Supporting Passenger Mobility and Choice by Breaking Modal Stovepipes

Comparing Amtrak and Motorcoach Service

July 2013

MJB & A

M.J. Bradley & Associates LLC

(603) 647 5746 / www.mjbradley.com

Authors: **Dana Lowell and David Seamonds**

M.J. Bradley & Associates LLC
1000 Elm Street, 2nd Floor
Manchester, NH 03101
(603) 647-5746 x103
dlowell@mjbradley.com

This document was prepared by M.J. Bradley & Associates for submission to:

111 K Street, NE 9th Floor
Washington, DC 20002-8110

The Reason Foundation
5737 Mesmer Ave.
Los Angeles, CA 90230

651 Pennsylvania Ave, SE
Washington, DC 20003

Table of Contents

List of Tables

List of Figures

Key Findings

This analysis compares customer costs (fare, travel time) and societal costs (government subsidies, air emissions) associated with twenty specific trips that can currently be taken between select U.S. city pairs on both an Amtrak train and on a scheduled intercity motorcoach bus. These specific trips were chosen to provide a representative comparison between these travel modes over a range of geographies, both urban and rural, and to include trips taken on the three major types of service operated by Amtrak (Northeast Corridor, including Acela; other short-corridor trains; and long-distance trains). The majority of these trips are between 100 and 200 miles one-way, while one is shorter and several are longer.

The key findings of this analysis are as follows:

Time and Schedule

- In general there are more schedule options by bus than by train. For all but one of the trips there are more scheduled buses each week than trains; for half of the trips there are more than twice as many scheduled buses per week.
- Total travel time is comparable for these modes; for ten of the twenty trips total travel time is shorter by train than by bus; for the other ten trips total travel time is shorter by bus. For half of the trips the difference in travel time between modes is less than one hour.

Passenger Cost and Government Subsidies

- For thirteen of the twenty trips the minimum one-week advanced purchase fare is lower for the bus than the train.
- Considering fully allocated costs (capital and operating expenses) motorcoaches average ($/passenger) less than 25% of the cost to provide comparable Amtrak service. The average savings to passengers and taxpayers to provide bus service over train service ranges from $17.03 to $422.39 per passenger.
- For two of the twenty analyzed trips Amtrak on average generates enough passenger revenue to cover both operating and capital costs (i.e. they are "profitable"). For the remaining eighteen trips average passenger revenue does not cover Amtrak's fully allocated expenses. For the remaining eighteen trips the average government (state and federal) subsidies to Amtrak range from $21.93/passenger to $289.56/passenger. By comparison, for the twenty trips analyzed the total indirect capital subsidies (Highway Trust Fund outlays) provided to support surface transportation range from $0.09/passenger to $0.74/passenger.

Environmental Efficiency

- Excluding the Northeast Corridor, where Amtrak operates electric locomotives, the average impact of scheduled intercity motorcoach service on air quality is lower than the impact of Amtrak service. Average per-passenger emissions of particulate matter and nitrogen oxides are approximately 80% lower for motorcoach trips than for Amtrak trips, and average emissions of volatile organic hydrocarbons are approximately 90% lower.
- For all trips, including those on the Northeast Corridor, the average impact of scheduled intercity motorcoach service on climate change is lower than the impact of Amtrak service. Average per-passenger emissions of carbon dioxide are 45% - 65% lower for motorcoach trips than for Amtrak trips.

Executive Summary

This report compares the cost and environmental impact of passenger trips taken on scheduled Amtrak trains to trips taken to the same destinations on existing scheduled intercity motorcoaches.

Amtrak currently operates over 300 trains per day on 43 different routes. These routes connect more than 500 cities and towns in 46 of the 48 lower continental United States. Approximately 36% of all Amtrak passengers are carried on the Northeast Corridor, between Boston, New York, and Washington DC, both on the Acela and on Northeast Corridor regional trains. In addition to Northeast Corridor trains, Amtrak operates both short-corridor trains that generally operate within a single state or within only a few adjoining states (27 routes), and long-distance trains than span the country, primarily from east to west (14 routes).

By comparison there are currently an estimated 4,088 companies that operate motorcoaches in the U.S. Almost 20% of these companies operate daily, scheduled intercity service between various city pairs in all 48 of the lower 48 states[1]. This scheduled intercity service is operated primarily by the large national carriers – Greyhound and Coach USA – but also by smaller local and regional companies. More than 16,000 motorcoaches operate regularly in fixed-route service[2] in the U.S. and almost half of all annual motorcoach miles are operated on scheduled, fixed routes.

There are currently bus stations with some scheduled intercity service in 2,766 U.S. cities and towns. There are less than 150 counties, parishes, or independent cities in the U.S. that are not currently served by some type of scheduled intercity service[3]. See Figure 1 for a map of this scheduled intercity Amtrak and bus service[4].

For this analysis the authors analyzed twenty specific trips between select city pairs in the continental United States. The specific trips that were analyzed are shown in Figure 2. Most of the analyzed trips are approximately 200 miles in length, but several are shorter and several are as long as 600 miles. The specific trips included in the analysis were chosen to provide representative geographic coverage of the lower 48 states, urban and rural trips, Amtrak trips on the Northeast Corridor, as well as short-corridor and long-distance Amtrak trains[5].

---

[1] John Dunham & Associates, *Motorcoach Census 2011*
[2] Fixed-route service includes inter-city service, airport service, and commuter service. Data from *Motorcoach Census 2011*
[3] According to the American Intercity bus Riders Association (www.aibra.org). Counties, parishes, and independent cities of 25,000+ population that are more than 25 miles from a bus or train station.
[4] A larger, printable version of this map can be found at: http://www.aibra.org/pdf/usmap.pdf
[5] Amtrak's designation of long-distance and short-corridor refers to the entire route over which a specific train operates. In general the specific trips chosen for this analysis cover only a portion of each corridor, and the analyzed trips on Amtrak long-distance trains may be as short as or shorter than the analyzed trips on short-corridor trains.

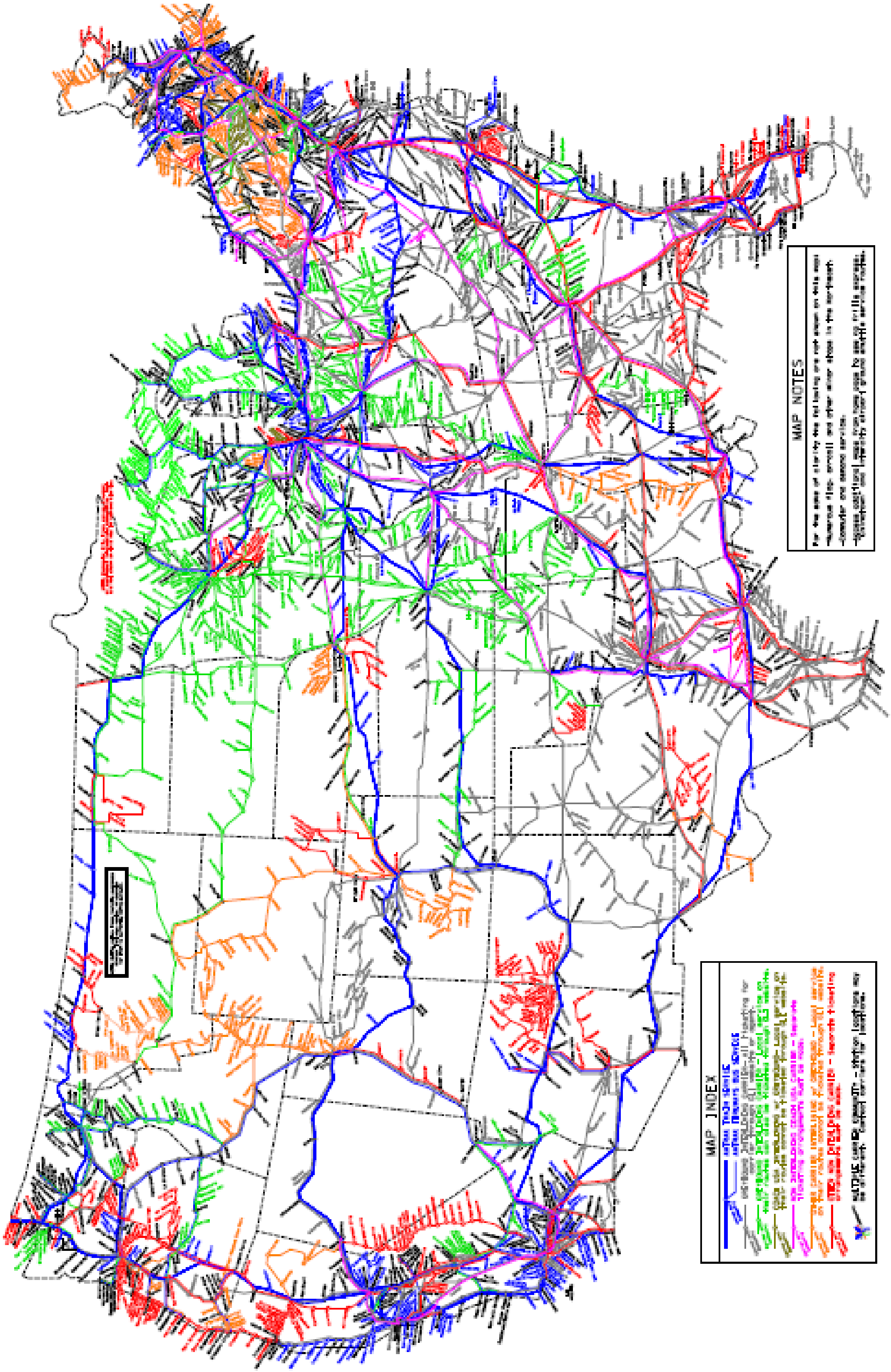

Figure 1 Scheduled Intercity Train (blue lines) and Bus Service (Please visit http://www.aibra.org/ for a clear Amtrak and intercity bus map)

In addition, trips were specifically chosen on those Amtrak corridors that are the most and least profitable on an operating basis, according to Amtrak financial data. All of the trips can be taken on a single Amtrak train or a single scheduled bus, with no transfers required for either mode.

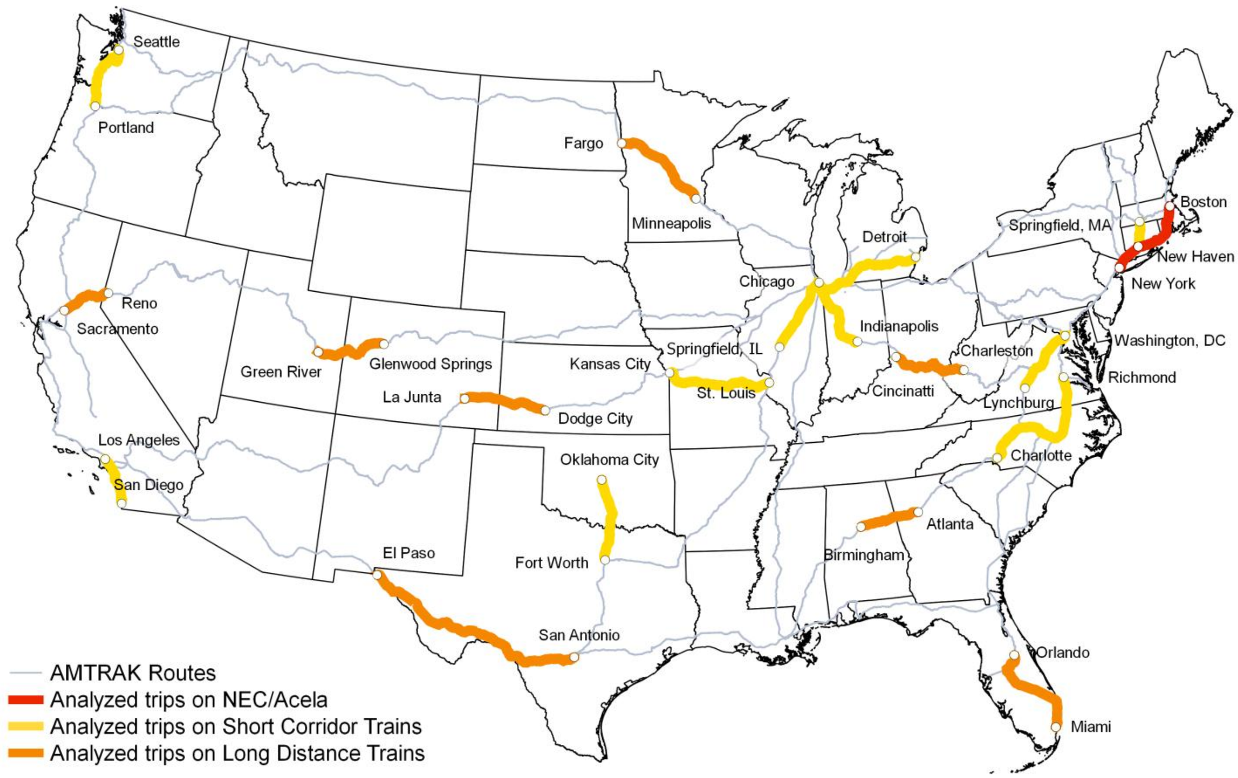

Figure 2 Amtrak and Motorcoach Trips Analyzed

The amount of service available for each of these twenty trips varies widely – from only one scheduled train or bus per day each way - between Dodge City Kansas and La Junta Colorado - to more than 35 trains or buses per day each way between Boston and New York City. In general the bus provides more schedule options than the train; for only one of the twenty trips are there more scheduled trains per week than buses (Chicago, IL – Springfield, IL). For half of the trips there are more than twice as many scheduled buses per week as trains.

The average speed on the route also varies significantly for both the train and the bus; for ten of the twenty trips total average travel time is less when taking the train, while for the other ten trips total average travel time is less when taking the bus. The difference in total travel time between modes is often small; for half of the trips the difference is less than one hour. The greatest differences are for the trips from Sacramento, CA to Reno, NV (bus travel time is 2.9 hours less) and from Cincinnati, OH to Charleston, WV (bus travel time is 3.7 hours longer).

See Figure 3 for a comparison of "typical" fares for each trip, based on data from the relevant carrier's website. All fares shown are for travel with at least one week advanced purchase; for both the train and bus fares are higher on most routes if tickets are purchased with less advanced notice. For some routes there are a range of fares shown – in many cases discounts are available for on-line purchase and/or fares vary by time of day departure.

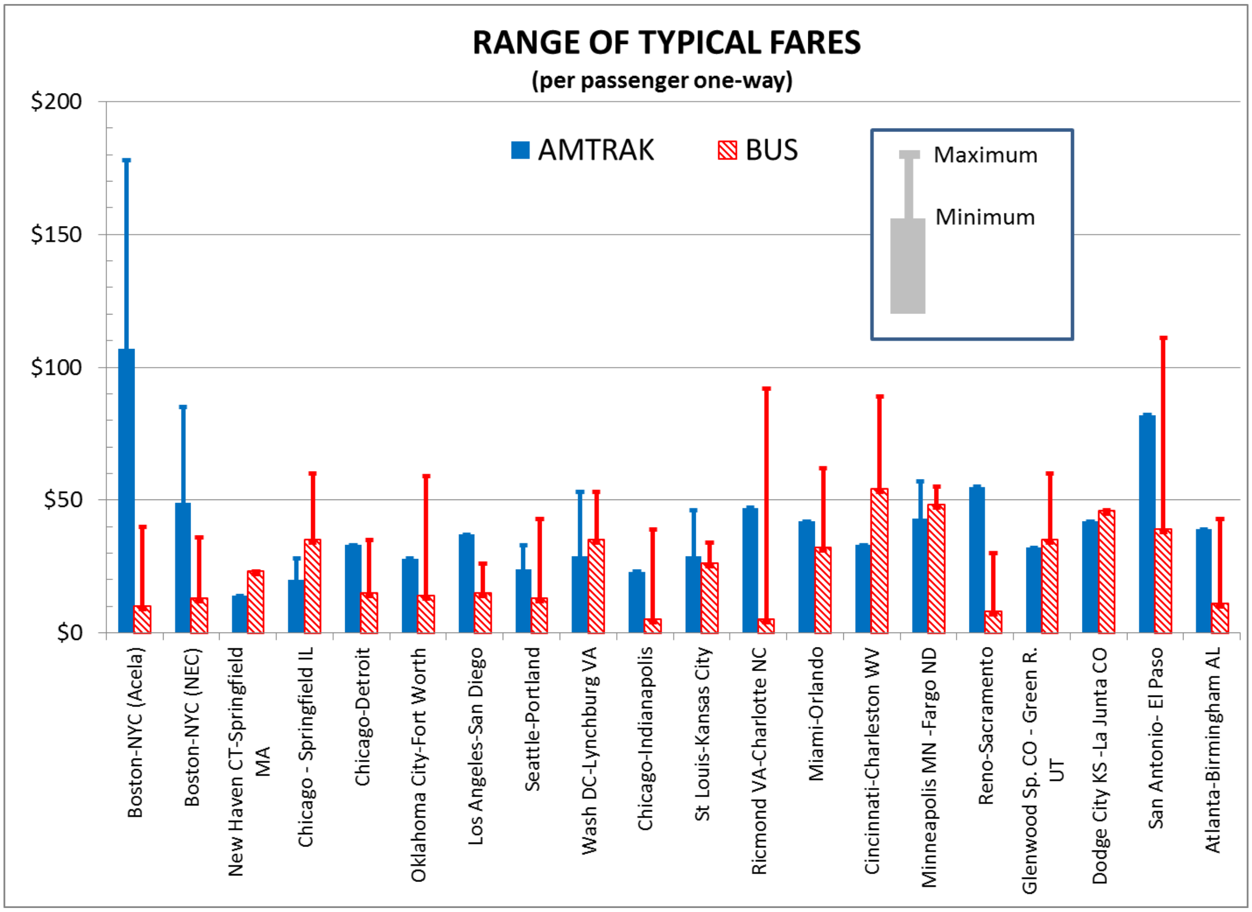

Figure 3 Comparison of Fares for Amtrak and Motorcoach Trips

As shown, fares are generally comparable between modes. For thirteen of the trips the minimum bus fare is lower than the minimum train fare. The biggest difference is for trips between Boston and New York City – the minimum fare for this trip on Amtrak's Acela train is $107 and the minimum fare on Amtrak's Northeast Corridor Regional trains is $49, compared to $10 for a motorcoach trip on Bolt Bus or MegaBus. Of the seven trips that are more expensive by bus the biggest difference is on the trip from Cincinnati, OH to Charleston, WV, which costs $33 on Amtrak's long-distance Cardinal train, but $54 on Greyhound. When comparing maximum fares there are only six trips which are cheaper by bus, and again the biggest difference is on the Northeast Corridor between Boston and New York City.

When you add in the "cost" to passengers of longer travel time on one mode versus the other the results are similar to the differences in fares. For thirteen of the twenty trips the total cost to customers for the fare plus the travel time difference is lower for the bus than for the train; on the other seven trips the total customer cost of the train is lower.

There are much more significant differences between modes in the average cost to provide service, as well as the amount of subsidy provided by local, state, and federal governments. See figure 4, which compares the average per-passenger cost to provide service for each of the analyzed trips.

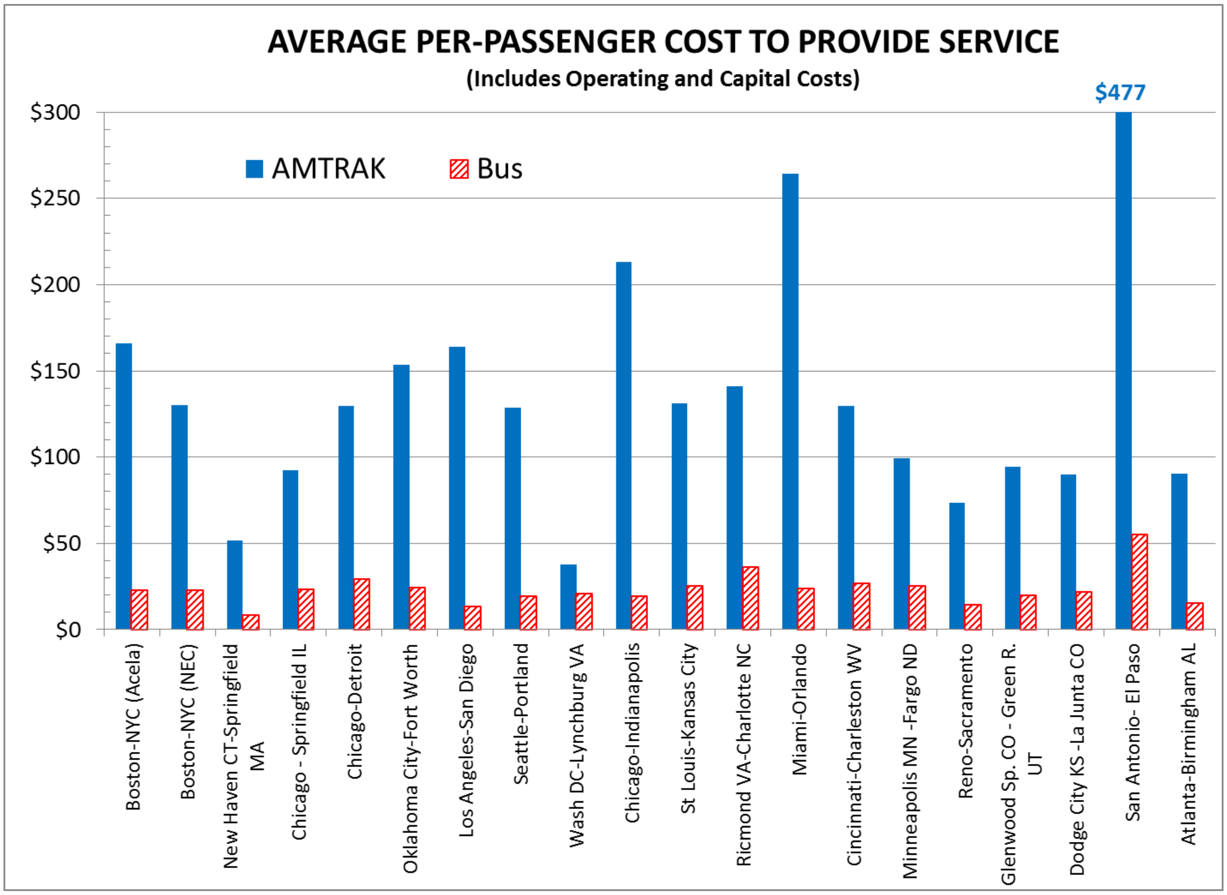

Figure 4 Comparison of Amtrak and Motorcoach Costs to Provide Service

For Amtrak trips the costs included in Figure 4 are based on fiscal year 2012 data reported by Amtrak for each route they operate, and they include both capital and operating costs. For motorcoach trips the costs shown are modeled costs based on industry-average cost data collected from American Bus Association member companies. These modeled motorcoach costs include the annualized cost of bus purchase, bus maintenance, fuel costs, driver labor costs, overhead and profit, and indirect government subsidies related to road building and maintenance of the highways on which motorcoaches operate.

As shown, for all of the analyzed trips the cost of providing scheduled motorcoach service is significantly lower than the cost of providing Amtrak train service. The cost difference ranges from a low of $17 per passenger (Washington, DC to Lynchburg, VA) to a high of more than $400 per passenger (San Antonio, TX to El Paso, TX).

Comparison of Figure 3 and Figure 4 shows that for intercity bus trips the fare charged is generally in line with average costs to provide service – which is not surprising since all of these buses are operated by private, for-profit companies. On the other hand, Amtrak's average cost to provide service on most of the analyzed trips is significantly higher than the fares that they charge. The difference is made up by state and federal subsidies.

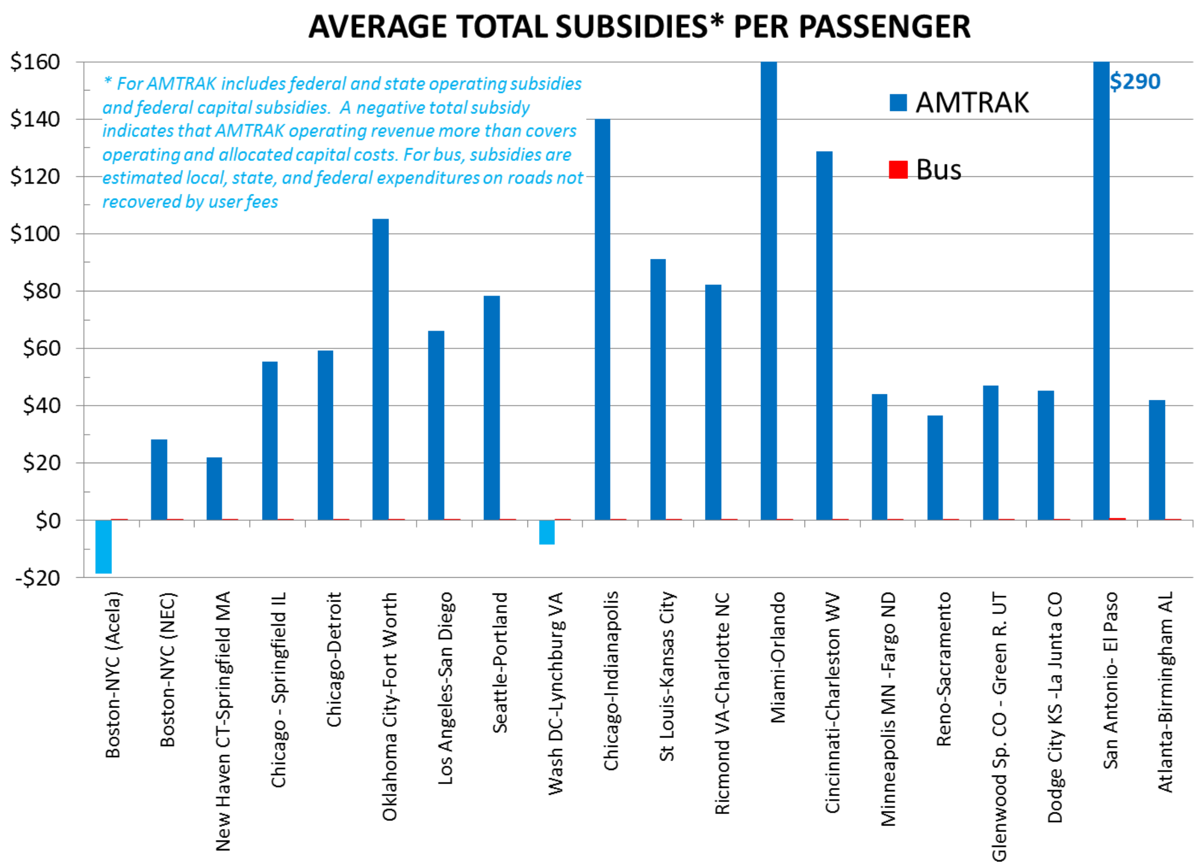

Figure 5 Comparison of Amtrak and Motorcoach Total Subsidies

See Figure 5 for a comparison of average total federal and state subsidies ($ per passenger) provided to Amtrak and to scheduled motorcoach buses for each of the trips analyzed. The Amtrak subsidies shown include state and federal operating subsidies and federal capital subsidies provided in fiscal year 2012. For motorcoaches the subsidies shown are indirect subsidies from local, state, and federal spending on highways which is not covered by road "user fees"[6]. None of the companies that operate scheduled intercity bus service for the trips analyzed here receive any direct capital or operating subsidies for these services.

As shown in figure 5, average total Amtrak capital and operating subsidies for the trips analyzed range from a low of $21.93 per passenger for trips from Springfield, MA to New Haven, CT to a high of $289.56 for trips from San Antonio, TX to El Paso, TX. Average total indirect capital subsidies provided to intercity motorcoaches for the analyzed trips range from $0.09 to $0.74 per passenger.

Two of the analyzed Amtrak trips are shown in Figure 5 to have negative average subsidies – trips taken on ACELA trains between Boston and New York City, as well as trips taken between Washington, DC and Lynchburg, VA. This means that Amtrak gets enough passenger revenue from these trips to pay the average capital and operating costs on these routes – i.e. these trips are profitable for Amtrak. These are the only two routes in the Amtrak system which are profitable. There are two other Amtrak routes that generate enough passenger revenue to cover their operating costs, but not enough to also cover their capital costs; these are the Northeast Corridor regional trains and the Carolinian short-corridor train that operates between New York City and Charlotte, NC.

This analysis also evaluated the environmental impact of taking a motorcoach compared to taking an Amtrak train, by determining for each mode and trip exhaust emissions (grams per passenger) of carbon dioxide (CO_2), nitrogen oxides (NO_x), volatile hydrocarbons (HC), and particulate matter (PM). See figure 6 for a comparison of average CO_2 emissions (grams per passenger) for all of the analyzed trips. As shown, for the trips analyzed per-passenger CO_2 emissions from motorcoaches were 45% to 66% lower than from Amtrak locomotives.

For trips on Amtrak routes other than the Northeast Corridor, per-passenger NOx, PM, and VOC emissions are also lower for motorcoach trips than for train trips. NOx and PM emissions are on average about 80% lower, while VOC emissions are about 90% lower. For trips on the Northeast Corridor, where Amtrak runs electric locomotives, trips by train generate per-passenger NOx, PM, and VOC emissions that are about 70% lower than those generated by motorcoach trips.

---

[6] User fees dedicated to cover a portion of government spending on roads include taxes on vehicles, tires, and fuel, as well as highway and bridge tolls.

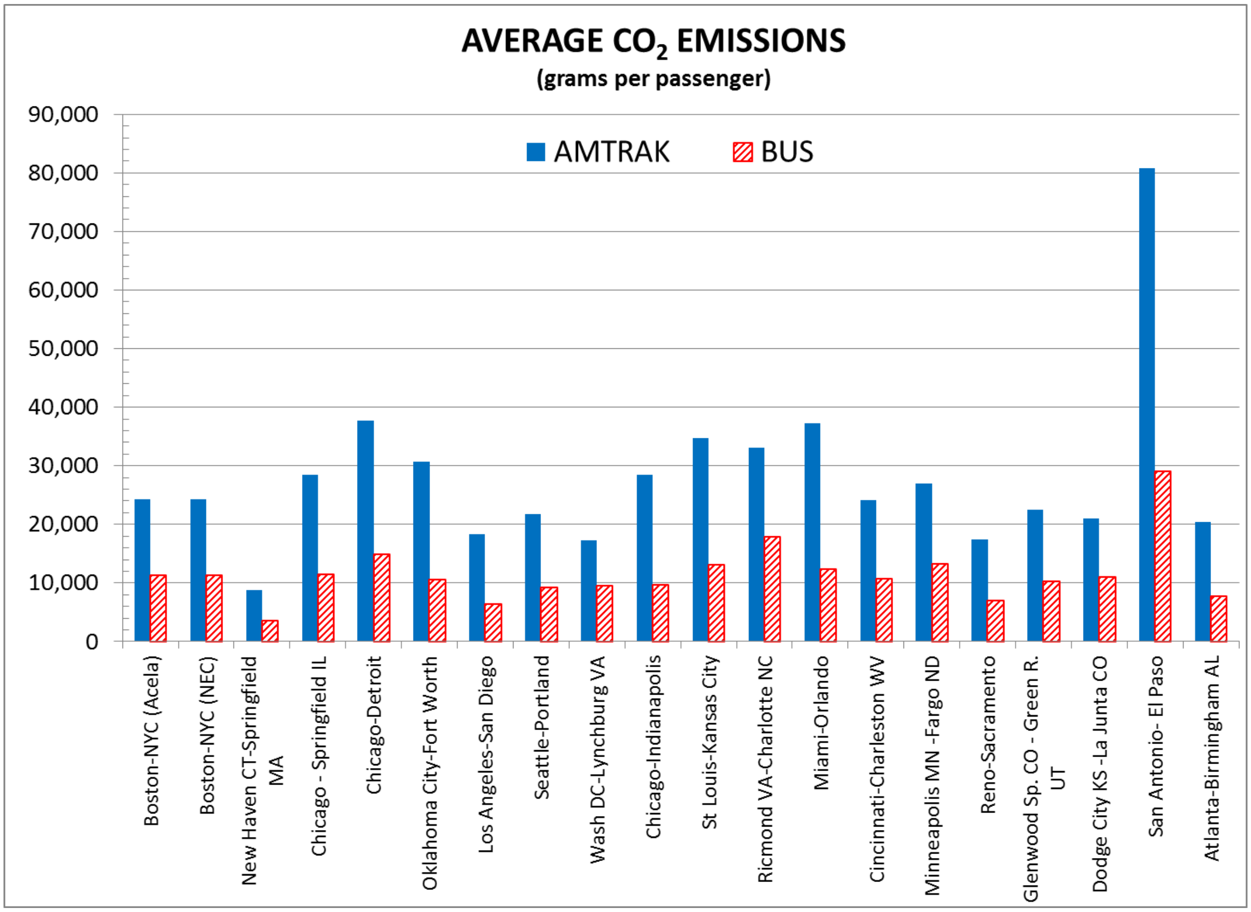

Figure 6 Comparison of Amtrak and Motorcoach CO_2 Emissions

1 Study Methodology

This section briefly discusses the methodology, data sources, and assumptions used in this study. Additional details are included in Appendix A.

1.1 Current Amtrak Service

Data on Amtrak ridership, service (annual seat-miles and passenger-miles) operating costs, and operating revenue - by route - was taken from the *Amtrak Monthly Performance Report, September 2012*. The year-to-date data in this report covers the entire 2012 fiscal year, which ran from October 1, 2011 to September 30, 2012. This is the most current full-year data available from Amtrak.

Data on Amtrak capital costs was taken from the *Amtrak Fiscal Year 2012 Budget and Comprehensive Business Plan*. This analysis includes $613.2 million in FY2012 capital spending allocated by Amtrak in that plan directly to individual routes, and $255 million of unallocated debt service. For this analysis the FY2012 debt service costs were allocated to routes in the same proportion as the FY2012 capital expenses allocated by Amtrak. This analysis does not include $73.4 million in capital costs from the FY2012 budget for "environmental remediation and station-related commercial projects" which Amtrak did not allocate to routes.

For each route, total operating costs, total capital costs, and total passenger revenue were divided by total annual passenger miles to get average costs and revenues per passenger mile on each route. Average FY2012 Amtrak operating costs on the analyzed routes ranged from $0.245 to $1.184 per passenger-mile. Average FY2012 Amtrak capital costs on the analyzed routes ranged from $0.035 to $0.251 per passenger-mile. Average FY2012 Amtrak passenger revenue on the analyzed routes ranged from $0.153 to $0.911 per passenger-mile.

To calculate average Amtrak costs to provide the specific trips analyzed ($ per passenger), the average costs on the applicable route ($/passenger-mile) were multiplied by the trip distance (miles). To calculate average Amtrak revenues from the specific trips analyzed ($ per passenger), the average revenue on the applicable route ($/passenger-mile) was multiplied by the trip distance (miles).

For seven of the trips analyzed Amtrak receives an annual state operating subsidy for the specific route used. These state subsidies are included by Amtrak in reported passenger revenues for each route. Amtrak reports the total amount of state subsidy received each year, but does not detail payment amounts by individual states or for individual routes. To determine how much state subsidy money was included in the average Amtrak revenue for each analyzed trip the authors collected information on state subsidy payments from local news accounts in the relevant states. For each route total annual state subsidy payments were divided by total annual passenger-miles to calculate the average state subsidy per passenger-mile on that route. Average state subsidies on the analyzed routes range from $0.01 to $0.23 per passenger-mile. To calculate the average state subsidy per trip ($ per passenger) the average state subsidy ($ per passenger-mile) was multiplied by the trip distance (miles).

For many of the trips analyzed average Amtrak operating revenues ($ per passenger) are insufficient to cover average operating costs ($ per passenger). The short-fall is covered by annual federal operating subsidies. In FY2012 Amtrak operating losses across all of its routes totaled $502.8 million, but federal operating subsidies totaled only $345.3 million, due to the limited number of routes that make money on an operating basis (primarily the Acela and Northeast Corridor regional trains) and to non-operating revenues realized by Amtrak. For each trip analyzed here the average federal operating subsidy ($ per passenger) was calculated by subtracting average passenger revenue from average operating cost for the trip; however, these preliminary figures were adjusted downward by 31% for each trip, to account for the difference between total operating losses and total federal operating subsidies in FY2012.

The trip distance for each trip was taken from Amtrak route maps included in Wikipedia. For each trip the number of weekly scheduled trains, the scheduled trip time, and typical one-way passenger fare were determined by reviewing the Amtrak website. This website was accessed on March 11 – 12, 2013. Listed fares are for travel with at least one week advanced purchase. On many routes tickets with less than one week advanced purchase are more expensive.

1.2 Current Motorcoach Service

For each trip analyzed the availability of existing scheduled motorcoach service to connect the starting and ending destination was determined by first accessing the websites of the major national bus companies. If one of the major national carriers serves the trip with a single bus (no transfers) information on available service from that company (weekly scheduled buses, scheduled trip time, and typical fare) was taken from the website. If no national carrier serves the route the authors checked the website of a regional or local carrier. These websites were accessed on March 11-12, 2013. Listed fares are for travel with at least one week advanced purchase. On many routes tickets with less than one week advanced purchase are more expensive. The minimum and maximum fares listed represent the range of fares available based on a number of factors including discounts for on-line purchase, discounts for pre-purchase and different fares for different days of the week or time of day.

The one-way trip length (miles) for each bus trip was determined using Google Maps, including any intermediate stops per the published schedule.

The average cost to provide scheduled bus service for each trip was determined using cost factors which account for all bus capital and operating costs, including: bus purchase/lease, annual bus maintenance, bus operator labor, fuel, and overhead and profit. Direct bus operator labor costs ($18.00 per hour) were taken from the U.S. Department of Labor, Bureau of Labor Statistics May 2011 *National Occupational Employment and Wage Estimates* (mean wage rate for labor category 53-3021 Bus Driver, Transit and Intercity). Indirect driver labor costs ($5.40 per hour) were taken from an economic impact model developed by John Dunham & Associates for the American Bus Association Foundation in January 2013.

Fuel costs ($/gallon) were taken from the U.S. Department of Energy, Energy Information Administration, *Weekly Retail Gasoline and Diesel Prices*, 02/04/13, (Diesel [on highway] all types). Assumed fuel costs range from $3.84/gallon to $4.24/gallon. Average fuel economy was assumed to be 6.0 miles per gallon, which is the U.S. motorcoach industry average, per the *Motorcoach Census 2011* conducted for the American Bus Association Foundation by John Dunham & Associates in June 2012.

All other major cost assumptions (bus purchase price, annual bus maintenance costs, overhead rates, bus miles per year) were determined via a survey of American Bus Association (ABA) member companies. Responding companies represent national, large and medium sized companies from various parts of the country. These companies operate a total of approximately 2,000 coach buses. While there was variability in the responses received, there was no clear pattern of regional differences, so the analysis assumes one set of bus operating cost factors for all routes. For each cost factor the values used represent the median of all responses received.

The bus operating cost factors were used to calculate an average cost per bus-mile for bus operations, which ranged from $3.14 to $4.13 per bus-mile for the routes analyzed. Per-mile bus operating costs vary by route primarily due to differences in average speed on the route (which affects driver costs) and differences in fuel costs for different parts of the country. To calculate average costs per passenger-mile, average costs per bus-mile were divided by the average motorcoach passenger load of 32 passengers (per *Motorcoach Census 2011*). For the analyzed trips the average cost to provide scheduled bus service ranged from $0.099 to $0.129 per passenger-mile. To calculate average costs per passenger-trip, average costs per passenger-mile were multiplied by trip length (miles).

None of the bus operators that operate service on the analyzed routes receive direct local, state, or federal capital or operating subsidies. However, these operators benefit from indirect government subsidies used to build and maintain the public roads on which motorcoaches operate. Some of these road-building costs are paid for by state and federal excise taxes on vehicles, tires, and vehicle fuel, as well as other "user fees" (i.e. tolls). However, historically these revenues have been insufficient to cover all costs. According to the Federal Highway Administration, in 2010 the federal government spent $30.2 billion on highways that came from general fund revenues as opposed to fuel and vehicle taxes, and state and local governments spent an additional $50 billion funded by property tax assessments and general fund appropriations[7].

To calculate the indirect road-related capital subsidy for intercity motorcoach services, this analysis used figures from an analysis by Nathan & Associates[8]. This analysis calculated average federal subsidies ($ per passenger-mile) attributable specifically to privately operated intercity buses by subtracting federal user fee revenue attributable to these buses from the proportion of total federal highway costs attributable to these buses. The analysis determined that between 2002 and 2009 federal subsidies to intercity buses averaged $0.0005 per passenger-mile.

Because the Nathan and Associates analysis only included federal spending, this analysis estimated the average state and local subsidy per passenger-mile using the Federal Highway Administration spending figures for 2010 noted above, by assuming that the percentage of total state and local highway spending attributable to intercity buses is the same as the percentage of total federal spending attributable to intercity buses, as determined by the Nathan & Associates analysis. Estimated state and local road-related subsidies to intercity buses using this methodology average $0.0008 per passenger-mile.

Estimated total federal, state, and local indirect road-related subsidies for intercity bus service ranged from $0.09 - $0.74 per trip for the trips analyzed.

1.3 Incremental Trip Time

See figure 7 for a representation of how total trip time was calculated for both Amtrak and motorcoach trips, on each route. As shown, the assumed total trip time for both modes includes the scheduled drive time, and an assumed average congestion delay, both of which vary by route. It also includes for every route a constant fifteen minutes for train or bus check-in at the departure station/terminal, and fifteen minutes for disembarking at the destination station/terminal.

---

[7] Federal Highway Administration, Highway Statistics 2010, Table HF-10, March 2012

[8] R. Damuth, Nathan & Associates, *Federal Subsidies for Passenger Transportation 1960 -2009*, March 2, 2011.

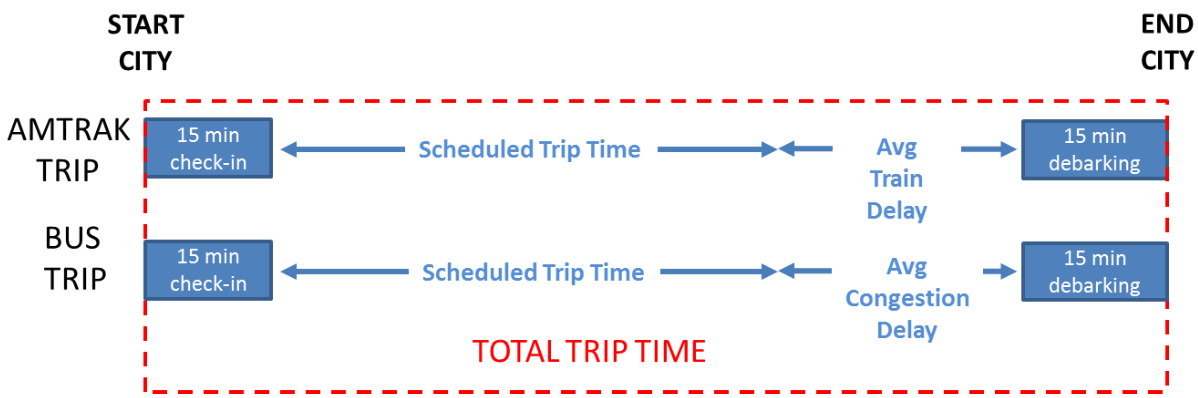

Figure 7 Calculation of Total Trip Time for Amtrak and Motorcoach Trips

For each route, scheduled drive time for Amtrak trips was taken from Amtrak's website, and scheduled drive time for motorcoach trips was taken from the motorcoach operator's website.

For Amtrak trips the assumed average congestion delay for each trip is calculated using the total annual train delay minutes on each route, per Amtrak's FY2012 monthly performance reports[9]. To calculate the average delay per train (minutes) total annual delay minutes on the route were divided by the number of annual trains operated on the route. The calculated average delay ranged from zero to 381 minutes per train. Most of the analyzed trips cover only a portion of the total route taken by each scheduled train. This analysis assumes that total train delays are evenly distributed across a route, so the average train delay per trip was calculated by multiplying the average delay per train times the trip length divided by the train's total corridor length. The average train delay per trip ranged from zero to 60 minutes for the analyzed trips.

For motorcoach trips the assumed average congestion delay for each trip is based on the Travel Time Index and Daily Congestion Time for the urban areas which include the starting and ending location of each trip. These values are published in the 2011 Annual Urban Mobility Report.[10]

The travel time index is a measure of the ratio of travel time in the peak period to travel time during free flow conditions in that urban area, and the Daily Congestion Time is a measure of the average time each day (hr) in which congested conditions exist, resulting in slower drive times. To assess the average increase in travel time due to congestion during the urban portion of each bus trip this analysis assumes that for each route the urban portion at both the starting and ending city is 30 miles long and that free flow traffic speed is 50 miles per hour, resulting in a baseline trip duration of 0.60 hours for the urban portions of each bus trip. This is multiplied by the travel time index to

[9] Amtrak Monthly Performance Reports, Oct 2011 - Sep 2012, Table E-1

[10] Texas Transportation Institute, *Congestion Data for Your City*, http://mobility.tamu.edu/ums/congestion_data/

determine the increase in trip time (hr) when traffic is congested. Since not all trips will occur during peak periods, this peak period delay time is multiplied by the ratio of daily congestion time (hr) to total available daily bus travel time (15 hours) to get the average congestion delay time for all daily trips.[11]

For the trips included in the study the calculated congestion delay for the urban portions of the bus trips during peak periods ranges from zero to 22 minutes per trip, and the average congestion delay for all daily trips ranges from zero to nine and a half minutes.

For each route the incremental total trip time for bus trips compared to Amtrak trips is calculated by subtracting total Amtrak trip time from total bus trip time. For nine of the 20 routes included in the analysis the incremental trip time is negative (i.e. the motorcoach trip takes less time than the Amtrak trip) and for eleven it is positive (i.e. the motorcoach trip takes more time than the Amtrak trip). Incremental trip times for the analyzed trips range from -2.9 hours to +3.7 hours.

1.4 Value of Incremental Trip Time

To determine the appropriate monetary value for incremental trip time for this analysis the authors used the methodology recommended by the U.S. Department of Transportation for transportation investments.[12] For personal travel this methodology starts with U.S. Census data on median annual household income, by census region, to calculate median hourly income ($/hr); DOT recommends using 70% of this figure for the value of time related to personal surface travel. For business travel the methodology starts with data from the Bureau of Labor Statistics on total employer costs for employee compensation ($/hr), by census region; DOT recommends using 100% of this figure for the value of time related to business surface travel. To determine a single figure for the value of time for all surface travel DOT assumes that 68.7% of travel is personal and 31.3% is for business.

Using this methodology, the values used to monetize incremental trip times in this study range from a low of $16.70/hr (East South Central region) to a high of $24.62/hr (New England region).

1.5 Emissions

Calculated exhaust emissions of nitrogen oxides (NOx), particulate matter (PM), volatile organic hydrocarbons (HC), and carbon dioxide (CO_2) from electrified Amtrak trains that operate on the Northeast Corridor between Boston and New York City are based

[11] For this analysis this average congestion delay is applied to all bus trips to a given urban area – in fact some daily trips will experience no congestion delay and others will experience a delay longer than the average.
[12] U.S. DOT, *Revised Departmental Guidance, Valuation of Travel Time in Economic Analysis, 2/22/03*

on average electricity use on the corridor (kilowatt-hours per passenger-mile) and estimated emission factors (g/kWh) for electricity generation in the states spanned by the trip. Average electricity use of 0.31 kWh/passenger-mile was calculated by dividing reported total annual electricity use (U.S. Department of Transportation, Bureau of Transportation Statistics, National Transportation Statistics, Table 4-26, data for 2011) by total annual passenger miles operated on the corridor (Amtrak Monthly Performance Report, September 2012, Table C-2, FY2011 total). Weighted average emission factors from electricity production are based on data from the U.S. Energy Information Administration, *State Electricity Profiles 2010* (DOE/EIA-0348 (01)/2, Jan 27, 2012), for the states of Massachusetts, Rhode Island, Connecticut, and New York and on emission factors from EPA's *AP-42*, *Compilation of Air Pollutant Emission Factors.* Emission factors from each state were weighted based on the Northeast Corridor track miles within the state.

Emission factors for Amtrak's diesel locomotives (used for all of the analyzed trips other than those on the Northeast Corridor) were determined based on the age of the locomotive fleet, and the applicable EPA engine emission standards. EPA emission standards for new locomotive engines did not take effect until the 2002 model year. In accordance with the fleet list in the Amtrak Fleet Strategy (Version 3.1, March 2012) all 289 of Amtrak's diesel locomotives were built prior to 2002, and were therefore delivered with unregulated engines. In 1997 EPA instituted Tier 0 standards, applicable retroactively, beginning in 2000, to locomotive engines built after 1973, when next remanufactured. In 2008 EPA mandated that, beginning in 2010, Tier 0 engines be further upgraded to Tier 0+ standards when next remanufactured. Based on standard industry practice to remanufacture locomotive engines every 10 years, this analysis assumes that all Amtrak locomotives have been remanufactured since 2000 and meet Tier 0 standards, and that 20% of them have been remanufactured since 2010 and therefore meet Tier 0+ standards.

Using the Tier 0 and Tier 0+ numerical emission standards (grams per kilowatt-hour of engine output, g/kWh), and reported average fuel use of 2.3 gallons per train mile for Amtrak diesel locomotives (Amtrak Monthly Performance Report, September 2012, Table A-2.2, FY2012) the authors calculated average distance-specific emission factors (grams per train mile) for Amtrak diesel locomotives. Average emissions of NOx, PM, VOC, and CO_2 per seat-mile were determined by dividing these emission factors by the average number of riders per train (FY2012 total annual seat-miles ÷ FY2012 total annual train-miles; from Amtrak Monthly Performance Report, September 2012, Table A-2.2). Average emissions per trip were calculated by multiplying g/seat-mile times trip distance (miles) and dividing by the load factor on the route (load factor = passengers ÷ seats).

Calculated exhaust emissions of NOx, PM, and VOC from motorcoach trips are based on distance-specific emission factors (g/mi) from EPA's MOVES emissions model. The emissions factors used are national average values for calendar year 2012, vehicle type = intercity bus, and roadway type = composite road (mixed driving cycles representing urban and rural traffic conditions). Distance-specific CO_2 emission factors (g/mi) are based on assumed average coach bus fuel economy of 6.0 MPG (*Motorcoach Census 2011*) and a fuel-specific CO_2 emissions factor of 10,084 grams CO_2 per gallon[13].

Emissions rates per passenger-mile were determined by dividing gram per mile emission factors by the average motorcoach load factor of 32 passengers per bus-mile (*Motorcoach Census 2011*). Emissions per trip (grams per passenger) were calculated by multiplying the grams per passenger-mile emission factors by trip distance.

[13] EPA 420-F-05-001, Feb 2005

2 Results

This section summarizes the detailed results of this analysis for each trip analyzed. Additional detail is provided in the tables included in Appendix A.

2.1 Amtrak Compared to Motorcoach – Service Levels

See Table 1 for the details of service provided by Amtrak between the twenty ity pairs analyzed here, and Table 2 for the details of current scheduled intercity motorcoach service between these same city pairs.

See Figure 8 for a comparison of total trip distances for each trip on each mode, Figure 9 for a comparison of service levels (scheduled trains or buses per week)[14], and Figure 10 for a comparison of total average trip times.

For the trips analyzed, the trip distance ranges from a low of 64 miles for the trip between Springfield, MA and New Haven, CT to a high of 605 miles for the trip between San Antonio, TX and El Paso, TX. The majority of the analyzed trips are between 100 and 200 miles in length.

The amount of service available for each of these twenty trips varies widely – from only one scheduled train or bus per day each way - between Dodge City Kansas and La Junta Colorado - to more than 35 trains or buses per day each way between Boston and New York City (including both ACELA and Northeast Corridor regional trains, and buses operated by Peter Pan Lines, Greyhound, Bolt Bus and Mega Bus)[15].

In general the bus provides more schedule options than the train; for only one of the 20 trips are there more scheduled trains per week than buses. For half of the trips there are more than twice as many scheduled buses per week as trains.

The average speed on the route also varies significantly for both the train and the bus; for ten of the twenty trips total average travel time is less when taking the train, while for the other ten trips total average travel time is less when taking the bus. The difference in total travel time between modes is often small; for half of the trips the difference is less than one hour. The greatest differences are for the trips from Sacramento, CA to Reno, NV (bus travel time is 2.9 hours less) and from Cincinnati, OH to Charleston, WV (bus travel time is 3.7 hours longer).

[14] Note that the number of weekly buses shown on each route in Figure 9 only includes the major carriers surveyed for this analysis, and may not represent the universe of bus options for some trips.
[15] There are additional scheduled motorcoach services operated between Boston and New York City by discount bus companies such as Chinatown Bus, Lucky Star Bus and GoToBus.

Table 1 Details of Amtrak Trips

Rte No.	Train	Start	End	Trip Length (mi)	Weekly One-way Trains	Station Stops	Scheduled Trip Time (hr)	Average Delay on Route (hr)	Total Trip Time (hr)
	AMTRAK TRIP								
RT 01	Acela	Boston, MA	New York, NY	229	112	5	3.58	0.08	4.16
RT 05	NE Regional	Boston, MA	New York, NY	229	140	11	4.22	0.17	4.88
RT 12	New-Haven Springfield	New Haven, CT	Springfield, MA	64	42	7	1.48	0.00	1.98
RT 20	Chicago-St Louis	Chicago, IL	Springfield, IL	201	49	7	3.41	0.32	4.22
RT 22	Wolverine	Chicago, IL	Detroit, MI	281	21	13	5.47	1.00	6.97
RT 29	Heartland Flyer	Oklahoma City, OK	Fort Worth, TX	206	7	6	4.23	0.73	5.47
RT 35	Pacific Surfliner	Los Angeles, CA	San Diego, CA	120	77	12	2.71	0.20	3.41
RT 36/34	Cascades/Coast Starlight	Seattle, WA	Portland, OR	187	42	7	3.50	0.32	4.32
RT 46	Washington-Lynchburg	Washington, DC	Lynchburg, VA	173	14	16	3.63	0.13	4.26
RT 54	Hoosier State	Indianapolis, IN	Chicago, IL	196	4	5	5.08	0.87	6.45
RT 56	Missouri River Runner	St Louis, MO	Kansas City, MO	250	14	9	5.67	0.10	6.27
RT 66	Carolinian	Richmond, VA	Charlotte, NC	378	7	13	7.03	0.79	8.32
RT 16/19	Silver Star/Silver Meteor	Miami, FL	Orlando, FL	357	14	12	6.18	0.93	7.61
RT 18	Cardinal	Cincinnati, OH	Charleston, WV	205	7	6	4.88	0.27	5.65
RT 25	Empire Builder	Minneapolis, MN	Fargo, ND	244	14	4	4.33	0.34	5.17
RT 27	California Zephyr	Reno, NV	Sacramento, CA	151	7	4	5.62	0.39	6.51
RT 27	California Zephyr	Glenwood Springs, CO	Green River, UT	194	7	2	4.08	0.50	5.09
RT 28	Southwest Chief	Dodge City, KS	La Junta, CO	203	7	3	3.83	0.36	4.70
RT 33	Sunset Limited	San Antonio, TX	El Paso, TX	605	7	4	11.62	0.97	13.09
RT 52	Crescent	Atlanta, GA	Birmingham, AL	164	7	2	4.20	0.28	4.98

Table 2 Details of Scheduled Intercity Motorcoach Trips

AMTRACK OPTION		BUS OPTION										
Rte No.	Train	Company	Start	End	Drive Route	Distance (mi)	Weekly One-way Buses	Station Stops	Scheduled Trip Time (hr)	Avg Congestion Delay (hr)	Total Trip Time (hr)	Incr Trip Time (hr)
RT 01	Acela	MEGA Bus/Bolt Bus	Boston, MA	New York, NY	I-95	215	161	1	4.25	0.145	4.90	0.74
RT 05	NE Regional	Greyhound/Peter Pan	Boston, MA	New York, NY	I-95	215	142	1	4.33	0.145	4.98	0.10
RT 12	New-Haven Springfield	Peter Pan Bus	New Haven, CT	Springfield, MA	I-91	68	42	3	1.83	0.025	2.36	0.38
RT 20	Chicago-St Louis	Greyhound	Chicago, IL	Springfield, IL	I-57 & 72W	219	14	7	5.00	0.050	5.55	1.33
RT 22	Wolverine	Greyhound	Chicago, IL	Detroit, MI	I-94	283	98	3	5.93	0.082	6.52	(0.46)
RT 29	Heartland Flyer	Greyhound	Oklahoma City, OK	Fort Worth, TX	I-35	202	56	8	6.71	0.056	7.26	1.80
RT 35	Pacific Surfliner	Crucero/Crucero Direct	Los Angeles, CA	San Diego, CA	I-5	121	140	3	2.56	0.160	3.22	(0.18)
RT 36/34	Cascades/Coast Starligh	Greyhound	Seattle, WA	Portland, OR	I-5	174	42	5	4.08	0.110	4.69	0.37
RT 46	Washington-Lynchburg	Greyhound	Washington, DC	Lynchburg, VA	I-29	181	14	5	5.38	0.092	5.97	1.71
RT 54	Hoosier State	Greyhound	Indianapolis, IN	Chicago, IL	I-65	183	49	4	3.67	0.078	4.24	(2.21)
RT 56	Missouri River Runner	Greyhound	St Louis, MO	Kansas City, MO	I-70	250	21	3	4.50	0.043	5.04	(1.22)
RT 66	Carolinian	Greyhound	Richmond, VA	Charlotte, NC	I-40 & I-85	340	56	2	7.93	0.033	8.46	0.13
RT 16/19	Silver Star/Silver Meteor	Greyhound (express)	Miami, FL	Orlando, FL	FL-91	234	30	1	4.50	0.075	5.07	(2.53)
RT 18	Cardinal	Greyhound	Cincinnati, OH	Charleston, WV	OH-32	204	14	5	8.79	0.021	9.31	3.66
RT 25	Empire Builder	Jefferson Lines	Minneapolis, MN	Fargo, ND	I-94 & 52	253	21	6	4.56	0.046	5.11	(0.06)
RT 27	California Zephyr	Greyhound	Reno, NV	Sacramento, CA	I-80	132	28	4	3.04	0.030	3.57	(2.94)
RT 27	California Zephyr	Greyhound	Glenwood Springs, CO	Green River, UT	I-70	195	14	2	3.88	0.000	4.38	(0.71)
RT 28	Southwest Chief	Greyhound	Dodge City, KS	La Junta, CO	US-400 / 50	210	7	6	4.50	0.000	5.00	0.30
RT 33	Sunset Limited	Greyhound	San Antonio, TX	El Paso, TX	I-10	553	14	5	10.33	0.051	10.88	(2.20)
RT 52	Crescent	Greyhound	Atlanta, GA	Birmingham, AL	I-20	147	49	3	2.92	0.066	3.49	(1.50)

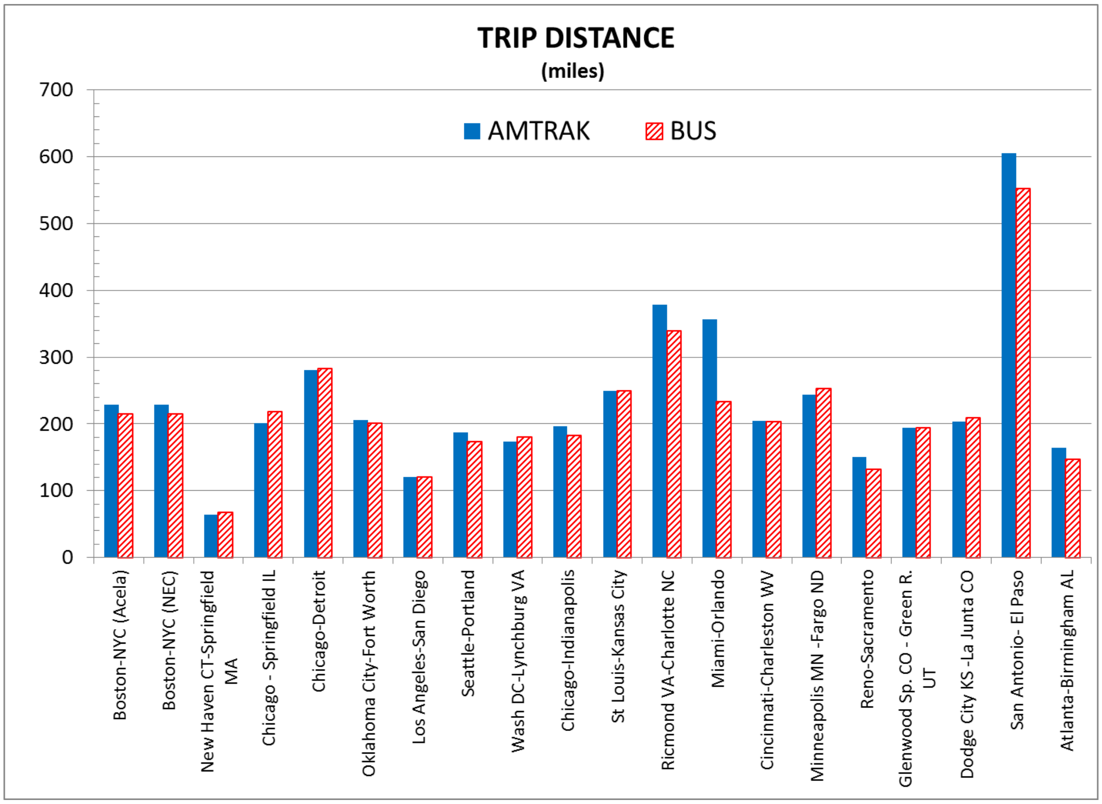

Figure 8 Comparison of Amtrak and Motorcoach Trip Distance

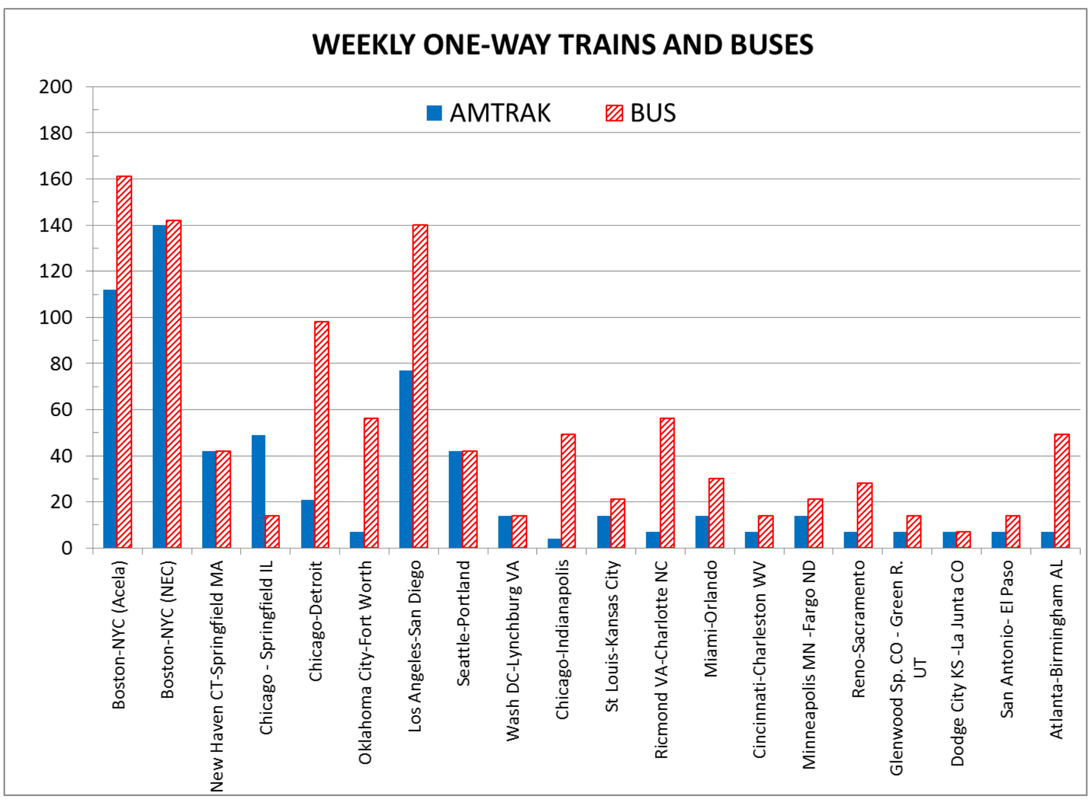

Figure 9 Comparison of Amtrak and Motorcoach Service Levels

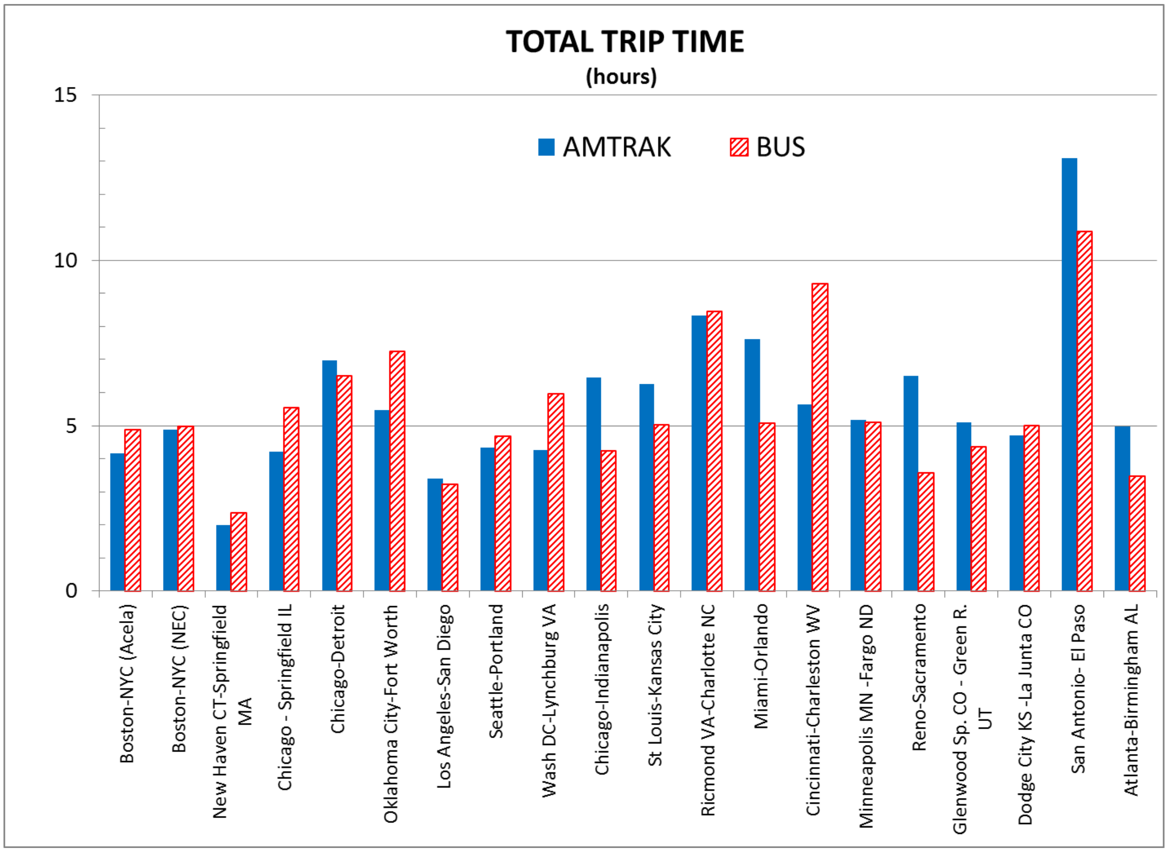

Figure 10 Comparison of Amtrak and Motorcoach Total Trip Time

2.2 Amtrak Compared to Motorcoach – Fares, Costs, & Subsidies

See Table 3 for a comparison of total customer costs when taking Amtrak and scheduled motorcoach service for the analyzed trips. The fares shown are for travel with at least one week advance purchase; for both the train and bus fares are higher on most routes if tickets are purchased with less advance notice. For some routes there are a range of fares shown – in many cases discounts are available for on-line purchase and/or fares vary by time of day departure.

As shown, fares are generally comparable between modes. For thirteen of the trips the minimum bus fare is lower than the minimum train fare. The biggest difference is for trips between Boston and New York City – the minimum fare for this trip on Amtrak's Acela train is $107 and the minimum fare on Amtrak's Northeast Corridor Regional trains is $49, compared to $10 for a motorcoach trip on Bolt Bus or MegaBus. Of the seven trips that are more expensive by bus the biggest difference is on the trip from Cincinnati, OH to Charleston, WV, which costs $33 on Amtrak's long-distance Cardinal train, but $54 on Greyhound. When comparing maximum fares there are only six trips which are cheaper by bus, and again the biggest difference is on the Northeast Corridor between Boston and New York City.

Table 3 Comparison of Amtrak and Motorcoach Customer Costs

TRIP		AMTRAK TRAIN/BUS COMPANY		TYPICAL FARE PER PASSENGER				"Cost" of Incr Trip Time, Bus	Total Customer Cost per Trip (Fare + Cost of Incr Travel Time)	
				AMTRAK		BUS				
Start	End	AMTRAK	BUS	MIN	MAX	MIN	MAX		AMTRAK	Bus
Boston, MA	New York, NY	Acela	MEGA Bus/Bolt Bus	$ 107.00	178.00	$10.00	$40.00	$18.14	$ 107.00	$28.14
Boston, MA	New York, NY	NE Regional	Greyhound/Peter Pan	$ 49.00	85.00	$13.00	$35.95	$2.34	$ 49.00	$15.34
New Haven, CT	Springfield, MA	New-Haven Springfield	Peter Pan Bus	$ 14.00	14.00	$23.00	$23.00	$9.30	$ 14.00	$32.30
Chicago, IL	Springfield, IL	Chicago-St Louis	Greyhound	$ 20.00	28.00	$35.00	$60.00	$26.91	$ 20.00	$61.91
Chicago, IL	Detroit, MI	Wolverine	Greyhound	$ 33.00	33.00	$15.00	$35.00	($9.23)	$ 33.00	$5.77
Oklahoma City, OK	Fort Worth, TX	Heartland Flyer	Greyhound	$ 28.00	28.00	$14.00	$59.00	$33.93	$ 28.00	$47.93
Los Angeles, CA	San Diego, CA	Pacific Surfliner	Crucero/Crucero Direct	$ 37.00	37.00	$15.00	$26.00	($4.29)	$ 37.00	$10.71
Seattle, WA	Portland, OR	Cascades/Coast Starlight	Greyhound	$ 24.00	33.00	$13.00	$43.00	$8.54	$ 24.00	$21.54
Washington, DC	Lynchburg, VA	Washington-Lynchburg	Greyhound	$ 29.00	53.00	$35.00	$53.00	$33.09	$ 29.00	$68.09
Indianapolis, IN	Chicago, IL	Hoosier State	Greyhound	$ 23.00	23.00	$5.00	$39.00	($44.73)	$ 23.00	($39.73)
St Louis, MO	Kansas City, MO	Missouri River Runner	Greyhound	$ 29.00	46.00	$26.00	$34.00	($25.15)	$ 29.00	$0.85
Richmond, VA	Charlotte, NC	Carolinian	Greyhound	$ 47.00	47.00	$5.00	$92.00	$2.58	$ 47.00	$7.58
Miami, FL	Orlando, FL	Silver Star/Silver Meteor	Greyhound (express)	$ 42.00	42.00	$32.00	$62.00	($49.07)	$ 42.00	($17.07)
Cincinnati, OH	Charleston, WV	Cardinal	Greyhound	$ 33.00	33.00	$54.00	$89.00	$74.19	$ 33.00	$128.19
Minneapolis, MN	Fargo, ND	Empire Builder	Jefferson Lines	$ 43.00	57.00	$48.00	$55.00	($1.32)	$ 43.00	$46.68
Reno, NV	Sacramento, CA	California Zephyr	Greyhound	$ 55.00	55.00	$8.00	$30.00	($68.08)	$ 55.00	($60.08)
Glenwood Springs, CO	Green River, UT	California Zephyr	Greyhound	$ 32.00	32.00	$35.00	$60.00	($14.88)	$ 32.00	$20.12
Dodge City, KS	La Junta, CO	Southwest Chief	Greyhound	$ 42.00	42.00	$46.00	$46.00	$6.24	$ 42.00	$52.24
San Antonio, TX	El Paso, TX	Sunset Limited	Greyhound	$ 82.00	82.00	$39.00	$111.00	($41.62)	$ 82.00	($2.62)
Atlanta, GA	Birmingham, AL	Crescent	Greyhound	$ 39.00	39.00	$11.00	$43.00	($24.98)	$ 39.00	($13.98)

Also shown in Table 3 is the "cost" to customers of the incremental travel time when taking the bus compared to Amtrak. For bus trips that are longer than Amtrak trips this cost is positive, but for bus trips that take less time than traveling by Amtrak this "cost" is negative (i.e. it is a savings to the customer). When you add together fares plus this cost to passengers of longer travel time on one mode versus the other the results for total customer cost are similar to the differences in fares. For thirteen of the twenty trips the total cost to customers for the minimum fare plus the travel time difference is lower for the bus than for the train; on the other seven trips the total customer cost of the train is lower. This is shown in Figure 11.

Note that in Table 3 and Figure 11 there are five trips for which the "total customer cost" of taking a motorcoach is shown as negative. This is because on these trips the value of travel time savings from taking the bus instead of Amtrak is greater than the minimum bus fare for the trip.

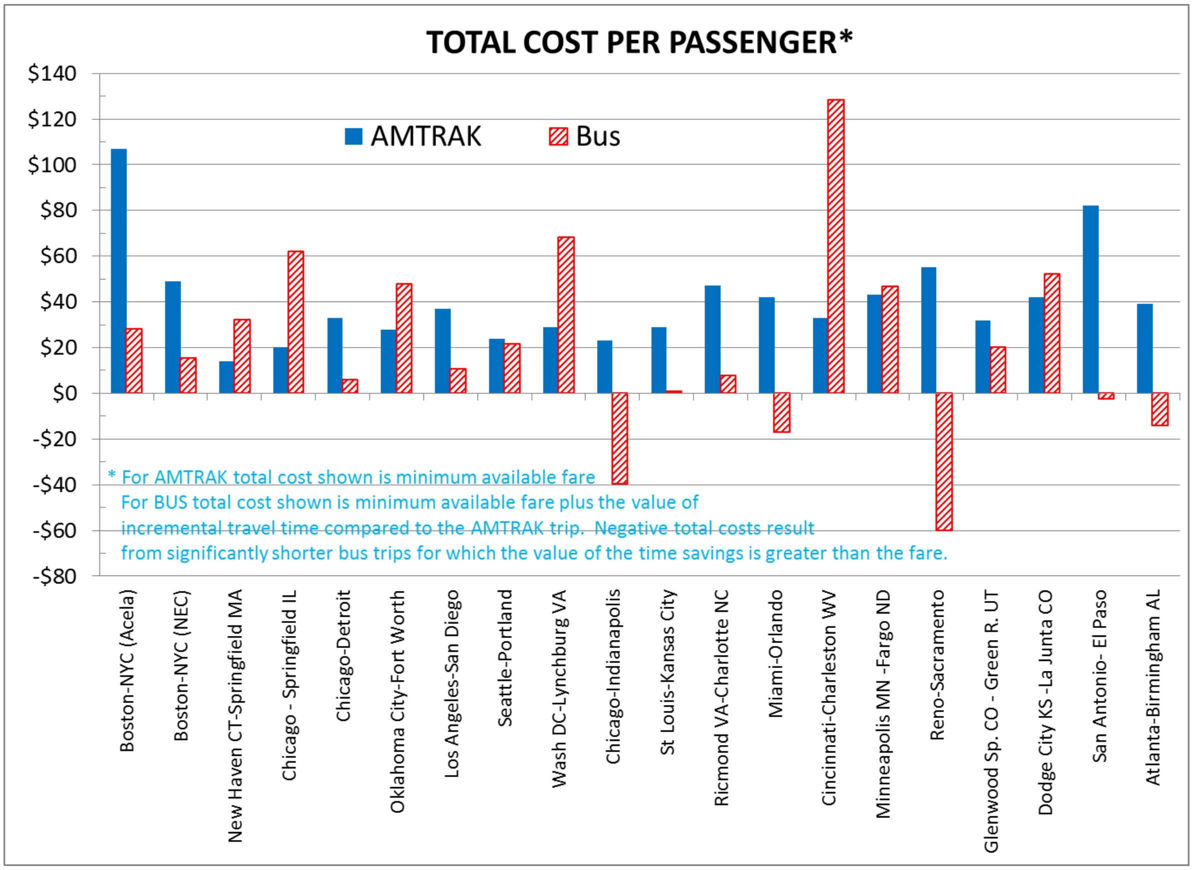

Figure 11 Comparison of Amtrak and Motorcoach Total Customer Costs

See Table 4 for a summary of the average cost per passenger of providing Amtrak service and scheduled motorcoach service for the analyzed trips, as well as the average local, state, and federal subsidy received by each mode for these trips. The cost of providing Amtrak service ranges from $37.93 per passenger (Washington DC – Lynchburg, VA) to $477.35 per passenger (San Antonio, TA – El Paso, TX). The cost of providing bus service ranges from $8.11 per passenger (Springfield, MA – New Haven, CT) to $54.96 per passenger (San Antonio, TA – El Paso, TX).

As shown, for all of the analyzed trips the cost of providing scheduled motorcoach service is significantly lower than the cost of providing Amtrak train service. The cost difference ranges from a low of $17.03 per passenger (Washington, DC to Lynchburg, VA) to a high of $422.39 per passenger (San Antonio, TX to El Paso, TX).

Comparison of the data in Table 3 and Table 4 shows that for intercity bus trips the fare charged is generally in line with average costs to provide service – which is not surprising since virtually all of these buses are operated by private, for-profit companies. On the other hand, Amtrak's average cost to provide service on most of the analyzed trips is significantly higher than the fares that they charge. The difference is made up by state and federal subsidies. These subsidies are shown in Table 4. The

Amtrak subsidies shown include state and federal operating subsidies and federal capital subsidies provided in fiscal year 2012. These average AMTAK subsidies are also shown graphically in Figure 12.

Table 4 Comparison of Amtrak and Motorcoach Costs & Subsidies

TRIP		AMTRAK TRAIN/BUS COMPANY		Average Cost Per Passenger to Provide Service		AMTRAK Subsidies Per Passenger				Bus Capital Subsidies per Passenger
Start	End	AMTRAK	BUS	AMTRAK	Bus	State Operating	Federal Operating	Federal Capital	TOTAL	
Boston, MA	New York, NY	Acela	MEGA Bus/Bolt Bus	$166.19	$22.63		($73.28)	$54.63	($18.65)	$0.29
Boston, MA	New York, NY	NE Regional	Greyhound/Peter Pan	$130.11	$22.73		($13.28)	$41.70	$28.41	$0.29
New Haven, CT	Springfield, MA	New-Haven Springfield	Peter Pan Bus	$51.77	$8.11		$15.60	$6.33	$21.93	$0.09
Chicago, IL	Springfield, IL	Chicago-St Louis	Greyhound	$92.37	$23.29	$20.21	$21.53	$13.68	$55.42	$0.29
Chicago, IL	Detroit, MI	Wolverine	Greyhound	$129.58	$29.32		$37.63	$21.66	$59.29	$0.38
Oklahoma City, OK	Fort Worth, TX	Heartland Flyer	Greyhound	$153.46	$23.95	$54.21	$35.37	$28.78	$118.36	$0.27
Los Angeles, CA	San Diego, CA	Pacific Surfliner	Crucero/Crucero Direct	$164.17	$13.22	$21.53	$22.50	$22.09	$66.11	$0.16
Seattle, WA	Portland, OR	Cascades/Coast Starlight	Greyhound	$128.55	$19.08	$13.69	$25.68	$38.94	$78.31	$0.23
Washington, DC	Lynchburg, VA	Washington-Lynchburg	Greyhound	$37.93	$20.90	$0.00	($14.53)	$6.12	($8.42)	$0.24
Indianapolis, IN	Chicago, IL	Hoosier State	Greyhound	$212.92	$19.00		$90.86	$49.29	$140.15	$0.24
St Louis, MO	Kansas City, MO	Missouri River Runner	Greyhound	$131.40	$25.06	$57.71	$8.76	$24.70	$91.17	$0.33
Richmond, VA	Charlotte, NC	Carolinian	Greyhound	$141.01	$36.02	$32.66	($3.40)	$52.98	$82.24	$0.45
Miami, FL	Orlando, FL	Silver Star/Silver Meteor	Greyhound (express)	$264.42	$23.91		$45.95	$133.20	$179.15	$0.31
Cincinnati, OH	Charleston, WV	Cardinal	Greyhound	$129.88	$26.58		$50.82	$20.36	$128.89	$0.27
Minneapolis, MN	Fargo, ND	Empire Builder	Jefferson Lines	$99.54	$25.37		$24.80	$19.24	$44.04	$0.34
Reno, NV	Sacramento, CA	California Zephyr	Greyhound	$73.29	$14.49		$23.85	$12.72	$36.57	$0.18
Glenwood Springs, CO	Green River, UT	California Zephyr	Greyhound	$94.16	$19.87		$30.64	$16.34	$46.99	$0.26
Dodge City, KS	La Junta, CO	Southwest Chief	Greyhound	$90.14	$21.73		$29.97	$15.42	$45.40	$0.28
San Antonio, TX	El Paso, TX	Sunset Limited	Greyhound	$477.35	$54.96		$207.33	$82.23	$289.56	$0.74
Atlanta, GA	Birmingham, AL	Crescent	Greyhound	$90.58	$15.31		$29.40	$12.46	$41.86	$0.20

Only six of the analyzed trips are on Amtrak routes that receive state operating subsidies. All Amtrak routes receive federal capital subsidies, and sixteen of the twenty analyzed trips are on routes that also receive federal operating subsidies.

In Table 4 and Figure 12 there are four trips for which the federal operating subsidy is shown as negative – this is because on these routes Amtrak passenger revenues are greater than their operating costs (i.e. these routes make an operating profit for Amtrak). These routes are the Acela, the Northeast Corridor Regional trains, the train from Washington DC to Lynchburg, VA, and the Carolinian short-corridor train that runs between New York City and Charlotte, NC (trip from Richmond, VA to Charlotte, NC). However, on only two of these routes do average passenger revenues cover both operating and capital costs – these are the Acela and the Washington, DC – Lynchburg, VA train[16]. For these routes total state and federal subsidies shown in Table 4 are negative, indicating that these routes are on average profitable on a fully allocated basis. While the Northeast Corridor regional trains and the Carolinian are profitable on an

[16] The train from Washington DC to Lynchburg, VA is an extension of the Northeast Corridor. One NEC regional train a day (out of 20) runs from Washington to Lynchburg. The Crescent long-distance train that runs from New York City to New Orleans also stops in both Lynchburg and Washington DC.

operating basis they are not profitable on a fully-allocated basis (i.e. passenger revenues do not cover both operating and capital costs).

As shown in Table 4, Amtrak makes an average profit of $18.65 per passenger for passengers traveling from Boston to New York City on the ACELA train. Amtrak makes an average profit of $8.42 per passenger for passengers traveling from Washington DC to Lynchburg, VA. For the other analyzed trips total Amtrak capital and operating subsidies range from a low of $21.93 per passenger for trips from Springfield, MA to New Haven, CT to a high of $289.56 for trips from San Antonio, TX to El Paso, TX.

For motorcoaches the subsidies shown in Table 4 are indirect subsidies from local, state, and federal spending on highways which is not covered by road user fees. For the trips analyzed here the total indirect subsidies provided to intercity motorcoach trips range from $0.09 to $0.74 per passenger.

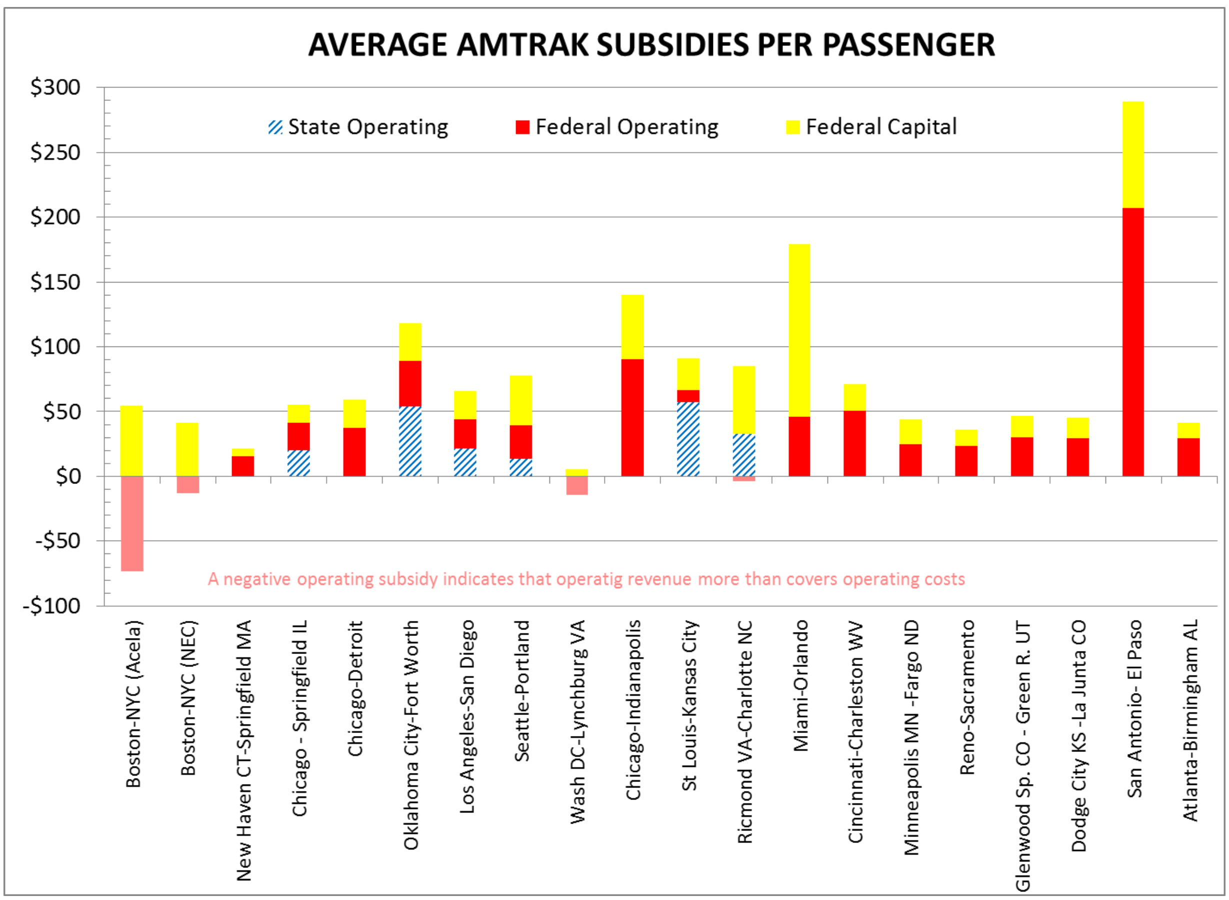

Figure 12 Average Amtrak State and Federal Subsidies

2.3 Amtrak Compared to Motorcoach – Emissions

This analysis also evaluated the environmental impact of taking a motorcoach compared to taking an Amtrak train, by determining for each mode and trip exhaust emissions (grams per passenger) of carbon dioxide (CO_2), nitrogen oxides (NO_x), volatile hydrocarbons (HC), and particulate matter (PM); see Table 5 for a summary of the results. This data is also compared graphically in Figure 13 (NOx), Figure 14 (PM), Figure 15 (HC) and Figure 16 (CO_2).

As shown, for trips on Amtrak routes other than the Northeast Corridor per-passenger NOx, PM, and VOC emissions are lower for motorcoach trips than for train trips. NOx and PM emissions are on average about 80% lower, while HC emissions are about 90% lower. For trips on the Northeast Corridor, where Amtrak runs electric locomotives, trips by train generate per-passenger NOx, PM, and VOC emissions that are about 70% lower than those generated by motorcoach trips.

For all of the trips analyzed per-passenger CO_2 emissions from motorcoaches were 45% to 66% lower than from Amtrak locomotives, even for trips on the Northeast Corridor.

Table 5 Comparison of Amtrak and Motorcoach Emissions

TRIP		AMTRAK TRAIN/BUS COMPANY		Distance [miles]		Emissions (g/passenger)							
						NOx		PM		HC		CO_2	
Start	End	AMTRAK	BUS	AMTRAK	BUS	AMTRAK	BUS	AMTRAK	BUS	AMTRAK	BUS	AMTRAK	BUS
Boston, MA	New York, NY	Acela	MEGA Bus/Bolt Bus	229	215	21.2	93.1	1.4	4.43	0.8	3.23	24,230	11,292
Boston, MA	New York, NY	NE Regional	Greyhound/Peter Pan	229	215	21.2	93.1	1.4	4.43	0.8	3.23	24,230	11,292
New Haven, CT	Springfield, MA	New-Haven Springfield	Peter Pan Bus	64	68	142.3	29.5	8.1	1.40	15.5	1.02	8,829	3,571
Chicago, IL	Springfield, IL	Chicago-St Louis	Greyhound	201	219	458.3	94.9	26.1	4.52	49.8	3.29	28,432	11,502
Chicago, IL	Detroit, MI	Wolverine	Greyhound	281	283	606.8	122.6	34.6	5.84	66.0	4.25	37,640	14,863
Oklahoma City, OK	Fort Worth, TX	Heartland Flyer	Greyhound	206	202	495.2	87.5	28.2	4.17	53.8	3.03	30,722	10,609
Los Angeles, CA	San Diego, CA	Pacific Surfliner	Crucero/Crucero Direct	120	121	294.4	52.4	16.8	2.50	32.0	1.82	18,261	6,355
Seattle, WA	Portland, OR	Cascades/Coast Starlight	Greyhound	187	174	351.0	75.4	20.0	3.59	38.2	2.61	21,775	9,139
Washington, DC	Lynchburg, VA	Washington-Lynchburg	Greyhound	173	181	279.5	78.4	15.9	3.73	30.4	2.72	17,338	9,506
Indianapolis, IN	Chicago, IL	Hoosier State	Greyhound	196	183	459.0	79.3	26.1	3.77	49.9	2.75	28,472	9,611
St Louis, MO	Kansas City, MO	Missouri River Runner	Greyhound	250	250	559.1	108.3	31.8	5.16	60.8	3.75	34,683	13,130
Richmond, VA	Charlotte, NC	Carolinian	Greyhound	378	340	532.8	147.3	30.3	7.01	57.9	5.10	33,050	17,857
Miami, FL	Orlando, FL	Silver Star/Silver Meteor	Greyhound (express)	357	234	601.2	101.4	34.2	4.83	65.3	3.51	37,296	12,290
Cincinnati, OH	Charleston, WV	Cardinal	Greyhound	205	204	390.0	88.4	22.2	4.21	42.4	3.06	24,196	10,714
Minneapolis, MN	Fargo, ND	Empire Builder	Jefferson Lines	244	253	435.0	109.6	24.8	5.22	47.3	3.80	26,987	13,288
Reno, NV	Sacramento, CA	California Zephyr	Greyhound	151	132	282.0	57.2	16.1	2.72	30.7	1.98	17,495	6,933
Glenwood Springs, CO	Green River, UT	California Zephyr	Greyhound	194	195	362.3	84.5	20.6	4.02	39.4	2.93	22,477	10,242
Dodge City, KS	La Junta, CO	Southwest Chief	Greyhound	203	210	339.3	91.0	19.3	4.33	36.9	3.15	21,050	11,029
San Antonio, TX	El Paso, TX	Sunset Limited	Greyhound	605	553	1,303.0	239.5	74.2	11.41	141.6	8.30	80,828	29,044
Atlanta, GA	Birmingham, AL	Crescent	Greyhound	164	147	328.1	63.7	18.7	3.03	35.7	2.21	20,356	7,721

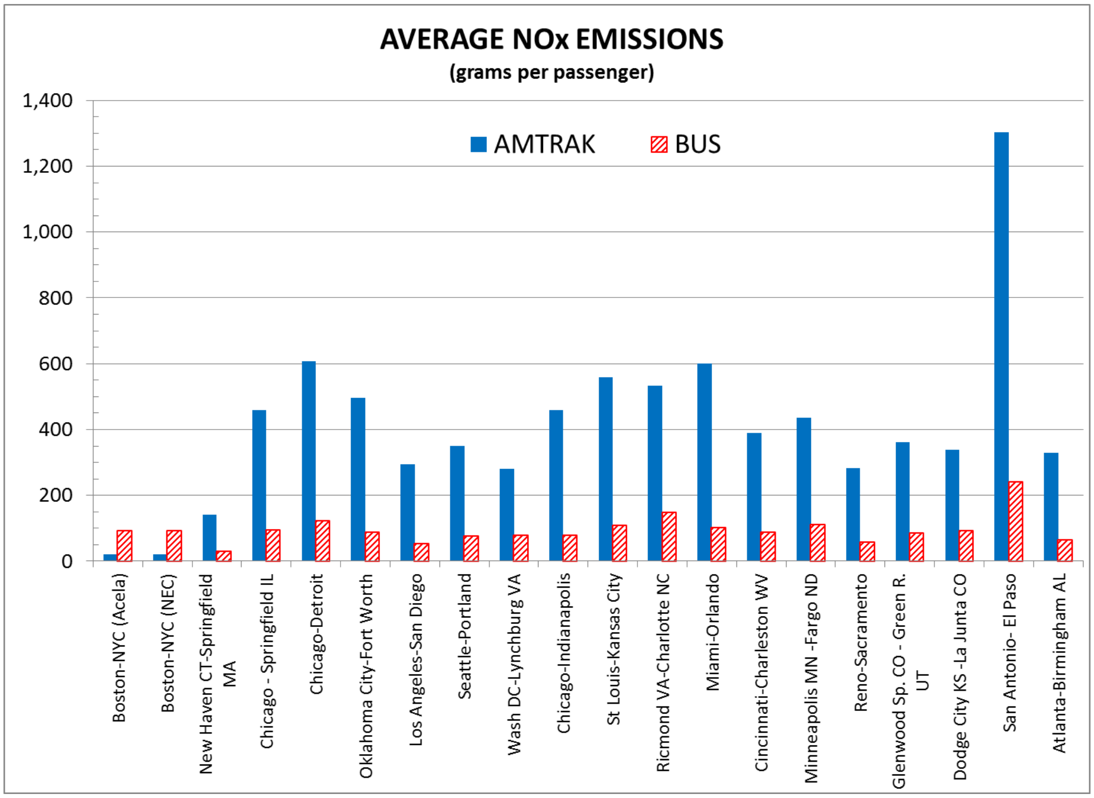

Figure 13 Comparison of Amtrak and Motorcoach NOx Emissions

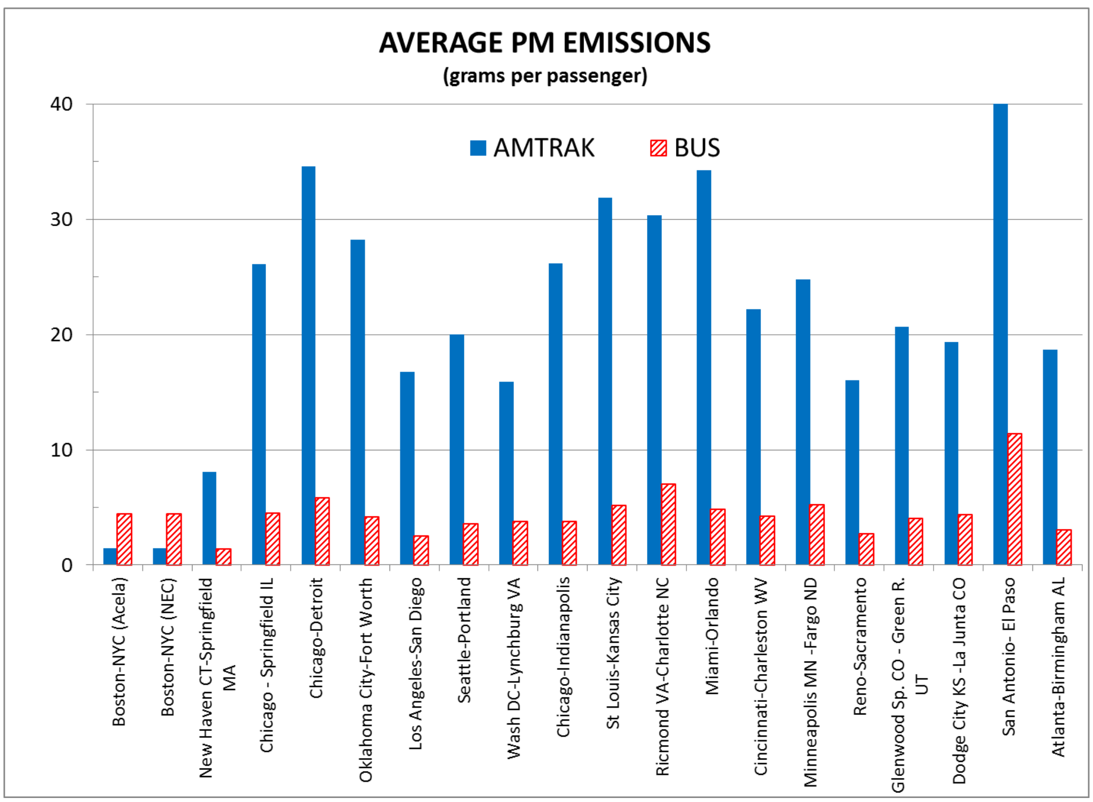

Figure 14 Comparison of Amtrak and Motorcoach PM Emissions

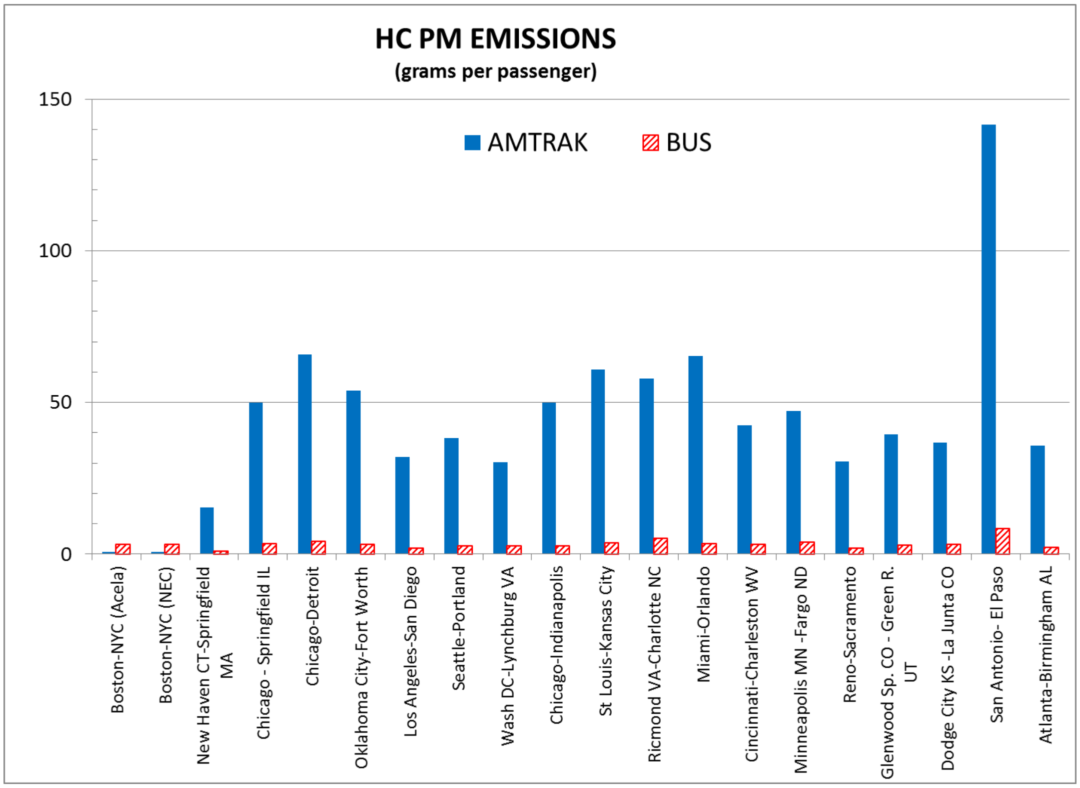

Figure 15 Comparison of Amtrak and Motorcoach HC Emissions

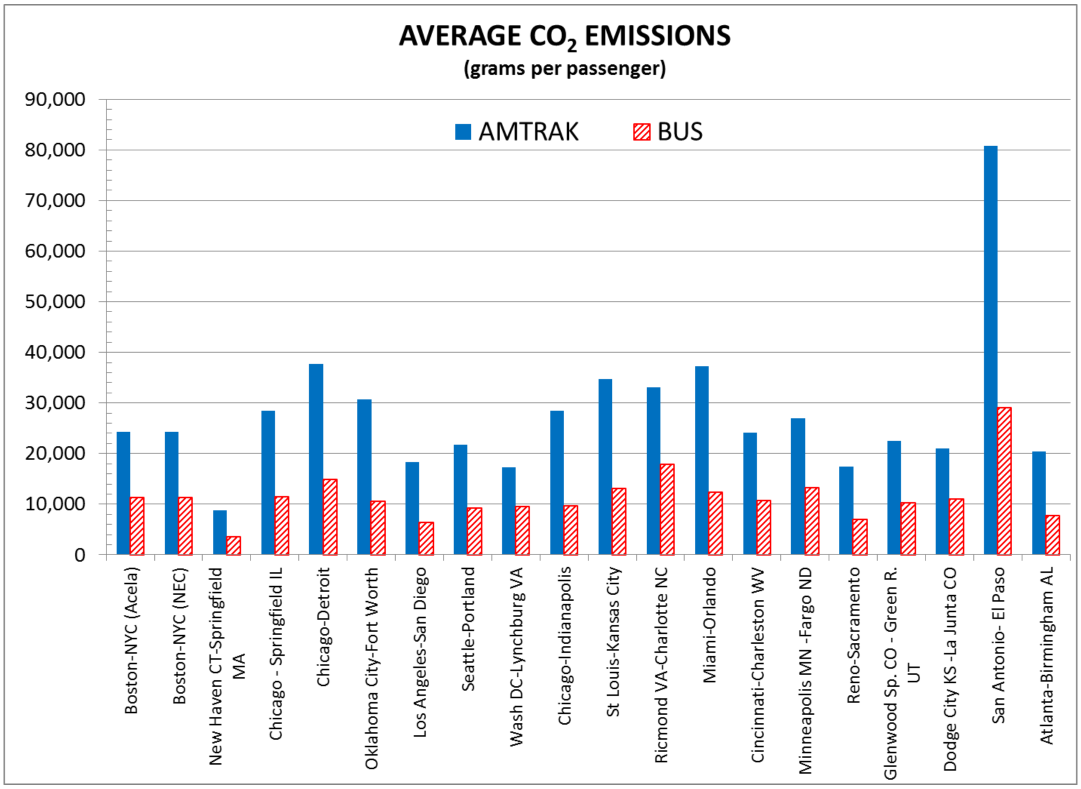

Figure 16 Comparison of Amtrak and Motorcoach CO_2 Emissions