



Mobile Source Emissions Calculator

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A Better City improves the economic competitiveness and quality of life of the Boston region by advancing and providing leadership on significant transportation, land development, and environmental policies, projects, and initiatives related to the commercial real estate sector.

Cover Photos

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Executive Summary

A Better City developed the Mobile Source Emissions Calculator to encourage commercial real estate and business owners to understand the contribution of their facility's mobile source emissions to their overall greenhouse gas (GHG) emissions. Developed to calculate emissions from commuters, business fleets, and business travel, the calculator will also be an important tool for the City of Boston to aggregate data on GHG emissions from these sources to help reach its climate change goals.

The calculator provides the following information for users:

- **Annual mobile source emissions** for employee/tenant commuters, business travel, and fleet vehicles.
- **Commuter mode split data** breaking down bike, walk, public transit, carpool, vanpool, and drive-alone trips by percent of total trips and total miles traveled, as well as telework rate.
- **Massachusetts Department of Environmental Protection (MassDEP) Rideshare Regulation report** providing commuter data that can be directly entered into the Rideshare reporting form.
- **Detailed emissions data** broken down by commute type, fleet vehicle fuel used, and mode of business travel with high-level recommendations for providing more sustainable transportation options.
- **Summary report with tenant/employee suggestions for improving their commutes.** In providing commute information, employees can provide their name and email or provide data anonymously.
- **Commuter program recommendations** to support the employee commutes.
- **Individual reports for all commuters** showing emissions by mode for the week of the survey, which can be emailed to them at their request.

The Mobile Source Emissions Calculator is a useful tool for the following users:

- Transportation Management Associations working with businesses to reduce congestion and pollution in city environments.
- Businesses and buildings reporting under the MassDEP Rideshare Regulation.
- State and municipal governments looking to manage mobile source reductions.
- Sustainability programs focused on reducing GHG emissions from stationary and mobile sources.
- Individual businesses and non-profits with goals to calculate and reduce mobile source GHG emissions.

Introduction and Purpose

According to Boston's inventory of 2008 greenhouse gas (GHG) emissions by sector, transportation is responsible for 27 percent of the city's emissions. These emissions come primarily from burning fossil fuels for cars, trucks, ships, trains, and planes. Over 90 percent of the fuel used for transportation is petroleum-based, including gasoline and diesel.

A Better City (ABC) has dedicated itself to helping major employers, large building owners and businesses throughout the Boston region reduce their carbon footprint. The Mobile Source Emissions Calculator builds on ABC's two successful [Transportation Management Associations \(TMAs\)](#)¹ and transportation demand management research aimed at shifting individuals away from driving alone, improving air quality, and reducing congestion. It also builds on the work of ABC's [Challenge for Sustainability](#)² program, which focuses on reducing GHG emissions that include energy use, waste, and water. The calculator allows building owners, employers and businesses participating in these programs to gain a greater understanding of the mobile source emissions contribution their facility or business makes to their overall GHG emissions. The City of Boston will also be able to use the calculator to aggregate data on GHG emissions from commuters, business fleets, and business travel to help reach its climate change goals.

This tool has been programmed to capture emissions specific to commuters in and out of the Boston area, as many of its assumptions are based on commuting options for Boston. However, it has the flexibility to be easily adapted for other areas in Massachusetts or the United States. It is hoped that this survey tool and calculator can serve as a model for other communities and cities throughout the country to track data more easily and promote informed decision-making regarding transportation infrastructure and policies.

This report presents the data and calculation methodologies used, input from advisory groups, and a detailed description of the Mobile Source Emissions Calculator.

Features

The Mobile Source Emissions Calculator facilitates the process of collecting and calculating an organization's emissions from commuting, business travel, and their business fleet. In addition to mobile source emissions, the calculator provides facilities with a complete view of their mode split between drive-alone commuters; individuals taking public transit or sharing a ride; and others that are biking, walking, or telecommuting to work. Facilities are then provided with high-level recommendations allowing them to develop new programs and policies to help shift their modes into more sustainable transportation options. The calculator also saves time for users by creating output reports to facilitate Massachusetts Department of Environmental Protection (MassDEP) Rideshare Regulation reporting; it also generates summary reports based on feedback from employee/tenant commuters to help develop policies or programs for a more sustainable commute.

¹ www.abctma.com

² <http://challengeforsustainability.org/>

Methodology

Emissions Factors and Calculations

The primary assumptions and data sources for the Mobile Source Emissions Calculator are shown below. The [Mobile Source Emissions Calculator website](#)³ provides a comprehensive 14-page methodology of all emissions factors, data used, information sources, assumptions and detailed calculations used in the calculator.

Table 1. captures the emissions factors used for calculating employee commuter, business travel, and fleet vehicle emissions. ABC used a combination of the U.S. Environmental Protection Agency's (EPA's) Motor Vehicle Emission Simulator (MOVES) modeling and other local and national data sources to develop these emissions factors for the Mobile Source Emissions Calculator. The MOVES modeling averaged all vehicle types driven in Middlesex, Norfolk, Suffolk, and Essex Counties (the four counties in and surrounding the Boston area).

Table 1. Emissions Factors Used in the Mobile Source Emissions Calculator

Transportation	Employee Commuter and Business Travel	2014 CO ₂ e per Passenger Mile (g/pass-mi)
Passenger Car/Carpool	MOVES (representative gas and diesel mix)	395
Passenger Truck	MOVES (representative gas and diesel mix)	551
Motorcycle	MOVES (gasoline)	407
Intercity Bus	MOVES (representative mix of gas and diesel) and Motorcoach Survey 2011 (average passengers per service mile)	55
Transit Bus/Employee Shuttle	MOVES (representative mix of gas, diesel, and compressed natural gas) for emissions factor per bus and 2012 National Transit Database for average ridership	107
Vanpool	VRIDE	68
Commuter Rail	2012 National Transit Database	173
Subway	2012 National Transit Database	132
Ferry Boat	2012 National Transit Database	1,016
No Vehicle (e.g., bike, walk)	None	0
Intercity Rail	DOT, BTS, National Transportation Statistics Table 4-26: Energy Intensity of Amtrak Services	133
Airplane	DOT, BTS, National Transportation Statistics Table 4-21: Energy Intensity of Certificated Air Carriers	181
Fleet Vehicles		Grams CO ₂ e /amount
Gasoline (g/gallon)	EIA (http://www.eia.gov/environment/emissions/co2_vol_mass.cfm)	8,900
Diesel (g/gallon)	EIA (http://www.eia.gov/environment/emissions/co2_vol_mass.cfm)	10,200

³ <http://projects.erg.com/conferences/abc/mobilecalc/CalculationMethodology.pdf>

Compressed Natural Gas (g/scf)	EIA (http://www.eia.gov/environment/emissions/co2_vol_mass.cfm)	53.1
Electricity	ISO 2012 Table 5.2 for MA (http://www.iso-ne.com/genrtion_resrcs/reports/emission/2012_emissions_report_fi nal_v2.pdf)	412.8
Biofuel (g/gallon)	EPA (http://www.epa.gov/climateleadership/documents/emission-factors.pdf)	9,451

BTS= Bureau of Transportation Statistics; CO_{2e}= carbon dioxide equivalent; DOT= U.S. Department of Transportation; EIA= U.S. Energy Information Administration; ISO= International Organization for Standardization

In addition to the emissions factors in Table 1, the methodology included a number of key assumptions built into the calculations for this tool. Some assumptions for the direct count component of the commuter emissions calculator include the following:

- The default value for people who walk or run to work in Boston is 11.4 percent, but this can be changed by the user. The default number of sick + vacation days for the direct count method is 20, but this can be changed by the user.
- The default one-way commute for people driving to work is 13.5 miles.
- A one-way vanpool ride is 40 miles.
- The miles driven per one-way private bus commute is 45.2 miles.
- The weighted average miles per trip for traveling into Boston from Zones 1a to 10, as well as the weighted average distance of all Interzone 1 to 9 travel on the commuter rail, was derived from Fiscal Year 2014 mTicket data and 2012 National Transit Database data. This weighted average also included the average distance traveled by subway and bus that these commuter rail passengers attached to their commuter rail trips.
- The weighted average miles per trip for traveling using a link pass (average bus and subway miles per trip), Massachusetts Bay Transportation Authority (MBTA) outer express bus pass, MBTA inner express bus pass, and local bus pass was derived from 2012 National Transit Database data. Outer and inner express bus data also included the average miles traveled by local bus or subway associated with each outer or inner express bus ride.

Some assumptions specific to the survey component of the Mobile Source Emissions Calculator include the following:

- The distances between commuter rail stations and MBTA subway stations were provided by Central Transportation Planning Staff and are used to find the distance when commuters select a starting and ending station.
- The distances between ferry stations were provided by the MBTA and are used to find the distance when commuters select a starting and ending station.
- The commuter survey asks for the distance traveled by the morning commuter and assumes that the average afternoon commute is the same.

Advisory Group Participation

In the early stages of development, ABC facilitated two advisory group meetings. The first advisory group was primarily composed of Massachusetts and City of Boston government representatives, including air and climate, and transportation department representatives. The second group was composed of business and university representatives. These advisory group meetings helped ensure that 1) the Mobile Source Emissions Calculator used sound and defensible data; 2)

calculation methodologies were consistent, when possible, with those of the state and city; and 3) the tool was optimized for user's data needs, navigation, and reporting requirements.

[Advisory Group Meeting with Massachusetts and Boston Government Representatives](#)

MassDEP, Massachusetts Department of Transportation, City of Boston, and Boston Transportation Department representatives attended and provided feedback about data sets and calculation methodologies used by the Mobile Source Emissions Calculator.

This meeting helped ensure that the Mobile Source Emissions Calculator:

- Used emissions factors, calculations, and other default data that were defensible and aligned as much as possible with state and local government data and methodologies.
- Crosschecked commuter-reported miles traveled with beginning and ending ZIP codes to validate commuter-reported estimates of miles traveled.
- Generated outputs for organizations to facilitate MassDEP Rideshare Regulation reporting.

[Advisory Group Meeting with Company, Healthcare, and University Representatives](#)

Harvard University, Dana-Farber, Mass General Hospital, P&G Gillette, and Eastern Research Group Inc. representatives attended and provided feedback about the Mobile Source Emissions Calculator's value of outputs and ease of use.

The major accomplishments of this meeting included:

- Enhancing the commuter survey to make it easier to fill out.
- Providing data entry fields that correspond with the types of data organizations can most easily collect regarding their business travel and fleet.
- Selecting data outputs and visualizations that provide value to the organization.

Mobile Source Emissions Calculator Description

This calculator provides building owners and businesses with a detailed understanding of their mobile source (transportation) emissions, which contribute to the building or business' overall GHG emissions. The calculator captures information from the three primary sources of mobile source emissions within a worksite or building: employee/tenant commutes, business travel, and fleet vehicles (Figure 1).

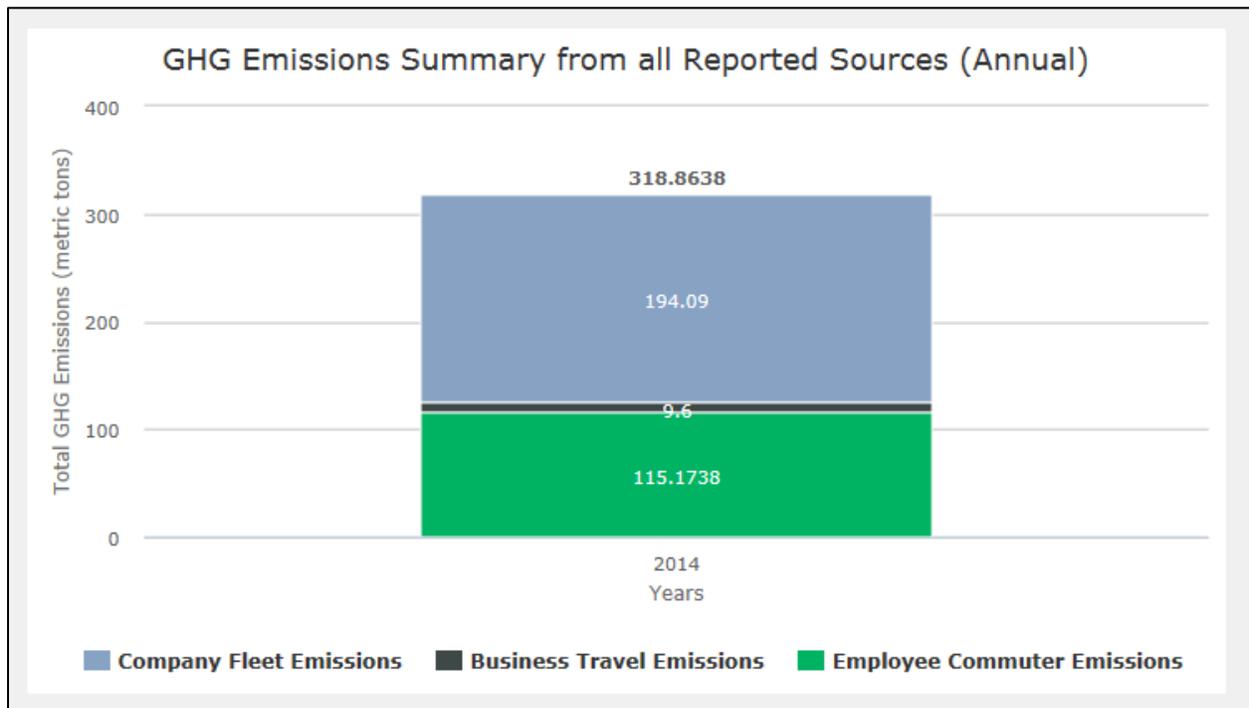
Key Features for Users

The calculator provides the following data and features for users:

- **Annual mobile source emissions** for employee/tenant commuters, business travel, and fleet vehicles.
- **Commuter mode split data** breaking down bike, walk, public transit, carpool, vanpool, and drive-alone trips by percent of total trips and total miles traveled, as well as telework rate.
- **MassDEP Rideshare trip report** providing commuter data that can be directly entered into the Rideshare reporting form.

- **Detailed emissions data** broken down by commute type, fleet vehicle fuel used, and mode of business travel with high-level recommendations for providing more sustainable transportation options.
- **Summary report with tenant/employee suggestions for improving their commutes.** In providing commute information, employees can provide their name and email or provide data anonymously.
- **Individual reports for all commuters** showing emissions by mode for the week of the survey, which can be emailed to them at their request.

Figure 1. GHG Emissions from Three Types of Mobile Emissions



Commuter Emissions

The Mobile Source Emissions Calculator provides the flexibility for organizations to determine commuter emissions in two ways—the commuter survey or direct count method. Regardless of the method selected, the Mobile Source Emissions Calculator generates a trip report that can be used to greatly facilitate MassDEP Rideshare Regulation reporting. It also provides a summary report from information collected during the commuter survey process, which captures and presents suggestions from employees/tenants about how to improve their commute. This can help companies and building owners develop and tailor effective transportation programs and policies for commuters.

Commuter Survey Method

The calculator’s commuter survey generates a URL unique to an organization for that year. This URL can be emailed to all or a random sample of employees or tenants for them to report their

miles by mode traveled to work for each day during a specific week of the year chosen by the company. The survey eases the burden on the survey taker by:

- Automatically calculating the distance between commuter rail, subway, and ferry stops (commuter just enters beginning and end station).
- Including a fuel-economy widget that automatically looks up the fuel economy of their vehicle (commuter just enters year, make, and model of vehicle).
- Validating the commuter miles entered via modes by matching the corresponding start and end ZIP codes.

The Mobile Source Emissions Calculator then calculates emissions by mode (Figure 2), mode split (Figure 3), and other commuter data such as telework frequency and how commuters think their commute can be improved.

Direct Count Method

The direct count method can be used when an organization has the capability of tallying the number of cars parked for a week, bikes parked for a week, count of employees working from home, bus passes, subway passes, and commuter rail passes by zone number. When this information is available, it may be an easier approach than emailing employees a survey link and promoting the survey. Similar to the commuter survey method, the direct count method also calculates emissions by mode (Figure 2) and mode split (Figure 3) using some assumptions on the average distance traveled by mode.

Figure 2. Commuter Emissions Data

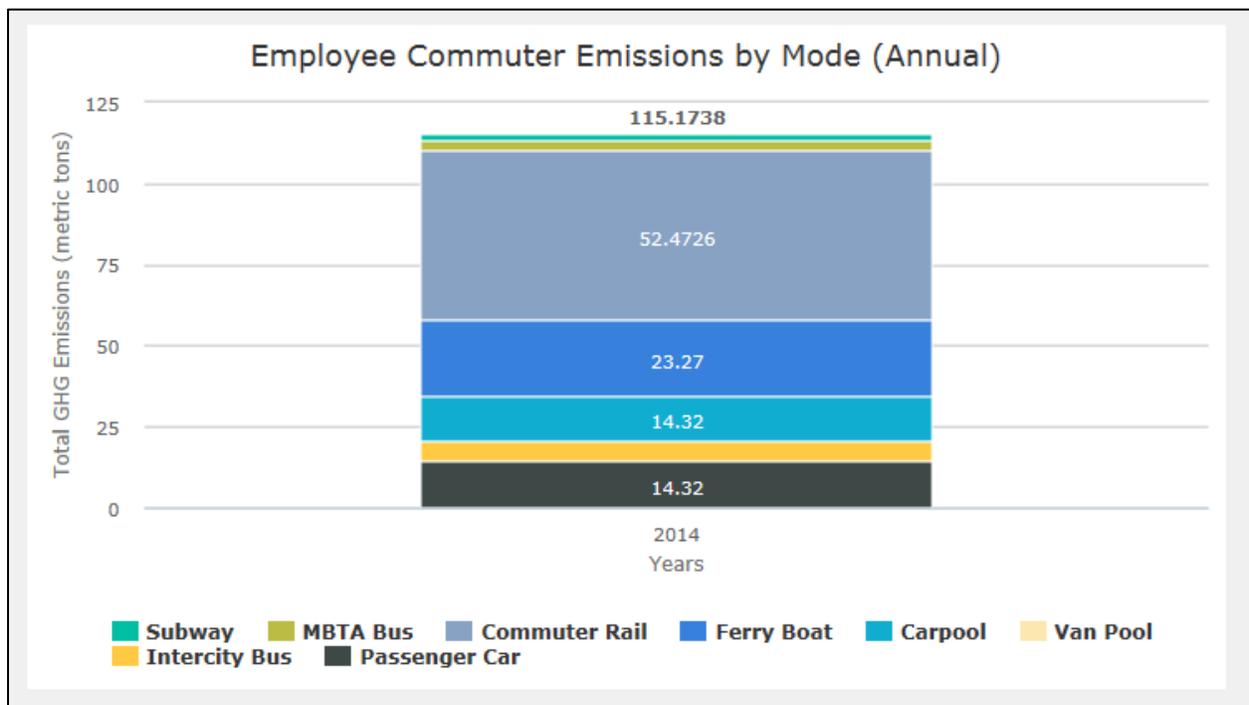
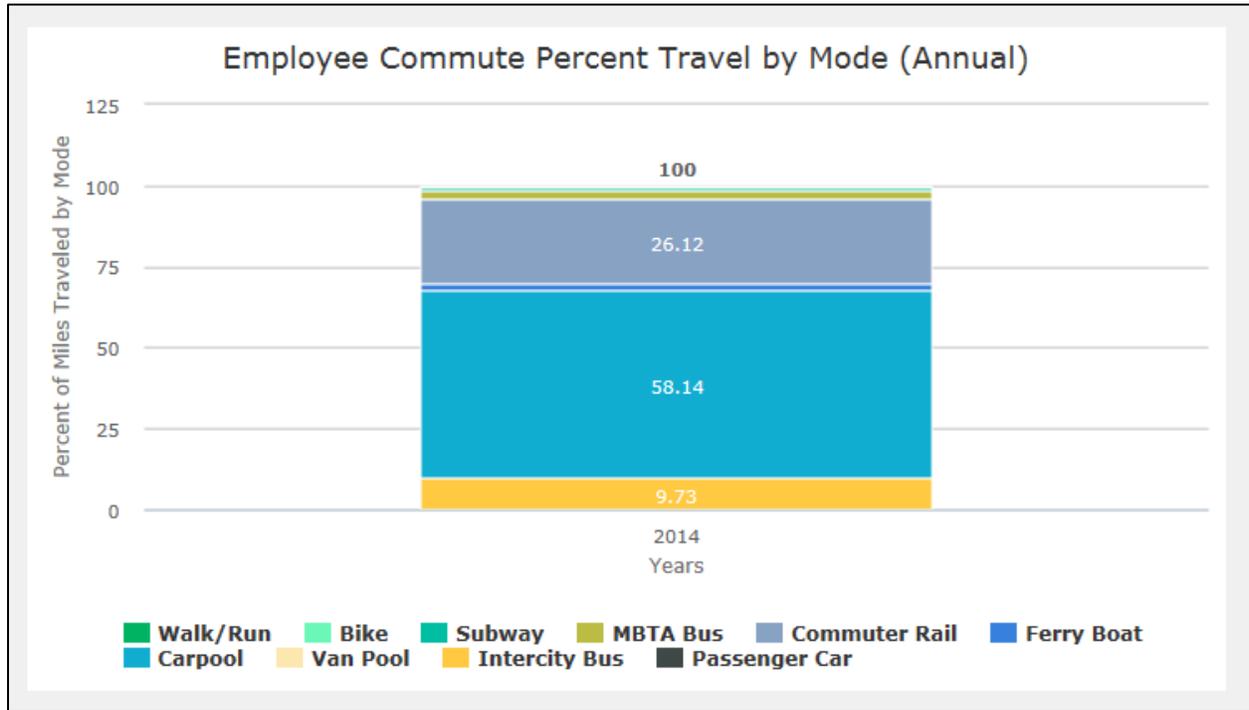


Figure 3. Mode Split Data for Commuters



MassDEP Rideshare Reporting

MassDEP administers the Commonwealth's Rideshare Regulation ([310 CMR 7.00](#)), which is an air quality initiative that requires employers exceeding applicable employee thresholds to develop plans and set goals to reduce commuter drive-alone trips by 25 percent from a baseline established through an employee survey. These reports must be submitted annually for all employers exceeding the following employee thresholds: businesses with 1,000 or more applicable commuters, educational institutes with 1,000 or more applicable commuters, and businesses with 250 or more applicable commuters who are also subject to the Massachusetts Air Operating Permit Program.

The Mobile Source Emissions Calculator facilitates data collection for this effort. The built-in employee survey and direct count form have both been aligned to generate the outputs needed for the Rideshare Regulation report.⁴ Figure 4 presents the output report from the Mobile Source Emissions Calculator that can be directly input into MassDEP Rideshare reports.

⁴ Visit the [MassDEP Rideshare website](http://www.mass.gov/eea/agencies/massdep/air/programs/rideshare.html) to learn more about the Rideshare Regulation and whether your facility is subject to it (<http://www.mass.gov/eea/agencies/massdep/air/programs/rideshare.html>).

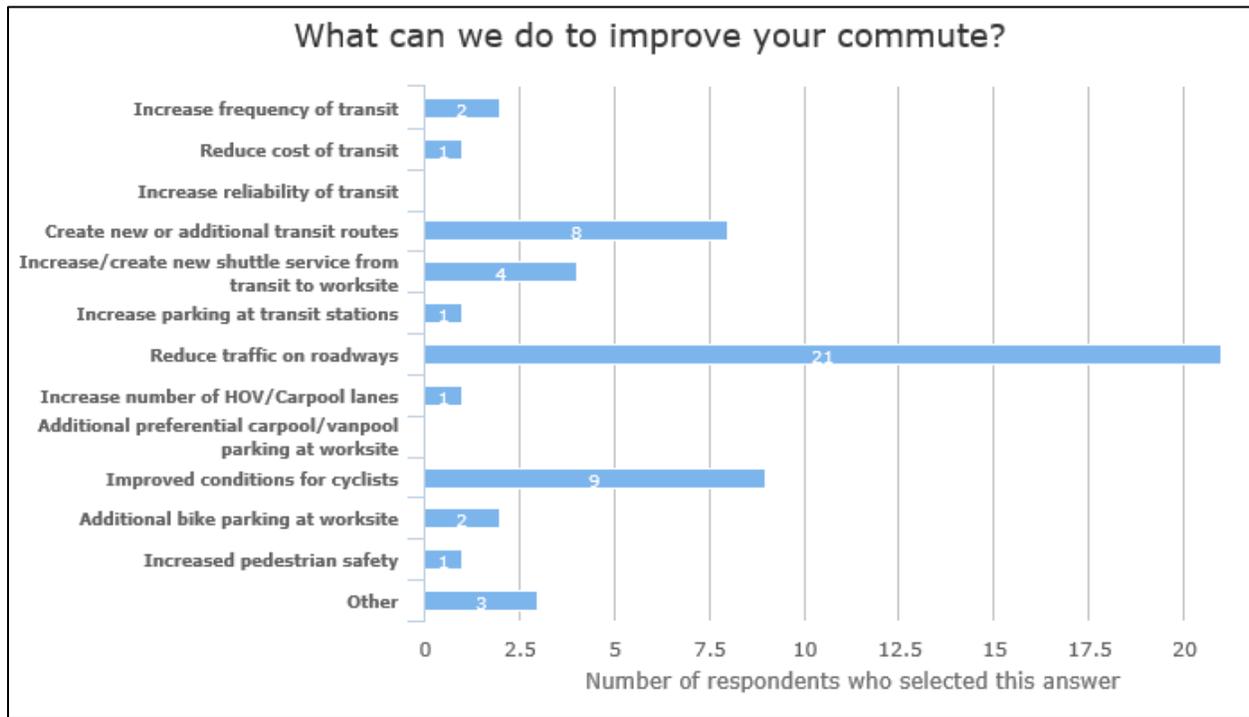
Figure 4. Sample ABC Trip Report to Assist with MassDEP Rideshare Reporting

Number of employees at your company or facility location being surveyed: 8	
Number of employees survey was sent out to: 8	
Number of survey responses: 8	
Survey response rate: 100%	
Commute Mode	Trips in Mode [all outputs below based on primary mode of travel]
Drive-Alone Commute	1
Carpool (2-6 commuters)	0
Vanpool (7+ commuters)	0
Public Transit (bus, ferry, subway, commuter rail)	18
Bicycle	9
Walk/Run	4
Telecommute	4
Flextime Day Off	0
Other (Motorcycle)	0
Other (Shuttle)	0
Out of Office (personal, sick, vacation day; scheduled day off; business trip or meeting)	4

Summary Report to Improve Employee/Tenant Commutes

The calculator provides a summary report at the employee/tenant level, which shows how the commute can be improved. It also provides these results in an aggregated summary form (see Figure 5) to help employers/building owners understand the obstacles their employees/tenants are facing to develop better policies and programs to assist those commuters. The summary report provides the emails and names of all employees who completed the survey (although they have the opportunity to complete it anonymously) to allow employers/building owners to easily implement drawings or contests to promote a better participation rate.

Figure 5. Summary Statistics for Improving Employee/Tenant Commutes



Commuter Program Recommendations

In addition to the information that employees provide, the calculator provides automated tailored recommendations (Figure 6) for commuter programs that a business could implement based on what it already offers. These recommendations, along with feedback from employees/tenants, can help businesses think of and implement the solutions that best suit the needs of their employees/tenants.

Figure 6. Automated Commuter Program Recommendations

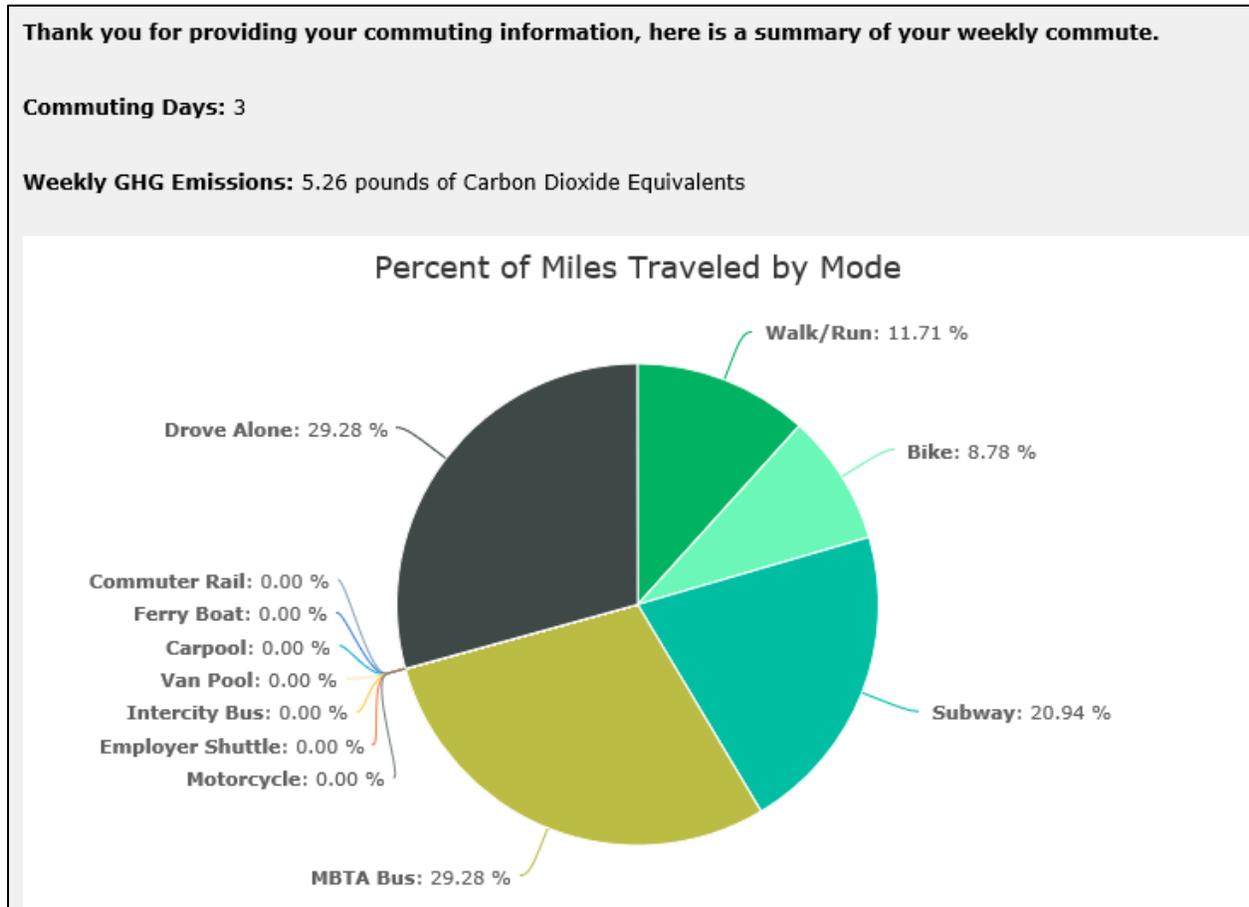
Based on the emissions results summarized above and the programs you are currently offering, the following commuter recommendations have been made:

- Your company does not offer carpool parking — consider creating carpool space.
- Your company does not provide a pre-tax vanpool incentive — consider offering a pre-tax benefit.
- Your company does not provide bike parking spaces — consider creating and promoting secure bike parking.
- Your company does not provide changing or shower facilities for cyclists — consider providing facilities.
- Your company does not provide transportation fringe benefits for cyclists — consider providing the benefits.
- Your company is not part of the MBTA Corporate Pass program — consider joining the program.
- Your company provides a T pass subsidy — consider increasing the subsidy and promoting it.
- Your company does not offer a pre-tax benefit for transit — consider providing a pre-tax benefit.
- Your company does not subsidize private commuter buses — consider offering a subsidy.

Individual Commuter Reports

After providing their mode of commuting into work for the week, each employee/tenant is provided with some summary statistics about his or her commute. These summary statistics provide the number of commuting days, pounds of CO₂ emitted for the week from commuting, percent of miles traveled by mode (see Figure 7), and tailored suggestions for reducing their emissions. The employee/tenant can choose to send these results to their email or print them out.

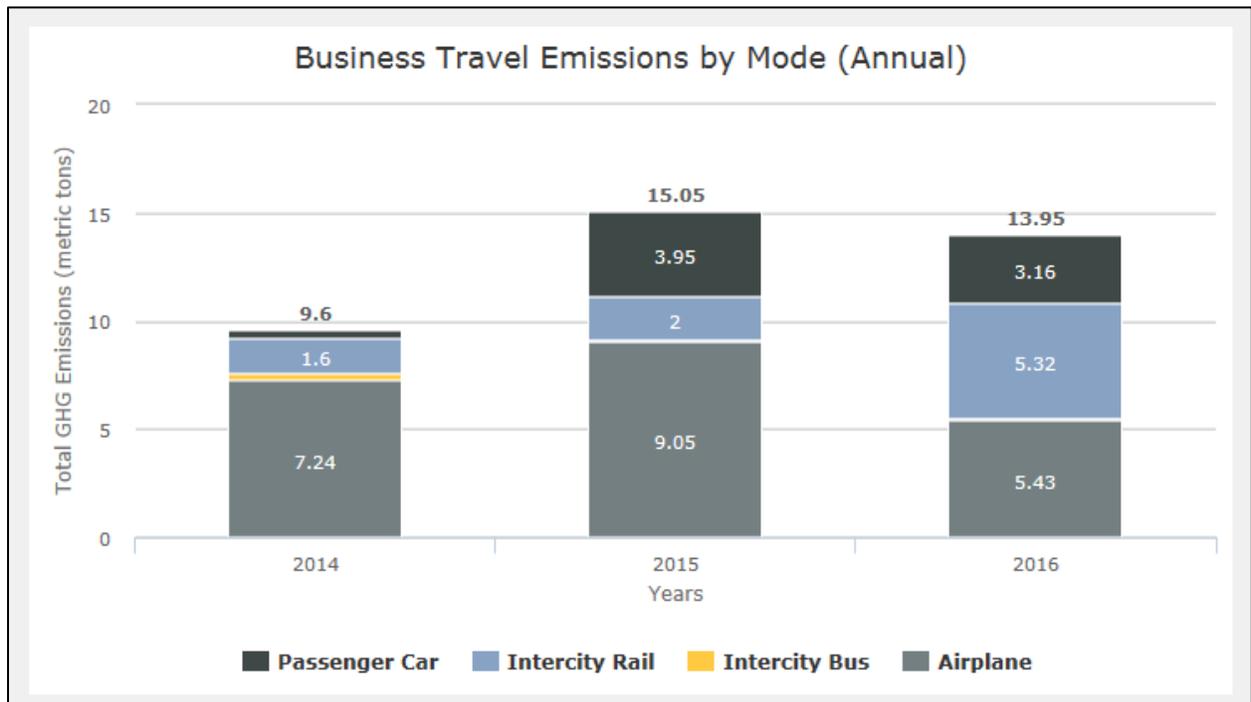
Figure 7. Individual Commuter Report



Business Travel Emissions

The business travel component of the Mobile Source Emissions Calculator prompts users to input miles driven by passenger car, intercity rail, intercity bus, and airplane and calculates emissions by each of these modes. The emissions are saved in the calculators and can be compared from year to year, as shown in Figure 8.

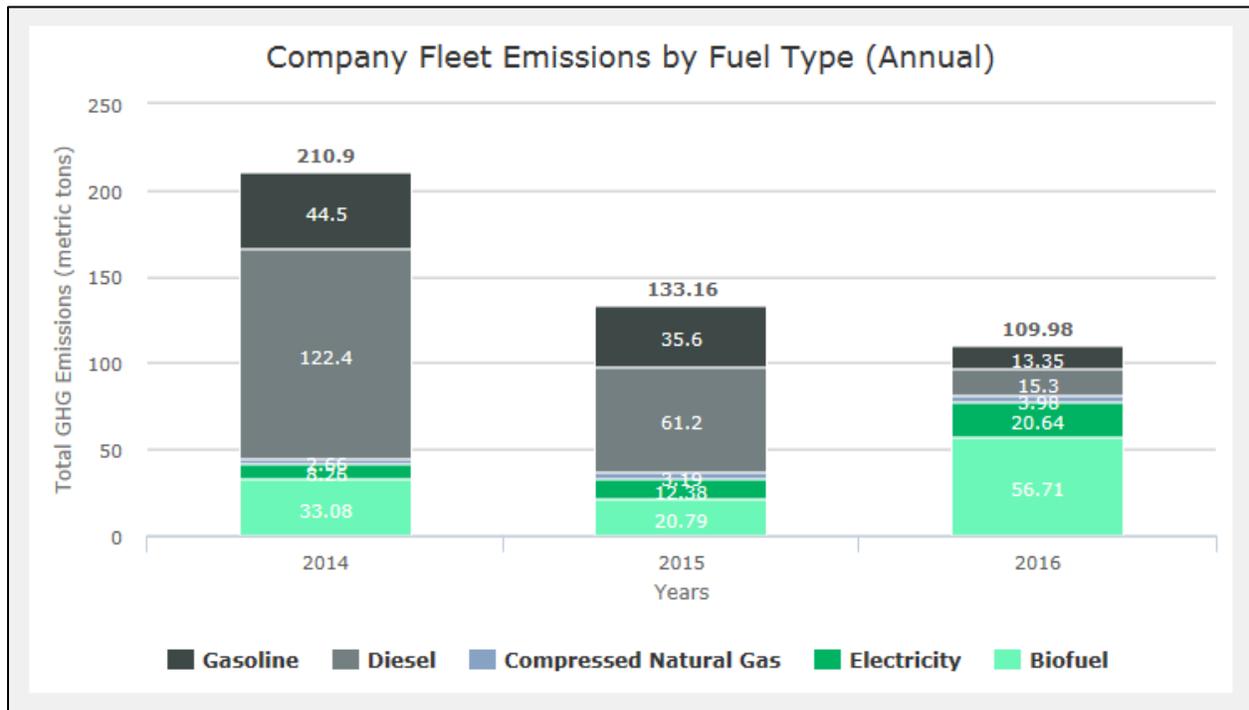
Figure 8. Business Travel Emissions



Fleet Vehicle Emissions

The fleet emissions component of the Mobile Source Emissions Calculator prompts users to input gasoline, diesel, compressed natural gas, electricity, and biofuel used for their business fleet to calculate total emissions. These emissions are broken down by year and fuel type, as shown in Figure 9.

Figure 9. Fleet Vehicle Emissions



Case Study

Company: Eastern Research Group, Inc.

Locations: Boston and Lexington offices

Employees: Boston: under 10; Lexington: 50 to 100.

Method Used: Commuter survey for both offices.

Benefits: Eastern Research Group, Inc., reported the following benefits of using the tool:

- Saved more than 30 hours in generating survey, cleaning data, and performing calculations relative to years in which we have implemented the survey ourselves.
- Data visualizations were helpful to send to employees when reporting results.
- Data are stored in an online location, and it is easy to pass the task on to another employee in future years.
- Employees appreciated seeing their personal emissions immediately after filling out the survey.

“We have been implementing commuter surveys for a number of years, and ABC’s Mobile Source Emissions Calculator simplified the process and allowed us to implement the survey with less than half the effort—all we had to do was send out the link and encourage our employees to take the survey and the Calculator compiled all the data for us.”

Charles Goodhue, Eastern Research Group, Inc.

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