The Antiplanner

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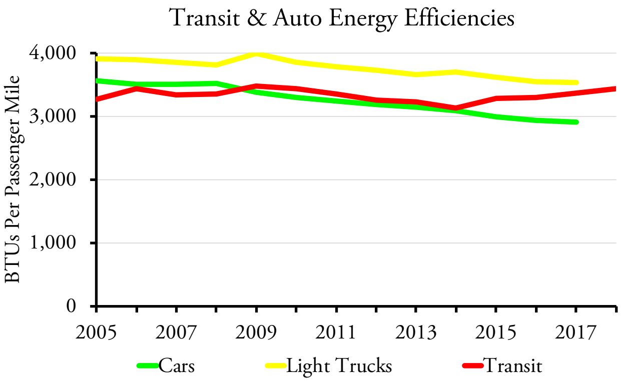
Urban Transit Is an Energy Hog

Transit is often touted as a way to save energy. But since 2009 transit has used more energy, per passenger mile, than the average car. Since 2016, transit has used more than the average of cars and light trucks together.

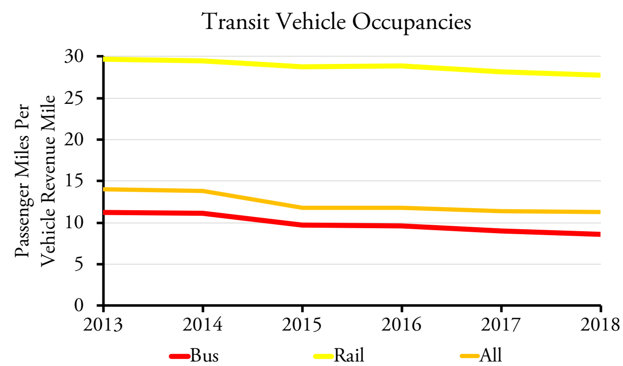
Automobiles and planes are becoming more energy efficient each year. But the annual reports of the National Transit Database reveals that urban transit is moving in the opposite direction, requiring more energy to move a person one mile in each of the last four years.



Transit has been less energy efficient than the average car since 2009. Light trucks (vans, pickups, SUVs) may soon become more efficient than transit as well. 2018 automobile data are not yet available; 2017 numbers are estimated from this report; prior years are from the Transportation Energy Databook.

The reason for this is simple: ridership is declining, but transit agencies aren't proportionately reducing miles of transit service. As a result, the average occupancies of buses and other transit vehicles has declined in every year since 2013. While transit agencies may be purchasing more fuel-efficient vehicles, the increase in average efficiencies per vehicle mile can't make up for the loss in passengers.

These numbers are based on the National Transit Database, which reports the number of gallons of Diesel fuel, gasoline, natural gas, and other fuels as well as the number of kilowatt-hours of electricity are used by transit systems across the country. I've converted these numbers to British thermal units (BTUs) using standard factors, such as that a gallon of Diesel fuel has 138,500 BTUs.



Transit occupancies have steadily declined since 2013. "Bus" includes commuter bus, rapid bus, trolley bus, and conventional bus (which the FTA calls "motor bus"). "Rail" includes commuter, heavy, light, and hybrid rail and streetcars, but not monorail or automated guideways. "All" includes all transit, not just bus and rail.

For electricity, I also took into account the fact that two-thirds of the energy used in a power plant is lost in generation and transmission. In other words, in order to deliver 1 kilowatt-hour (3,412 BTUs) of energy to a customer, an electrical system must consume the equivalent of 10,236 BTUs of fossil fuels or other energy at the power plant. Electric motors tend to be more efficient than internal combustion engines, but when the losses from generation and transmission are accounted for, the efficiencies are about the same.

Energy Consumption by Mode

The calculations show that ferries and streetcars use huge amounts of energy per passenger mile. Automated guideways (i.e., people movers) aren't shown in the chart on page 3 but use even more energy per passenger mile than ferries. Buses and light rail are well above the average automobile.

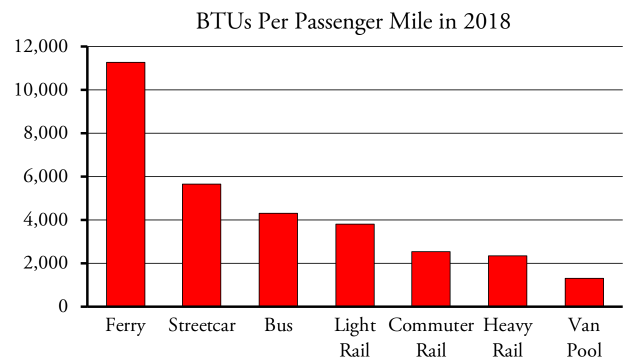
Commuter and subway/elevated trains (heavy rail) appear to be more efficient, but this is largely because

Energy & Greenhouse Gases Per Passenger Mile by Rail System

Rail System	BTUs	Grams CO_2
Commuter Rail		
Alamont (San Jose-Stockton)	1,044	76
Albuquerque	3,834	281
Boston	2,736	200
Chicago Metra	1,977	158
Chicago N. Indiana	2,852	190
Connecticut	9,741	713
Dallas-Fort Worth	4,876	357
Denver	2,776	178
Los Angeles	2,600	190
Maryland	2,952	181
Miami Tri-Rail	4,012	294
Minneapolis North Star	3,318	243
Nashville	6,452	472
New Jersey Transit	2,728	108
New York Long Island RR	1,857	51
New York Metro-North	2,752	78
Orlando	6,212	455
Philadelphia DOT	2,440	87
Philadelphia SEPTA	4,879	175
Portland-Boston	2,622	192
Salt Lake City	2,758	202
San Diego	3,118	228
San Francisco	1,430	105
Santa Rosa SMART	2,335	171
Seattle	1,638	120
Virginia Railway Express	1,788	131
Heavy Rail		
Atlanta	2,111	88
Baltimore	14,579	552
Boston	3,417	127
Chicago	3,391	126
Cleveland	4,674	302
Los Angeles	4,340	90
Miami	5,138	223
New York MTA	1,770	34
New York PATH	2,389	55
Philadelphia PATH	4,760	110
Philadelphia SEPTA	4,026	144
San Francisco	1,879	39
San Juan	2,141	77
Staten Island	5,344	103
Washington	4,342	232
Light Rail		
Baltimore	6,933	263
Boston	3,421	127
Buffalo	7,601	146

Rail System	BTUs	Grams CO_2
Light Rail (continued)		
Charlotte	4,091	150
Cleveland	15,223	982
Dallas	5,584	286
Denver	3,796	243
Houston	4,388	224
Los Angeles	3,337	69
Minneapolis-St. Paul	4,227	197
NJ Hudson-Bergen	4,682	108
NJ Newark	5,643	130
Norfolk	7,592	253
Phoenix	2,076	83
Pittsburgh	10,831	388
Portland	2,743	34
Sacramento	5,153	107
Salt Lake City	4,699	336
San Diego	2,283	47
San Francisco	4,311	90
San Jose	5,200	108
Seattle	1,607	15
St. Louis	4,182	327
Streetcars		
Atlanta	19,672	816
Charlotte	8,706	319
Cincinnati	13,674	882
Dallas-DART	26,383	1,350
Dallas-McKinney	4,051	207
Detroit	14,542	730
Kansas City	3,269	256
Kenosha	32,938	2,094
Little Rock	40,961	2,167
Memphis	18,009	787
New Orleans	3,337	165
Philadelphia	4,857	174
Portland	2,715	33
San Francisco	5,761	120
Seattle	13,641	125
Tacoma	5,140	47
Tampa	8,759	381
Tucson	12,907	515
Washington	56,997	3,041
Hybrid Rail		
Austin	2,773	203
Denton	5,264	385
NJ River Line	2,530	185
Oakland	3,194	231
Portland	3,812	275
San Diego	2,689	197

commuter- and heavy-rail numbers are dominated by New York where occupancy rates are high. As shown in the table on page 2, commuter rail lines in such regions as Dallas-Ft. Worth, Miami, and even Philadelpha use far more than the average amount of energy per passenger mile, as do heavy rail lines in Baltimore, Boston, Los Angeles, and Miami. Perhaps the biggest surprise is the DC Metrorail, the nation's second-most heavily used rail system, which consumes almost 25 percent more energy per passenger mile than the average light truck used in 2017.



Ironically, the most energy-efficient transit mode—van pools—is the one that is based on conventional automobiles rather than large buses or railcars.

Energy Consumption by Urban Area

The numbers for individual urban areas are even worse for transit. Among the largest 100 urban areas, transit is more energy-efficient than cars only in New York, San Francisco-Oakland, and Honolulu. Transit in Atlanta and Portland is less energy-efficient than cars but more than the average light truck. Just about everywhere else, transit is a real energy hog. The adjacent table has numbers for the 54 urban areas. Among smaller urban areas, Stockton (which is the 102nd largest area) appears to be more energy efficient than cars, but only because the Altamont Commuter Express is attributed to Stockton.

Even where rail transit appears to be more energy efficient than driving on an operational basis, this doesn't account for the energy costs of construction. Urban roads carry far more passengers over their lifetimes than rail lines, so the energy cost of construction per passenger mile is much higher for rail transit. Rails must be rebuilt about every 30 years, which also requires large amounts of energy. Heavy use of steel and concrete also has a high greenhouse gas cost.

Greenhouse Gases

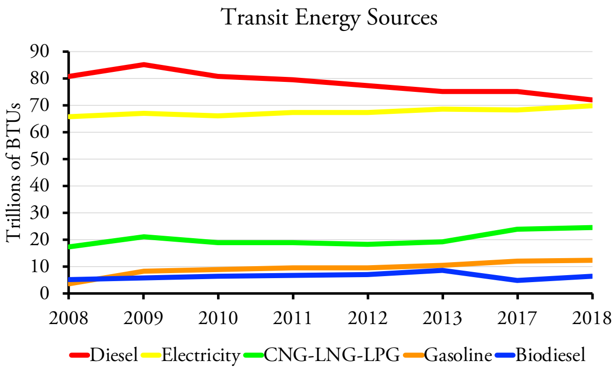
Though transit is less energy efficient than the average car, it emits slightly fewer greenhouse gases per passenger mile than than the average car. Transit was actually worse than the average car as recently as 2010, but by 2014 it had reduced its climate footprint by 25 percent.

It accomplished this partly by partially converting

Energy and GHGs Per Passenger Mile by Urban Area

	BTUs	Grams CO_2
New York	2,341	94
Los Angeles	4,218	287
Chicago	3,395	197
Miami	4,854	324
Philadelphia	4,435	210
Dallas-Ft. Worth	6,482	441
Houston	4,066	290
Washington	4,459	277
Atlanta	3,172	204
Boston	3,477	202
Detroit	4,601	326
Phoenix	5,296	389
San Francisco-Oakland	2,616	115
Seattle	4,101	280
San Diego	3,648	240
Twin Cities	4,479	300
Tampa-St. Petersburg	5,601	417
Denver	4,027	279
Baltimore	4,425	269
St. Louis	5,062	378
San Juan	4,483	314
Riverside	7,231	581
Las Vegas	4,274	341
Portland	3,270	159
Cleveland	5,821	417
San Antonio	6,013	466
Pittsburgh	5,242	341
Sacramento	6,642	392
San Jose	4,531	264
Cincinnati	5,399	394
Kansas City	6,895	523
Orlando	5,000	370
Indianapolis	6,844	500
VA Beach	6,032	419
Milwaukee	5,329	389
Columbus	7,309	565
Austin	5,103	373
Charlotte	4,687	305
Providence	4,746	347
Jacksonville	6,514	488
Memphis	6,811	495
Salt Lake	4,011	293
Louisville	5,101	372
Nashville	5,472	396
Richmond	4,397	344
Buffalo	4,875	309
Hartford	4,958	363
Bridgeport	5,671	413
New Orleans	6,598	458
Raleigh	6,156	443
Oklahoma City	5,971	449
Tucson	5,293	383
El Paso	4,714	390
Honolulu	2,746	200

from Diesel to other fuel sources; originally biodiesel but more recently compressed natural gas. In addition, the nation's electric industry has converted from heavy reliance on coal to heavy reliance on natural gas. Both of these changes reduced greenhouse gas outputs per unit of energy. Since 2014, however, declining transit ridership increased greenhouse gas emissions per passenger mile by about 7 percent.



The main transit energy trend over the last decade has been the replacement of Diesel fuels with compressed natural gas, which paralleled the electric industry's conversion from coal to natural gas.

Calculations of greenhouse gas emissions are straightforward for fossil fuels as burning a gallon of gasoline, Diesel, or natural gas results in a consistent output of carbon dioxide. For electricity, I presumed that the electricity used by a transit agency is generated by a the combination of power sources used in the agency's state, as reported in the Department of Energy's *State Electricity Profiles*. Even if a transit company claims that it buys renewable energy, the reality is that electricity is fungible, and renewable energy consumed by a transit agency means less renewable energy for someone else.

While transit scores better than automobiles overall, this is only because of New York, which produces some 44 percent of transit riders and whose electricity profile claims to emit less than half the national average of carbon dioxide per kilowatt-hour. However, New York doesn't generate enough electricity to satisfy its needs and must import some, and the greenhouse gases attributable to imported electricity is unknown.

Two-thirds of all states are net electricity exporters, and some major exporters such as Texas and Wyoming generate most of their electricity with fossil fuels. Many of the importer states, including California and New York, generate most of their electricity from non-fossil-fuel sources, but their imports are probably more dependent on fossil fuels.

For a sensitivity analysis, I assumed that electricity brought into net importer states was generated by the national average of fuel sources. Under this assumption, electric-powered transit generated 22 percent more greenhouse gases in California, 15 percent more in New York, and about 7 percent more in Massachusetts, Maryland, and Virginia, while Washington DC transit generated 17 percent less greenhouse gases. For the most part, these numbers aren't big enough to fuss about, especially since we can't accurately estimate the mix of sources of energy that is imported into the various states. The greenhouse gas emissions shown in the above tables are based on state electricity profiles with the caveat that the actual numbers in California and New York are probably higher while DC is probably lower.

Based on the state profiles, transit may be more greenhouse-gas-efficient than cars nationwide, but it is less efficient than cars in 93 out of the nation's 100 largest urban areas. Further, transit is more greenhouse-gas-efficient than light trucks in only three more urban areas. Thus, driving a car or light truck is more climate-friendly than transit in 90 of the nation's 100 largest urban areas (and all but a handful of the smaller ones).

The results of my calculations of energy consumption and greenhouse gas emissions for each transit agency, mode, and urban area are in my 2018 Transit Database summary spreadsheet. For details on how to use this spreadsheet, see last week's policy brief.

Randal O'Toole, the Antiplanner, is a land-use and transportation policy analyst and author of Romance of the Rails: Why the Passenger Trains We Love Are Not the Transportation We Need. *Masthead photo of the Altamont Commuter Express is by David Gruber.*