U.S. Department of Transportation
Federal Transit Administration

Public Transportation's Role in Responding to Climate Change

Through the National Transit Database, the Federal Transit Administration (FTA) collects and analyzes data from across the country on public transportation fuel use, vehicles deployed, rides taken, and other key metrics. This data, combined with information from the U.S. Department of Energy and the U.S. Environmental Protection Agency, provides valuable insight into the relative impacts of automobile, truck, SUV, and public transportation travel on the production of greenhouse gas emissions. National level data show significant greenhouse gas emission savings by use of public transportation, which offers a low emissions alternative to driving. This paper presents an analysis of the data and frames it in a broader context. It concludes with a description of FTA actions that address climate change.

Based on an examination of FTA's data and other academic, government, and industry sources, public transportation can reduce greenhouse gas emissions by:

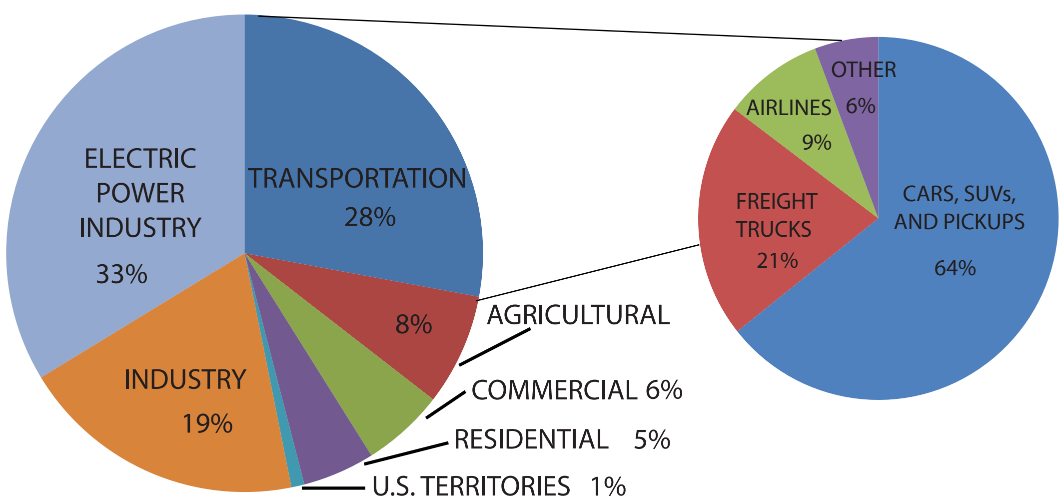
- Providing a low emissions alternative to driving.
- Facilitating compact land use, reducing the need to travel long distances.
- Minimizing the carbon footprint of transit operations and construction.

Greenhouse Gas Sources: Vehicles and Carbon Dioxide

Carbon dioxide makes up 95% of all transportation-related greenhouse gas emissions. Cars, SUVs, and pickup trucks running on conventional gasoline, diesel, and other fuels emit carbon dioxide. Combined, they account for roughly two-thirds of transportation-related emissions (see fig. 1). Transportation is the second largest source of total U.S. greenhouse gas emissions.

FIGURE 1
Transportation Accounts For 28% of U.S. Greenhouse Gas Emissions.

Source:
U.S. Environmental Protection Agency, *Inventory of Greenhouse Gas Emissions and Sinks: 1990-2006*, April 2008.



The 2007 Intergovernmental Panel on Climate Change report (which represents the consensus of the world's leading climate scientists and was approved by member governments including the U.S.) concluded that greenhouse gas emissions must be reduced by 50 to 85% by 2050 in order to limit global warming to 4 degrees Fahrenheit, thereby avoiding many of the worst impacts of climate change.

Reducing greenhouse gas emissions from transportation will likely require a broad range of strategies, including increasing vehicle efficiency, lowering the carbon content of fuels, and reducing vehicle miles of travel. Public transportation can be one part of the solution.

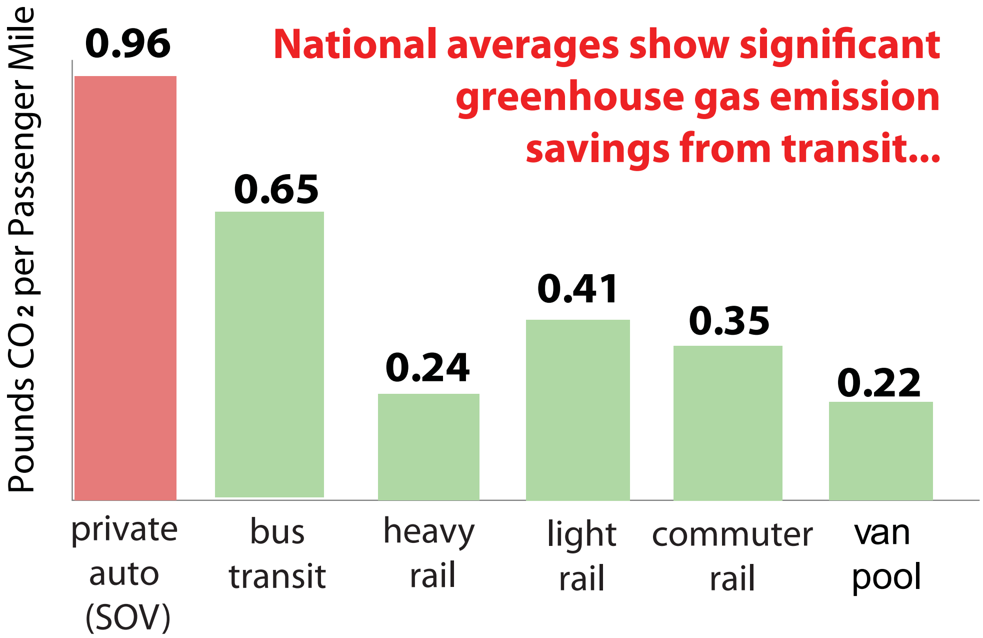


FIGURE 2
Estimated CO_2 Emissions per Passenger Mile for Transit and Private Autos

Source:
See Appendix II for data sources and methodology.

The average passenger car in the United States produces just under one pound of carbon dioxide per mile traveled.

Public Transportation Produces Lower Greenhouse Gas Emissions Than autos

National averages demonstrate that public transportation produces significantly less greenhouse gas emissions per passenger mile than private vehicles (see fig. 2). Leading the way is heavy rail transit, such as subways and metros, which produce about 75% less in greenhouse gas emissions per passenger mile than an average single-occupancy vehicle (SOV). Light rail systems produce 57% less and bus transit produces 32% less.[1]

Transit's emissions savings would be even greater with higher ridership levels. Recent increases in ridership are not captured in the results presented in this paper, as the figures rely on 2007 transit data, the most recent national dataset available.

Estimates are calculated from fuel usage and passenger mile data in the 2007 National Transit Database, standard emissions factors for different fuels are from the U.S. Department of Energy, and sub-regional electricity emissions factors are from the U.S. Environmental Protection Agency (see Appendix II: Methodology).

The environmental benefits of public transportation vary based on the number of passengers per vehicle, the efficiency of the bus or train, and the type of fuel used (see Appendix I for estimates for transit agencies across the country).

What Individuals Can Do To Reduce Their Carbon Footprint

Switching to riding public transportation is one of the most effective actions individuals can take to reduce their carbon footprint.

Car transportation alone accounts for 47% of the carbon footprint of a typical American family with two cars—by far the largest source of household emissions and, as such, the largest target for potential reductions. The average passenger car in the U.S. produces just under 1 pound of carbon dioxide per mile traveled.

If just one driver per household switched to taking public transportation for a daily commute of 10 miles each way, this would save 4,627 pounds of carbon dioxide per household per year—equivalent to an 8.1% reduction in the annual carbon footprint of a typical American household. This benefit has a greater impact than other actions, such as replacing light bulbs with compact fluorescents (a 1.6% reduction based on 20 out of 25 light bulbs changed) or adding R-40 insulation to a home attic (a 1.2% reduction).[1]

The number of riders greatly impacts transit's emissions savings.

The more passengers that are riding a bus or train, the lower the emissions per passenger mile. For instance, U.S. bus transit, which has about a quarter of its seats occupied on average, emits an estimated 32% lower greenhouse gas emissions per passenger mile than the average U.S. single occupancy vehicle. The savings increases to 83% for a typical diesel transit bus when it is full with 40 passengers (see fig. 3).

When expanding transit service as a greenhouse gas reduction strategy, communities would likely want to ensure that passenger loads are sufficient to achieve efficiencies over the alternative of driving.[2] For example, the average 40-passenger diesel bus must carry a minimum of 7 passengers on board to be more efficient than the average single-occupancy vehicle. Similarly, the average heavy rail car would need to have at least 19% of seats full to exceed the efficiency of a automobile carrying an average passenger load.

quent stops in denser urban areas). In terms of vehicle efficiency for instance, many transit agencies are replacing older diesel buses with new hybrid-electric buses, which consume 15% to 40% less fuel, and consequently produce 15% to 40% fewer carbon dioxide emissions.

Taking lifecycle emissions into account also shows emissions savings from transit.

Transit-based greenhouse gas emissions per passenger mile are significantly lower than those from driving, even taking into account emissions from construction, manufacture, and maintenance.

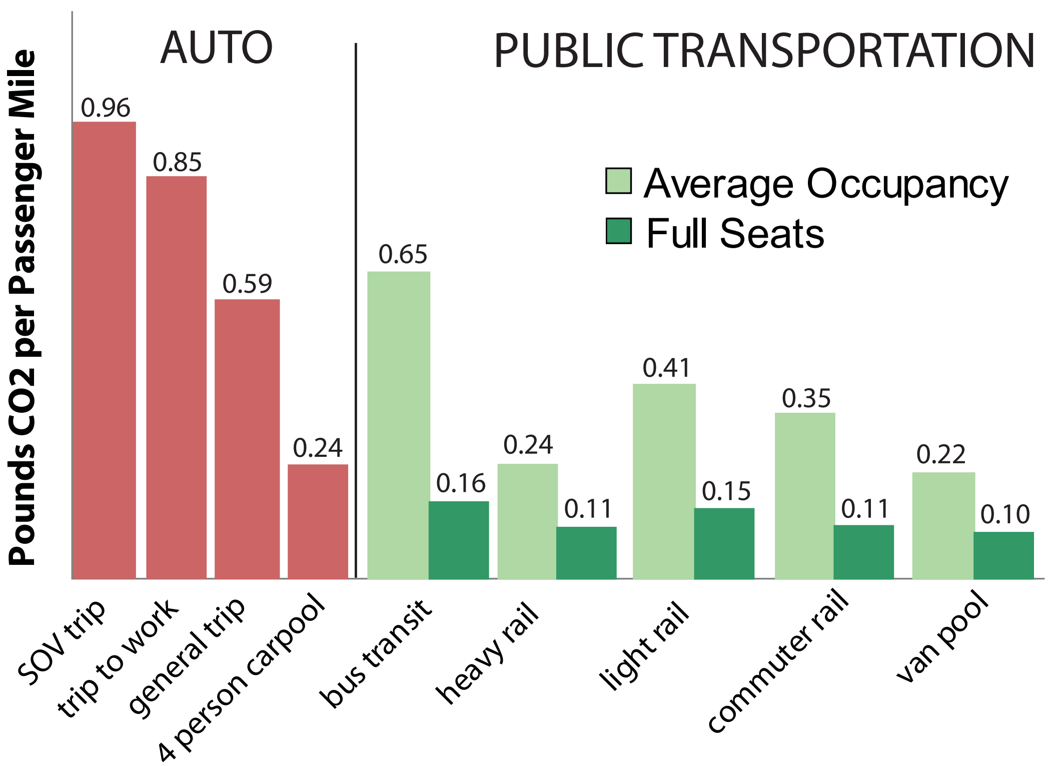


FIGURE 3

Estimated CO_2 Emissions per Passenger Mile for Average and Full Occupancy

Sources:
See Appendix II for data sources and methodology.

Notes: The average number of passengers for private auto trips is 1.14 for work trips and 1.63 for general trips.

Power sources and vehicle efficiency also impact transit's emissions.

Most rail transit systems are powered by electricity. Those relying on electricity from a low emissions source, such as hydroelectric, not surprisingly, have much lower emissions than those relying on coal power plants. (See Appendix I for emissions factors). Rail vehicles also vary in terms of energy efficiency due to weight and engineering factors.

Emissions from bus systems vary due to the use of low carbon fuels, more energy efficient vehicles, and different operating environments (such as fre-

Life cycle emissions include a full accounting of all emissions generated over the full life of a transportation system. This includes emissions from building the highway or rail system, manufacturing the vehicles, maintaining the infrastructure and vehicles, producing and using the fuel, and eventually disposing of the vehicles and infrastructure. The previous graphs only showed tailpipe emissions, or solely the emissions from burning fuel or generating electricity to move a vehicle.

Researchers at the University of California at Berkeley have developed a methodology for measuring life cycle greenhouse gas emissions from cars and public transportation (see fig. 4).[3] As transit systems vary greatly, the researchers chose a handful of systems, including the San Francisco Bay Area's heavy rail BART system and light rail Muni system, California's commuter rail system Caltrain, and Boston's light rail Green Line. The researchers found that including full life cycle greenhouse gas emissions increased estimates by as much as 70% for autos, 40% for buses, 150% for light rail, and 120% for heavy rail.

While including emissions from construction of infrastructure has a larger impact on rail transit than on automobiles, the results still show significant emissions savings from average occupancy rail and bus transit over average occupancy sedans, SUVs, and pickups.[4] The researchers found that including greenhouse gas emissions from construction and maintenance of the BART heavy rail transit system increases estimated greenhouse gas emissions per passenger mile from 64 grams to 140 grams, but that this still represents a 63% and 69% savings over travel by sedan and SUV, respectively. Similarly, emissions per passenger mile on Boston's light rail Green Line increase from 120 to 230 grams, still offering a 55% and 62% savings over sedan and SUV travel, respectively.

...transit greenhouse gas emissions per passenger mile are still significantly lower than those from driving, even taking into account emissions from construction, manufacture, and maintenance.

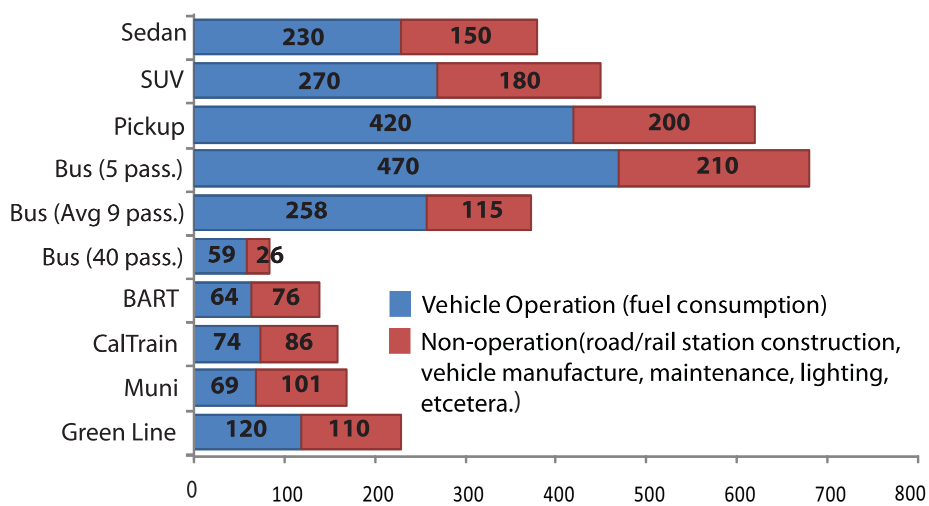


FIGURE 4
Greenhouse Gas Emissions from Full Life Cycle, including Operation, Construction and Maintenance

Source: Chester, 2008.
Note: The study uses passengers per vehicle of 1.58 for sedans, 1.74 for SUVs, and 1.46 for pickups. Authors of the study assume peak buses have 40 passengers and off-peak buses have 5 passengers. The 9 passenger case for bus is calculated from 5 and 40 person cases presented in study.

Public Transportation Facilitates Compact Land Use, Which Plays a Role in Greenhouse Gas Reductions

Public transportation reduces emissions by facilitating higher density development, which conserves land and decreases the distances people need to travel to reach destinations. In many cases, higher density development would be more difficult without the existence of public transportation because more land would need to be devoted to parking and travel lanes. By facilitating higher density development, public transportation can shrink the footprint of an urban area and reduce overall trip lengths. In addition, public transportation supports increased foot traffic, street-level retail, and mixed land uses that enable a shift from driving to walking and biking. Public transportation can also facilitate trip chaining, such as combining dry-cleaning pick-up, shopping, and other errands on the way home from a station. Finally, households living close to public transportation tend to own fewer cars on average, as they may not need a car for commuting and other trips. A reduced number of cars per household tends to lead to reduced car use, and driving may cease to be the habitual choice for every trip.[5]

Multiple studies have quantified this relationship between public transportation, land use, and reduction in travel. The studies show that for every additional passenger mile traveled on public transportation, auto travel declines by 1.4 to 9 miles.[6] In other words, in areas served by public transportation, even non-transit users drive less because destinations are closer together. A recent study used modeling to isolate just the effect of public transportation on driving patterns (rather than that effect combined with denser land use creating a need for improved public transportation). That study, conducted by consulting firm ICF and funded through the Transit Cooperative Research Program, found that each mile traveled on U.S. public transportation reduced driving by 1.9 miles. It concluded that public transportation reduces U.S. travel by an estimated 102.2 billion vehicle miles traveled (VMT) each year, or 3.4% of annual U.S. VMT.[7] A study published by the Urban Land Institute found that within areas of compact development, driving is reduced 20% to 40% compared to average U.S. development patterns.[8]

Moreover, by reducing congestion, transit reduces emissions from cars stuck in traffic. The Texas Transportation Institute's 2007 Mobility Report estimates that by reducing congestion, transit saved an estimated 340 million gallons of fuel in 2005.[9]

Combining the emissions savings from passengers taking transit rather than driving, with VMT reduction due to transit's impact on the built environment, and savings from reduced congestion due to transit, the ICF report finds that public transportation reduces carbon dioxide emissions by 37 million metric tons annually.[10]

Public Transportation Providers Use Energy Conservation and Technology to Reduce Emissions from Operations

Public transportation agencies across the country are taking actions to reduce the greenhouse gas intensity of their operations. Some agencies are building new administrative and maintenance facilities to Leadership in Energy and Environmental Design (LEED) standards or higher. For instance, New York City Transit built a LEED certified maintenance facility that has fuel cell units, rooftop solar panels, natural lighting, and rain water storage to wash buses and cars. The agency is also reducing emissions from construction by using recycled content in construction materials. Many agencies are replacing older buses with new hybrid buses. Bus manufacturer New Flyer, with 42% of the U.S. transit bus market, reports that while hybrid buses comprised only one percent of its sales in 2003, hybrid buses are expected to comprise half of its sales in 2009.

Agencies are also using alternative fuels such as biodiesel and piloting hydrogen fuel cell buses, which produce zero emissions when the hydrogen is produced from a zero emission power source such as solar.

Most rail transit is powered by electricity, which offers efficiency improvements over internal combustion engines. Rail agencies are looking to further reduce energy consumption by lowering the amount of electricity used in powering vehicles. In Phoenix, for example, the new light rail system uses regenerative braking to lower electricity consumption.

As the electric power industry shifts to more renewable sources of energy, as being mandated in several states, electric public transportation systems provide even more emissions reduction benefits. When the electricity is generated from a zero emissions source, such as wind, hydroelectric, nuclear, or solar, the public transportation systems that use these power sources are also zero emission.

Several transit agencies are installing on site renewable energy generation to power parts of their systems. Boston's transit agency is installing wind turbines, New York City Transit plans to harvest power from the tides by installing turbines in tidal waters, and Los Angeles Metro is installing solar panels on its properties.

Solar Panels on Roof of New York City Transit Roosevelt Avenue -74th St. Station

FTA Actions to Address Climate Change

The Federal Transit Administration (FTA) works with public transportation providers and other key stakeholders to implement strategies that reduce greenhouse gas emissions from the transportation sector. FTA's grants, technical assistance, research, and policy leadership all play a role in the agency's efforts to address climate change.

FTA grows and sustains public transportation as a low-emission alternative to automobiles through the agency's $10 billion a year grant programs. Over 1,500 transit agencies representing every state in the country benefit from FTA grants.

Portland Streetcar (Tri-Met), Portland, Oregon

FTA provides technical assistance in planning and transit-oriented development. Combining investment in public transportation with compact, mixed-use development around transit stations has a synergistic effect that amplifies the greenhouse gas reductions of each strategy.

FTA research on alternative fuels and high fuel efficiency vehicles has yielded the introduction of low emission technologies such as hybrid-electric buses, compressed natural gas vehicles, and biodiesel. FTA's new Electric Drive Strategic Plan and the National Fuel Cell Bus Program are intended to introduce the next generation of low emission vehicles. FTA encourages adoption of clean technologies by supporting a higher share of the cost of purchasing clean vehicles. In addition, FTA's Clean Fuel Bus Program targets investment in clean transit vehicles.

FTA conducts policy research, produces outreach materials, and engages stakeholders in addressing the challenge of climate change.

FTA has also partnered with the American Public Transportation Association (APTA) to develop a standard methodology for measuring greenhouse gas emissions produced by public transportation, so agencies can track and reduce their emissions.

FTA sponsors training in Environmental Management Systems (EMS), a set of procedures organizations use to continually assess and reduce the energy and environmental impact of their operations.

Finally, FTA contributes to research on climate change mitigation and adaptation in the transportation sector through the U.S. Department of Transportation Climate Change Center. In 2008, the Center produced two key studies on the impacts of climate change on transportation infrastructure. The Center also produced a report on integrating climate change considerations into transportation planning and launched a web-based clearinghouse (see www.climate.dot.gov). Currently, the Center is preparing a report to Congress on a full range of strategies to reduce greenhouse gas emissions from all modes of transportation.

Transit-Oriented Development in Boulder, Colorado

FOOTNOTES

1. Comparison is with single occupancy vehicles as policy typically focuses on shifting single occupancy trips to transit rather than shifting high occupancy trips. Comparisons with average occupancy private vehicles and carpools are found in figure 3.

2. Communities may still wish to expand transit for benefits other than environmental ones, such as providing access to jobs, spurring economic development, and providing mobility for people who cannot afford to drive or who cannot drive because of age or disability.

3. Mikhail Chester, *Life-cycle Environmental Inventory of Passenger Transportation Modes in the United States*, University of California, Berkeley, August 2008.

4. Average bus occupancy is 9 passengers, according to the National Transit Database. Authors of the Berkeley study assume peak buses have 40 passengers, off-peak buses have 5 passengers, sedans have 1.58 passengers, SUVs 1.74, and pick-ups 1.46.

5. American Public Transportation Association, Climate Change Standards Working Group, Discussion Paper, July 2008.

6. Newman, P. and J. R. Kenworthy (1999). *Sustainability and Cities: Overcoming Automobile Dependence*. Washington, D.C., Island Press. Studied 32 major cities worldwide. Showed a reduction of 5 to 7 miles.

Neff, J. W. (1996). Substitution Rates Between Transit and Automobile Travel. *Association of American Geographers Annual Meeting*. Charlotte, NC. Studied U.S. urbanized areas. Showed a reduction of 5.4 to 7.5 miles.

Pushkarev, B. S., J. M. Zupan, et al. (1982). *Urban Rail in America: An Exploration of Criteria for Fixed-Guideway Transit, Indiana University Press.*

Holtzclaw, J. (2000). Does A Mile In A Car Equal A Mile On A Train? Exploring Public Transit's Effectiveness In Reducing Driving. Studied three cities in the San Francisco Bay Area. Showed a reduction of 1.4 to 9 miles.

7. T*he Broader Connection between Public Transportation, Energy Conservation and Greenhouse Gas Reduction*, ICF International, TCRP Project J-11/Task 3, February 2008. http://www.apta.com/research/info/online/land_use.cfm

8. *Growing Cooler: The Evidence on Urban Development and Climate Change*, Urban Land Institute, Smart Growth America, National Center for Smart Growth, Center for Clean Air Policy, September 2007. http://www.smartgrowthamerica.org/gcindex.html

9. Texas Transportation Institute, 2007 Mobility Report, http://mobility.tamu.edu/ums/

10. T*he Broader Connection between Public Transportation, Energy Conservation and Greenhouse Gas Reduction*, ICF International, funded through Transit Cooperative Research Program (TCRP) Project J-11/Task 3, February 2008. http://www.apta.com/research/info/online/land_use.cfm

Appendix I

Estimated Carbon Dioxide Emissions per Passenger Mile for U.S. Transit Systems, 2007

Listed by system type in order of total passenger miles. See Appendix II for data sources and methodology.

Average U.S. Single Occupany Vehicle: 0.964 pounds CO_2/passenger mile

Heavy Rail Systems

State	Heavy Rail Common Name	Pounds CO_2/ passenger mile	% of total heavy rail passenger miles traveled in the U.S.	KWH/ seat mile (Efficiency of Vehicle)	Average % of seats full (Ridership)	Pounds CO_2/ MWH for eGRID subregion (Carbon Content)
NY	New York City Subway	**0.171**	59.8%	0.108	58%	922
DC, MD, VA	Washington Metro	**0.336**	9.9%	0.098	32%	1,096
CA	San Francisco BART	**0.089**	8.5%	0.071	32%	399*
IL	Chicago "L"	**0.604**	6.9%	0.132	34%	1,556
GA	Atlanta MARTA	**0.265**	3.4%	0.067	37%	1,490
MA	Boston "T"	**0.336**	3.2%	0.163	44%	909
PA	Philadelphia SEPTA	**0.374**	2.4%	0.153	45%	1,096
NJ	New Jersey PATH	**0.296**	2.2%	0.250	92%	1,097
CA	Los Angeles Metro	**0.378**	1.2%	0.244	57%	879
FL	Miami-Dade Transit	**0.729**	0.8%	0.123	22%	1,328
NJ	New Jersey PATCO	**0.560**	0.5%	0.128	25%	1,098
MD	Baltimore Metro	**0.451**	0.4%	0.075	18%	1,096
OH	Cleveland Rapid	**0.867**	0.3%	0.170	31%	1,556
NY	Staten Island Railway	**0.365**	0.3%	0.112	28%	923
National Average Weighted by Passenger Miles		**0.239**	99.8%	.109	46%	972

SOURCE: Federal Transit Adminstration (2007 National Transit Database), U.S. Department of Energy, U.S. Environmental Protection Agency

Note: *Energy Data not available for the following privately operated systems: Puerto Rico Heavy Rail (Tren Urbano)*

Note: *This paper uses the Climate Registry General Reporting Protocol method for determining the emissions factors for purchased electricity. That method is to use the eGRID subregion data published by the U.S. Environmental Protection Agency unless electricity is purchased directly from a generation source with a known emissions factor. The calculations for all of the transit systems in this paper use the eGRID subregion emissions factors with the exception of the BART system. The BART system purchases electricity directly rather than through the general subregion grid. As such, BART was able to provide an emissions factor specific to the electricity it purchases, 399 pounds per megawatt hour, which was used in the calculations rather than the eGRID factor for its subregion of 879 pounds per megawatt hour. The system specific factor yields 0.089 pounds CO2 per passenger mile for the BART system while the subregion eGRID factor yields 0.196 pounds CO2 per passenger mile. This changes that national average only slightly, from 0.248 to 0.239 pounds CO2 per passenger mile.*

Light Rail Systems

State	Transit Authority	Pounds CO_2/ passenger mile	% of total light rail passenger miles traveled in U.S.		KWH/ seat mile (Efficiency of Vehicle)	Average % of seats full (Ridership)	Pounds CO2/ MWH for eGRID subregion (Carbon Content)
CA	Los Angeles County Metropolitan Transportation Authority (LACMTA)	**0.269**	15.1%		0.1347	44%	879
CA	San Diego Trolley, Inc. (MTS)	**0.176**	10.8%		0.0812	41%	879
OR	Tri-County Metropolitan Transportation District of Oregon (TriMet)	**0.213**	9.7%		0.0979	42%	921
MA	Massachusetts Bay Transportation Authority (MBTA)	**0.266**	9.1%		0.1989	68%	909
TX	Dallas Area Rapid Transit (DART)	**0.609**	7.2%		0.1583	37%	1421
MO	Bi-State Development Agency (METRO)	**0.479**	7.1%		0.0800	31%	1844
CO	Denver Regional Transportation District (RTD)	**0.754**	6.2%		0.0795	21%	2036
CA	San Francisco Municipal Railway (MUNI)	**0.412**	5.5%		0.1724	37%	880
UT	Utah Transit Authority (UTA)	**0.233**	4.3%		0.1158	46%	921
CA	Sacramento Regional Transit District (Sacramento RT)	**0.398**	4.1%		0.1349	30%	879
PA	Southeastern Pennsylvania Transportation Authority (SEPTA)	**0.550**	3.6%		0.1862	37%	1096
CA	Santa Clara Valley Transportation Authority (VTA)	**0.453**	2.8%		0.1198	23%	881
MN	Metro Transit, MN	**0.572**	2.7%		0.1322	42%	1814
MD	Maryland Transit Administration (MTA)	**0.888**	2.1%		0.1425	18%	1096
PA	Port Authority of Allegheny County (Port Authority)	**1.379**	1.8%		0.2623	30%	1556
TX	Metropolitan Transit Authority of Harris County, Texas (Metro)	**0.398**	1.5%		0.1256	45%	1421
OH	The Greater Cleveland Regional Transit Authority (GCRTA)	**1.016**	1.0%		0.2049	31%	1556
NY	Niagara Frontier Transportation Authority (NFT Metro)	**0.455**	0.7%		0.1969	36%	820
NJ	New Jersey Transit Corporation (NJ TRANSIT)	**0.570**	0.7%		0.1522	29%	1096
LA	New Orleans Regional Transit Authority (NORTA)	**0.616**	0.1%		0.0749	14%	1135
TN	Memphis Area Transit Authority (MATA)	**2.852**	<0.1%		0.0875	5%	1495
WA	Central Puget Sound Regional Transit Authority (ST)	**0.444**	<0.1%		0.1442	30%	921
FL	Hillsborough Area Regional Transit Authority (HART)	**0.960**	<0.1%		0.1509	21%	1328
NC	*Charlotte Area Transit System (CATS)	**0.603**	<0.1%		0.1695	32%	1146
AR	Central Arkansas Transit Authority	**1.617**	<0.1%		0.1542	11%	1135
WI	Kenosha Transit (KT)	**4.278**	<0.1%		0.2169	8%	1556
National Average Weighted by Passenger Miles		**0.411**	96.3%		0.1274	36%	1144

SOURCE: Federal Transit Adminstration (2007 National Transit Database), U.S. Department of Energy, U.S. Environmental Protection Agency

Note: *Island Transit, in TX is not included as this is a diesel system rather than an electric system. Energy data not available for privately operated portion of New Jersey Transit Corporation (NJ Transit).*
Note: *Five of the twenty-six light rail systems, representing less than three percent of all U.S. light rail travel, have carbon dioxide emissions per passenger mile greater than single occupancy private cars.*
Note: *At the time of this printing, 2007 data for the Charlotte Area Transit System was not available. As such, 2006 data is used here.*

50 Largest Directly Operated Bus Systems

State	Agency	Pounds CO_2/ passenger mile	% of total bus passenger miles traveled in U.S.		Average % Seats Full (Ridership)	Pounds CO_2/ seat mile (CO_2 Efficiency of Vehicle)
NY	MTA New York City Transit (NYCT)	**0.504**	8.89%		34%	0.171
CA	Los Angeles County Metropolitan Transportation Authority (LACMTA)	**0.464**	7.31%		34%	0.157
NJ	New Jersey Transit Corporation (NJ TRANSIT)	**0.553**	4.52%		23%	0.125
IL	Chicago Transit Authority (CTA)	**0.741**	3.74%		26%	0.190
PA	Southeastern Pennsylvania Transportation Authority (SEPTA)	**0.748**	2.34%		25%	0.185
WA	King County Department of Transportation - Metro Transit Division (King County Metro)	**0.492**	2.28%		24%	0.118
FL	Miami-Dade Transit (MDT)	**0.676**	2.10%		26%	0.179
DC	Washington Metropolitan Area Transit Authority (WMATA)	**0.782**	2.01%		23%	0.182
TX	Metropolitan Transit Authority of Harris County, Texas (Metro)	**0.577**	1.95%		25%	0.142
MN	Metro Transit	**0.533**	1.49%		23%	0.122
NY	MTA Bus Company (MTABUS)	**0.926**	1.46%		17%	0.159
PA	Port Authority of Allegheny County (Port Authority)	**0.685**	1.41%		21%	0.141
CO	Denver Regional Transportation District (RTD)	**0.528**	1.29%		25%	0.131
CA	Orange County Transportation Authority (OCTA)	**0.570**	1.25%		23%	0.132
MD	Maryland Transit Administration (MTA)	**0.689**	1.22%		27%	0.185
TX	Dallas Area Rapid Transit (DART)	**0.876**	1.18%		17%	0.146
NJ	Academy Lines, Inc.	**0.183**	1.16%		50%	0.092
OR	Tri-County Metropolitan Transportation District of Oregon (TriMet)	**0.584**	1.10%		22%	0.126
IL	Pace - Suburban Bus Division (PACE)	**0.632**	1.02%		28%	0.177
GA	Metropolitan Atlanta Rapid Transit Authority (MARTA)	**0.745**	1.02%		20%	0.150
CA	Alameda-Contra Costa Transit District (AC Transit)	**0.728**	1.00%		20%	0.144
MA	Massachusetts Bay Transportation Authority (MBTA)	**0.910**	0.99%		18%	0.163
CA	San Francisco Municipal Railway (MUNI)	**0.578**	0.97%		32%	0.183
MI	City of Detroit Department of Transportation (DDOT)	**0.600**	0.92%		26%	0.155
NJ	Hudson Transit Lines, Inc. (Short Line)	**0.248**	0.92%		40%	0.099
OH	The Greater Cleveland Regional Transit Authority (GCRTA)	**0.714**	0.88%		20%	0.140
FL	Broward County Office of Transportation (BCT)	**0.576**	0.84%		28%	0.159
UT	Utah Transit Authority (UTA)	**0.604**	0.83%		22%	0.132
NY	Metropolitan Suburban Bus Authority	**0.553**	0.81%		32%	0.175
TX	VIA Metropolitan Transit (VIA)	**0.842**	0.76%		21%	0.178
FL	Central Florida Regional Transportation Authority (LYNX)	**0.617**	0.72%		23%	0.141
WA	Central Puget Sound Regional Transit Authority (ST)	**0.455**	0.65%		no data	no data
WI	Milwaukee County Transit System (MCTS)	**0.733**	0.63%		18%	0.135
CA	Santa Clara Valley Transportation Authority (VTA)	**0.820**	0.63%		17%	0.136
NJ	Suburban Transit Corporation (Coach USA)	**0.281**	0.62%		36%	0.100
OH	Southwest Ohio Regional Transit Authority (SORTA / Metro)	**0.605**	0.61%		23%	0.137
MO	Bi-State Development Agency (METRO)	**0.860**	0.60%		16%	0.139
CA	San Diego Metropolitan Transit System (MTS)	**0.852**	0.48%		21%	0.183
TX	Capital Metropolitan Transportation Authority (CMTA)	**0.748**	0.46%		26%	0.198
PA	Trans-Bridge Lines, Inc.	**0.220**	0.46%		46%	0.102
NC	Charlotte Area Transit System (CATS)	**0.782**	0.44%		20%	0.153
VA	Transportation District Commission of Hampton Roads	**0.754**	0.43%		22%	0.169
RI	Rhode Island Public Transit Authority (RIPTA)	**0.576**	0.43%		24%	0.140
MI	Suburban Mobility Authority for Regional Transportation (SMART)	**0.875**	0.39%		18%	0.158
CA	Santa Monica's Big Blue Bus (Big Blue Bus)	**0.474**	0.38%		35%	0.165
CA	Long Beach Transit (LBT)	**0.640**	0.38%		26%	0.165
NJ	Rockland Coaches, Inc.	**0.403**	0.35%		27%	0.107
CA	Omnitrans (OMNI)	**0.674**	0.35%		20%	0.137
MD	Ride-On Montgomery County Transit	**1.068**	0.35%		18%	0.191
NY	Niagara Frontier Transportation Authority (NFT Metro)	**0.754**	0.34%		17%	0.125
National Average Weighted by Passenger Miles (includes the 50 systems above as well as the other 324 systems with fuel data in the NTD)		**0.653**			24%	0.154

SOURCE: Federal Transit Adminstration (2007 National Transit Database), U.S. Department of Energy, U.S. Environmental Protection Agency

Note: *86% of bus passenger miles are on directly operated systems. 14% of bus passenger miles are on privately operated (contracted out) bus systems. The list above is the 50 largest directly operated bus systems by passenger miles, which account for 67% of all transit bus passenger miles traveled in the United States. Data for the entire list of 374 directly operated bus systems is available from the Federal Transit Administration but is not listed here due to space constraints. The national averages shown at the bottom of the table as well as earlier in the graphs include all 374 directly operated bus systems.*

Commuter Rail

State	**Agency**	**% of total commuter rail passenger miles traveled in U.S.**	Pounds CO2 / passenger mile		**Pounds CO2/seat mile** (Vehicle CO2 Efficiency)	**Average % of seats full** (Ridership)	**Fuel Source**
NJ	New Jersey Transit Corporation (NJ TRANSIT)	**20.5%**	0.317		0.104	33%	Diesel and Electricity
NY	MTA Long Island Rail Road (MTA LIRR)	**20.3%**	0.392		0.126	32%	Diesel and Electricity
NY	Metro-North Commuter Railroad Company	**19.1%**	0.284		0.092	33%	Diesel and Electricity
IL	Northeast Illinois Regional Commuter Railroad Corp. (Metra)	**15.4%**	0.418		0.130	31%	Diesel and Electricity
MA	Massachusetts Bay Transportation Authority (MBTA)	**7.1%**	0.342		0.103	30%	Diesel
PA	Southeastern Pennsylvania Transportation Authority (SEPTA)	**4.3%**	0.448		0.109	24%	Electricity
IN	Northern Indiana Commuter Transportation District (NICTD)	**1.1%**	0.247		0.086	35%	Electricity
National Average Weighted by Passenger Miles		**87.8%**	0.352		0.111	32%	

SOURCE: Federal Transit Adminstration (2007 National Transit Database), U.S. Department of Energy, U.S. Environmental Protection Agency

Systems or portions of systems for which data are not available because they are not directly operated:

State	**Agency**	**% of total commuter rail passenger miles traveled in U.S.**
CA	Southern California Regional Rail Authority (Metrolink)	3.7%
CA	Peninsula Corridor Joint Powers Board (PCJPB)	2.5%
MD	Maryland Transit Administration (MTA)	2.1%
FL	South Florida Regional Transportation Authority (TRI-Rail)	1.0%
VA	Virginia Railway Express (VRE)	0.9%
WA	Central Puget Sound Regional Transit Authority (ST)	0.5%
CA	North County Transit District (NCTD)	0.4%
CA	Altamont Commuter Express (ACE)	0.3%
PA	Pennsylvania Department of Transportation (PENNDOT)	0.2%
ME	Northern New England Passenger Rail Authority (NNEPRA)	0.2%
TX	Fort Worth Transportation Authority (The T)	0.2%
TX	Dallas Area Rapid Transit (DART)	0.1%
CT	Connecticut Department of Transportation (CDOT)	0.1%
TN	Regional Transportation Authority (RTA)	0.0%

SOURCE: Federal Transit Adminstration (2007 National Transit Database), U.S. Department of Energy, U.S. Environmental Protection Agency

Van Pool

State	Name	Pounds CO2 / passenger mile	% of Total Van Pool Passenger Miles Traveled in U.S.		Average % of seats full (Ridership)	Pounds CO2 / seat mile (CO2 efficiency of Vehicle)
UT	Utah Transit Authority (UTA)	**0.178**	7.3%		54%	0.097
WA	King County Department of Transportation Metro Transit Division (King County Metro)	**0.268**	6.7%		53%	0.142
IL	Pace Suburban Bus Division (PACE)	**0.336**	5.8%		49%	0.165
WA	Ben Franklin Transit (BFT)	**0.144**	4.3%		69%	0.100
CT	Greater Hartford Ridesharing Corporation The Rideshare Company	**0.273**	4.2%		48%	0.132
AZ	Phoenix VPSI, Inc.	**0.198**	3.9%		57%	0.113
WA	Pierce County Transportation Benefit Area Authority (Pierce Transit)	**0.223**	3.3%		51%	0.115
GA	Marietta VPSI, Inc.	**0.170**	2.8%		44%	0.074
TX	Dallas Area Rapid Transit (DART)	**0.171**	2.7%		78%	0.134
WA	Snohomish County Public Transportation Benefit Area Corporation (Community Transit)	**0.247**	2.6%		50%	0.124
WA	Intercity Transit (I.T.)	**0.169**	2.5%		75%	0.127
TX	Dallas VPSI, Inc.	**0.240**	2.4%		52%	0.124
NC	Charlotte Area Transit System (CATS)	**0.198**	1.8%		56%	0.110
NC	Research Triangle Regional Public Transportation Authority (TTA)	**0.120**	1.6%		88%	0.106
HI	Honolulu VPSI, Inc.	**0.269**	1.6%		47%	0.125
FL	Miami Lakes VPSI, Inc.	**0.218**	1.4%		54%	0.119
IA	Des Moines Area Regional Transit Authority (DART)	**0.222**	1.3%		57%	0.126
VA	Transportation District Commission of Hampton Roads	**0.184**	1.0%		69%	0.126
GA	Georgia Regional Transportation Authority (GRTA)	**0.205**	0.9%		51%	0.104
AK	VPSI, Anchorage	**0.231**	0.8%		49%	0.114
WA	Kitsap Transit	**0.286**	0.8%		47%	0.134
TX	Capital Metropolitan Transportation Authority (CMTA)	**0.389**	0.8%		39%	0.152
TN	Regional Transportation Authority (RTA)	**0.112**	0.5%		No data	
WA	Spokane Transit Authority (STA)	**0.315**	0.5%		38%	0.120
WA	Skagit Transit (SKAT)	**0.198**	0.5%		51%	0.101
GA	Douglas County Rideshare (Rideshare)*	**0.306**	0.5%		39%	0.121
FL	County of Volusia, dba: VOTRAN (Votran)	**0.187**	0.4%		76%	0.142
CT	2Plus Partners in Transportation, Inc (2Plus)	**0.191**	0.4%		No data	
MO	Kansas City Area Transportation Authority (KCATA)	**0.276**	0.3%		57%	0.158
WA	Yakima Transit (YT)	**0.211**	0.3%		49%	0.104
MI	Interurban Transit Partnership (The Rapid)	**0.230**	0.2%		59%	0.137
WI	Milwaukee County Transit System (MCTS)	**0.209**	0.1%		59%	0.124
VT	Chittenden County Transportation Authority (CCTA)	**0.154**	0.1%		62%	0.095
SC	Santee Wateree Regional Transportation Authority (SWRTA)	**0.284**	0.0%		47%	0.134
WA	Link Transit	**0.220**	0.0%		No data	
TX	Corpus Christi Regional Transportation Authority (The B)	**0.164**	0.0%		76%	0.123
MI	Kalamazoo Metro Transit System (Metro Transit)	**0.273**	0.0%		64%	0.175
CA	Kings County Area Public Transit Agency (KART)	**no data**	0.0%		No data	
National Average Weighted by Passenger Miles		**0.224**	64.7%		55%	**0.097**

SOURCE: Federal Transit Adminstration (2007 National Transit Database), U.S. Department of Energy, U.S. Environmental Protection Agency

Systems for which data are not available because they are not directly operated:

San Diego Association of Governments (SANDAG), Metropolitan Transit Authority of Harris County, Texas (Metro), New Jersey Transit Corporation (NJ TRANSIT), Greater Richmond Transit Company (GRTC Transit System), Madison County Transit District (MCT), Denver Regional Transportation District (RTD), Space Coast Area Transit (SCAT), Los Angeles County Metropolitan Transportation Authority (LACMTA), Central Florida Regional Transportation Authority (LYNX), Metropolitan Council, Southwestern Pennsylvania Commission (SPC), VIA Metropolitan Transit (VIA), Hillsborough Area Regional Transit Authority (HART), Transfort, Placer County Department of Public Works (PCDPW), Salem Area Mass Transit District (Cherriots), Coast Transit Authority (CTA), Lee County Transit (LeeTran), Lane Transit District (LTD), Interurban Transit Partnership (The Rapid)

Definitions of Transit Modes

Bus
A transit mode comprised of rubber-tired passenger vehicles operating on fixed routes and schedules over roadways. Vehicles are powered by diesel, gasoline, battery, or alternative fuel engines contained within the vehicle.

Heavy Rail
A transit mode that is an electric railway with the capacity for a heavy volume of traffic. It is characterized by high speed and rapid acceleration passenger rail cars operating singly or in multi-car trains on fixed rails, separate rights-of-way from which all other vehicular and foot traffic are excluded, sophisticated signaling, and high platform loading.

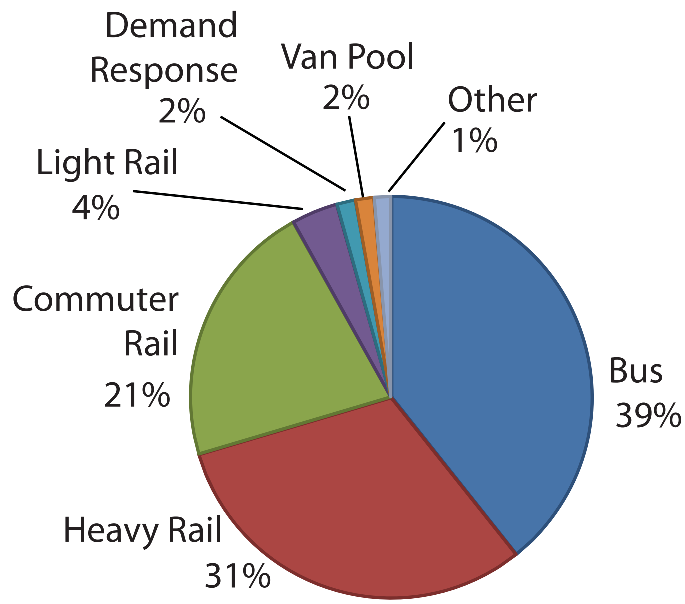
Light Rail
A transit mode that typically is an electric railway with a light volume traffic capacity compared to heavy rail. It is characterized by passenger rail cars operating singly (or in short, usually two car, trains) on fixed rails in shared or exclusive right-of-way, low or high platform loading, and vehicle power drawn from an overhead electric line via a trolley or a pantograph.

Commuter Rail
A transit mode that is an electric or diesel propelled railway for urban passenger train service consisting of local short distance travel operating between a central city and adjacent suburbs. Service must be operated on a regular basis by or under contract with a transit operator for the purpose of transporting passengers within urbanized areas, or between urbanized areas and outlying areas. Such rail service, using either locomotive hauled or self-propelled railroad passenger cars, is generally characterized by multi-trip tickets, specific station to station fares, railroad employment practices, and usually only one or two stations in the central business district. Intercity rail service is excluded, except for that portion of such service that is operated by or under contract with a public transit agency for predominantly commuter services.

Vanpool
A transit mode comprised of vans, small buses and other vehicles operating as a ride sharing arrangement, providing transportation to a group of individuals traveling directly between their homes and a regular destination within the same geographical area. The vehicles shall have a minimum seating capacity of seven persons, including the driver. For inclusion in the National Transit Database, it is considered mass transit service if it is operated by a public entity, or is one in which a public entity owns, purchases, or leases the vehicle(s). It must be open to the public and that availability must be made known.

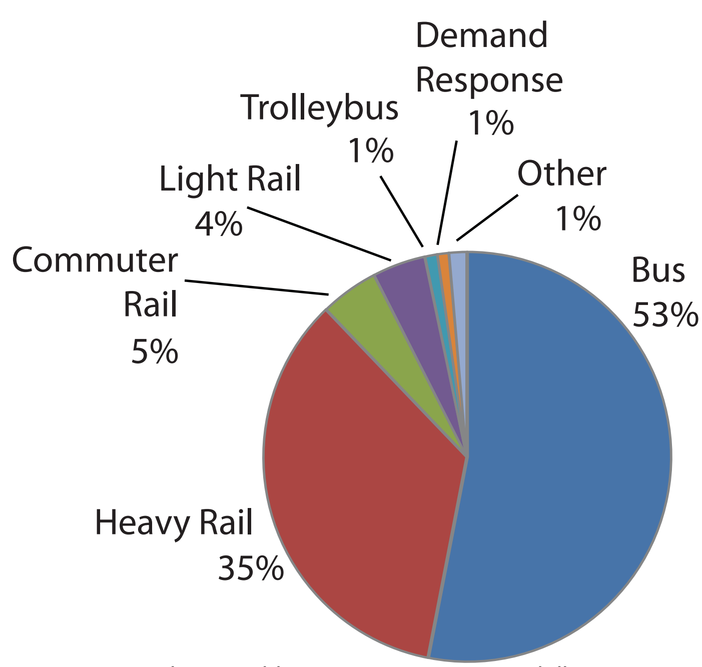
Other Transit Modes
The analysis in this paper includes bus, heavy rail, light rail, commuter rail, and van pool transit modes, which together account for 97 percent of U.S. transit passenger miles. Demand response accounts for 2 percent. Demand response service is not covered in this paper because it is not typically seen as an alternative to driving for reducing greenhouse gas emissions. The other modes included in the National Transit Database -- ferryboat, publico, trolleybus, automated guideway, cable car, Alaska Railroad, inclined plane, and monorail -- combined account for the remaining 1 percent, and as such are not covered in the paper.

Distribution of Public Transportation Passenger Miles, 2007



Total 2007 public transportation passenger miles: 52 billion.
Other: ferryboat, publico, trolleybus, automated guideway, cable car, Alaska Railroad, inclined plane, monorail.
Source: National Transit Database, 2007

Distribution of Public Transportation Passenger Trips, 2007



Total 2007 public transportation trips: 10 billion.
Other: ferryboat, publico, trolleybus, automated guideway, cable car, Alaska Railroad, inclined plane, monorail.
Source: National Transit Database, 2007

Appendix II: Data Sources and Methodology

Estimates of greenhouse gas emissions per passenger mile are calculated from fuel usage and passenger mile data in the 2007 National Transit Database, standard emissions factors for different fuels from the U.S. Department of Energy, and sub-regional electricity emissions factors from the U.S. Environmental Protection Agency. The average fuel economy for the in-use fleet of all cars, SUVs, and pick-up trucks in the United States is from the U.S. Environmental Protection Agency. The average number of passengers per private auto is from the 2001 National Household Transportation Survey. The average percent of seats occupied for transit is calculated from average number of seats per vehicle, vehicle miles, and passenger miles in the 2007 National Transit Database.

Private Car

The average fuel economy for light-duty vehicles (cars, SUVs, and pick-up trucks) is 20.3 miles per gallon[1] and gasoline releases 19.564 pounds of carbon dioxide per gallon burned.[2] Therefore, for each mile traveled driving alone, 0.964 pounds of carbon dioxide (19.564/20.3), or about 1 pound, is released into the atmosphere.

According to the 2001 National Household Transportation Survey, the average private auto work and general purpose trips have 1.14 and 1.63 passengers, respectively. These load factors are used for calculating greenhouse gas emissions per passenger mile for private auto work and general trips.

Transit

The Federal Transit Administration's National Transit Database provides data on fuel and electricity used in powering transit vehicles such as buses and trains, number of people riding, and distances traveled for each transit system. The analysis uses Tables 17 and 19 of the most recent full set of annual data available, the 2007 National Transit Database, http://www.ntdprogram.gov/ntdprogram/data.htm.

Transit agencies are only required to report energy data from systems that they directly operate. They are not required to report energy data from systems that are operated by a private contractor. As such, the figures presented are only for directly operated systems. Directly operated systems account for 99.8 percent of heavy rail system passenger miles, 96 percent of light rail passenger miles, 68 percent of transit bus passenger miles, 88 percent of commuter rail passenger miles, and 65 percent of van pool miles.

Transit Bus

Carbon dioxide emissions per passenger mile for U.S. transit bus systems were calculated as follows: Annual bus system fuel usage was obtained from the Federal Transit Administration's 2007 National Transit Database. The total quantity of each fuel type was multiplied by the standard CO2 emissions factor provided by the Department of Energy to obtain pounds of CO2 produced. This figure was then divided by total passenger miles from the National Transit Database.

Emissions from a typical transit bus can also be calculated as follows: A 40 foot diesel transit bus with a fuel economy of 3.47 miles per gallon[3] releases 6.45 pounds of carbon dioxide per mile.[4] A bus with 9.2 passengers, the national average, would emit 0.70 pounds per passenger mile.[5]

The national average passenger load on buses is actually 11 passengers, as calculated by dividing total transit bus passenger miles by total transit bus vehicle revenue miles (miles when the bus is in service). However, one needs to account for bus running time when the bus is out of service and has no passengers, for example, when it is heading back to the depot. To account for this, divide total transit bus passenger miles by total transit bus vehicle miles (including when the bus is in service and when it is not), to obtain 9.2 passengers.

Heavy and Light Rail Transit

Almost all heavy and light rail transit systems, such as subways and streetcars, are powered by electricity. For these systems, the level of carbon dioxide emissions depends on the types of power plants supplying the electricity (coal, gas, nuclear, hydroelectric, wind, etc.). The calculations in this fact sheet use the carbon dioxide emissions per megawatt hour for the power supplied to the electrical grid in the particular sub-region in which the transit agency operates. The data is from the U.S. Environmental Protection Agency's Emissions & Generation Resource Integrated Database (eGRID) 2006 v2.1, http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html. Sub-region emission factors are used rather than state level emission factors as regional power grids do not correspond with state lines. In addition, using the eGRID sub-region data rather than the state level data is recommended by the Climate Registry General Reporting Protocol, Chapter 14, http://www.theclimateregistry.org/downloads/GRP.pdf.

The Federal Transit Administration's National Transit Database provides data on electricity used in powering trains, number of people riding, and distances traveled for each transit system. The fact sheet uses Tables 17 and 19 of the most recent full set of annual data available, the 2007 National Transit Database, http://www.ntdprogram.gov/ntdprogram/data.htm.

Carbon dioxide emissions per passenger mile are then calculated by dividing the annual number of kilowatt hours used in propulsion for each transit system by the annual number of passenger miles, then multiplying that figure by the emissions factor specific to the sub-region in which the system operates.

Seat miles traveled is calculated by multiplying vehicle revenue miles by average seating capacity, as reported in the 2007 National Transit Database. Average percent of seats full is calculated by dividing seat miles by passenger miles.

Commuter Rail

Some commuter rail systems are powered by diesel and others are powered by electricity. Further, some transit agencies operate commuter rail systems that have both electrically powered lines and diesel powered lines. The gallons of diesel and kilowatt hours of electricity consumed by each system are used to estimate total carbon dioxide emissions using the emissions factor for diesel and the emissions factor for the sub-region's electrical grid. The estimated total pounds of carbon dioxide emissions for the system are then divided by the total number of passenger miles to obtain carbon dioxide emissions per passenger mile.

It should be noted that only directly operated systems report energy data to the National Transit Database. Privately operated systems, or systems that contract out their operations, are not required to report energy data to the National Transit Database. While only one heavy rail system (Puerto Rico's) and only part of one light rail system (New Jersey Transit) are privately operated, 14 of the 21 commuter rail systems are privately operated by freight railroads or other entities. However, the seven directly operated systems represent 89 percent of all U.S. commuter rail passenger miles. The fact sheet is only able to calculate emissions per passenger mile for the seven directly operated systems and the weighted national average represents only these seven systems.

Van Pool

Van pool emissions are calculated in the same manner as bus emissions.

Other Transit Modes

The analysis in this paper includes heavy rail, light rail, bus, commuter rail, and van pool transit modes, which together account for 97 percent of U.S. transit passenger miles. Demand response accounts for 2 percent; ferryboat, publico, trolleybus, automated guideway, cable car, Alaska Railroad, inclined plane, and monorail combined account for the remaining one percent.

FOOTNOTES:

1. 20.3 miles per gallon was the average fuel economy for the in-use fleet of all light-duty vehicles in 2003 according to EPA. This includes passenger cars and light-duty trucks (SUVs and pick-ups)
U.S. Environmental Protection Agency, Emission Facts, February 2005. http://www.epa.gov/OMS/climate/420f05003.pdf
See also: *United States Environmental Protection Agency, Greenhouse Gas Emissions from the U.S. Transportation Sector, 1990-2003*, March 2006, p17.

2. United States Department of Energy, Energy Information Administration, *Voluntary Reporting of Greenhouse Gases Program, Fuel and Energy Source Codes and Emission Coefficients*, http://www.eia.doe.gov/oiaf/1605/coefficients.html, see row for motor gasoline.

3. Federal Transit Administration, T*ransit Bus Life Cycle Cost and Year 2007 Emissions Estimation*, July 2, 2007, prepared by West Virginia University. http://www.fta.dot.gov/documents/WVU_FTA_LCC_Final_Report_07-23-2007.pdf
Page 32 shows a predicted fuel economy of 3.86 mpg for a 40 foot diesel transit bus. The study then corrects the CO2 emissions estimate by multiplying by (1/.9) to account for idle and hotel load. This is equivalent to a 10% reduction in fuel economy from 3.86 mpg to 3.47 mpg as CO2 emissions and miles per gallon are inversely proportional.

4. Diesel fuel releases 22.384 pounds of carbon dioxide per gallon burned. 22.384/3.47=6.45 pounds of carbon dioxide per mile. United States Department of Energy, Energy Information Administration, *Voluntary Reporting of Greenhouse Gases Program, Fuel and Energy Source Codes and Emission Coefficients*, http://www.eia.doe.gov/oiaf/1605/coefficients.html, see row for distillate fuel, including diesel.

5. Calculated from Federal Transit Administration, 2006 National Transit Database. Note that this is the average for the entire motorbus mode, which consists of 40 foot buses as well as smaller buses used for less populated routes and larger articulated buses used for heavy ridership routes. An average specific to 40 foot buses was not available.

FOR MORE INFORMATION, PLEASE SEE:
http://www.fta.dot.gov/sustainability

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