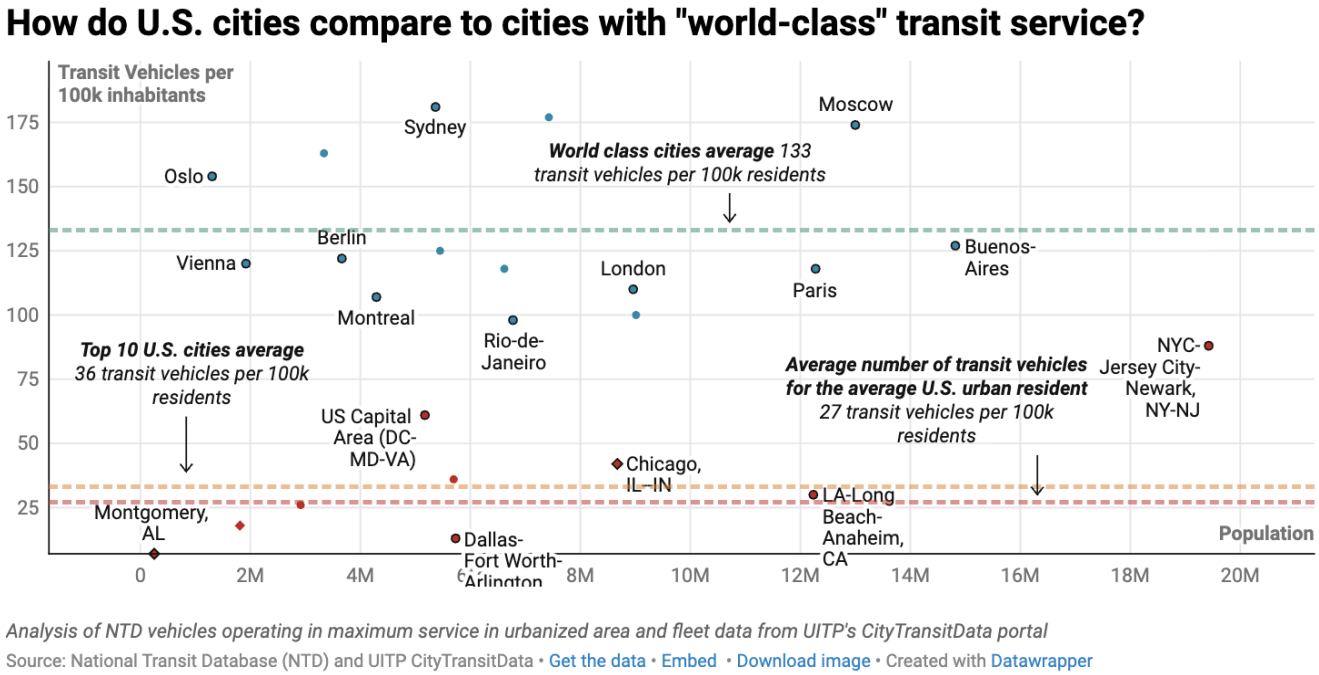
How do we scale U.S. transit to "world-class" levels?

The goal of this analysis is to identify a definition for "world-class" transit based on examples in global peer cities that could be applied to the United States and used to determine how much additional investment might be required to bring existing service up to a "world-class" standard.

Defining "world-class" transit abroad

First, we define "world-class" transit by identifying the average number of transit vehicles in service, as a share of the population, in globally competitive, transit-rich cities, citing prominent examples such as London, Paris, Barcelona, Singapore, and Buenos Aires. To do so, we utilized data collected by the International Association of Public Transport on their CityTransitData website. On average, the 17 cities from outside the United States that we evaluated had more than 130 transit vehicles in service for every 100,000 residents. Data listed by UITP described transit service availability at a regional level, being roughly comparable to the urbanized area level used in the United States.



Analysis of NTD vehicles operating in maximum service in urbanized area and fleet data from UITP's CityTransitData portal

Source: National Transit Database (NTD) and UITP CityTransitData • Get the data • Embed • Download image • Created with Datawrapper

Interactive chart

To understand how American regions performed in relation to their global peers, we drew on domestic data sources. We evaluated the total number of buses (including commuter buses, trolley buses, articulated buses, and bus rapid transit vehicles), light rail vehicles and streetcars, heavy rail vehicles (subways and metros), and commuter rail vehicles in service in U.S. urbanized areas using data from the Federal Transit Administration's National Transit Database (NTD). We

did not evaluate vanpool and demand response vehicles, which are not often used for frequent, fixed-route service that often characterizes "world-class" transit.

When evaluating the number of transit vehicles operated in maximum service (VOMs) per resident in a U.S. urbanized area, American regions provide significantly less transit service compared to the transit-rich global benchmark. In the top 10 most populated U.S. urbanized areas, there are only 36 transit vehicles per 100k residents, while the average resident of an urban area with over 50,000 inhabitants lives in a place with only 27 transit vehicles operating for every 100k residents. U.S. regions provide a fifth of transit service, as measured by transit vehicle fleet size per capita, compared to their global economic peers that make up the world-class transit benchmark.

Setting targets for world-class transit fleets in the United States

To achieve World-Class American Transit, the United States would need to dramatically increase investment in transit capital and operations to build out and run a fleet of vehicles that is closer in scale to its global peers that run transit at world-class levels. We set targets for new, "world-class" transit fleets according to urban areas' population density. For the most densely populated areas (UZAs at the 95th percentile of density and higher), we set the highest targets: 100 vehicles per 100k residents in 2045. Meanwhile, we assigned lower targets to the least dense urbanized areas, scaling targets down with urban areas of lower density. For each UZA, we created an estimated level of service that corresponded with the density of the area, with service levels generally increasing according to the rules in this table:

Population Density	Population in UZA (2023)	2023 Fixed Route transit VOMs per 100k	2045 "World-class transit" Target VOMs
>95th percentile	52.9 million	24	100
95th to 85th	54.8 million	23	80 or better
85th to 70th	42.2 million	22	70 or better
70th to 50th	36.6 million	17	60 or better
50th to 40th	16.1 million	17	50 or better
40th or below	29.5 million	12	40 or better

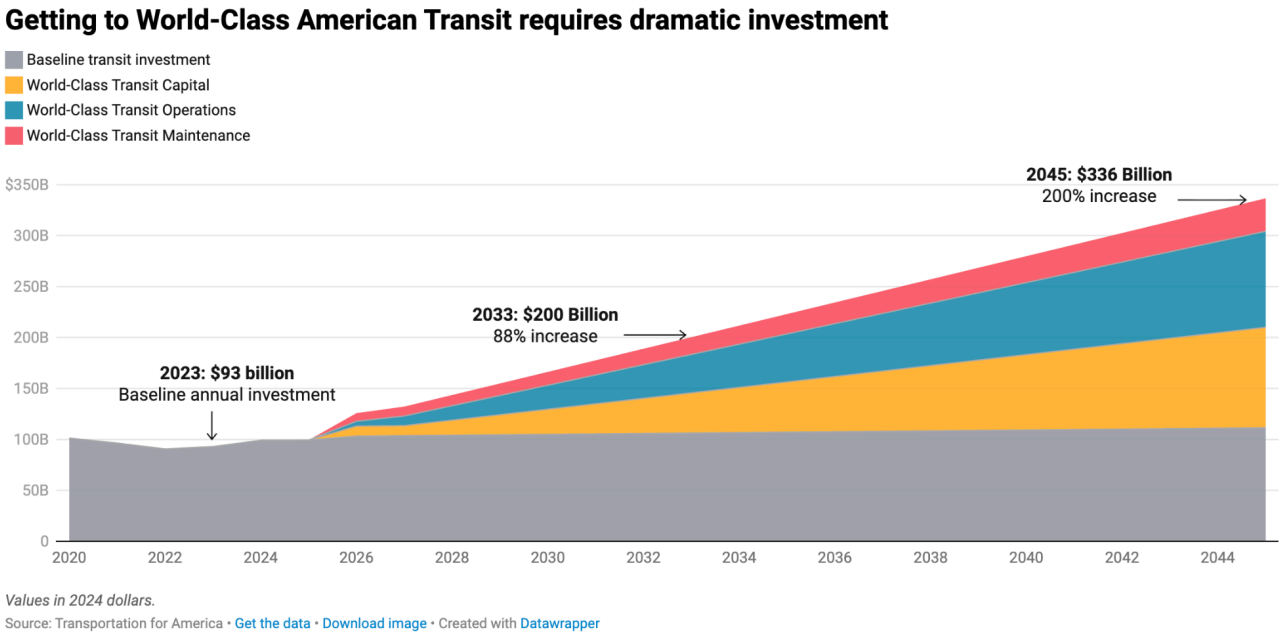
In areas where the new transit service target fell below existing service levels (often due to significantly above average transit in some smaller cities), we added 10 vehicles per 100,000 residents over existing levels in that urbanized area to ensure that increased investment would result in a tangible improvement over existing service. We acknowledge that using population density alone is a simple heuristic and, unfortunately, glosses over essential elements of transit planning that would be required to make

precise estimates of investment needed to achieve world-class transit. Transit is highly dependent on street design and destination proximity, which can be improved in the future if regions focus on transit oriented development.

Adjusting for population growth

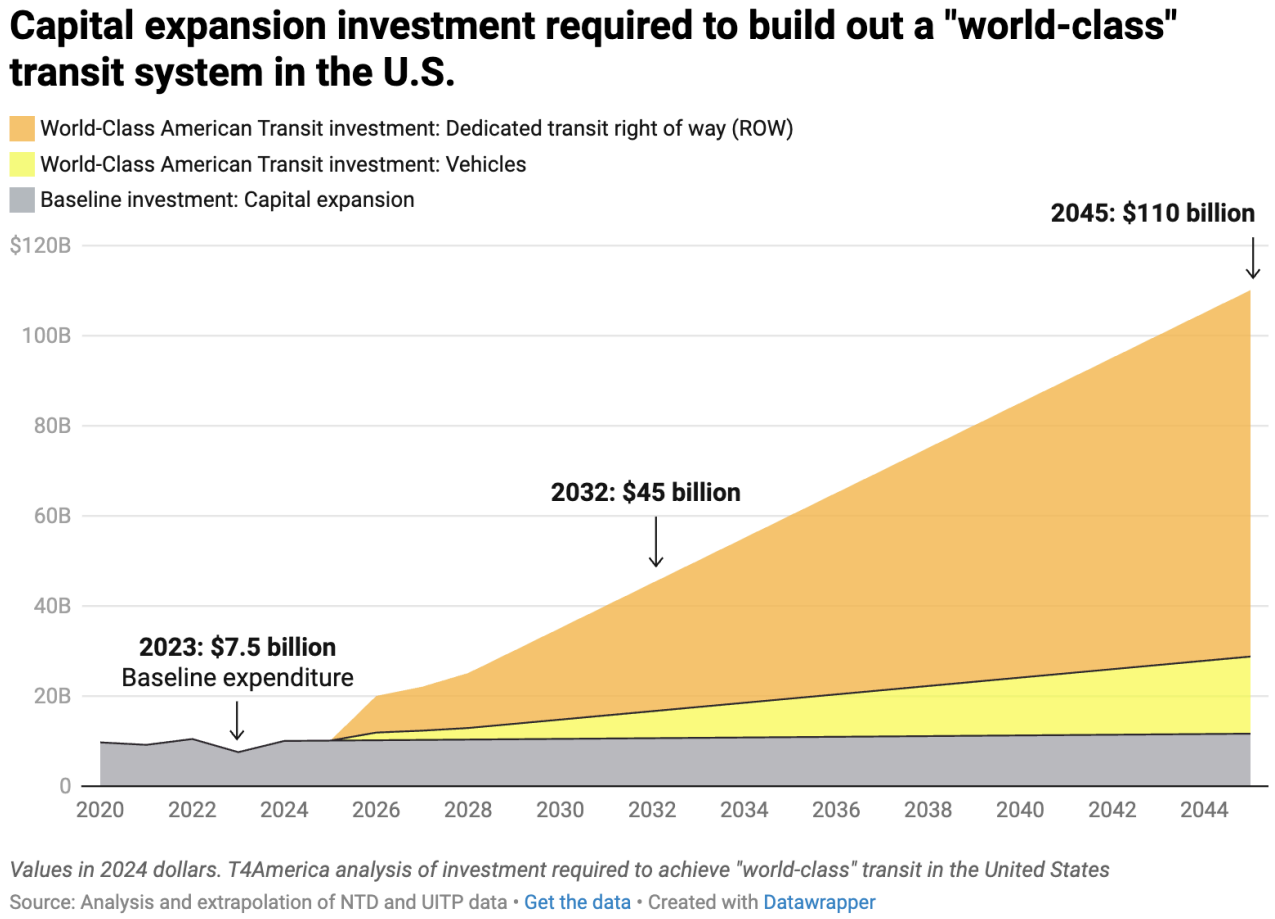
According to 2023 NTD data, there were a reported 232 million Americans living in the 452 urbanized areas of over 50,000 residents. To account for population increase between today and 2045, we used U.S. Census population growth projections and assumed that there will be 358,437,973 people living in the United States in 2045. Although unrealistic, we do not assume any shifts in the share of the total U.S. population living in existing urbanized areas (UZAs). Instead, we assume a simple proportional increase in existing UZAs' populations in proportion to their existing share of the U.S. population. Under these assumptions, 248,589,431 people would live in UZAs in 2045, and the population would be distributed throughout UZAs in the same proportions as they are today. These projections were used to account for population growth when setting 2045 targets for world-class transit.

Capital, operations, and maintenance assumptions



Interactive chart

Capital expansion investments



Interactive chart

The difference between the number of transit vehicles operated per 100,000 residents in 2023 and the target number of vehicles per 100,000 residents required to achieve world-class transit service in 2045 served as the scaling factor used to determine the number of vehicles needed to achieve World-Class American Transit.

For example, in the Los Angeles-Long Beach-Anaheim, CA UZA, according to data from transit agencies reporting to the NTD in 2023, 30 vehicles were operated in maximum service for every 100k residents, with 3,665 fixed-route transit vehicles serving a reported population of 12,237,376 residents. The Los Angeles area is the densest urbanized area in the United States, and according to the aforementioned population density-based target, we set a target to grow the transit fleet to have 100 transit vehicles operating in maximum service for every 100k residents.

Assuming a future population of 13,097,216 in 2045, the Los Angeles-Long Beach-Anaheim, CA UZA would need 13,097 vehicles in service to meet its target—a 257% increase over existing levels. Across all the UZAs evaluated in this report, a world-class American transit fleet would grow to 175,959 fixed-route transit vehicles, or 71 transit vehicles for every 100k people in 2045, a major increase compared to 2023's 27 transit vehicles for every 100k people.

Transit vehicle procurement cost estimates

How much would transit fleets need to expand over existing levels to achieve World-Class American Transit by 2045?

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Urbanized Area (UZA)	Transit vehicle fleet size 2023	Baseline transit service (2023)	World-Class bus and rail fleet size	Target transit service (World-Class American Transit)
New York-Jersey City-Newark, NY-NJ	17,026 transit vehicles	88 vehicles per 100k people	*20,778 transit vehicles*	***100 vehicles per 100k people***
Los Angeles-Long Beach-Anaheim, CA	3,665 transit vehicles	30 vehicles per 100k people	*13,097 transit vehicles*	***100 vehicles per 100k people***
Chicago, IL-IN	3,631 transit vehicles	42 vehicles per 100k people	*7,424 transit vehicles*	***80 vehicles per 100k people***
Miami-Fort Lauderdale, FL	1,245 transit vehicles	20 vehicles per 100k people	*6,412 transit vehicles*	***100 vehicles per 100k people***
Houston, TX	936 transit vehicles	16 vehicles per 100k people	*5,011 transit vehicles*	***80 vehicles per 100k people***
Dallas-Fort Worth-Arlington, TX	736 transit vehicles	13 vehicles per 100k people	*4,908 transit vehicles*	***80 vehicles per 100k people***
Philadelphia, PA-NJ-DE-MD	2,048 transit vehicles	36 vehicles per 100k people	*4,267 transit vehicles*	***70 vehicles per 100k people***
Washington-Arlington, DC-VA-MD	3,151 transit vehicles	61 vehicles per 100k people	*4,431 transit vehicles*	***80 vehicles per 100k people***
Atlanta, GA	754 transit vehicles	15 vehicles per 100k people	*2,729 transit vehicles*	***50 vehicles per 100k people***
Boston, MA-NH	1,945 transit vehicles	44 vehicles per 100k people	*3,276 transit vehicles*	***70 vehicles per 100k people***

2023 transit fleet totals describe vehicles operating at maximum service and excludes vanpool and demand response vehicles.

Source: National Transit Database (2023) • Get the data • Created with Datawrapper

Interactive table

While increased transit investment would most likely translate to changes in the mix of modes utilized by transit agencies, for the purposes of this report, the ratios of bus, light rail, heavy rail, and commuter rail vehicles in agencies' fleet mix reported in 2023 were simply scaled up for the 2045 world-class transit scenario. For example, in Los Angeles, we assumed that the agency

would need to triple the number of vehicles compared to its 2023 fleet, procuring a net 8,369 new buses and 1,063 new rail vehicles.

We then estimated the cost to acquire each newly procured transit vehicle based on publicly available cost data identified by other contemporary analyses such as those from Eno Transportation, the Brookings Institution, and the Transit Cost Project, keeping costs steady to 2024 dollars across this analysis. Additionally, to account for the shorter service lifetime of buses compared to rail vehicles, we assumed that buses would need to be replaced within the evaluation period, and as such, increased the bus costs by 1.25 times to account for new units that retire during the 2026-2045 time period.

Mode	Procurement cost estimate
Bus per vehicle cost	$1,000,000
Light rail per vehicle cost	$4,000,000
Heavy rail per vehicle cost	$3,500,000
Commuter rail per vehicle cost	$3,600,000

Dedicated ROW construction cost estimates

Interactive Table: How many new miles of dedicated transit right-of-way might be needed to achieve World-Class American Transit?

UZA Name	Miles of reported dedicated transit ROW (2023)	World-Class American Transit: New miles of transit ROW (all modes)	World-Class American Transit: Cost of new ROW
New York-Jersey City-Newark, NY-NJ	1,546 miles	272 new miles	$45,742,609,628
Los Angeles-Long Beach-Anaheim, CA	650 miles	702 new miles	$79,540,059,854
Chicago, IL-IN	718 miles	352 new miles	$63,890,268,431
Miami-Fort Lauderdale, FL	125 miles	373 new miles	$50,846,516,553
Houston, TX	215 miles	270 new miles	$23,398,649,809
Dallas-Fort Worth-Arlington, TX	169 miles	356 new miles	$49,818,847,279
Philadelphia, PA-NJ-DE-MD	369 miles	246 new miles	$55,854,873,897
Washington-Arlington, DC-VA-MD	230 miles	139 new miles	$40,345,206,627
Atlanta, GA	132 miles	180 new miles	$45,023,406,888
Boston, MA-NH	467 miles	167 new miles	$40,582,416,679

Additional 442 rows not shown.

Includes reported dedicated bus, light rail, heavy rail, and commuter rail miles by NTD full reporters.
Source: National Transit Database - 2023 • Created with Datawrapper

Interactive table

We did not evaluate the existing expansion plans of regions and transit agencies when preparing this report. Instead, this report assumed that the miles of new dedicated transit right-of-way would be proportional to the number of vehicles added to the fleet to reach "world-class" transit service levels. Specifically, we assume the total miles of dedicated transit right-of-way for bus rapid transit, urban rail, and commuter rail would vary depending on the number of each vehicle procured, corresponding with the number of vehicles that would likely run on a new transit line (or the general transit coverage of buses needed to support a BRT line). For urban areas that are less dense and with less ambitious target transit service levels (areas with a target of less than 60 vehicles per 100k residents in 2045), we assumed that no new dedicated right-of-way would be constructed.

How many vehicles for a new mile of ROW?

Mode	For every…	Construct…	Minimum target transit vehicles/100k residents
Bus	180 new vehicles	10 miles of dedicated right-of-way	60 vehicles per 100k or greater, or the regional population is greater than 5 million
Light rail	100 new vehicles	25 miles of dedicated right-of-way	60 vehicles per 100k or greater, or the regional population is greater than 5 million
Heavy rail	120 new vehicles	27 miles of dedicated right-of-way	60 vehicles per 100k or greater, or the regional population is greater than 5 million
Commuter rail	25 new vehicles	5 miles of dedicated right-of-way	60 vehicles per 100k or greater, or the regional population is greater than 5 million

**In the case of New York City and Chicago's urbanized areas (where there is robust existing rail), we made exceptions and reduced the total miles of new track to be built under this scenario.*

Similar to how we estimated the per-vehicle procurement costs by mode, we evaluated existing public procurement data and research on transit capital construction costs to estimate the per-mile cost by mode. These capital construction cost estimates were derived from data on existing projects available from the Eno Transportation Center and Transit Costs Project. These estimates are intended to be illustrative and unlikely to be a fit for every region.

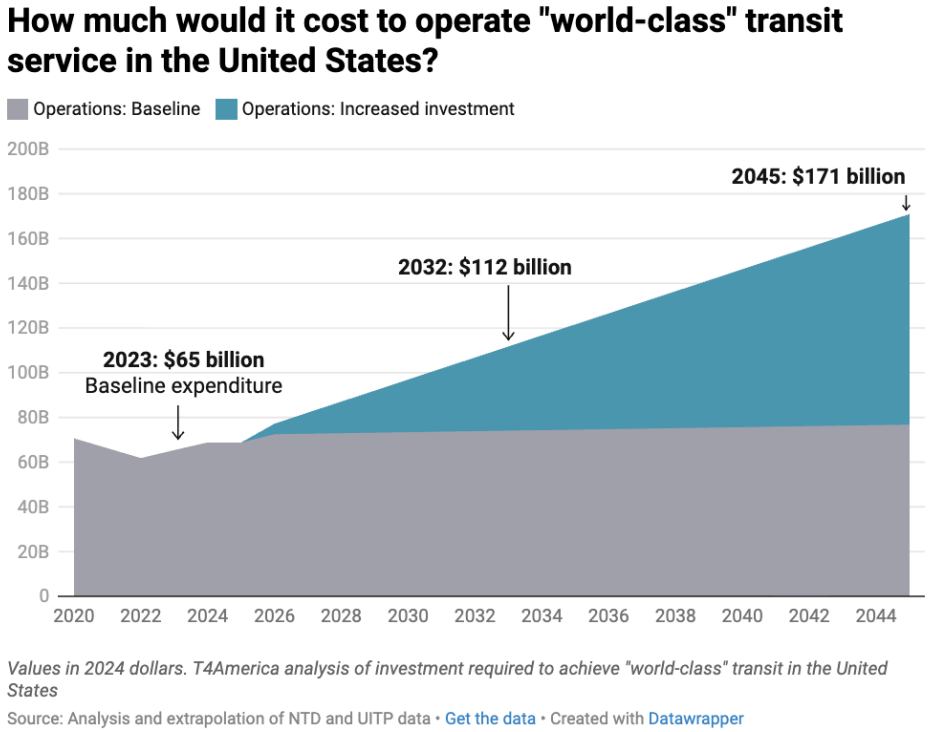
Mode	Capital cost estimate
Dedicated bus ROW per mile cost	$30,000,000
Light rail ROW per mile cost	$300,000,000
Heavy rail ROW per mile cost	$450,000,000
Commuter rail ROW mile cost	$200,000,000

Regional adjustments to construction costs

Certain regions face higher-than-average transit capital construction costs, whether due to limitations of the existing built environment, complex local geography, political and environmental factors, high labor costs, and or material needs. In high-cost regions, such as the New York-Jersey City-Newark, NY-NJ urbanized area or Seattle-Tacoma, WA urbanized area, costs can be dramatically higher than in other regions. In New York City, the Phase I Second Avenue Subway project had cost over $2.5 billion per mile to construct new heavy rail track and stations. In Seattle, the planned 4.1-mile West Seattle Link Extension project is now estimated to cost about $1.7 billion per mile to construct. Addressing these high costs will require increasing in-house transit agency engineering capacity, a more efficient and cost-effective transit construction workforce pipeline, and a greater use of joint development and value capture at and around stations to offset high costs. However, other projects in regions with relatively lower costs, like Sacramento's Phase 2 South Corridor Light Rail Extension, cost only $77 million per mile, or in another case, the Draper Light Rail Line in Salt Lake City cost $44 million per mile (both in 2021 dollars). **If you are considering using cost estimates found in this report in your own transit advocacy, consider the type of region you might be in, what advocates in your region are already working on, and existing transit capital expansion plans before referencing specific cost figures from this report.**

Region type	Construction-cost adjustment modifier
High-cost region	Up to 2 times to 5 times baseline cost
Average-cost region	Baseline costs
Low-cost region	0.5 times to 0.75 times baseline cost

Operations costs



[Interactive chart]

Operating costs assumptions are derived from figures reported by transit agencies to the Federal Transit Administration's NTD in 2023, summing the total reported operating costs, including fuel, salaries, tires, facilities, and other miscellaneous costs associated with each fixed route transit mode, over a year. We then divided those costs by the number of vehicles operating at maximum service to find per-vehicle operating costs. This series of estimates served as the baseline estimated expenditure required to support each new vehicle's operation expenses when added to an agency's fleet between 2026 and 2045. No automation or efficiency increases were assumed in this report, though those would significantly help reduce costs.

Vehicle mode	**Annual per-vehicle operations cost assumption***
Bus (all types)	$733,093
Light rail vehicle	$2,107,393
Heavy rail vehicle	$1,226,047
Commuter rail	$1,443,851

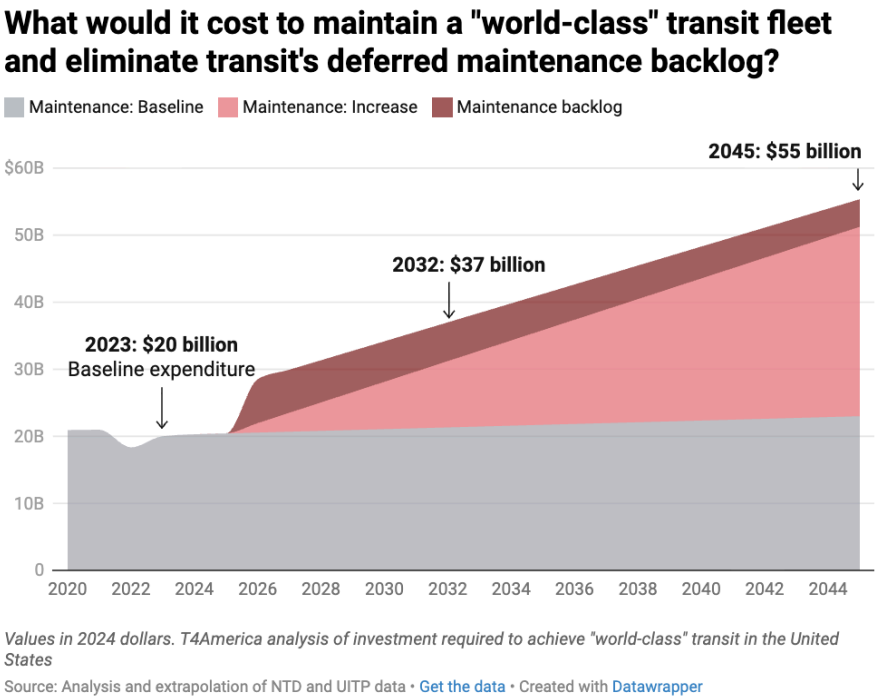
Based on total operating costs reported to the National Transit Database, per vehicle operating at maximum service in 2023 NTD Operating Expenses. Like capital costs, costs to operate remain fixed at 2024 dollar levels in this illustrative scenario analysis.

2023 National Transit Database – reported operating costs

Mode	*2023 Operating Expenditures*	*Cost per VOMs*	*2023 VOMs*	*2023 Vehicle Revenue Hours*
Commuter Bus	*$1,049,213,462*	*$381,949*	*2,747*	*3,990,290*
Demand Response	*$6,623,772,454*	*$157,274*	*42,116*	*67,735,403*
Ferry Boat	*$1,078,412,426*	*$5,392,062*	*200*	*598,879*
Light Rail	*$2,935,598,515*	*$2,107,393*	*1,393*	*7,041,123*
Bus	*$28,016,886,757*	*$600,203*	*46,679*	*154,033,829*
Streetcar	*$276,213,419*	*$1,296,777*	*213*	*877,832*
Trolleybus	*$312,440,521*	*$1,048,458*	*298*	*1,266,361*
Vanpool	*$175,503,269*	*$16,788*	*10,454*	*4,378,622*
Bus Rapid Transit	*$317,419,896*	*$901,761*	*352*	*1,349,304*
Hybrid Rail	*$148,158,090*	*$2,389,647*	*62*	*173,264*
Monorail	*$81,875,999*	*$974,714*	*84*	*247,278*
Commuter Rail	*$8,270,377,107*	*$1,443,851*	*5,728*	*11,398,700*
Alaska Railroad	*$60,628,460*	*$993,909*	*61*	*45,230*
Aerial Tramway	*$8,339,285*	*$114,237*	*73*	*355,648*
Heavy Rail	*$11,073,660,029*	*$1,226,047*	*9,032*	*36,457,490*
Inclined Plane	*$4,617,755*	*$1,154,439*	*4*	*9,870*
Publico	*$9,598,817*	*$30,765*	*312*	*440,224*
Cable Car	*$74,057,382*	*$2,848,361*	*26*	*92,722*

VOMs= Vehicles operated in maximum service in 2023.

Maintenance cost estimates



Interactive chart

Between the years 2005 and 2023, annual maintenance costs generally tracked alongside operation costs, ranging from 22.8 to 31.7 percent of total operations expenditures. Maintenance costs averaged 27.6% of expenditures on maintenance. For the purpose of estimating costs in this report, we assume that all new maintenance costs over baseline levels would equal 30 percent of new operations expenditures, on the higher end of those aforementioned previous expenditures. Baseline maintenance costs are extrapolated from a linear forecast of 2005-2023 maintenance costs adjusted for inflation to 2024 dollars.

We also accounted for the costs to fix existing assets in disrepair. The U.S. Department of Transportation's (USDOT) Conditions and Performance (C&P) report analyzes the nation's existing infrastructure assets and investments required to expand and maintain them. Specifically, the latest C&P report, which produced estimates using 2018 data, found that U.S. transit infrastructure had a deferred maintenance backlog of over $100 billion. The report estimated that between 2018 and 2038, more than $20 billion would need to be dedicated to maintenance to eliminate this backlog. Accounting for inflation, a more recent analysis from FTA found that the value of this backlog grew to over $140 billion in 2022. Adjusting the 25th edition C&P report's figures for inflation since its publication, we will need to spend an average of $5.4 billion over baseline levels for a 20-year period to address the historic underinvestment in existing transit systems' state of good repair, totalling an additional $106 billion in capital investment to eliminate the deferred maintenance backlog completely.