

THE CENTER FOR
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CLIMATE POLICY LAB
THE FLETCHER SCHOOL
TUFTS UNIVERSITY



The Future of
Transportation
*Symposium Proceedings
and Discussion*

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Abstract

This discussion paper summarizes the proceedings of the January 11, 2018 symposium, “The Future of Transportation,” hosted at The Fletcher School by the Climate Policy Lab and Acadia Center, a nonprofit organization focused on advancing the clean energy future. Considering the importance of finding sustainable models for transportation that reduce climate impacts, this was an opportunity for academics, advocates, company leaders, and state, regional, and municipal decisionmakers to examine the relevant issues, with a focus on New England. Topics included the prospects of regional market-based solutions, advanced transportation technologies, and innovations in transportation accessibility and design to reduce carbon pollution from the transportation sector. This paper aims to capture and offer to a broader audience the discussions that took place at the symposium, thereby fostering further discussion and action to address the challenges and opportunities that exist in meeting transportation, climate, and energy goals.

Acknowledgements

The authors would like to thank Acadia Center’s President, Daniel Sosland, Communications Director Krysia Wazny, Policy Analyst Jordan Stutt, and former Senior Advisor Jeremy McDiarmid for their initiative in organizing thought-provoking discussion panels with insightful speakers; Peter Shattuck for his initiating the concept of this conference; CIERP Associate Directors Penny Storey and Mieke van der Wansem and Program Coordinator Jillian DeMair for logistical and administrative support; Secretary Matthew Beaton for providing stimulating opening remarks; Professor Kelly Sims Gallagher of the Climate Policy Lab at CIERP for her thoughtful closing observations; symposium special partner Transportation for Massachusetts (T4MA); symposium convening partners Environmental League for Massachusetts (ELM) and Metropolitan Area Planning Council (MAPC); symposium sponsors Anbaric Development Partners and Wynn Boston Harbor; and all of the panelists and participants for joining us in January and offering their valuable insights.

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Introduction

On January 11, 2018, the Climate Policy Lab (CPL) of The Fletcher School at Tufts University and Acadia Center, together with its partners,¹ held a symposium on “The Future of Transportation” with a focus on New England. The symposium brought together companies, academics, advocates, and state, regional, and municipal decisionmakers to explore the rapidly shifting transportation landscape and to identify ways technology and policy are poised to shape transportation systems over the next 20 plus years. This transportation symposium sought to delineate the concrete opportunities and challenges surrounding regional market-based solutions, advances in technologies, and innovations in transportation accessibility, all under the broader rubric of reducing carbon pollution from the transportation sector.

By convening this symposium at The Fletcher School’s Climate Policy Lab, based in the Center for International Environment and Resource Policy (CIERP), the symposium sought to better understand why certain transportation, energy, and climate policies do or do not work. For the first time in 40 years, the U.S. transportation sector is responsible for more carbon dioxide emissions than any other sector, surpassing even the incumbent electric generation sector.² Moreover, this is a time for the development of disruptive transportation technologies. Companies are beginning to recognize the need for innovative approaches for revenue growth and the fact that mobility and equity issues are inexorably linked, while consumers are demanding new services. Because of these interconnections, these themes figured into the topics discussed in four panels:

- Regional Climate Policy for the Transportation Sector
- Electrification of Transportation
- Building a 21st-Century Transportation System: Where Do We Need to Be in 2030?
- Transportation of the Future: A Longer View

In this discussion paper, we provide an overview of the issues raised in the symposium’s panel discussions and opening and closing remarks. We use the panels as a starting point to broaden the discussion and develop next steps for policymakers, stakeholders, and innovators. Holding discussions such as these in a university setting provides an opportunity for participants to step back and reflect upon a more holistic view of transportation planning and theory, including exploring the many connections among transportation and energy, the environment, social equity concerns, and the introduction of new technologies.

1 The symposium was hosted in collaboration with special partner Transportation for Massachusetts (T4MA) and two convening partners: The Environmental League for Massachusetts (ELM) and the Metropolitan Area Planning Council (MAPC).

2 Tom Randall, “Transport Sector Now Largest Source of GHG Pollution in US,” *Transport Topics*, December 4, 2017, <http://www.ttnews.com/articles/transport-sector-now-largest-source-greenhouse-gas-pollution-us>

BACKGROUND TO THE LINK BETWEEN TRANSPORTATION AND CLEAN ENERGY

Transportation is the next frontier for the reduction of greenhouse gas (GHG) emissions nationally and in New England. After COP 23 (the 23rd Conference of the Parties) in Bonn in 2017, seven states—Massachusetts, Connecticut, Rhode Island, Delaware, New York, Maryland, Vermont, and Washington—indicated that they would explore regional climate policies for transportation. Already, five of these states—Massachusetts, Connecticut, Rhode Island, Vermont, and New York—have committed to putting nearly 1.4 million zero-emissions vehicles (ZEVs) on the road by 2025. To deepen and expand this commitment, states will need to offer incentives for electric vehicle purchases, create infrastructure for charging stations, and make a range of other transportation investments.

The benefits of a regional approach to transportation enhances more than the environment. An additional benefit is the creation of jobs. The Georgetown Climate Center conducted a study on behalf of the Transportation and Climate Initiative (TCI), a collaboration of 12 northeast and mid-Atlantic states, which found that an approach that creates revenues from reductions in vehicle GHG emissions would create 100,000 new jobs and put over \$14.4 billion into families’ pockets by 2030.³ These revenues would help to offset the decline from gas tax receipts due to improved fuel economy, while providing a needed revenue stream for investments to modernize the transportation system. The development of low-carbon transportation options will also need have a strong social equity component so that low-income communities, who are underserved by the current transportation system and experience greater health impacts from air pollution, do not bear a disproportionate burden of costs.

Independent of, but following this symposium, Governor Charlie Baker of Massachusetts created by executive order a high-powered “Commission on the Future of Transportation.” This Commission is charged with developing a range of possible scenarios between 2020 and 2040 and advising on how to account for demographic, technology, climate, and other anticipated changes. Many public interest groups have noted the key issues of infrastructure and financing as critical to any future transportation.⁴

3 Drew Veysey, Gabe Pacyniak, and James Bradbury, “Redesigning Transportation Emissions in the Northeast and Mid-Atlantic: Fuel System Considerations,” Georgetown Climate Center, November 13, 2017, http://www.georgetownclimate.org/files/report/GCC_TransportationFuelSystemConsiderations_Nov2017.pdf

4 Massachusetts Taxpayers Foundation, “Transportation in an Era of Transition: Rethinking Resources: The State needs a New Blueprint,” September 2017, <https://www.masstaxpayers.org/sites/masstaxpayers.org/files/Transportation%20in%20Transition.pdf>

KEY TAKEAWAYS FROM THIS SYMPOSIUM

- Solutions to the energy/environmental nexus in transportation are connected to other complex issues involving technology, infrastructure, social justice and economic development, public health, and smart growth.
- There is an urgency to address transportation issues given new technology developments, the growth of the urban core, the exigencies of pollution and climate change, and the desire for infrastructure improvement. But the looming questions involve how to finance, how to implement, and who decides priorities and outcomes.
- As in electricity generation, regional environmental coordination in transportation is very critical; thus, the RGGI (Regional Greenhouse Gas Initiative) model provides a conceptual starting point, although transportation solutions will include very different components, involving fuel mix, electrification, congestion pricing, and vehicles miles traveled.

Opening the Symposium

Matthew Beaton
 Secretary of Energy and Environmental Affairs,
 Commonwealth of Massachusetts

In his opening remarks, Matthew Beaton, Secretary of Energy and Environmental Affairs for the Commonwealth, linked energy, environment, and transportation, and spoke about the regional nature of solutions. Emissions do not respect state borders, and regional coalitions clearly have a more durable and extensive impact on long-term policy solutions. The interaction between the New England governors and the Eastern Canadian premiers serves as an example of a regional framework.

The Secretary's remarks reiterated the Commonwealth's commitment to GHG reductions. He even noted his expectation that Massachusetts would "far exceed" its relative proportional share of emissions reductions in the United States as set out in the Paris climate agreement. On the energy front, the driver of GHG reductions is the Massachusetts Global Warming Solutions Act (GWSA). To date the focus has been on power generation, but now there is growing recognition that there must be focus on transportation as well—in his words, "cracking the code"—in a holistic focus that includes land use and transit-oriented development. The Secretary noted specific solutions will include electrification and the creation of electric vehicle charging corridors.

Panel 1: Regional Climate Policy for the Transportation Sector

Panelists:

David Littell, Regulatory Assistance Project (RAP)
 Rachel Mulroy, Coalition for Social Justice
 Rafael Mares, Conservation Law Foundation and T4MA
 Jordan Stutt, Acadia Center, moderator

The framing concept for this panel is the Regional Greenhouse Gas Initiative (RGGI), the first mandatory market-based program in the United States to reduce greenhouse gas emissions. It is a nine-state program in which the participants set a regional cap for carbon emissions from the power sector, hold quarterly auctions for emissions allowances, and reinvest the auction proceeds into the clean energy economy and create jobs.⁵ Much has been written about the success and challenges of RGGI, but for our purposes, it represents a collaborative commitment to GHG reduction, a process to achieve it, and a means of measuring success. While the details of a RGGI for transportation has yet to be designed—and would entail many complexities—the notion of regional cooperation is clearly essential to improving the environment in the region.⁶

The challenge is whether and how to apply RGGI to transportation. The panelists in this session addressed the reasons for RGGI's success and durability as well as its shortcomings. This discussion represents a general attempt at finding similarities and differences in designing an approach for the transportation sector.

RGGI AS A POSSIBLE MODEL TO ADDRESS ENVIRONMENTAL ISSUES IN TRANSPORTATION

Components of RGGI's Success

RGGI's strength comes from its flexibility. Because it operates in nine states, it allows each state to adapt to the regional emissions requirements via the emissions reduction pathways available in that state. States also retain a great deal of flexibility in determining how to reinvest auction revenue to meet local goals. This inherent flexibility allows for states to balance their varying commercial interests under the same RGGI umbrella. Moreover, each state's environmental and energy leadership has been willing to meet frequently to work out long-term structural changes necessary to move forward with the program's goals. Another key component that makes RGGI flexible is the three-year compliance period, which enables the power generation sector to adapt within the confines of the RGGI approach.

A salient aspect of RGGI's success is that each participating state has experienced a positive impact on its economy through jobs and the money available for energy

⁵ See <https://www.rggi.org>

⁶ Veysey, Pacyniak, and Bradbury have put forth an approach in "Redesigning Transportation Emissions."

efficiency. These contributions have been vital to its success in that it eliminates the argument that the cost of undertaking emissions reductions is either too high to bear or going to economically burden states' industries.⁷

RGGI's popularity in these two regards highlights the need to ensure that a similar system for transportation would allow for optimal flexibility for participating states and relevant industries, creating a pathway to reduce emissions while spurring economic growth.

Importance of Leadership

The states that lead the way on a RGGI for transportation will benefit in two ways: (1) they will gain the intellectual and investment capital from being the policy innovator and (2) they will become the technological leader of implementing such a policy, which would become a long-term economic driver for the states. Leadership is the main challenge that stands in the way of creating such an initiative. It is legally and technologically feasible, but it requires governors and public policy leaders to connect with one another and make a commitment to begin working on these issues. Further, from a practical standpoint, early stage cooperation is necessary to lay out effective compliance measures.

Links to Other Environmental Programs

Although RGGI's functionality is often attributed to its market-based character, RGGI stands as a policy tool among a wider group of initiatives and is ensconced in a broader realm of supportive, complementary policies. For example, the adoption of renewable portfolio standards (RPS's), whereby states set renewable energy targets, helps strengthen the foundation for green energy in participating RGGI states. Under an RPS system, renewable energy credits (RECs) are generated. These RECs represent the environmental benefits of one megawatt-hour of generation and can be sold separately or together with the underlying electricity generation. The buying and selling of RECs provides a way to demonstrate claims of renewable energy generation. Another complementary set of programs includes investment in demand reduction. If a RGGI-like program for the transportation system is to be developed, an equivalent policy environment, with complementary and supportive policies, would help to deliver broad benefits at low costs. These are some of the challenges.

Reduction of GHG emissions in transportation will entail a four-legged stool of policies: fuel efficiency, carbon content of fuel, vehicle miles travelled (VMT), and efficiency of transportation. It is important to acknowledge that policymakers should not keep any one of these components in neutral. All four legs need to be addressed simultaneously.

Regarding fuel efficiency and carbon content of fuel, technology will play a substantial role. While policymakers are working on these issues, the technology is changing rapidly. Electric vehicles (EVs) would have a large impact on both fuel efficiency and

⁷ Jordan Stutt, Peter Shattuck, and Varun Kumar, "Outpacing the Nation: RGGI's Environmental and Economic Success," Acadia Center, September 2017, <https://acadiacenter.org/document/outpacing-the-nation-rggi>

carbon content of fuel. However, the emergence of autonomous vehicles (AVs) could be problematic as they could increase vehicle miles traveled if they are not integrated thoughtfully. If AVs emerge as combustion vehicles rather than EVs, this could be largely detrimental to the reduction of GHG emissions. VMT fee programs may be one way to get ahead of this issue, and although a VMT fee pilot program did not make it into law in Massachusetts, it should be revisited. The advantage of VMT fee programs is their flexibility. Prices can be higher for rush hours in locations where the city offers an alternative public transit option and prices can be low for drivers in areas without public transportation access or in more rural areas. VMT fees can also be modified to reflect a driver's income, to address social and equity issues in the transportation sector. VMT fees can also be modified for vehicle size to address the discrepancy between how much space different vehicles take up on the road.

The impact on transportation systems will depend on how the states choose to raise money, their choices for reinvesting any revenue raised through a RGGI for transportation, and their focus on GHG reductions. This money choice will include investments in roads, EV infrastructure, and bike and pedestrian pathways, all of which will have impact on the efficiency of transport in cities. To assure that a RGGI system for transportation will achieve its goals, there need to be solutions to all the tangential concerns that are a part of the larger picture.

SOCIAL JUSTICE CONSIDERATIONS AND OPPORTUNITIES TO IMPROVE RGGI

While RGGI has received praise for its economic and environmental performance, the RGGI states still have significant work to do to distribute the program's benefits more equitably. The RGGI states can do more to better address environmental justice—by reducing pollution in overburdened communities—and social justice—by investing a larger share of RGGI revenue in low-income communities and communities of color. In Massachusetts for example, reinvestment of RGGI revenue into energy efficiency programs has delivered regional climate and economic benefits, but the greatest benefits are experienced by the individual recipients of energy efficiency measures. These energy efficiency measures have disproportionately benefited wealthier communities, rather than low-income communities and communities of color. Before designing a RGGI-like program for the transportation sector, policymakers should more actively engage in a stakeholder analysis at the individual and community level to ensure more equitable distribution of benefits.

Massachusetts' listening sessions on the future of transportation have started to evoke environmental justice communities' transportation concerns. Often these concerns are not obvious to all levels of policymakers. Promotion of cycling and ride sharing serves as an example of how listening sessions can build critical awareness. In listening sessions on these topics, it emerged that neither are optimal forms of transportation from an environmental justice perspective. While bike-share options may be welcomed in white, suburban communities because they are "progressive and environmentally

friendly,” low-income, non-white communities are unlikely to utilize them because non-white cyclists are typically and cynically assumed to be poor—cycling is thus perceived as a stigma rather than in a positive vein. Moreover, in some communities, lower income individuals who want to become drivers for ride sharing companies, have trouble getting credit for obtaining auto loans, thus making it more difficult for them to receive the employment opportunities from these programs.

MOVING FORWARD: OPPORTUNITIES AND NEXT STEPS

- The opportunity exists to create a transportation system that is not only greener, but also more equitable.
- The sale of allowances under a RGGI-like program could generate revenue to be reinvested in projects to modernize the transportation system.
- A RGGI-like program for transportation and/or policies could contribute to the economic well-being of low-income communities through reinvestment in those communities.
- Electric bus fleets might be an example of where reinvestment could benefit low-income communities and provide the added value of job creation.
- Policymakers must ensure that any system developed does not disproportionately penalize individuals who have not contributed as much to GHG emissions, a complex task that has not yet been addressed in many of the domestic environmental and energy causation issues.

Panel 2: Electrification of Transportation

Panelists:

Gina Coplon-Newfield, Sierra Club
Jonathan Church, Worcester Regional Transit Authority
Watson Collins, Electric Power Research Institute (EPRI)
Julia Gold, Rhode Island Department of Transportation (RI DOT)
Stephen Lacy, Greentech Media, moderator

The theme of the second panel at the *Future of Transportation Symposium* was a broad overview of the electrification of transportation in the private and public sector. As the panel was represented by individuals with experience using electric vehicles in both sectors, the discussion built off their experiences and their perspectives on electrification in both the long and short term. The World Economic Forum has identified energy and mobility, linked to the global trend of urbanization, whereby an additional 2.5 billion people will live in cities by 2050, as a critical transformation known as the Fourth Industrial Revolution.⁸ As electric vehicles (EVs) become more affordable, they are expected to account for more than 25 percent of all miles driven globally in 2030, up from 4 percent today. This quantum leap will require huge changes in technology, i.e., battery storage, energy systems, new business models, and changes in public priorities.

The benefits of EVs will be limited if there is insufficient grid infrastructure to support this enhancement and made even worse if the vehicles are charged with electricity generated through fossil fuels rather than by renewable energy.

ON THE CUSTOMER'S DEALERSHIP EXPERIENCE

The customer experience is key to widening the use of electric vehicles. In 2017, electric vehicles made up merely 1.3 percent of total vehicles sales, although the number is increasing substantially each year. At present, there are only about 1 million electric vehicles on the road.

The findings of a study conducted by the Sierra Club titled “Rev Up Electric Vehicles,” examining the electric vehicle shopping experience, shed light on changes that need to be made on the dealership side to increase sale of electric vehicles.⁹ The study did a comparison of the experience at dealerships in California compared with the other 9 states that have signed on to the Zero Emission Vehicles (ZEV) mandate. The key findings of the study addressed availability of electric vehicles on the dealership lot

⁸ Jean-Pascal Tricoire and Francesco Starace, “These 3 Elements are Crucial to the Future of Electric Cars.” World Economic Forum, February 13, 2018, <https://www.weforum.org/agenda/2018/02/mobility-future-electric-cars-fourth-industrial-revolution>

⁹ For details on the Rev Up Electric Vehicles study, see Mary Lunetta and Gina Coplon-Newfield, “Rev Up Electric Vehicles: Multi-State Study of the Electric Vehicle Shopping Experience,” Sierra Club, 2016, https://content.sierraclub.org/creative-archive/sites/content.sierraclub.org/creative-archive/files/pdfs/1371%20Rev%20Up%20EVs%20Report_09_web.pdf

(it was 2.5 times more likely that there would be no electric vehicles available in a dealership in the other ZEV states as compared to California), display of the vehicles (42 percent of the time the electric vehicles were not prominently displayed or somewhat prominently displayed), information on credits and rebates available (about 33 percent of the time the salesperson did not discuss the federal and state tax credits and rebates available that would reduce the price of the vehicle), among other things. Therefore, several changes need to be made at the dealership level to increase electric vehicle sales.

EXPERIENCES TO DATE WITH ELECTRIFICATION

Rhode Island's Experience

Rhode Island's first experience with electrification of the transit system is an early indicator of the links between environmental benefits and enhanced mobility. Particularly on public transportation, some of the challenges that the Rhode Island Department of Transportation (RIDT) faced in the electrification of its fleet were to ensure that the necessary infrastructure was present to support electric buses, educating employees on best practices when using electric vehicles, and ensuring that all players are brought to the table for discussions. These issues have become more relevant as a part of the settlement that Rhode Island received from Volkswagen,¹⁰ since part of the money will go towards purchasing electric buses for Rhode Island. The plans are to purchase 13 buses. One of the critical reasons why RIDT cannot change to a completely electric fleet is that the National Grid would be unable to support all the buses. The costs involved in setting up fast charging stations is an additional cost added to electrification, which needs to be factored into any purchase of electric buses. Another issue in Rhode Island is that there is low ridership of public transportation and a negative stigma attached to it. Therefore, increasing awareness and changing this perception is another action item for RIDT.

The discussion pointed to another public policy conundrum: the situation of being the first mover in the marketplace. Public agencies are often apprehensive about being the first players in the market. Rather than being one of the first to electrify their fleet, RIDT would prefer to learn from the experiences of other agencies and thereafter introduce new policies. Moreover, as the technology is rapidly advancing, the biggest question with any policy change in the sector is whether to integrate with the current technology or introduce changes later in the future when the technology has been tested and is perhaps cheaper. Another prong of the technology question is how autonomous vehicles fit into the efforts to electrify transport. The issues faced in the electrification of public transit clearly differ from those faced in attracting consumers in the private sector.

10 The dispute between Volkswagen AG (VW) and the State of Rhode Island concerned VWs violation of Rhode Island state laws that prohibited the sale and leasing of diesel vehicles that contained emission control defect device software. Rhode Island was one of the 10 states that received a settlement from VW because of its violation of emissions standards. Rhode Island received more than \$4.1 million out of the total \$157,448,480 that VW paid to the 10 states. See details at <http://www.ri.gov/press/view/30001>.

Worcester's Experience: Case Study of an Electric Bus Fleet

The Worcester Regional Transit Authority (WRTA) is the first authority to deploy battery-electric buses in a northern climate, and therefore, its current experiences are particularly noteworthy for the future of electrified public transit. From 2013–2014, the WRTA launched 6 Proterra battery-electric buses.

One of the most critical issues for the WRTA is whether the pilot has been financially positive. These results are still being examined. One impact has been falling oil prices. Since the time when the buses were purchased, the diesel prices have fallen, and as a result, the expected savings in fuel costs have been reduced. On the other hand, in the period that the electric fleet has been in use, the WRTA has experienced a reduction in maintenance costs. As the useful life of both electric buses and diesel buses is 12 years, the reduction of maintenance costs over the useful life would require an intensive examination to understand the full impact. The biggest issue regards charging time and range. The charging technology that buses are using include overhead and plug-in chargers. Reducing outages in the charging stations and charging times are key issues for future improvement. The rider experience has not changed, and as a matter of fact, the electric buses have a positive marketing benefit and increased ridership. Looking to the future, public agencies thinking about full conversions to electric bus fleets are understandably cautious, and often prefer to wait and observe the experiences in other places.

INTEGRATION OF ELECTRICITY GRIDS AND THE EV MARKET

Electric Power Research Institute (EPRI), a technology and research arm of the utility industry, focuses on the need for interaction between the auto and utility industry. EPRI works to integrate these two sectors because innovation independently by both sectors would be futile if the industries do not work together. There is also recognition of the need to ensure exceptional customer experience to broaden the use of electric vehicles, which is the shared responsibility of the auto and utility industries.

ASSESSING THE CURRENT EV SITUATION

The session concluded with each of the panelists commenting on the positives and setbacks relating to electrification of transport. The opportunity of achieving carbon emission reduction goals with electric vehicles, in both private and public transport, is a major positive. The current and future condition of grid infrastructure is of great concern and could ultimately curtail the expansion of EVs. This panel also highlighted the importance of broadening access to EV technology for all customers, not just confining its availability to wealthier elites. Moreover, for structural and customer reasons, there is a suggestion that in the United States we are not moving fast enough towards what is an inevitable outcome in the movement away from fossil fuels in transportation. In the private sector, the need for fast charging stations and reduction of range anxiety, that is, the ability to provide responsive client service, will hasten deployment. In the public

sector, there are other structural issues, but deployment will increase as the cost of electric buses is reduced and they are proven to provide reliable service.

MOVING FORWARD: OPPORTUNITIES AND NEXT STEPS

Auto Industry

- The limited options of electric vehicles and their promotion in dealerships needs to be addressed by the auto industry.
- Transit agencies should consider shifting to electric bus fleets and thus create demand for their manufacture.
- Utilities should install charging stations at key locations, ensuring that renewable sources of power are used for the electrification of vehicles.
- Government should introduce policies to incentivize use of electric vehicles.

Utilities

- A key component of ensuring exceptional client service of electrification facilities and the grid is that utilities take initial steps. The first step would be to increase access to charging stations. The increase in charging stations, however, should not be done in a random manner, but only after careful examination of markets and primarily in regions where there is reduced fossil fuel generation.

Transport Authorities

- Electrification of public transit will be a key strategy to meeting carbon emission goals. Additionally, the negative stigma attached to the use of public transport needs to be overcome with marketing campaigns and awareness programs to increase ridership and attract a broad spectrum of riders.
- Government also plays a key role in this process. There is a need to publicize the current tax incentives for electric vehicles. Moreover, at present, there are incentives being provided for use of electric vehicles but increasing awareness of this is important. Further, the government could play a role in supporting smart electric grids which will enable the auto and utility industry to interact and ensure that developments and advancements in grid modernization occur in a mutually beneficial manner. Importantly, the government can also include other under-represented players in the discussion to ensure more inclusive policies.

Panel 3: Building a 21st-Century Transportation System: Where Do We Need to Be in 2030?

Panelists:

Rebecca Davis, Metropolitan Area Planning Council (MAPC)

Christopher Dempsey, Transportation for Massachusetts

Jesse Mermell, Alliance for Business Leadership

Jon Chesto, Boston Globe, moderator

The framing concept for this very interactive panel was the pressing need to revamp and rethink our transportation systems today for the future in the Boston area, but the issues discussed were often broader. As we move into the future, ideas and potential solutions are already in play but require deeper analysis to be shaped into viable opportunities. Clearly tied to these issues is the growth of urban society and the associated economic and social pressures.

ROAD PRICING (REVENUE AND EQUITY)

Coupled with the urgent need to cut greenhouse gas emissions (GHG), traffic congestion is limiting our economic growth and hampering our lifestyles. For example, the average driver in Boston loses \$150 per month due to traffic congestion via lost wages and fuel costs. There is a cost of being in traffic even when people are not aware of it. Our current methods of transportation and our historical approaches to ease gridlock (i.e., adding more highway lanes) have not been successful in reducing traffic, and in some cases even increase it. One method that can be used to address traffic congestion is applying supply and demand economics to road usage. The toll approach comes in several forms, the most notable being the idea of congestion pricing.

The current system of “one toll fits all” does not make sense. Traversing Boston’s Tobin Bridge, for example, is the same price at 7am as it is at 2am. One actionable solution to congestion would be to price the roads according to congestion (demand). In this type of approach, we need to recognize socioeconomic issues as well as perhaps provide subsidies like utility subsidies for lower income households. Lower income communities are disproportionately hurt by the current levels of congestion economically and health-wise, therefore these communities also stand to gain much more if the proper steps are taken to ease congestion and provide efficient, timely, and clean mass transit.

The reason why we have not implemented this type of solution is not technological—the technology to do real-time tolling has existed for quite some time—the impasse is political. A change to a more “use-based” road fee/toll system could and should happen over the next decade in this region with thoughtful implementation. A recent plan in

Washington, D.C. was not well thought out, and New York City, after a failed attempt under the Bloomberg Administration, is rethinking a new approach.

STATUS OF THE MBTA: A MASSACHUSETTS-SPECIFIC ISSUE

The MBTA, or “T” for short, is integral to transport in and around Boston. However, it is plagued by many of the same issues that other aging mass transit systems in the United States face, such as delayed and unreliable service, old cars and infrastructure, and a lack of coverage in lower income neighborhoods. The panel members sought to address the current challenges of updating the “T” while also moving to redesign it so that it is a user-friendly, timely, efficient, reliable, and cost-effective alternative to driving or using rideshare services.

Choice: Improving the Existing System or Building to the Future

A large and looming initial question is whether to take a sequential approach by making repairs and then expanding and improving the system or to take on repairs and improvements simultaneously. An “all at once” approach could start at the local town and state levels with the setting of priorities which provide responsive solutions. Everett, for example, is a city that has taken control of its transportation future and found ways to fund rapid transit buses, including a grant from the Barr Foundation.

Build with an Eye to the Future

The Longfellow Bridge connecting Boston to Cambridge, built in 1899, is an example of forward-thinking design. At the time, subways were not yet ubiquitous to cities, but the bridge designers left some extra lanes on the bridge because they had an inkling that a subway would someday need to use the bridge. Any approach aimed at MBTA improvements should be similar—an eye must be on the future and development must unfold accordingly. In terms of funding sources, Seattle recently passed a regional ballot initiative (a mechanism that does not yet exist in Massachusetts) that allows counties and cities to raise money to fund transit innovation and improvement. Seattle will spend over \$50 billion over the next 10 years to build new light rail.¹¹

Ties to Economic Development

Improvements to urban transit systems like the MBTA are crucial to business at all levels. For example, small business owners are concerned about how their workers and their customers are going to get to their businesses. Again, Seattle serves as an example: the mayor and business leaders (e.g., Amazon) supported a ballot initiative to allow Seattle to fund its own transportation improvements. Universal design of any mass transit system is also vital, so that everyone, regardless of socioeconomic status or restricted mobility, wants to and can use the system. Rapid bus transit and improving the bus stations themselves, to make them visually appealing via artwork, can improve attitudes toward the system.

11 Heidi Groover, “Sound Transit Unveils \$50 Billion Light Rail Package Including Lines to Ballard and West Seattle,” *The Stranger*, March 24, 2016, <https://www.thestranger.com/slog/2016/03/24/23862901/sound-transit-unveils-draft-plan-for-this-falls-light-rail-ballot-measure>

PUBLIC-PRIVATE PARTNERSHIPS (PPPS) FOR TRANSPORTATION

Public-private partnerships (PPPs) have become the buzz word for fixing broken public systems by bringing private sector resources and expertise to public assets. These partnerships do not mean privatization of traditionally public functions, but rather ways to be efficient and effective. Large infrastructure projects involving transportation are especially attractive and can offer a steady return.

However, there are pros and cons to this approach concerning whether PPPs will be a solution for transit over time. On the negative side, where investments are not well thought out, the results are often not improvements. One example is the development of toll roads, where research by the Congressional Research Service shows in various toll road case studies that overly optimistic forecasts of utilization and revenue have resulted in PPP financial failures.¹² There are other circumstances, as well, when private investment goals and public needs do not converge. On the positive side there is “value-capture,” where private investments in public infrastructure like transportation can drive up the value of real estate investments, benefitting both public and private interests. In the end, dependence on PPPs is not a silver bullet in all circumstances.

Transportation and Real Estate Linkages

The concept of value-capturing—the benefits of value added from transit improvements to real estate revenue¹³—has proven to be very helpful, for example in the building of a new station at Assembly Square in Somerville, Massachusetts. This notion of smart growth and the link to real estate development serves as a positive connection.

Private Investment: Not a Panacea

Private investment will not be the silver bullet in tackling our transportation issues. Private investment remains a financing, not a funding tool simply because the investor’s ulterior goal is to create a stable revenue stream. Other resources will need to provide the main funding for innovation and investments in transport.

Notion of Public Good

Transport and access to transport continues to be a public good, just like clean energy. Massachusetts has had a long-term policy commitment to clean energy procurement and support of energy innovation noting opportunities to reduce GHG emissions while at the same time supporting Massachusetts businesses. There is no reason why Massachusetts should not be the leading state in transport innovation and business development and take the same approach to transport as it is taking in energy.

12 Robert S. Kirk, “Tolling U.S. Highways,” Congressional Research Service, August 26, 2016, <https://fas.org/sgp/crs/misc/R43575.pdf>

13 American Public Transportation Association, “Value Capture for Public Transportation Projects,” August 2015, <https://www.apta.com/resources/reportsandpublications/Documents/APTA-Value-Capture-2015.pdf>

INTRODUCTION OF AUTONOMOUS VEHICLES (AVS)

Autonomous vehicles (AVs) have already arrived in Boston. Though Boston has a pilot program in the Innovation District, the City of Boston is taking some very cautious steps in potentially introducing AVs to Boston proper.¹⁴ On the one hand, electric AVs could increase efficiency of transport and thus decrease congestion. On the other hand, there is the dystopian possibility that because of the increased comfort in transport due to AVs, people might be tempted to use these cars more frequently, counterbalancing any gain in technological efficiency. Crucial questions were addressed during the panel, including how to plan around AVs, how to avoid a dystopian future, how the roll-out of AVs will be accomplished and with what investment, and finally, how to incentivize users to switch to electric AVs from combustion engine vehicles.

Parking

Before even talking about AVs, we should address the issue of parking. In theory, more AVs should negate our need for parking; in practice, this will only work if we opt for shared fleets and dedicate time to educating people and businesses about what constitutes a reasonable amount of parking.

It also means planning our policies smartly to avoid the scenario of AVs continuously and perhaps aimlessly circling in our cities, leading to the unintended consequence of more traffic. With the development of better AV technology and decreasing costs funded by billionaire investors, there is the risk that these developments will cause more tolerance for traffic.

The Role of Cities and Towns

Cities and towns need to retain their local autonomy over AVs to prevent industry and federal government from dictating policies at the local level that are detrimental to local communities and municipalities. Thus, the transport community must be proactive and create structures and frameworks in which we feel comfortable regulating AV companies. This also includes setting up a sound AV testing regime through Massachusetts Department of Transportation, something which is already under discussion.

Need to Focus on Social Justice

As with all new technologies, there needs to be analysis of AV's impact on a range of technologies, in terms of access, costs, and benefits. These changes need to be discussed early in the planning and implementation stages among the communities affected by the introduction of AVs.

Active Transportation

The panel addressed active transportation as an important consideration on the human side of transportation. While the focus tends to be on either large or technological

¹⁴ City of Boston, "Autonomous Vehicles: Boston's Approach," updated April 20, 2018, <https://www.boston.gov/departments/new-urban-mechanics/autonomous-vehicles-bostons-approach#self-driving-vehicle-testing>

systems and innovation, active transportation (e.g., walking, biking) is crucially important as a connection between private and public transportation systems.

Related Lifestyle Concerns

While we think of cars, in the future we also need to develop the concept of the "complete street," where walking and biking play a role, particularly in the urban core. Additional innovations in transportation, such as a bike-share system, can be regional rather than municipality-focused if we are to bridge communities.

The Role of Progressive Business Thinking

Larger companies in the region are very interested in pushing the agenda of active transportation, particularly for their employees. These businesses see a link between health, sustainability, benefits, and work environment. Suburban employers are building walkable and bikeable campuses. Often employee or "bottom up" driven, employees are great advocates when it comes to promoting active transportation.

Building upon the Good that Exists

In Boston, the Emerald Necklace serves as a great example of a biking and walking network. In general, New England towns already have a good core of active transportation networks. Existing networks should be expanded and improved to become even more accessible.

MOVING FORWARD: OPPORTUNITIES AND NEXT STEPS

Building a robust transportation system that will accommodate future technology is one of the greatest challenges for all sectors of government—federal, state, and municipal. There are issues of costs and revenues as well as implementation. Considering environmental issues adds more complexity. We are in the process of developing many policy approaches, which will also add disruption and change. Each of the topics addressed in this panel entails its own set of challenges and opportunities.

Road Pricing

- Identify which roads/bridges could support rapid bus transit without further increasing personal vehicle congestion and high capital costs.
- Implement a pilot program of electric rapid transit bus lines from select low-income neighborhoods to downtown Boston (high payoff, low risk).
- Take a lead in nationwide congestion pricing, electric rapid bus transit, and possibly wireless charging. Institute a pilot program on select roads to experiment with VMT (high payoff, high risk).
- Undertake additional research and analysis about transportation issues to lower the risk of the VMT recommendation: examine economic, technological, and policy solutions that could be implemented to make road tolling socially and environmentally equitable.

MBTA

- Devise a coherent, two-pronged plan that supports concurrent repairs and modernization of the existing MBTA system without reducing service.
- Consider ballot initiatives to allow towns in Massachusetts to fund their own transportation improvements with an understanding that they will have a greater say in how and where their mass transit money is spent.
- Make the “T” more user friendly and more reliable via increased technology linkage as well as address infrastructure improvements to ensure less service interruptions.
- Review experiences in other states/nations to determine what impacts they could have in Massachusetts.

Public Private Partnerships

- Leverage the real estate owned by the MBTA, either to fund innovation or to support co-beneficial infrastructure projects.
- Develop realistic assessments of the role and opportunities for PPPs: PPPs have proven to be prone to optimistic and unrealistic assumptions, resulting in financial failures. Reasonable and pragmatic forecasting in PPPs remains a challenge.

Undertake research: identify alternatives to basic PPPs; determine what concepts of value-capturing apply to Boston and Massachusetts; identify alternative funding sources in addition to private investors; specify the concrete policies and innovations would it take to make Massachusetts a leader in transport innovation, while accounting for economic, social, and environmental sustainability.

AVs

- Monitor the level of private investment in AV technology and leverage it positively.
- Retain autonomy for cities and towns regarding AVs and prevent detrimental policies dictated by industry players and federal institutions.
- Ensure early awareness and transparency of AV policy changes to allow all stakeholders to voice opinions.
- Educate the public about what AVs are supposed to achieve, namely an increase in transport efficiency resulting in less traffic.
- From an environmental, health, and efficiency point of view, encourage the deployment of electric and shared AVs.

- Undertake research: Investigate AV testing systems in place in comparable cities that can be a learning experience for Boston; determine the types of behavioral changes the introduction of AVs will induce; determine the costs of AVs; assess the differences between privately-owned AVs and public transport AVs; consider whether smaller municipalities can implement a local AV regime and determine funding sources to ensure their autonomy.

Active Transportation

- Recognize that large employers and industry leaders often makes conscious decisions about where to locate in part based on active transportation access. This creates incentives for municipalities to develop more active transportation.
- Emphasize that increased active transportation comes with various co-benefits, including the reduction of local road congestion but also health- and environment-related improvements.
- Identify successful early case studies that can catalyze more active transportation projects.
- Recognize that active transportation is a social improvement that will initially require investment of public money, and where the benefits are not as tangible, which tends to place it on a lower priority scale.
- Identify the impact of New England weather on modes of active transportation.
- Understand the social stigmas surrounding active transportation among various socioeconomic groups.
- Determine how to include proponents of active transportation into decision-making processes at earlier stages.

Panel 4: Transportation of the Future: A Longer View

Panelists:

Kristopher Carter, City of Boston
 Michael Manville, University of California, Los Angeles
 Mary Skelton Roberts, Barr Foundation
 Michael Widmer, formerly of Massachusetts Taxpayer Foundation
 Cameron Peterson, MAPC, co-moderator
 Elizabeth Weyant, MAPC, co-moderator

The framing of this panel was a less constrained look at the future. The previous panel had discussed issues in more specific context, while this panel had a broader purview: investigation of future trends that could shape transportation in the 21st century. While there was some overlap, other issues raised included vehicle miles traveled (VMT) tax, an MBTA tailored rider experience in a broader context, congestion pricing, and additional commentary on autonomous vehicle adoption.

There was consensus that New England must greatly reduce transportation emissions and alleviate congestion by 2030. Policy recommendations, however, were varied. While some panelists suggested correcting market failures through personal vehicle use taxes, others recommended improvements to public transportation or early adoption of autonomous vehicles. The “Transportation of the Future” panel—the final panel of the day—presented compelling cases for a VMT tax, congestion pricing, and major investment in improved user experience design for MBTA public transportation. The panel also presented an update on Boston’s autonomous vehicle testing program in the Seaport district, highlighting promising opportunities but also upcoming challenges in autonomous vehicle integration.

VEHICLE MILES TRAVELED (VMT) TAX

Revenues from the gasoline tax are drying up. While Corporate Average Fuel Economy (CAFE) standards have had the national effect of reducing per-person consumption, the federal component of the gas tax has stayed flat at 18.4 cents/gallon since 1993, leading in part to a projected \$75 billion shortfall in the federal Highway Trust Fund by 2020.¹⁵ Massachusetts has seen marginal growth in revenues after raising its gas tax

15 Ashley Langer, Vikram Maheshri, and Clifford Winston, “Ditching the Gas Tax: Switching to a Vehicle Miles Traveled Tax to Save the Highway Trust Fund,” *Brookings*, June 28, 2017, <https://www.brookings.edu/research/ditching-the-gas-tax-switching-to-a-vehicle-miles-traveled-tax-to-save-the-highway-trust-fund>

from 21 to 24 cents in 2013, but the state is still struggling to manage aging roads and public transportation infrastructure as state tax revenues remain fairly stagnant.^{16 17}

The vehicle miles traveled tax provides one opportunity to climb out of the transportation budget deficit. Also called open-road tolling, the VMT tax is implemented through a series of automated tolling gates on high-use roads. The effect is to tax people in accordance with their road use, which can both raise revenues and provide an incentive for drivers to carpool or use public transportation. Because tolling is conducted with transponders in each vehicle, the tax can be calibrated to each vehicle’s impact on both the roads and the environment. Heavy, high-emission vehicles like cargo trucks would pay the lion’s share of the total tax, while lighter electric vehicles could enjoy greatly reduced rates. Revenues raised through the VMT tax could also be used for infrastructure improvements and to enhance public transportation options.

While many states have demonstrated interest in a VMT tax, none have implemented one thus far. Oregon is furthest along in the implementation process and is currently running a volunteer-only pilot program to test whether revenues would be greater than gasoline tax revenues in practice.¹⁸ Other states interested in applying a VMT tax include California, which is also running a pilot program, and Washington. Connecticut, Delaware, and Pennsylvania have applied for federal funding assistance to design and implement their own pilot programs as well.

According to a study published in the *Journal of Public Economics*, a VMT tax designed to raise \$55 billion per year would increase social welfare by 20 percent over a comparable gas tax.¹⁹ This includes increases in government revenues, as well as decreases in vehicle accidents, congestion, and local pollution.²⁰

16 Shira Schoenberg, “How Much Does Massachusetts Get from the State Gas Tax?” *Mass Live*, July 30, 2016, http://www.masslive.com/politics/index.ssf/2016/07/massachusetts_motor_fuels_tax.html

17 Joshua Miller, “Tax Revenue Rises, but State Still Faces Budget Deficit,” *Boston Globe*, June 5, 2017, <https://www.bostonglobe.com/metro/2017/06/05/tax-revenue-ticks-may-state-faces-budget-hole/wYz1vWYdEF1vpPCFRXllbJ/story.html>

18 Stephen Miller, “Oregon’s Pay-Per-Mile Driving Fees: Ready for Prime Time, But Waiting for Approval,” *Streets Blog USA*, June 26, 2017, <https://usa.streetsblog.org/2017/06/26/oregons-pay-per-mile-driving-fees-ready-for-prime-time-but-waiting-for-approval>

19 Ashley Langer, Vikram Maheshri, and Clifford Winston, “From Gallons to Miles: A Disaggregate Analysis of Automobile Travel and Externality Taxes,” *Journal of Public Economics*, Vol. 152, August 2017, <https://doi.org/10.1016/j.jpubeco.2017.05.003>

20 Langer, Maheshri, and Winston, “Ditching the gas tax.”

MBTA RIDER EXPERIENCE

Winning public support for public transportation initiatives is a question of branding and consumer responsiveness. Public transportation can be considered analogous to a music streaming platform that captures only a small percentage of all possible users while doing minimal work to attract more. In short, public transportation is built for a larger city with the expectation that a small percentage of the occupants will find public transportation to be the most convenient option. Consider, however, a music streaming service that designs an individualized consumer experience, sourcing geographic, demographic, psychographic, and behavioral information about each of its consumers. It is more successful because it uses that information to constantly adjust and tailor the product to those consumers. Public transportation planners must do the same.

Critics of public transportation, most notably Elon Musk, have often observed that public transportation is inconvenient and uncomfortable compared to personal vehicles.²¹ But in cities like Seattle, planners have found that improving reliability and timeliness of public transportation over driving can have a positive effect on ridership.²² Cities like Chicago and New York have also attempted to improve the ridership experience through public art displays at stations and aboard trains and buses, and New York has worked to provide Wi-Fi in public transportation hubs.²³ The challenge in implementing any solution to improve ridership experience seems to be quantifying the effect on riders. While User Experience Magazine has developed a fascinating study of user experience challenges in public transportation, there seems to be little else in the way of published research on the topic.²⁴

Transportation leaders need to develop much more thorough profiles of their riders to improve overall customer experience. This may sound simple, but it is likely to be far more difficult in implementation, especially since riders are unlikely to offer up sensitive personal information to public transportation systems in the same way that they often do (without realizing it) to web-based companies.

One suggestion is a dynamic pricing model, which, when paired with a more pleasant transit experience, could be a way to fund that experience and incentivize ridership. Dynamic pricing, though, would make budgeting for transportation much more difficult, seeing as fees would be variable with demand. Washington DC's Metro system has implemented a peak and off-peak pricing system, but the effect has been to confuse riders and make public transportation less cost-effective during rush hour.

21 Aarian Marshall, "Elon Musk Reveals His Awkward Dislike of Public Transit," *Wired*, December 14, 2017, <https://www.wired.com/story/elon-musk-awkward-dislike-mass-transit>

22 Andrew Small, "How Seattle Bucked a National Trend and Got More People to Ride the Bus," *CityLab*, October 16, 2017, <https://www.citylab.com/transportation/2017/10/how-seattle-bucked-a-national-trend-and-got-more-people-to-ride-the-bus/542958>

23 Brian Zanghi, "How Smart Cities Can Increase Public Transit Ridership (Industry Perspective)," *FutureStructure*, May 17, 2017, <http://www.govtech.com/fs/perspectives/how-smart-cities-can-increase-public-transit-ridership-industry-perspective.html>

24 Suzanne Boyd and Ian Wyosnick, "Illuminating the Journey: Improving Public Transit Rider Experience," *User Experience Magazine*, 16(3), July 2016, <http://uxpamagazine.org/illuminating-the-journey>

Metro's ridership woes may serve as a warning in that regard.²⁵ A second suggestion is smart expansion, which is prioritizing the way that the MBTA chooses to take on new projects. This may be the most effective path forward, but will likely require a concerted information sharing effort between planners, public transportation managers, riders, and local governments.

TRANSPORTATION CONGESTION PRICING

Transportation congestion is the most salient transportation issue for voters. While many demand wider roads—as well as more of them—congestion cannot be addressed by expansion. In fact, it can be argued that expansion efforts worsen congestion. This is because travelers choose the path of greatest convenience for their morning commute. When new lanes are added to a highway, it has the temporary effect of lessening congestion, making it easier to drive into the city. As drivers find this out, they begin to substitute away from their previous transportation plan and use the newly expanded road. Road use continues to grow until traffic congestion reaches the same level it had previously, but now there are even more cars attempting to enter the city. This phenomenon has been widely observed by researchers and documented in news publications like *Wired* magazine.²⁶

Congestion introduces several negative externalities on the local environment and health for commuters and families living near congested areas. In fact, a 2010 study showed significant health effects because of congestion, calculated at \$31 billion in the 83 cities studied.²⁷ The study also found an estimated \$60 billion lost in wasted time and fuel. Congestion slows down commutes, increases emissions, and puts more stress on transportation infrastructure. The real goal for transportation planners should not be to just raise revenues for bigger roads, but to also decrease congestion.

The congestion pricing model accomplishes this through dynamic pricing for road use in congested areas. This often takes the form of automatic tolling as vehicles enter city centers and other high-traffic roadways. The model has already been implemented in cities in the UK and several others to great effect.²⁸ Notably, the Swedish town of Gothenburg has seen a 12 percent decrease in traffic underscored by increased public transportation ridership.²⁹ The primary complaint against the model is that it benefits

25 Jason Russell, "Let's Face It: Washington, DC's Metro is the Worst in the World," *Washington Examiner*, June 19, 2017, <http://www.washingtonexaminer.com/lets-face-it-washington-dcs-metro-is-the-worst-in-the-world/article/2626197>

26 Adam Mann, "What's Up with That: Building Bigger Roads Actually Makes Traffic Worse," *Wired*, June 17, 2014, <https://www.wired.com/2014/06/wuwt-traffic-induced-demand>

27 Jonathan I. Levy, Jonathan J. Buonocore, and Katherine von Stackelberg, "Evaluation of the Public Health Impacts of Traffic Congestion: A Health Risk Assessment," *Environ Health* 9(65), October 2010, <https://dx.doi.org/10.1186%2F1476-069X-9-65>

28 Alex Davies, "London's Congestion Pricing Plan is Saving Lives," *Wired*, March 10, 2015, <https://www.wired.com/2015/03/londons-congestion-pricing-plan-saving-lives>

29 Eric Jaffe, "Sweden's Lesser-Known Congestion Pricing Program Is Also a Big Success," *CityLab*, April 20, 2015, <https://www.citylab.com/transportation/2015/04/swedens-other-congestion-pricing-program-is-also-a-big-success/390933>

the wealthy, who can afford the pricing. However, data shows that wealthy riders already make up the bulk of car commuters, meaning that these drivers are receiving a discounted rate on their commute because of the lack of congestion pricing models in effect.³⁰

Congestion pricing has been proposed in New York City and San Francisco, but like the VMT tax, has not yet been implemented in the United States.

FUTURE OF AUTONOMOUS VEHICLES IN BOSTON

Autonomous vehicles are not quite here, but all signs point to rapid adoption in the next 30 years. AVs can contribute enormously to Boston's transportation goals of 1) access; 2) safety; and 3) reliability. To best understand and prepare for autonomous vehicle adoption, Boston and the state of Massachusetts have signed into effect executive orders for AV testing and adoption plans. Rather than allow companies or the federal government to dictate what AV adoption will look like, Boston has taken the lead by designing its own transportation goals and asking interested partners to sign Memorandums of Understanding (MOUs) prior to beginning operations in the city. NuTonomy, Optimum Ride, and Aptiv have all begun running trial programs in the Seaport area, and the city makes their reports public. Expected changes from AVs include ride sharing (shared fleets) and a reduced need for parking.

There are challenges associated with autonomous vehicle adoption, especially when it comes to emissions. Most studies find that autonomous vehicles are likely to increase VMT, even in shared fleets, because riders will prefer them to public transportation. Additionally, autonomous vehicles that do not park as often will drive more than vehicles today.³¹

30 Michael Manville, "Is Congestion Pricing Fair to the Poor?" *Medium*, August 14, 2017, <https://medium.com/100-hours/is-congestion-pricing-fair-to-the-poor-62e281924ca3>

31 Laura Bliss, "Even Shared Autonomous Vehicles Could Spell Traffic Disaster," *CityLab*, May 10, 2017, <https://www.citylab.com/transportation/2017/05/even-shared-autonomous-vehicles-could-spell-traffic-disaster/525951>

MOVING FORWARD: OPPORTUNITIES AND NEXT STEPS

This panel spoke to the future. There are many unknowns, and while there are opportunities and challenges, the next step is some basic research on a range of issues.

Vehicle Miles Traveled

- Determine the projected revenues from a VMT tax in Massachusetts in comparison to the current revenues from the gas tax in Massachusetts and decide whether to fund both infrastructure and public transportation expansion projects.
- Suggest ways to implement this type of policy outside of highway settings, for example, in the urban core, and determine the cost.

Future MBTA Experience

- Given the current complaints about MBTA service, improve how the MBTA conducts and responds to user information surveys.
- Assess whether customers are willing to support and adopt a dynamic pricing model since that will mean behavioral change.

Congestion Pricing

- Deepen and analyze the successes and failures of current and new congestion pricing models.
- Model the impact of congestion pricing on the lower, middle, and upper income customer and account for distance from urban core for commuters.

AVs in Boston: Future Implementation

- Determine the impact that AVs will have on parking revenues and the changes to traffic signals, as well as map out an AV city of the future.
- Consider how the AV industry will be organized in terms of both private and public fleets, given disruptions that we have already seen from ride-sharing services Uber and Lyft. How soon do we expect shared fleets? Privately owned AVs?
- Plan for the public safety issues related to AVs.

Concluding Session: Final Thoughts

Kelly Sims Gallagher

*Professor of Energy and Environmental Policy, Director of the Climate Policy Lab,
Co-Director of the Center for International Environment and Resource Policy,
The Fletcher School, Tufts University*

Given the expansive reach of this symposium, Professor Kelly Sims Gallagher provided a framework for moving forward because transportation policy is the new frontier for climate change mitigation efforts given the growing demand for vehicles. No matter what actual outcomes are implemented, she spoke to the importance of objective policy analysis, discerning which policies work, which do not, and why.

For policymakers, there are challenges in incentivizing options like EVs, enhanced public transportation, and shared fleets. In moving into these opportunities, there is a need to be cautious and not create outcomes that contravene policy goals. For example, we need to ensure that electrification of a fleet does not create more CO₂ through coal generation or more cars on the road, leading to greater congestion.

There are ways to use policy measures to incentivize EV purchases and ensure that opportunities to purchase EVs are available to lower-income buyers. In other words, calibrated incentives are important in the link between transportation, energy and the environment, as policymakers seek to achieve the critical outcome of GHG reduction.

Innovation is critical to the future and that is especially clear in the transportation realm, where disruption is currently occurring. The White House's proposed 57 percent cut to the nation's energy R&D budget will have a ripple effect throughout the country and threaten the United States' leadership role in transportation and technology development. New England has strengths in both areas and has an opportunity to make the appropriate and meaningful investment in both policy design and technological innovation to achieve energy and environmental objectives.

Bibliography

American Public Transportation Association. "Value Capture for Public Transportation Projects." August 2015. <https://www.apta.com/resources/reportsandpublications/Documents/APTA-Value-Capture-2015.pdf>

Bliss, Laura. "Even Shared Autonomous Vehicles Could Spell Traffic Disaster." *CityLab*. May 10, 2017. <https://www.citylab.com/transportation/2017/05/even-shared-autonomous-vehicles-could-spell-traffic-disaster/525951>

Boyd, Suzanne, and Ian Wyosnick. "Illuminating the Journey: Improving Public Transit Rider Experience." *User Experience Magazine*, 16(3). July 2016. <http://uxpamagazine.org/illuminating-the-journey>

City of Boston. "Autonomous Vehicles: Boston's Approach." Updated April 20, 2018. <https://www.boston.gov/departments/new-urban-mechanics/autonomous-vehicles-bostons-approach#self-driving-vehicle-testing>

Davies, Alex. "London's Congestion Pricing Plan is Saving Lives." *Wired*. March 10, 2015. <https://www.wired.com/2015/03/londons-congestion-pricing-plan-saving-lives>

Groover, Heidi. "Sound Transit Unveils \$50 Billion Light Rail Package Including Lines to Ballard and West Seattle." *The Stranger*. March 24, 2016. <https://www.thestranger.com/slog/2016/03/24/23862901/sound-transit-unveils-draft-plan-for-this-falls-light-rail-ballot-measure>

Jaffe, Eric. "Sweden's Lesser-Known Congestion Pricing Program Is Also a Big Success." *CityLab*. April 20, 2015. <https://www.citylab.com/transportation/2015/04/swedens-other-congestion-pricing-program-is-also-a-big-success/390933>

Kirk, Robert S. "Tolling U.S. Highways." Congressional Research Service. August 26, 2016. <https://fas.org/sgp/crs/misc/R43575.pdf>

Langer, Ashley, Vikram Maheshri, and Clifford Winston. "Ditching the Gas Tax: Switching to a Vehicle Miles Traveled Tax to Save the Highway Trust Fund." *Brookings*. June 28, 2017. <https://www.brookings.edu/research/ditching-the-gas-tax-switching-to-a-vehicle-miles-traveled-tax-to-save-the-highway-trust-fund>

Langer, Ashley, Vikram Maheshri, and Clifford Winston. "From Gallons to Miles: A Disaggregate Analysis of Automobile Travel and Externality Taxes." *Journal of Public Economics*, Vol. 152. August 2017. <https://doi.org/10.1016/j.jpubeco.2017.05.003>

Levy, Jonathan I., Jonathan J. Buonocore, and Katherine von Stackelberg. "Evaluation of the Public Health Impacts of Traffic Congestion: A Health Risk Assessment." *Environ Health* 9(65). October 2010. <https://dx.doi.org/10.1186%2F1476-069X-9-65>

Lunetta, Mary, and Gina Coplon-Newfield. "Rev Up Electric Vehicles: Multi-State Study of the Electric Vehicle Shopping Experience." Sierra Club. 2016. https://content.sierraclub.org/creative-archive/sites/content.sierraclub.org/creative-archive/files/pdfs/1371%20Rev%20Up%20EVs%20Report_09_web.pdf

Mann, Adam. "What's Up with That: Building Bigger Roads Actually Makes Traffic Worse." *Wired*. June 17, 2014. <https://www.wired.com/2014/06/wuwt-traffic-induced-demand>

Manville, Michael. "Is Congestion Pricing Fair to the Poor?" *Medium*. August 14, 2017. <https://medium.com/100-hours/is-congestion-pricing-fair-to-the-poor-62e281924ca3>

Marshall, Aarian. "Elon Musk Reveals His Awkward Dislike of Public Transit." *Wired*. December 14, 2017. <https://www.wired.com/story/elon-musk-awkward-dislike-mass-transit>

Massachusetts Taxpayers Foundation. "Transportation in an Era of Transition: Rethinking Resources: The State needs a New Blueprint," September 2017. <https://www.masstaxpayers.org/sites/masstaxpayers.org/files/Transportation%20in%20Transition.pdf>

Miller, Joshua. "Tax Revenue Rises, but State Still Faces Budget Deficit." *Boston Globe*. June 5, 2017. <https://www.bostonglobe.com/metro/2017/06/05/tax-revenue-ticks-may-state-faces-budget-hole/wYz1vWYdEFIvpPCFRXllbJ/story.html>

Miller, Stephen. "Oregon's Pay-Per-Mile Driving Fees: Ready for Prime Time, But Waiting for Approval." *Streets Blog USA*. June 26, 2017. <https://usa.streetsblog.org/2017/06/26/oregons-pay-per-mile-driving-fees-ready-for-prime-time-but-waiting-for-approval>

Randall, Tom. "Transport Sector Now Largest Source of GHG Pollution in US." *Transport Topics*. December 4, 2017. <http://www.ttnews.com/articles/transport-sector-now-largest-source-greenhouse-gas-pollution-us>

Russell, Jason. "Let's Face It: Washington, DC's Metro is the Worst in the World." *Washington Examiner*. June 19, 2017. <http://www.washingtonexaminer.com/lets-face-it-washington-dcs-metro-is-the-worst-in-the-world/article/2626197>

Schoenberg, Shira. "How Much Does Massachusetts Get from the State Gas Tax?" *Mass Live*. July 30, 2016. http://www.masslive.com/politics/index.ssf/2016/07/massachusetts_motor_fuels_tax.html

Small, Andrew. "How Seattle Bucked a National Trend and Got More People to Ride the Bus." *CityLab*. October 16, 2017. <https://www.citylab.com/transportation/2017/10/how-seattle-bucked-a-national-trend-and-got-more-people-to-ride-the-bus/542958>

Stutt, Jordan, Peter Shattuck, and Varun Kumar. "Outpacing the Nation: RGGI's Environmental and Economic Success." Acadia Center. September 2017. <https://acadiacenter.org/document/outpacing-the-nation-rggi>

Tricoire, Jean-Pascal, and Francesco Starace. "These 3 Elements are Crucial to the Future of Electric Cars." World Economic Forum. February 13, 2018. <https://www.weforum.org/agenda/2018/02/mobility-future-electric-cars-fourth-industrial-revolution>

Veysey, Drew, Gabe Pacyniak, and James Bradbury. "Redesigning Transportation Emissions in the Northeast and Mid-Atlantic: Fuel System Considerations." Georgetown Climate Center. November 13, 2017. http://www.georgetownclimate.org/files/report/GCC_TransportationFuelSystemConsiderations_Nov2017.pdf

Zanghi, Brian. "How Smart Cities Can Increase Public Transit Ridership (Industry Perspective)." *FutureStructure*. May 17, 2017. <http://www.govtech.com/fs/perspectives/how-smart-cities-can-increase-public-transit-ridership-industry-perspective.html>



THE FLETCHER SCHOOL

TUFTS UNIVERSITY

The Climate Policy Lab (CPL)

Center for International Environment and Resource Policy (CIERP)

The Fletcher School
Tufts University
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The Fletcher School at Tufts University was established in 1933 as the first graduate school of international affairs in the United States. The primary aim of The Fletcher School is to offer a broad program of professional education in international relations to a select group of graduate students committed to maintaining the stability and prosperity of a complex, challenging, and increasingly global society.

The Center for International Environment and Resource Policy (CIERP) was established in 1992 to support the growing demand for international environmental leaders. The Center provides an interdisciplinary approach to educate graduate students at The Fletcher School. The program integrates emerging science, engineering, and business concepts with more traditional subjects such as economics, international law and policy, negotiation, diplomacy, resource management, and governance systems.

The Climate Policy Lab (CPL) convenes teams of scholars and practitioners to evaluate existing climate policies empirically and works with governments contemplating new climate policies. The main questions the Lab seeks to answer are: Which climate policies work in practice? Which don't work? Why? Under what conditions would they work elsewhere? The scope of the Lab is global while remaining highly attuned to state, national, and bi-lateral policy processes. It has a particular emphasis on international comparative policy analysis.