Greenhouse Gas Reduction Strategy Alternatives: Cost-Effectiveness Analysis

Executive Summary

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ES.1 MPO ROLE IN GHG REDUCTION

This study was undertaken to provide information about cost-effective greenhouse gas (GHG) reduction strategies to help the Boston Region Metropolitan Planning Organization (MPO) make informed decisions when prioritizing and funding projects, programs, and studies to reduce GHG emissions in the future. The MPO acknowledges that climate change likely will affect the Boston region significantly if climate trends continue as projected. In order to minimize the negative impacts, the MPO is taking steps to decrease our carbon footprint while simultaneously adapting our transportation system to minimize damage from natural hazards. The MPO has several tools at its disposal to support reductions in GHG emissions that are produced by the region's transportation system, including the MPO's:

- Capital-investment funds allocated through the Long-Range Transportation Plan (LRTP) and the Transportation Improvement Program (TIP)
- Planning and research funds, which are described in the Unified Planning Work Program (UPWP)
- Public outreach and involvement tools, which are supported with UPWP funds and can be used to disseminate information
- Potential role as an advocate for various transportation policies and practices

Using its vision, goals, and objectives, the MPO considers projects and strategies that protect and enhance the environment. One goal is Clean Air and Clean Communities with an objective to "reduce greenhouse gases generated in the Boston region by all transportation modes as outlined in the Global Warming Solutions Act."

ES.2 LITERATURE REVIEW

One objective of this study was to research literature about GHG-reduction strategies, in order to understand their potential to reduce greenhouse gas emissions and their cost-effectiveness in terms of implementation costs. Twenty-three strategies were identified that fall into three categories (required employer-offered compressed work week and compressed workweek: mandatory public and voluntary private are separated resulting in 24 strategies in Appendix A):

- Creating a more efficient transportation system that has lower GHG emissions
- Promoting fuel efficiency and cleaner vehicles
- Coordinating transportation with land use decisions

Of these strategies, it was determined that the MPO could support 14 either through funding in the LRTP and TIP, study through the UPWP with eventual funding for implementation in the LRTP or TIP, and publicizing through public outreach. Table ES.1 shows the 23 strategies with the MPO fundable strategies in green. Strategies that the MPO could study that are not in green would require a partnership with another agency in order to implement that strategy. Also included in the table are rankings for potential GHG reductions and the average direct cost-effectiveness of strategies for which cost information was available. The rankings of the GHG and cost-effectiveness information are outlined in section 4.2 of the report.

TABLE ES.1
Twenty-Three Promising Strategies by Type, Potential MPO Role in Implementation, and GHG and Cost-Effectiveness Ranking (Based on National Data)

Category	Strategy	Strategy Type	Potential MPO Role	GHG Ranking*	Cost Ranking**
Creating a More Efficient Transportation System that Has Lower GHG Emissions	Pedestrian Improvements	Transportation System Planning, Funding, and Design	Fund or Study	14	13
	Bicycling Improvements	Transportation System Planning, Funding, and Design	Fund or Study	19	12
	Workplace Transportation Demand Management	Travel Demand Management	Fund or Study	13	9
	Teleworking	Travel Demand Management	Fund or Study	11	17
	Individualized Marketing of Transportation Services	Travel Demand Management	Fund	17	8
	Ridesharing	Travel Demand Management	Fund or Study	24	7
	Car Sharing	Travel Demand Management	Fund or Study	23	4

Category	Strategy	Strategy Type	Potential MPO Role	GHG Ranking*	Cost Ranking**
	Compressed Work Weeks	Travel Demand Management	Study	5/15	1
	Expansion of Urban Fixed-Guideway Transit	Transportation System Planning, Funding, and Design	Fund or Study	10	18
	Rail Freight Infrastructure	Transportation System Planning, Funding, and Design	Fund or Study	21	11
	Increased Transit Service	Transportation System Management and Operations	Fund or Study	12	19
	Transit Fare Reductions	Transportation System Management and Operations	Study	16	16
	Pay-As-You-Drive Insurance	Taxation and Pricing	Study or Advocate	3	6
	Vehicle-Miles-Traveled Fees	Taxation and Pricing	Study or Advocate	6	10
	Congestion Pricing	Taxation and Pricing	Study or Advocate	8	14
	Carbon Tax or Cap-and-Trade	Taxation and Pricing	Study or Advocate	1	NA
	Alternative Construction Materials	Construction Practices	Advocate	9	15
Promote Fuel Efficiency and Cleaner Vehicles	Truck-Idling Reduction	Transportation System Management and Operations	Fund or Study	18	5
	Reduced Speed Limits	Transportation System Management and Operations	Study or Advocate	7	3
	Driver Education and Eco-Driving	Public Education	Publicize	2	N/A
	Information on Vehicle Purchases	Public Education	Publicize	20	N/A

Category	Strategy	Strategy Type	Potential MPO Role	GHG Ranking*	Cost Ranking**
Coordinate Transportation with Land Use Decisions	Compact Development	Land Use Policies	Study or Advocate	4	2
	Parking Management	Land Use Policies	Fund or Study	22	NA

*GHG Ranking is from most effective to least effective in reducing GHG emissions.
**Cost Ranking is from the most cost-effective to the least cost-effective in reducing GHG emissions.
Note: Green text indicates that a strategy can be funded by the MPO.
Source: Central Transportation Planning Staff.

As shown in the table, each category is broken down into strategy type:

1. Creating a more efficient transportation system that has lower emissions
    - Transportation System Planning, Funding, and Design Transportation System Management and Operations
    - Travel Demand Management
    - Taxation and Pricing
2. Promoting fuel efficiency and cleaner vehicles
    - Transportation System Management and Operations
    - Public Education
3. Coordinate transportation with land use decisions
    - Land Use Policies

The majority of the strategies fall into “creating a more efficient transportation system” category. The pricing strategies, such as cap-and-trade or carbon tax, congestion pricing, pay-as-you-drive insurance, and VMT fee, have the most potential to reduce GHG emissions. The MPO does not have the authority to implement these programs. Thus, for these strategies, it may be appropriate to advocate for implementation to whichever local, State, or Federal body that has jurisdiction. For example, a carbon tax or cap-and-trade policy could greatly benefit greenhouse gas reduction in transportation, but would fall under national or state jurisdiction. The MPO could, however, study or advocate for the programs.

The MPO can implement a number of other strategies in this category. Infrastructure investments in transit, walking, bicycling, and rail facilities and improvements to transit service (transportation system planning, funding, and design and transportation system management and operations) are needed to strengthen low-carbon transportation choices; however, they are at the mid-to-lower end of strategies that are both GHG and cost-effective.

Many of the travel demand management strategies that the MPO could fund rank lower in GHG reduction, but many are more cost-effective than the infrastructure projects. Both the infrastructure and the travel demand management strategies should not be discounted in importance because of their smaller relative potential for reductions or lower cost-effectiveness. These strategies can affect the success of others, or are important for balancing equity and other needs of the transportation system as a whole. Some of the least-cost effective strategies, namely the transit-focused strategies and teleworking, have the ability to achieve larger reductions in total; without these strategies, larger emission reductions might not be achieved. In addition, both the transit strategies and teleworking have many other benefits that support cost expenditure, in addition to GHG reduction. These strategies have important mobility and accessibility benefits.

The MPO can publicize two of the strategies that fall under the “promoting fuel efficiency and cleaner vehicles” category. Driver education/eco-driving can play a big part in reducing greenhouse gas emissions from transportation; however, the MPO can only publicize and promote this program for its GHG benefits. The MPO could consider seeking funding partnerships to deploy driver education or eco-driving. It also could study truck-idling reduction and potentially fund the purchase of idle reduction equipment for trucks through its CMAQ program. The MPO could study the effects of implementing reduced speed limits, but this strategy would ultimately need to be enforced through the local and state police.

All strategies, in the “coordinating transportation with land use decisions” category, will require partnerships or strengthened collaboration across agencies. For instance, MAPC develops the land use plan for the region, so it is better positioned to support the compact land use strategy. Ultimately, local entities would need to implement any land use changes in their municipalities. Compact development not only has the potential to achieve the fourth-largest GHG reductions, but also could affect the strategies that the MPO can directly implement—transit infrastructure improvements and walking and bicycle facilities. This strategy highlights the benefits of the MPO/MAPC partnership.

Partnering may be advantageous for strategies that the MPO can study. For example, MAPC has already worked with communities in the Boston region to improve parking management. The MPO may be able to use its transportation expertise to support its existing work further by coordinating with MAPC to study promising parking policies under consideration so they can be implemented by municipalities.

Another example, the workplace transportation demand management and outreach campaigns and incentives strategies could benefit and expand from the existing work of MassRIDES and transportation management associations. The MPO's new Community Transportation program can help to provide CMAQ funding for startup shuttle-service operations.

Deployment of some of the greenhouse gas reduction strategies discussed in the literature review would represent change in the MPO's historical funding patterns. The MPO may consider forging new partnerships for implementation or funding of strategies. As noted in the literature review, all of the strategies could benefit from further research. Data about which strategies Massachusetts is implementing could make for better-informed decision making. Further research is needed to quantify the potential emissions reductions at the state and metropolitan regional levels.

ES.3 EVALUATION OF MPO INVESTMENTS

In developing its current LRTP, *Charting Progress to 2040*, the MPO re-evaluated its past practices and set a new course by moving away from programming expensive capital-expansion projects to ease congestion, instead setting aside more funding for small operations-and-management projects that support bicycle, pedestrian, and transit, along with fewer major roadway improvements. This is in line with greenhouse gas emissions-driven decision making. This type of funding plan is compatible with some of the strategies discussed in the literature review, especially if highway funds are flexed to transit projects.

Many of the projects that have been funded in past TIPs fall into the Intersections Improvements, Complete Streets, and Bicycle and Pedestrian improvements investment programs. Shuttle services have been funded in the past under older Suburban Mobility and Clean Air and Mobility programs—any new shuttle service projects now would fall into the new Community Transportation investment program. In the past, the MPO flexed highway funding to major infrastructure transit projects including the completed Assembly Square MBTA station and the proposed Green Line Phase II project extending the Green Line from College Avenue in Somerville to Mystic Valley Parkway in Medford.

Staff analyzed the projects that were funded or proposed for funding in past TIPs to determine their GHG and cost-effectiveness impacts. GHG emissions can be estimated using the travel demand model for highway and transit major infrastructure projects that meet capacity-adding characteristics. The majority of capacity-adding projects funded by the MPO have been analyzed as a bundle as

part of the LRTP using the travel demand model, a procedure that does not allow staff to associate a GHG reduction with a particular project. Although select major infrastructure projects have been analyzed for GHG benefits if a project-level analysis was performed by CTPS, this work used a variety of emissions factors developed through older emission models. Work that is more recent is underway; however, that work was not completed in time to include it in this report.

Given the limited availability of comparable regional model results using the same emissions model, the cost-effectiveness analysis focused on the projects that were analyzed using off-model spreadsheet analyses. The analyses included projects that were funded in the TIP under the MPO's four investment programs:

- Complete Streets
- Intersection Improvements
- Bicycle and Pedestrian Multi-Use Paths
- Shuttle Bus Services funded under the former Suburban Mobility or Clean Air and Mobility programs

For intersection and Complete Street projects, the cost per ton of GHG reduction varies widely, much more so than the construction cost per lane-mile. Projects that substantially improve a roadway's efficiency also tend to be cost-effective with a low cost per ton of GHG reduction.

The location of the project is also important. Projects located in the Inner Core and Regional Centers communities usually have higher construction costs per lane-mile than projects in the Maturing Suburbs and Developing Suburbs. However, the average tons reduction per lane-mile is greater for both the Inner Core and Regional Centers than for the Maturing and Developing Suburbs. Both of these differences may be attributed to the higher density of these more urbanized communities. Higher urban density usually implies higher construction costs as well as higher traffic volumes being funneled through inefficient roadway subsystems.

The higher average construction costs and efficiency benefit of the urbanized groups roughly balance out, and the average cost per ton of annual GHG reduction is similar for the Inner Core, Regional Centers, and Maturing Suburbs. The lower average cost-effectiveness in the Developing Suburbs may be attributable to lower traffic volumes in these communities.

Multi-use paths are used by pedestrians, bicycles, and other non-motorized vehicles. Unlike the roadway programs, GHG reductions from these projects do not reflect improved traffic efficiency. Instead, the construction of a multi-use path is assumed to make the non-motorized modes more attractive. The annual GHG reduction reflects an estimate of mode shifts away from auto across the projects.

See Table ES.2 for results of the analyses of the three investment programs.

TABLE ES.2
Projected Greenhouse Gas Reductions by Type of Investment Program
(All Costs are Thousands of Dollars)
(All Tons are Tons/Year)

Type of Program	Cost	Lane-Miles	Tons GHG	Cost per Lane-Mile	Cost per Ton	Tons per Lane-mile
Intersections	$35,804	8.88	4,813	$4,032	$7	542
Complete Streets	257,531	85.66	11,995	3,006	21	140
Multi-use Paths	41,174	21.80	1,055	1,889	39	48
All Programs	$334,509	107.46	13,050	$3,113	$26	121

Source: Central Transportation Planning Staff.

While costs and cost-effectiveness will vary widely within the three investment programs, the relationships of the program averages shown in Table ES.2 make sense intuitively. Much of the inefficiency of regional traffic is the result of obsolete and poorly designed intersections. Investing in only those lane-miles required to undertake the intersection program would reduce the most amount of GHG for the least cost. As noted in the literature review, transportation system management strategies, such as signal control management and integrated corridor management have the ability to achieve moderate GHG reductions. However, some roadway system-focused strategies have little or no ability to reduce emissions once induced demand is included the analysis.

At the opposite extreme are investments in multi-use paths. Most of the user benefits accrue to existing bicyclists and pedestrians, and the GHG reductions shown here are achieved only by attracting incremental users abandoning the auto mode.

The fourth investment program included shuttle services. Shuttle services can affect the success of other more cost-effective GHG strategies by balancing equity and other needs of the transportation system as a whole. They can offer other significant benefits including mobility, transportation equity, and livability. The service allows people who would ordinarily drive to their destination the

option to leave their car at home and use public transportation. The results of the shuttle service analysis are shown in Table ES.3 (assuming the net emissions from new shuttles and vehicle miles saved from private automobiles).

TABLE ES.3
Projected Greenhouse Gas Reductions from MPO-Funded Shuttle Services

Sponsor	Service	Total MPO Investment	Net CO_2 Tons/Year	Initial MPO Cost/Tons per Year
MetroWest	Route 7	$43,438	42	$1,042
MetroWest	Woodland Service	139,000	147	947
Cape Ann Transportation Authority	Stage Fort	8,000	7	1,214
Acton	Dial-a-Ride	65,993	48	1,363
Acton	Park and Ride	52,993	94	561
GATRA	Franklin Service	175,655	30	5,852
GATRA	Marshfield/Duxbury Service	186,608	146	1,280
Combined		$671,687	514	$1,307

GATRA = Greater Attleboro-Taunton Regional Transit Authority.
Source: Central Transportation Planning Staff.

Funding this type of service is the most cost-effective to the MPO in reducing GHG when compared to the other three types of investments (Complete Streets, Intersections, and Bicycle/Pedestrian). This is because the MPO provided the startup funding for these services but the sponsors continue to support the services to realize mobility benefits, which continue to result in GHG reductions.

Finally, MassDOT performed a GHG analysis for projects that were included in its 2013−2019 Statewide Transportation Improvement Programs grouped into similar investment programs as the investment programs used by the Boston Region MPO. The only difference was that MassDOT's calculations were done over the useful life of the project, while the MPO's analysis shows the reductions for the project's first year. The useful life for highway, bicycle, and pedestrian projects was 50 years and the useful life for transit projects was 15 years.

Table ES.4 shows a comparison of statewide and MPO cost-effectiveness calculations with the projects in descending order from projects that are most cost-effective to those with a lower impact. The MPO information presented earlier in this section was revised to useful life to show a comparison with the statewide results.

TABLE ES.4
Cost-Effectiveness of Statewide and MPO Investment Programs

Investment Program	Dollars of Investment (Tons per Year)	Dollars of Investment (Over the Useful Life)
MPO Shuttle Startups	$1,307	$87
MPO Intersections	7,000	140
MA Bus Service Expansion and Bus Replacement	9,850	197
MPO Complete Streets	21,000	420
MPO Bicycle/Pedestrian	39,000	780
MA Traffic Operation Improvements	43,200	864
MA Bicycle/Pedestrian	151,550	3,031

Source: Central Transportation Planning Staff.

As shown in the table, when comparing similar investment programs between the MPO and the state as a whole, the Boston Region MPO area has a lower cost per ton, which can be attributed to Boston's greater density, and greater use of the facilities.

ES.4 ONGOING WORK

Several activities are underway at both the state and MPO level that will help the MPO in making decisions to fund the most cost-effective projects to reduce GHG emissions. These are described below.

- First-Mile and Last-Mile Transit Connections Study (MPO Initiative): As part of this study, the MPO staff is assisting municipalities, Transportation Management Associations, or other service providers that request planning support for addressing first- and last-mile connections to transit. Candidate locations are being identified through outreach to MAPC subregions and other MPO outreach activities. For identified locations, MPO staff will document existing conditions, including barriers and opportunities for linking residential, commercial, and employment areas to transit services and stations, and will propose services that could fill the gaps. Staff also may recommend improvements to support access for pedestrians and bicyclists, where applicable.

- Focus40, MassDOT's vision for MBTA's investments: MassDOT and the MBTA are in the process of developing a 25-year strategic vision for MBTA transit investments. Once completed, MassDOT and the MBTA will work with the public and stakeholders to develop and evaluate different

investment strategies to address current and future needs. This information will help the MPO to determine projects that could be funded by the MPO in later years. Transit will help the MPO to achieve its Capacity Management and Mobility goal its Clean Air and Clean Communities goal, specifically by reducing GHG.

- MassDOT Capital Investment Plan: Once the CIP is completed, the MPO will have information about projects and programs that the state will fund over the next five years. This will allow the MPO to consider projects that were not part of the CIP, and which it may want to fund under the MPO target program to help move toward its objective of reducing GHG emissions.

- MassDOT is in the process of identifying new tools and developing practices to comply with federal and state laws to assess, track, and reduce GHGs from MassDOT and MPO transportation projects.

Once this work is completed, staff will update the MPO on the outcomes of these activities.