conformity analyses and administer state ZEV and clean fuels policies. In many states, environmental agencies are the lead promoters of electric vehicle deployment, but in some states,

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referred to here as the federal transportation framework. A series of federal transportation authorization bills has created and revised this federal framework beginning with the Federal Highway Act in 1921. The scope of the federal role has increased over time, and the current framework, referred to as the post-Interstate era, began with the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. Intermodal Surface Transportation Efficiency Act of 1991, Pub. L. No. 102-240, 105 Stat. 1914. The most recent federal transportation reauthorization, the Fixing America's Surface Transportation (FAST) Act, Pub. L. No. 114-94, was passed in 2015. *See generally* DILGER, *supra* note 132.

139. *See Vehicles*, ENERGY.GOV, http://energy.gov/public-services/vehicles [https://perma.cc/S7Q6-2K6E].

140. *See, e.g.*, 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624-63,200 (Oct. 15, 2012); Medium- and Heavy-Duty Vehicle Fuel Efficiency Program, 49 C.F.R. § 535.5 (2011).

141. Renewable Fuels Standard, Clean Air Act § 211(o), 42 U.S.C.A. § 7545(o) (2012); Transportation Conformity, Clean Air Act § 176, 42 U.S.C. § 7506 (2012).

142. Statewide and nonmetropolitan transportation planning, 49 U.S.C.A. § 5304. All states are dependent on federal transportation funding. *See generally* Robert S. Kirk & William J. Mallett, *Funding and Financing Highways and Public Transportation*, CONG. RES. SERV. NO. R44674 (2016), https://fas.org/sgp/crs/misc/R44674.pdf [https://perma.cc/X6EV-3P2N]. For more information on the state transportation improvement programs, see Kevin McCoy, Amy Ingles & William Lyons, *STIP State of the Practice Review: Development and Use of Statewide Transportation Improvement Programs*, U.S. DEP'T OF TRANSP. (2016), https://www.fhwa.dot.gov/planning/processes/statewide/practices/stip/index.cfm [https://perma.cc/P5UL-A8SX].

transportation or energy agencies play this role or agencies share these tasks.[143] In some states, there is also a state office that conducts statewide land use planning, often with some mandate to align such planning with state transportation planning.[144]

In large metropolitan regions, metropolitan planning organizations ("MPOs")—federally designated planning entities that include representatives of all jurisdictions in the metropolitan area—identify projects for investment through federally required transportation improvement programs ("TIPs") and conduct regional transportation planning.[145] To varying degrees, MPOs may also seek to coordinate metro-region land use planning.

Local governments have jurisdiction over land use, parking, and local road usage.[146] Design of urban and other communities to be "walkable" and promote transit-oriented development plays a vital role in reducing emissions in the transportation sector. For example, Arlington, Virginia has experienced significant economic growth while reducing automobile congestion and holding GHG emissions flat by investing in transit-oriented development and promoting density through zoning and providing alternatives to single occupancy vehicles.[147] Investment in transit, bike, and walking paths, coupled with limits on new parking and mixed use development, have created opportunities to enhance quality of life and economic development while reducing emissions.[148]

Implementing low-carbon transportation policies presents complex jurisdictional issues. It requires both vertical (across levels of government) and horizontal (across a given government's

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143. For example, in California, Maryland, Massachusetts, and New York the environmental agencies play the lead role, whereas in Oregon, Vermont, and Washington transportation agencies play the lead role.

144. States that have dedicated planning offices or departments include Connecticut, Delaware, Georgia, Hawaii, Maine, Maryland, New Hampshire, New Jersey, Oregon, Rhode Island, Vermont, and Washington. *See* Douglas R. Porter, *State Framework Laws for Guiding Urban Growth and Conservation in the United States*, 13 PACE ENVTL. L. REV. 547, 549 (1995); Jerry Anthony, *Do State Growth Management Regulations Reduce Sprawl?*, 39 URB. AFF. REV. 376, 379 (2004).

145. Metropolitan Transportation Planning, 49 U.S.C. § 5303 (2012).

146. Richard Briffault, *Our Localism: Part I—The Structure of Local Government Law*, 90 COLUM. L. REV. 1 (1990).

147. ARLINGTON ECON. DEV., FROM THE DIRECTOR: THE VALUE OF SMART GROWTH (July 2013), https://www.arlingtoneconomicdevelopment.com/resources/economic-update/2013/july/from-the-director-the-value-of-smart-growth/ [https://perma.cc/UJY5-RRZD].

148. *See generally* Reid Ewing et al., *Growing Cooler: The Evidence on Urban Development and Climate Change*, URB. LAND INST. (2007), https://www.nrdc.org/sites/default/files/cit_07092401a.pdf [https://perma.cc/9QDD-QWZT].

departments and agencies) coordination, and the alignment of multiple planning processes.

Another challenge is the maturity of the analytic tools available and the lack of robust data on the effectiveness of some low-carbon transportation policies. There are a number of valuable analytic methods and tools that are available to monitor emissions and progress towards goals. These include California's statewide transportation demand model,[149] the Federal Highway Administration's ("FHWA") energy and emission reduction policy analysis tool ("EERPAT") designed to evaluate GHG emission reductions in the planning process,[150] the EPA's Motor Vehicle Emissions Simulator ("MOVES") model which can provide projected CO_2 emissions from vehicle fleets using the same methodology used for transportation conformity analysis,[151] and others,[152] all of which provide useful data and continue to evolve and improve.

Modeling the transportation sector is more complex than modeling the electric power sector, where there is a relatively small universe of emitting sources. Many transportation modeling tools require a significant, ongoing investment of resources. Some state officials working with EERPAT report that it takes two years to develop an initial analysis, including a significant investment in staff training and resources.[153] In addition, in many cases there is a lack of robust real-world data on the carbon emission benefits of specific strategies, such that there is a significant range of uncertainty inherent in the models and tools.[154] These challenges only serve to underscore the need for additional focus on GHG planning. As government agencies throughout all levels of government implement ongoing planning

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149. *See California Statewide Travel Demand Model*, CAL. DEP'T OF TRANSP., http://www.dot.ca.gov/hq/tpp/offices/omsp/statewide_modeling/cstdm.html [https://perma.cc/4S96-2UJ5].

150. *See EERPAT-Energy and Emissions Reduction Policy Analysis Tool*, U.S. DEP'T OF TRANSP., https://www.planning.dot.gov/fhwa_tool/default.aspx [https://perma.cc/B6MP-FXHX].

151. *See MOVES and Other Mobile Source Emissions Models*, EPA, https://www.epa.gov/moves [https://perma.cc/57BQ-BZFK] (last updated Dec. 19, 2016).

152. *See, e.g.*, *Air Quality–Models & Methodologies*, U.S. DEP'T OF TRANSP., https://www.fhwa.dot.gov/environment/air_quality/methodologies/ [https://perma.cc/46JY-PXKX] (last updated Jan. 31, 2017).

153. These observations come from Georgetown Climate Center staff based on their conversations with state staff participating in the Transportation and Climate Initiative, which Georgetown Climate Center has facilitated over the last several years.

154. *Id.*

processes and take actions informed by these planning processes, the methods, tools, and data will improve and the discipline will mature. In short, it is critical to learn by doing and to share lessons through collaboration.

Fortunately, there are several important examples of GHG planning and collaboration that are already underway or under consideration. Some are identified here as potential models, with the recognition that further work will need to be done to identify how GHG planning for transportation can be expanded and refined.

D. Four Potential Transportation GHG Planning Processes

Four models to be considered include a recently promulgated federal GHG performance measure; state GHG planning processes, including California's SB 375; the potential of using transportation conformity for GHG planning; and assessment of GHG emissions under NEPA.

In a major development at the federal level, the FHWA recently finalized a GHG measure as part of its performance measure rulemaking under MAP-21.[155] MAP-21 requires the FHWA to identify performance measures and provide guidelines for their use, and requires states to set goals and measure progress using these measures. In its recently proposed rule, the FHWA took comment on such a GHG emissions measure.[156] Nine state Departments of Transportation and twenty-four MPOs commented in support of the creation of a GHG measure; ten state DOTs and two MPOs opposed such a rule.[157] Other entities, including the American Association of State Highway and Transportation Officials, did not support creating new measures of any kind at the current time.[158]

The rule will require that state DOTs be required to set two-year GHG targets for GHG emissions resulting from travel on the national highway system, and MPOs be required to set targets every four years. Under the MAP-21 framework, it is up to states and MPOs where to set the level of the targets—there is no federal guidance or

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155. *See* National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program, 82 Fed. Reg. 5970, 5979, 5993-6003 (Jan. 18, 2017).

156. *See* National Performance Management Measures; Assessing Performance of the National Highway System, Freight Movement on the Interstate System, and Congestion Mitigation and Air Quality Improvement Program, 81 Fed. Reg. 23,806, 23,830 (Apr. 26, 2016).

157. *See* 81 Fed. Reg., *supra* note 155, at 5993.

158. *Id.* at 6001.

requirement. However, states and MPOs will be required to integrate their targets into statewide and metropolitan long range plans, report on progress toward their targets, and consider how their investment programs (i.e., "statewide transportation improvement programs") will affect achievement of targets.[159] The first targets will be due from states in October 2018.[160]

Assuming it moves forward, this federal requirement has the potential to catalyze tremendous progress in GHG planning and assessment. At the current time, only a handful of states are conducting GHG planning for transportation. Under this performance measure requirement, all states will need to engage in some form of GHG planning, even if the targets they set are not ambitious. This requirement is expected to produce significant improvements in GHG planning data, tools, and understanding of mitigation strategy effectiveness.

As with other GHG related administrative actions, however, there is some uncertainty about whether this strategy will be maintained under President Trump. The performance measure is not explicitly required by MAP-21 or other laws, and some commentators have questioned its legality.[161] As with other administrative action, the Trump Administration could seek to rescind or weaken the action, although such action would require a notice and comment rulemaking.[162]

A second strategy for GHG planning is state-level GHG planning for transportation. Several states—including California, Maryland, Massachusetts, and New York—are already systematically evaluating opportunities for GHG emissions reductions as part of statewide planning processes.[163] In all these processes, the states are increasingly considering how the transportation sector can contribute to emission reduction goals.

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159. *Id.*

160. *Id.* at 6003.

161. *See id.* at 5993-5996.

162. *See supra* notes 19, 20, and 23 (discussing legal standards for rescinding or weakening administrative action).

163. *See, e.g.*, CAL. AIR RES. BD., THE 2017 CLIMATE CHANGE SCOPING PLAN UPDATE (2017), https://www.arb.ca.gov/cc/scopingplan/2030sp_pp_final.pdf [https://perma.cc/KW9U-F648]; MD. COMM'N ON CLIMATE CHANGE, 2016 ANNUAL REPORT (2016), http://www.mde.state.md.us/programs/Marylander/Documents/MCCC/Publications/2016Report/MCCC_2016_final.pdf [https://perma.cc/2VBK-EP26]; N.Y. St. DEP'T OF ENVTL. CONSERVATION, MITIGATION OF CLIMATE CHANGE, http://www.dec.ny.gov/energy/99223.html [https://perma.cc/X5BQ-8JPY]; 310 MASS. CODE. REGS. 7, 60 (proposed regulations) (2016); VT. DEP'T OF PUB. SERV., *supra* note 131.

California has also required MPOs to set binding targets and incorporate GHG planning into their planning through SB 375, building upon federal MPO planning requirements. The SB 375 legislation requires eighteen regions to develop land use and transportation plans that would meet GHG reduction targets for 2020 and 2035 set by CARB.[164] Although there is currently debate over the effectiveness of the program—as well as litigation over whether and how program obligations may be enforced[165]—the program has required GHG planning to be systematically integrated at the MPO level.

Other examples of ways in which GHG planning is being incorporated into transportation and land use planning include New York's Cleaner, Greener Communities, an incentive program that provides state funding to regions that incorporate GHG land use and transportation planning as part of broader land use planning.[166] There have also been efforts in metropolitan regions and cities to incorporate land use planning for compact development and low-carbon transportation, such as the Cape Cod Commission Action Plan, New York City's "Roadmap to 80 X 50," and the San Francisco Bay Area's "Plan Bay Area," among others.[167]

A third potential strategy for incorporating GHG planning with existing planning frameworks is through transportation conformity planning. The Clean Air Act Amendments of 1977 included provisions to ensure that federal transportation funding would be used in ways that "conformed" or were consistent with state air quality goals for states that had not met air quality goals.[168] States

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164. S. 375, Gen. Assem., 2007-2008 Reg. Sess. (Cal. 2008) (codified in scattered sections of the Cal. Gov't Code and at Cal. Pub. Res. Code § 21,155).

165. *See, e.g.*, Bay Area Citizens v. Ass'n of Bay Area Gov'ts, 248 Cal. App. 4th 966 (Cal. App. 1st Dist. 2016) (upholding Bay Area Governments' decision to develop a plan that would achieve additional reductions beyond what preexisting statewide mandates would achieve).

166. N.Y. ST. ENERGY RES. AND DEV. AUTH., *Cleaner, Greener Communities Program* (Apr. 2015), https://www.nyserda.ny.gov/-/media/Files/About/Statewide-Initiatives/CGC-Plans/cleaner-greener-communities-fs.pdf [https://perma.cc/5R2E-H3FL].

167. N.Y.C., ROADMAP TO 80 X 50 (2014), http://www1.nyc.gov/site/sustainability/codes/80x50.page [https://perma.cc/3SSA-3CN2]; ASS'N OF BAY AREA GOV'TS, PLAN BAY AREA (2013), http://files.mtc.ca.gov/pdf/Plan_Bay_Area_FINAL/Plan_Bay_Area.pdf; U.S. DEP'T OF TRANSP., CAPE COD CLIMATE CHANGE SCENARIO PLAN. PROJECT (2011), https://www.volpe.dot.gov/transportation-planning/public-lands/cape-cod-climate-change-scenario-planning-project [https://perma.cc/QB3Z-T2QF].

168. Conformity requirements apply to non-attainment or maintenance areas. *See* 42 U.S.C. § 7506(c), CAA Sec. § 176(c).

and MPOs subject to conformity requirements must model the effects of proposed transportation investments on conventional air pollutants.[169] The tool most frequently used by air quality planners to project emissions is the MOVES model, which was developed by the EPA. MOVES has the capability to project not only conventional pollutants, but also CO_2 emissions.[170] Air quality planners in most states therefore already have the knowledge and processes for evaluating CO_2 emissions impacts from transportation investments under the conformity process.

Finally, NEPA guidance from the White House Council on Environmental Quality issued in 2016 will require federally funded projects to evaluate impacts on GHG emissions and analyze potential alternatives.[171] This will lead to significant changes in how projects are evaluated, whether they are allowed to move forward and under what circumstances. As with other executive actions, the Trump Administration may seek to revisit or revoke this action.[172]

Ultimately, systematic, iterative GHG planning, monitoring, and evaluation will need to be pursued at all levels of government. State and local governments can again lead the way, improving analysis techniques, planning processes, generating more robust data, and showing what can be done through political will and leadership in piloting innovative approaches. Achieving significant emissions reductions from transportation will require integration of GHG planning broadly, especially at the state and MPO levels.

The next Part discusses another emerging area of research and focus: preparing our transportation sector for the impacts of climate change. Given that climate change impacts are already occurring, using the best science available to inform investment in transportation

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169. *Id. See also* FED. HIGHWAY ADMIN., TRANSPORTATION CONFORMITY: A BASIC GUIDE FOR STATE AND LOCAL OFFICIALS, https://www.fhwa.dot.gov/environment/air_quality/conformity/guide/guide01.cfm [https://perma.cc/WL8W-7HWJ] (last updated Apr. 5, 2017).

170. *See* EPA, USING MOVES FOR ESTIMATING STATE AND LOCAL INVENTORIES OF ONROAD GREENHOUSE GAS EMISSIONS AND ENERGY CONSUMPTION (2016), https://www.epa.gov/sites/production/files/2016-06/documents/420b16059.pdf [https://perma.cc/K8R2-T9NZ].

171. WHITE HOUSE COUNCIL ON ENVTL. QUALITY, FINAL GUIDANCE FOR FEDERAL DEPARTMENTS AND AGENCIES ON CONSIDERATION OF GREENHOUSE GAS EMISSIONS AND THE EFFECTS OF CLIMATE CHANGE IN NATIONAL ENVIRONMENTAL POLICY ACT REVIEWS (2016), http://www.georgetownclimate.org/files/report/nepa_final_ghg_guidance.pdf [https://perma.cc/J5AB-VGZE].

172. *See e.g.,* Hannah Northey, *FERC Keeps Obama Guidance Alive in Manual for Gas Projects*, E&ENEWS (Feb. 24, 2017), https://www.eenews.net/stories/1060050517 [https://perma.cc/ZR8C-M5WZ] (discussing likelihood of Trump Administration revoking GHG guidance).

infrastructure and operations is vital. Once again, state and local communities on the front lines of these impacts are leading the way.

IV. MAINSTREAMING RESILIENCE CONSIDERATIONS INTO TRANSPORTATION DECISION-MAKING

Our transportation system was designed and built using data and norms from the twentieth century, under the assumption that historic conditions would accurately represent future conditions.[173] Given the environmental changes we are already experiencing, such as rising heat, extreme weather events, droughts, and rising seas,[174] we know that we cannot maintain the same level of transportation services—much less improve them—without a concerted effort to incorporate climate projections into our transportation programs and investments.[175]

We are only at the early stages of implementing changes to our transportation system with climate change impacts in mind. Limited availability of down-scaled modeling data and uncertainty regarding the likely changes are often cited by transportation engineers as obstacles to changing practices,[176] and their departments generally adhere to codes and standards based solely on past conditions. However, maintaining a state of good repair is becoming more difficult given new extremes in heat, precipitation. and rising seas that contribute not only to storm surge during major storms but to more routine "sunny day" flooding in some coastal communities.[177]

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173. *See, e.g.,* FED. HIGHWAY ADMIN., U.S. DEP'T OF TRANSP., ASSESSMENT OF KEY GAPS IN THE INTEGRATION OF CLIMATE CHANGE CONSIDERATIONS INTO TRANSPORTATION ENGINEERING, TRANSPORTATION ENGINEERING APPROACHES TO CLIMATE RESILIENCE 37 (2014), https://www.fhwa.dot.gov/environment/sustainability/resilience/ongoing_and_current_research/teacr/key_gaps/fhwahep15059.pdf [https://perma.cc/9WTH-ZLTJ].

174. U.S. NAT'L CLIMATE ASSESSMENT, CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT 19-67 (2014).

175. *Id.,* at 130-49.

176. *See, e.g.*, FED. HIGHWAY ADMIN., *supra* note 173.

177. In Miami Beach, Florida, "sunny day" flooding is occurring more regularly as sea-level rise, a rising groundwater table, and monthly high-tide events push seawater back up through the city's stormwater drainage system and cause street flooding in lower-lying areas of the city. Miami Beach updated its Storm Water Management Master Plan in 2012, taking into account how sea-level rise would impact stormwater infrastructure, and the city has begun making investments (including elevating roadways) to reduce flood risk. *See Miami Beach Stormwater Infrastructure Adaptation,* ADAPTATION CLEARINGHOUSE, GEO. CLIMATE CTR., http://www.adaptationclearinghouse.org/resources/miami-beach-stormwater-infrastructure-adaptation.html [https://perma.cc/HF9U-8BHG] (last updated Jan. 28, 2016).

At the federal level, the DOT, FHWA, and Federal Transit Administration ("FTA") have begun to promote consideration of climate change projections. Through research studies,[178] pilot programs,[179] and policy guidance,[180] DOT is promoting consideration

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178. For example, U.S. DOT completed a two-phase, multi-year Gulf Coast Study that examined climate change impacts to the transportation network and infrastructure in the central Gulf Coast region. Through this work, U.S. DOT developed lessons and a variety of tools to help transportation planners, owners, and operators across the country as they analyze vulnerabilities, prioritize assets to protect, and identify adaptation strategies for those assets. *See* FED. HIGHWAY ADMIN., U.S. DEP'T OF TRANSP., GULF COAST STUDY (2015), https://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/ [https://perma.cc/S7FE-S9KB].

179. FHWA has sponsored two rounds of pilot projects, partnering with state DOTs and MPOs to conduct climate change vulnerability and risk assessments for their transportation systems and infrastructure, and in some cases to evaluate adaptation options. FHWA has used lessons to revise and expand its "Climate Change & Extreme Weather Vulnerability Assessment Framework," released initially in December 2012. *See* FED. HIGHWAY ADMIN., U.S. DEP'T OF TRANSP., CLIMATE CHANGE RESILIENCE PILOTS, https://www.fhwa.dot.gov/environment/climate_change/adaptation/resilience_pilots/ [https://perma.cc/2DRS-QM87] (last updated Mar. 27, 2017). FTA also sponsored seven pilot projects, beginning in 2011, for climate change adaptation assessments on transit systems. *See* FED. TRANSIT ADMIN., U.S. DEP'T OF TRANSP., TRANSIT AND CLIMATE CHANGE ADAPTATION: SYNTHESIS OF FTA-FUNDED PILOT PROJECTS, FTA REPORT NO. 0069 (Aug. 2014), https://www.transit.dot.gov/sites/fta.dot.gov/files/FTA_Report_No._0069.pdf [https://perma.cc/J26S-RPSE].

180. U.S. DOT and modal administrations have released several policies relating to climate change adaptation. In 2011, in response to Executive Order 13514–Federal Leadership in Environmental, Energy, and Economic Performance, U.S. DOT issued its "Policy Statement on Climate Change Adaptation," declaring DOT's policy to integrate "consideration of climate change impacts and adaptation into the planning, operations, policies, and programs of DOT" and directing the modal administration to incorporate climate adaptation into planning processes and investment decisions. *See* U.S. DEP'T OF TRANSP., POLICY STATEMENT ON CLIMATE CHANGE ADAPTATION (2011), https://www.fhwa.dot.gov/environment/climate_change/adaptation/policy_and_guidance/usdot.cfm [https://perma.cc/W5TS-A9ZN]. U.S. DOT also updated its departmental Climate Adaptation Plan in October 2014, describing steps to take to help fully integrate climate resilience and adaptation into DOT policies, programs, and operations. *See* U.S. DEP'T OF TRANSP., CLIMATE ADAPTATION PLAN (2014), https://www.transportation.gov/sites/dot.gov/files/docs/2014-%20DOT-Climate-Adaptation-Plan.pdf [https://perma.cc/N9GK-LGFD]. FHWA issued Order 5520, "Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events," in December 2014, formally establishing FHWA's policy on preparedness and climate change resilience, and committing FHWA to working to identify risks from climate change and extreme weather events and integrate consideration of these risks into planning, operations, policies, and programs. *See* FED. HIGHWAY ADMIN., U.S. DEP'T OF TRANSP., *Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events*, FHWA Order No. 5520 (Dec. 15, 2014), https://www.fhwa.dot.gov/legsregs/directives/orders/5520.cfm [https://perma.cc/VQL4-T53D]. FHWA has also issued technical guidance documents to assist transportation agencies in using best available

of climate change in investments in new infrastructure and rebuilding post-disaster (when most of the funding flows). DOT has also supported development of a database developed by Georgetown Climate Center that shares best practices at the state and local level through over 100 case studies.[181]

Transportation resilience has also been a key topic in international dialogues and efforts to build collaboration across national borders. DOT and the Transportation Research Board of the National Academy of Sciences ("TRB") have sponsored and hosted conferences bringing experts together from throughout the United States and around the world to inform emerging best practices and to advance research in this area.[182] TRB has also begun to promote resilience by establishing committees that promote more climate-ready transportation systems.[183] These efforts are in their early stages but are aimed at understanding what current approaches, policies,

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approaches to assess vulnerabilities of infrastructure and facilities. *See, e.g.,* FED. HIGHWAY ADMIN., U.S. DEP'T OF TRANSP., *Highways in the Coastal Environment: Assessing Extreme Events*, Publication No. FHWA-NHI-14-006, 2 HYDRAULIC ENGINEERING CIRCULAR 25 (Oct. 2014), https://www.fhwa.dot.gov/engineering/hydraulics/pubs/nhi14006/nhi14006.pdf [https://perma.cc/XC55-D8JA].

181. *Transportation Sector Case Studies*, ADAPTATION CLEARINGHOUSE, GEO. CLIMATE CTR., http://www.adaptationclearinghouse.org/sectors/transportation/case-studies-b.html [https://perma.cc/A2SW-BHXT] (last updated Jan. 22, 2015).

182. FHWA and FTA collaborated with the Transportation Research Board ("TRB") to organize the first "International Conference on Surface Transportation System Resilience to Climate Change and Extreme Weather Events," held in Washington, D.C. in September 2015. TRB released a circular summarizing the sessions held at the three-day event. *See Transportation Research Circular E-C204, Surface Transportation System Resilience to Climate Change and Extreme Weather Events: First International Conference*, TRANSP. RES. BD. (Feb. 2016), http://onlinepubs.trb.org/onlinepubs/circulars/ec204.pdf [https://perma.cc/TGW8-WK7L]. TRB also jointly hosted a symposium with the European Commission in June 2016, entitled "Transportation Resilience: Adaptation to Climate Change and Extreme Weather Events." The symposium sought to foster trans-Atlantic collaboration to identify research and innovation needs relating to different aspects of transportation decision-making in a disaster preparation, response, and recovery context.

183. In 2015, TRB designated resilience as one of the "hot topics" and established a new Resilience Section that brings together three TRB standing committees (including the Committee on Critical Transportation Infrastructure Protection) to promote discussion, disseminate research findings, and identify priority research topics relating to resilience and recovery from system stresses and service disruptions (caused by climate change, extreme weather events, or otherwise). *See* Tom Wakeman, *Presenting a New Transportation Research Board Section: Transportation System Resilience, First Int'l Conference on Surface Transp. Sys. Resilience to Climate Change and Extreme Weather Events* (Sept. 26, 2015), http://onlinepubs.trb.org/onlinepubs/conferences/2015/ClimateChange/95.TomWakeman.pdf [https://perma.cc/6K9R-ESMX].

regulations, and funding practices serve as barriers to communities attempting to change the ways infrastructure is built, rebuilt, maintained, and managed. Building, operating, and maintaining infrastructure with climate change in mind requires accessible scientific information. It also requires outreach to those in state and local agencies charged with building, maintaining, and operating transportation systems. Federal and state funding incentives must be aligned with understanding and incorporating climate projections into investment decisions.

While building climate change considerations into decision-making is only at early stages, examples can be identified and best practices shared through conferences, reports, tool kits, and databases. Already a number of states including California, Maryland, Massachusetts, New York, and Washington have begun to incorporate anticipated climate impacts in planning and investment requirements for roads, bridges, transit, ports, and terminals. For example, Washington's "mini-NEPA" guidance developed by its state DOT ("WSDOT") requires consideration of how climate change will affect proposed projects and how the project can be designed more resiliently.[184] In considering alternatives for one project, the new Mukilteo Multimodal Ferry Terminal, WSDOT evaluated the ability of different design options to withstand projected sea-level rise and more intense storms, and selected a site that allows most access roads and support facilities to be located in less vulnerable upland areas.[185] New York's Community Risk and Resiliency Act requires certain state programs to consider future climate risks caused by sea-level rise, storm surge, and flooding in the application and permitting process, including any approval, financing, or undertaking of public infrastructure projects by state infrastructure agencies.[186] The Act

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184. WASH. ST. DEP'T OF TRANSP., GUIDANCE FOR NEPA AND SEPA PROJECT-LEVEL CLIMATE CHANGE EVALUATIONS (Nov. 2014), http://www.wsdot.wa.gov/NR/rdonlyres/BDF7C3DA-4F27-4CD5-8D02-6813027A928B/0/WSDOT_Climate Guidance.pdf [https://perma.cc/47FC-S28F].

185. *WSDOT Mukilteo Multimodal Ferry Terminal Environmental Impact Statement,* ADAPTATION CLEARINGHOUSE, GEO. CLIMATE CTR., http://www.adaptationclearinghouse.org/resources/wsdot-mukilteo-multimodal-ferry-terminal-environmental-impact-statement.html [https://perma.cc/R527-3DWX] (last updated Mar. 22, 2016).

186. 2014 SESS. LAW NEWS OF N.Y. Ch. 355 (S. 6617-B) § 2 (amending N.Y. ENVIR. CONSER. L. § 6-0107). The Community Risk and Resiliency Act adds a new criterion to the state's smart growth public infrastructure criteria, with which public infrastructure projects must be consistent to the extent practicable. The new resiliency criteria reads, "to mitigate future physical climate risk due to sea level rise, and/or storm surges and/or flooding, based on available data predicting the likelihood

also requires the state's Department of Environmental Conservation to adopt regulations establishing state sea-level rise projections—important guidance to inform decision-making and investments.[187] And in Maryland, the state's Coast Smart Council (established by state law[188] as a body within the Department of Natural Resources) has adopted siting and design criteria[189] requiring certain capital projects to avoid or minimize impacts from future sea-level rise and coastal flooding through preliminary planning, siting, design, construction, and other practices.[190]

In addition to changes in state law and agency programs intended to institutionalize resilience in decision-making and investments, there are numerous examples of how states are considering sea-level rise, flooding, and other impacts in project-level decision-making. For example, parts of California's famed Highway 1 are being moved inland due to worsening coastal erosion,[191] and a portion of Florida's Highway A1A was redesigned with new features to make it more resilient to flooding after sustaining damage in Superstorm Sandy.[192]

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of future extreme weather events, including hazard risk analysis data if applicable." N.Y. ENVIR. CONSER. L. § 6-0107(2)(k).

187. N.Y. ENVIR. CONSER. L. § 3-0319.

188. MD. NAT. RES. CODE § 3-1002.

189. *Coast Smart Construction Program*, MD. COAST SMART COUNCIL (2015), http://dnr2.maryland.gov/ccs/coastsmart/Documents/2015_CS_ConstructionProgram.pdf [https://perma.cc/L6PM-FA9B].

190. State capital projects that involve the construction of a structure or reconstruction of a structure with substantial damage must be constructed or reconstructed in compliance with the siting and design criteria established by the Council. *See id.* at 3-4.

191. The California Department of Transportation ("Caltrans") is realigning a 2.8 mile section of Highway 1 in San Luis Obispo County in order to reduce vulnerability to future bluff retreat caused by storm damage and erosion, expected to worsen also with rising sea levels. The project will move the highway nearly 500 feet inland and restore the existing highway area to natural conditions; these measures are expected to protect the highway for the next 100 years. *See Piedras Blancas Highway 1 Realignment–Caltrans/San Luis Obispo*, ADAPTATION CLEARINGHOUSE, GEO. CLIMATE CTR., http://www.adaptationclearinghouse.org/resources/piedras-blancas-highway-1-realignment-caltrans-san-luis-obispo.html [https://perma.cc/NU78-6GC4] (last updated Mar. 21, 2016).

192. The Florida Department of Transportation ("FDOT") worked with the City of Fort Lauderdale to redesign and rebuild a portion of highway A1A that washed out during Superstorm Sandy. Although relocation of the vulnerable highway was not an option, as it provides the sole access for over 150 homes, the new design did include measures to make it more resilient to future flooding and erosion. For example, the seaward edge of the pavement was elevated, and other features were added to protect the roadway including a new underground drainage system and vegetated median, a decorative seawall next to the road, beach nourishment to extend the beach adjacent to the roadway, and an improved dune system. *See FDOT Rebuild of Highway A1A in Fort Lauderdale*, ADAPTATION CLEARINGHOUSE, GEO.

Bridges have been elevated in New Orleans post-Katrina[193] and a runway at JFK Airport in New York that was raised a foot prior to Sandy did not flood as others did during the storm.[194] Traditional pipe-shaped culverts were replaced in Vermont with open-bottom, reinforced arches below roads and bridges to allow for increased water flow, as well as enhanced fish passage after Tropical Storm Irene scoured out hundreds of miles of roads and bridges.[195]

Materials used in transportation networks are also affected by climate change impacts. As a result, new materials or construction practices are being used in designing roads, bridges, parking lots, transit systems, and even airport runways. Black asphalt, which absorbs heat and buckles on roads and runways (even melting around airplane tires),[196] is being replaced by lighter colored and more reflective materials able to withstand higher temperatures.[197]

CLIMATE CTR., http://www.adaptationclearinghouse.org/resources/rebuild-of-highway-a1a-in-fort-lauderdale.html [https://perma.cc/7GBU-LJGF] (last updated May 17, 2016).

193. The I-10 Twin Span Bridge over Lake Pontchartrain outside New Orleans failed during Katrina when storm surge pushed multiple bridge spans off their piers. When rebuilding, the state raised the bridge piers by twenty-three feet above the old elevation, and modified other design features to strengthen the bridge against future storm surge. During Hurricane Isaac in 2012, the approaches to the bridge flooded but the new bridge itself experienced damage only to electrical and signage components. *See* U.S. GOV'T ACCOUNTABILITY OFF., CLIMATE CHANGE: FUTURE FEDERAL ADAPTATION EFFORTS COULD BETTER SUPPORT LOCAL INFRASTRUCTURE DECISION MAKERS, REPORT GAO-13-242 45-48 (Apr. 2013), http://www.gao.gov/assets/660/653741.pdf [https://perma.cc/34ZK-B9J9].

194. Runway 13R-31L at JFK was renovated using concrete pavement instead of asphalt in order to minimize costs over the lifetime of the runway. The concrete surface helps avoid heat-related impacts that are seen more often with asphalt runways, but the new runway also provides flood-risk-reduction benefits because the repaving was done over the existing base, resulting in a runway that was over a foot higher than previously. During Sandy, storm surge reached near the southern part of the runway but did not reach the primary runway surface, which—with its increased height—acted as a flood barrier for property on the other side. *See generally JFK Airport Runway 13R-31L Rehabilitation (John F. Kennedy International Airport, New York City, NY)*, ADAPTATION CLEARINGHOUSE, GEO. CLIMATE CTR., http://www.adaptationclearinghouse.org/resources/jfk-airport-runway-13r-31l-rehabilitation-john-f-kennedy-international-airport-new-york-city-ny.html [https://perma.cc/NL6A-LK55].

195. *See* Justin B. Clancy & Jessica Grannis, *Lessons Learned from Irene: Climate Change, Federal Disaster Relief, and Barriers to Adaptive Reconstruction*, GEO. CLIMATE CTR. (2013), http://www.georgetownclimate.org/files/report/Lessons%20Learned%20From%20Irene%20-%20Finalv2.pdf [https://perma.cc/F39P-BPRE].

196. *See, e.g.*, Megan Garber, *Wait, Tarmac Can *Melt*?*, ATLANTIC (Jul. 9, 2012), http://www.theatlantic.com/technology/archive/2012/07/wait-tarmac-can-melt/259565/ [https://perma.cc/KEU3-LEPH].

197. For example, the Port Authority of New York and New Jersey awards sustainability credits to projects that mitigate the heat island effect through the use of

Permeable pavements are being used to help absorb excessive storm water.[198] In some places, roads are designed and built with materials that will have less environmental impact when the road washes out, under the assumption that it will happen more frequently.[199]

Transit systems that help move millions of people in New York and Boston are also at risk as seen during Superstorm Sandy and historic snowfalls. Efforts to hold water back from subway stations and tunnels[200] and to elevate electrical equipment are underway.[201] In

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light colored or porous paving materials in place of dark, absorptive materials. *See generally* PORT AUTH. OF N.Y. & N.J., SUSTAINABLE INFRASTRUCTURE GUIDELINES (Mar. 23, 2011), http://www.panynj.gov/about/pdf/Sustainable-infrastructure-guidelines.pdf [https://perma.cc/3BHW-ZYET]. Airport taxiways and runways at Newark Liberty International Airport and JFK International Airport have been reconstructed with concrete materials that provide greater solar reflectance. *See, e.g.*, ADAPTATION CLEARINGHOUSE, *supra* note 194.

198. For example, the Pringle Creek community in Salem, Oregon installed porous pavement on all of its streets, in addition to other green infrastructure techniques like rain gardens and bioswales. The features are designed to return ninety percent of rainwater to the local aquifer. During a heavy rainstorm in 2006, the porous pavement and other green infrastructure features successfully filtered the rainwater and prevented any flooding, whereas neighboring communities' traditionally-paved streets were flooded. *See generally Pringle Creek (Salem, Oregon) Green Streets Initiative*, ADAPTATION CLEARINGHOUSE, GEO. CLIMATE CTR., http://www.adaptationclearinghouse.org/resources/pringle-creek-salem-oregon-green-streets-initiative.html [https://perma.cc/3JL5-2BJA] (last updated Oct. 31, 2015).

199. For example, in the Gulf Islands National Seashore (managed by the National Park Service) and the Merritt Island National Wildlife Refuge (managed by U.S. Fish and Wildlife Service), FHWA's Eastern Federal Lands Division designed "sacrificial" roads with alternative materials like sand for fill, limestone, and coquina shell. *See generally Florida 'Sacrificial' Roads Projects*, ADAPTATION CLEARINGHOUSE, GEO. CLIMATE CTR., http://www.adaptationclearinghouse.org/resources/florida-e-sacrificial-e-roads-projects.html [https://perma.cc/RVE4-56BL] (last updated Jan. 29, 2016).

200. For example, the Port Authority of New York and New Jersey is incorporating both short-term and more permanent flood mitigation and flood protection measures into design and operations of its PATH transit system. These include floodgates, concrete and sand-filled barriers, and temporary measures like barriers that can be installed and tightened in front of individual doors immediately before an extreme weather event. *See generally Port Authority of New York and New Jersey: PATH System Resiliency and Recovery Improvements*, ADAPTATION CLEARINGHOUSE, GEO. CLIMATE CTR., http://www.adaptationclearinghouse.org/resources/port-authority-of-new-york-and-new-jersey-path-system-resiliency-and-recovery-improvements.html [https://perma.cc/VQ9Y-Y7BR] (last updated Jan. 16, 2015).

201. Damage to electrical equipment during Superstorm Sandy prevented transit systems and airports from resuming operations quickly after the storm and. as a result, efforts are being made to make these critical facilities more resilient to future flooding. The Port Authority of New York and New Jersey, for example, is elevating electrical substations that supply its PATH transit system with power, and is both elevating and relocating a substation at LaGuardia airport that was located in a flood

New Jersey, the state and New Jersey Transit partnered with the U.S. Department of Energy to develop a microgrid that will make the state's transit system (which includes critical evacuation routes) more resilient in the face of extreme events that affect the centralized grid.[202] Railroad tracks and other infrastructure are also being evaluated for their capacity to safely expand and operate during sustained heatwaves and other extremes.[203]

While costly to build, rebuild, and retrofit transportation systems to be resilient amid changing climate conditions, it is even more costly to continue with business as usual. Given the vital role of transportation systems in providing for human mobility, commerce, and economic development, we cannot afford to ignore the significant changes that lie ahead. At the same time, investment in new, more resilient infrastructure can spur economic growth and job creation. In particular, "green infrastructure" investments such as nature-based stormwater management strategies (e.g., parks and rain gardens)

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prone area. *See generally Elevating Electrical Substation for Port Authority of New York and New Jersey*, ADAPTATION CLEARINGHOUSE, GEO. CLIMATE CTR., http://www.adaptationclearinghouse.org/resources/elevating-electrical-substations-for-port-authority-of-new-york-and-new-jersey.html [https://perma.cc/ZD8Q-3W3N] (last updated Mar. 31, 2016).

202. The new microgrid, known as NJ TransitGrid, will include a Traction Power System with a new natural-gas-fired power plant that will provide electricity for trains to operate on critical portions of the system and for signals, certain stations, pumping, and other important functions. The project will also include a distributed generation system sited at specific facilities that utilizes renewable energy installations; these sources will power stations, maintenance facilities, bus garages, and other facilities. *See generally New Jersey TransitGrid: Microgrid Project to Help Power NJ Transit*, ADAPTATION CLEARINGHOUSE, GEO. CLIMATE CTR., http://www.adaptationclearinghouse.org/resources/new-jersey-transitgrid-eo-microgrid-project-to-help-power-nj-transit.html [https://perma.cc/7ZUW-EA3H] (last updated Jan. 29, 2016).

203. For example, the Norwalk River Railroad Bridge ("Walk Bridge") in Connecticut has experienced costly service failures and closures due to extreme heat. The swing bridge allows marine traffic to pass underneath, but heat events have prevented proper closure of the bridge after opening to allow for barge passage, which necessitates halting of rail service over the bridge. The Walk Bridge is a critical rail connection between Boston and New York City along the Northeast Corridor, so any disruptions have the potential to cause significant economic impacts. Connecticut DOT is in the process of replacing the Walk Bridge, and the new design will incorporate redundancies to better prepare for increasing extreme heat and other weather events. *See generally Connecticut DOT: Walk Bridge Replacement Project*, ADAPTATION CLEARINGHOUSE, GEO. CLIMATE CTR., http://www.adaptationclearinghouse.org/resources/connecticut-dot-walk-bridge-replacement-project.html [https://perma.cc/P2Q7-XTZ3] (last updated Mar. 30, 2016).

provide ways to manage water, enhance the safety of transportation systems, and provide other amenities year-round.[204]

It will take unprecedented and concerted efforts of federal, state, and local government officials and private sector designers and developers to include climate change considerations in the myriad decisions and investments affecting transportation systems and services in a changing world. As other Parts of this Article note, the changes underway include not only the impacts of climate change, but other changes that are brought about by policies aimed at curbing emissions.

Alternatives to conventional internal combustion engine vehicles can not only reduce emissions but also offer opportunities to enhance communities' resilience to climate change impacts. For example, during Sandy, when petroleum supplies were low, compressed natural gas buses were used in Atlantic City, New Jersey to evacuate elderly and disabled residents from vulnerable areas,[205] and natural gas trucks were used to clean up refuse on Long Island after the storm.[206] Electric vehicle drivers were able to use the energy stored in their vehicles to drive and to run or charge small appliances when their homes lost power.[207] Bicycles were used to deliver supplies to areas where the storm disrupted conventional transportation options.[208] The availability of safe and cleaner alternatives can provide options

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204. *See Green Infrastructure Toolkit*, GEO. CLIMATE CTR., http://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/introduction.html [https://perma.cc/4ZBJ-EUVH].

205. *See Sandy Recovery*, MOTORWEEK (Mar. 21, 2013), http://www.motorweek.org/features/auto_world/sandy_recovery [https://perma.cc/8MU6-QFFT].

206. *See id.*

207. *See, e.g.*, Jim Motavalli, *Sandy Cut the Power? No Problem, Say Electric Car Owners*, TXCHNOLOGIST (Nov. 8, 2012), http://txchnologist.com/post/35290154002/sandy-cut-the-power-no-problem-say-electric-car [https://perma.cc/68KL-LJBM]; Damon Lavrinc, *Hacked Nissan EVs power homes after Hurricane Sandy*, WIRED (Nov. 8, 2012), https://www.wired.com/2012/11/sandy-ev-powered-home/ [https://perma.cc/SG3P-4ANA].

208. *See, e.g.*, Mina Keyes, *Adaptive Transportation: Bicycling Through Sandy's Aftermath*, PROJECT FOR PUB. SPACES BLOG (Nov. 28, 2012), https://www.pps.org/blog/adaptive-transportation-bicycling-through-sandys-aftermath/ [https://perma.cc/7AUH-JW8F]; Sarah Goodyear, *The Power of Bicycles in Disaster Recovery*, CITYLAB (Nov. 7, 2012), http://www.citylab.com/weather/2012/11/power-bicycles-disaster-recovery/3834/ [https://perma.cc/6N2Q-DVMG]. *See also* Sarah Kaufman et al., *Transportation During and After Hurricane Sandy*, RUDIN CTR. FOR TRANSP., N.Y.U. WAGNER GRADUATE SCH. OF PUB. SERV. (Nov. 2012), http://wagner.nyu.edu/files/rudincenter/sandytransportation.pdf [https://perma.cc/9ZF3-Q7E6].

and build community cohesion,[209] another factor in enhancing resilience.[210]

At the same time, reliance on gasoline taxes to fund roads, bridges, and transit can result in opposition to promoting low-carbon alternatives, including electric vehicles. At a time when current transportation infrastructure is already given a near-failing grade (D)[211] due largely to underinvestment, the challenges of upgrading and maintaining quality under changing climate conditions makes the task of providing a robust and safe transportation network all the more challenging. It is impossible to consider how to make transportation infrastructure more climate-ready without tackling this issue of funding.[212] And it is politically difficult to raise taxes to provide for existing and future transportation needs.

The next Part discusses difficulties in meeting current and future funding needs given the current business model for transportation which relies on dwindling revenues from federal and state gasoline taxes to fund infrastructure investment.

V. INTEGRATING EMISSIONS-REDUCTION AND TRANSPORTATION FUNDING STRATEGIES

In addition to the challenges of climate change and the need to curb emissions and prepare for a new and dynamic set of conditions, the current transportation funding model is broken. The 18.4 cent-per-gallon federal gasoline tax enacted in 1993 is not indexed to inflation, has never increased, and is no longer sufficient to support

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209. *See, e.g.*, Todd Litman, *Community Cohesion as a Transport Planning Objective*, VICTORIA TRANSPORT POL'Y INST. (2017), http://www.vtpi.org/cohesion.pdf [https://perma.cc/V9B6-S6H5].

210. *See, e.g.*, Eric Williams, *Social Resiliency and Superstorm Sandy: Lessons from New York City Community Organizations*, ASS'N FOR NEIGHBORHOOD & HOUS. DEV. (2014), http://www.anhd.org/wp-content/uploads/2011/07/Social-Resiliency-and-Superstorm-Sandy-11-14.pdf [https://perma.cc/2EKL-A8XQ].

211. *See* AM. SOC'Y OF CIV. ENG'RS, 2013 REPORT CARD FOR AMERICA'S INFRASTRUCTURE, (2013), http://www.infrastructurereportcard.org/making-the-grade/report-card-history/2013-report-card/ [https://perma.cc/4UUU-82ST].

212. In September 2012, FHWA issued a memorandum intended to clarify the eligibility of adaptation activities to address climate change and extreme weather-related risks for funding through the Federal-Aid and Federal Lands Highway programs. *See generally* FED. HIGHWAY ADMIN., U.S. DEP'T. OF TRANSP., *Eligibility of Activities to Adapt to Climate Change and Extreme Weather Events under the Federal-Aid and Federal Lands Highway Program* (Sept. 24, 2012), https://www.fhwa.dot.gov/federalaid/120924.cfm [https://perma.cc/L77L-B47L]. However, this did not add or designate any new funds for adaptation but merely aimed to clarify that existing funds could be used for adaptation purposes in many instances.

the nation's transportation needs.[213] Six times between 2008 and 2014, Congress transferred money—about sixty-three billion dollars in total—from the general treasury to the Highway Trust Fund to make up the shortfall. In August 2014 the Congressional Budget Office estimated that $157 billion in additional revenue would be needed to maintain current spending levels plus inflation between 2015 and 2024.[214] Nonetheless, the Fixing America's Surface Transportation ("FAST") Act that passed in December 2015 provided no new sustainable source of transportation funding.[215] As a result, states are beginning to consider broader approaches to emissions reductions, exploring the use of market signals to drive reductions and raise funds for transportation systems often in dire need of repair.

This challenge is fundamentally linked to strategies to reduce GHG emissions because current funding sources are based on fossil fuel consumption. As the United States succeeds in reducing transportation emissions and thus fossil fuel use, there is a direct reduction in revenues raised through gasoline taxes that fund transportation infrastructure. New funding models are needed—not just to address inflation, but also to address the fact that the transportation system must shift away from consumption of gasoline. These twin challenges call for a new business model for the transportation sector—one that both drives emission reductions while raising revenues to invest in alternatives and in transportation infrastructure.

A 2015 Georgetown Climate Center report found that existing state and federal fuel and vehicle standards will result in a loss of thirty-five billion dollars in gasoline tax receipts for states in the northeast and mid-Atlantic region between 2015 and 2030.[216] As noted above, these standards are critical for meeting GHG reduction goals and improving fuel efficiency and local air quality, but they will

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213. *See* Robert S. Kirk & William J. Mallett, CONG. RES. SERV., FUNDING AND FINANCING HIGHWAYS AND PUBLIC TRANSPORTATION NO. R44674 (2016), https://fas.org/sgp/crs/misc/R44674.pdf [https://perma.cc/KVE4-A3FS].

214. *See* U.S. GOV'T ACCOUNTABILITY OFF., FUNDING THE NATION'S SURFACE TRANSPORTATION SYSTEM (2017), http://www.gao.gov/key_issues/funding_nations_surface_transportation_system/issue_summary [https://perma.cc/BF8G-5UYU].

215. The Fixing America's Surface Transportation Act added $53.3 billion from the surplus of the Federal Reserve Bank, $6.9 billion from reducing the dividends paid to Federal Reserve member banks, $6.2 billion from reserved oil sales, and $5.1 billion from customs fees and other sources. *See* Fixing America's Surface Transportation Act, Pub. L. No. 114-94, 129 Stat. 1312 (2015).

216. Combined state and federal gas tax revenue. *See* Pacyniak et al., *supra* note 2, at 18.

have an unsustainable effect on transportation funding if new ways to fund the transportation system are not enacted.[217]

In addition to traditional transportation infrastructure needs like the maintenance of roads and bridges, new investments to prepare for climate impacts are needed.[218] A low-emission, resilient transportation system will require expansion and maintenance of transit systems. Efforts such as those recommended in this Article, including ZEV incentives and infrastructure programs, more integrated transportation and climate planning processes, and efforts to plan for, and recover from, the unavoidable impacts of climate change will all require significant investment of public funds and yet will detract from available funding under current funding mechanisms.

In the absence of federal action on transportation funding, states are developing strategies that address the linked GHG and funding challenges. In 2015, California's comprehensive cap-and-trade program began to cover transportation fuels. In addition to the emission reductions achieved by the cap itself, proceeds from the program's auction of allowances are invested to support clean transportation projects and programs that meet other objectives under the state's Global Warming Solutions Act.[219] Another California law mandates that twenty-five percent of the funds generated must be used for the benefit of low-income communities and that ten percent must be spent within these communities themselves.[220]

The first two appropriations of auction proceeds in fiscal years 2013-14 and 2014-15 totaled over $900 million, and provided significant new funds for transportation and emissions-reduction programs at a time when state DOTs all over the country were struggling to find funds to maintain transportation systems and struggling to raise gas taxes.[221] California's 2015-16 plan includes

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217. *See supra* text accompanying notes 16-18.

218. *See supra* text accompanying notes 213-17.

219. *See* CAL. AIR RES. BD., CALIFORNIA CLIMATE INVESTMENTS, http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/auctionproceeds.htm [https://perma.cc/7YCT-P978] (last updated May 26, 2017); CAL. AIR RES. BD, ASSEMBLY BILL 32 OVERVIEW, https://www.arb.ca.gov/cc/ab32/ab32.htm [https://perma.cc/SB8U-PT3U] (last updated Aug. 5, 2014).

220. S.B. 535 (2011-2012 REG. LEG. SESS.); CAL. HEALTH & SAFETY CODE § 39713 (West 2016).

221. *See* CAL. AIR RES. BD., ANNUAL REPORT TO THE LEGISLATURE ON INVESTMENTS OF CAP-AND-TRADE AUCTION PROCEEDS 4 (2015), http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/2015ggrf-annual-report-to-legislature.pdf [https://perma.cc/F3GW-ZDUD].

$500 million for high-speed rail, $100 million for low-carbon transit operations, $265 million for a transit and intercity rail capital program, $400 million for affordable housing and sustainable communities programs, and $350 million for low-carbon transportation, which includes electric vehicles (trucks, buses, and light-duty vehicles) and supports the state's zero-emission vehicle goal.[222]

On the east coast, Connecticut, Delaware, the District of Columbia, New York, Rhode Island, and Vermont announced in 2015 that they will work together through TCI to develop market-based policies to achieve substantial reductions in GHGs and other pollutants from transportation.[223] The announcement accompanied the release of the Georgetown Climate Center and Cambridge Systematics report, finding the region could reduce transportation sector emissions twenty-nine to forty percent by 2030 from 2011 levels, and raise significant funds through money kept in the region to offset anticipated transportation funding losses.[224]

Other states are exploring the potential for mileage-based user fees ("MBUFs") to provide a new source of transportation funding that raises proceeds from all drivers regardless of fuel-efficiency, as well as from drivers of alternative-fuel vehicles who do not currently pay gasoline taxes.[225] These VMT-based strategies address funding challenges but do not necessarily help promote lower-emission transportation. In fact, they remove the price signal that the existing gasoline tax model provides by requiring drivers of more efficient

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222. *See* CAL. AIR RES. BD., CAP-AND-TRADE AUCTION PROCEEDS SECOND INVESTMENT PLAN: FISCAL YEARS 2016-17 THROUGH 2018-19, B-3 (Jan. 2016), https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/16-17-final-second-investment-planii.pdf [https://perma.cc/LN82-VBGX].

223. *See Five Northeast States and DC Announce They Will Work Together to Develop Potential Market-Based Policies to Cut Greenhouse Gas Emissions from Transportation*, GEO. CLIMATE CTR. (2015), http://www.georgetownclimate.org/five-northeast-states-and-dc-announce-they-will-work-together-to-develop-potential-market-based-poli [https://perma.cc/3ZX4-QMVD].

224. *See* Pacyniak et al., *supra* note 2.

225. Oregon has pioneered the exploration of mileage based user fees through its OreGO program. *See generally A New Way to Fund Roads for All Oregonians*, MYOREGO, http://www.myorego.org [https://perma.cc/XSK4-F9ND]. The 2015 Fixing America's Surface Transportation (FAST) Act (Pub. L. No. 114-94) created a grant program to fund demonstration projects. In 2016, FHWA announced $14.2 million in grants to eight projects, including projects in California, Delaware, Hawaii, Minnesota, Missouri, Oregon, and Washington. *See* Press Release, U.S. Dep't. of Transp., Federal Highway Administration Announces More than $14 Million in Grants to Test New Ways of Funding Highways (Aug. 30, 2016), https://www.fhwa.dot.gov/pressroom/fhwa1648.cfm [https://perma.cc/25B9-JT2R].

vehicles to pay the same amount per mile as drivers of less efficient vehicles. MBUFs could be designed to promote lower-emission driving by varying the fee according to the efficiency of the vehicle, but this raises similar challenges as the existing gasoline tax if funding becomes too dependent on less efficient vehicles.

While it is yet to be seen which strategies states will explore and ultimately adopt, market-based policies aimed at reducing GHGs and reinvesting funds have the potential to support transportation-related projects and other goals, alleviating the current tension between strategies to reduce emissions and those to fund the transportation system.

CONCLUSION

Transportation is a challenging sector, with multiple emissions sources, a multitude of public and private actors, and long-standing investments and land use patterns that require both time and resources to change. Personal choices and behavior are also critical factors, and political concerns about revenue raising also make it difficult to tackle these issues directly. Transportation is the most difficult sector from which to control GHG emissions.

On the other hand, there are significant opportunities for improvement in the sector's emissions profile. Many of these opportunities involve transitions to technologies and development approaches that are attractive in their own right, reduce conventional air pollution emissions, and enhance quality of life.

This Article identifies a number of approaches that could move the transportation sector in a more sustainable direction, both environmentally and economically. Transitions of this magnitude and nature are not easy and require political will, long-term vision, and commitment.

But one thing is clear: state, national, and even international goals to reduce reliance on fossil fuels and avoid the worst consequences of climate change cannot be achieved without significant transformation in policy, incentives, and investments across all levels of decision-making in this vital sector.