U.S. Public Transit Systems Changes. Trends. Opportunities.

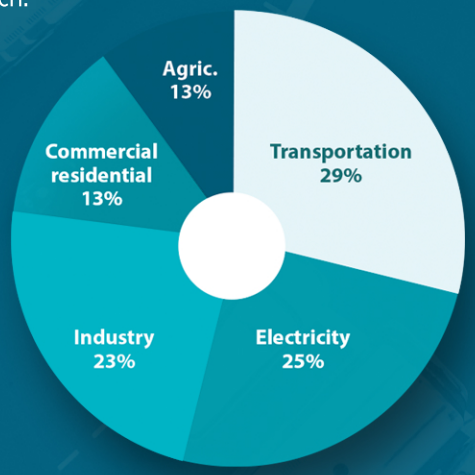
Getting people to and from their places of work has long been viewed as the primary reason for travel on transit. But that paradigm—call it the *commuter paradigm*—has been changing, and in recent years changing rapidly. Today's public transit authorities are confronted by a fascinating set of new challenges and opportunities.

Some of the changes derive simply from the growing affluence of Americans. Their range of travel interests and their options for mobility have multiplied. It's not just about commuting anymore.

Two other factors are having more immediate and pressing effects on the evolution of public transit. One is the increased concern among large segments of the public about climate change, which increasingly is being accepted as an active crisis. There's a greater urgency to reduce the levels of greenhouse gases emitted by our highly energy-dependent economy, and particularly by the transportation sector. (See chart.)

The transportation sector, according to the Environmental Protection Agency (EPA), accounts for the largest share (29%) of America's greenhouse-gas emissions. More than 90% of that share comes from gasoline and diesel fuels.

The second factor impacting public transit was the COVID pandemic. Those effects continue to reverberate. COVID and concerns over climate have been causing public transit authorities to rethink their priorities; they are seeking novel ways of attracting ridership. Let's look a little closer at each.

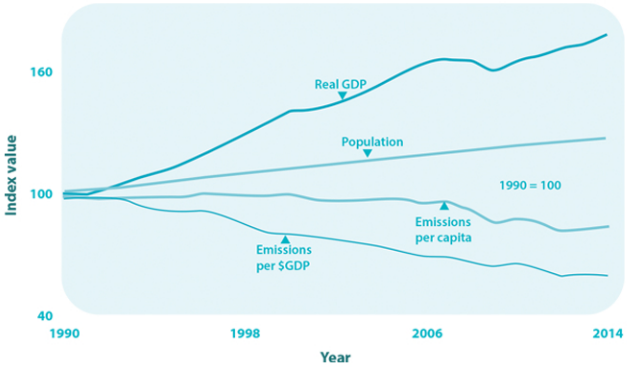


Total U.S. Greenhouse Gas Emissions by Economic Sector in 2019

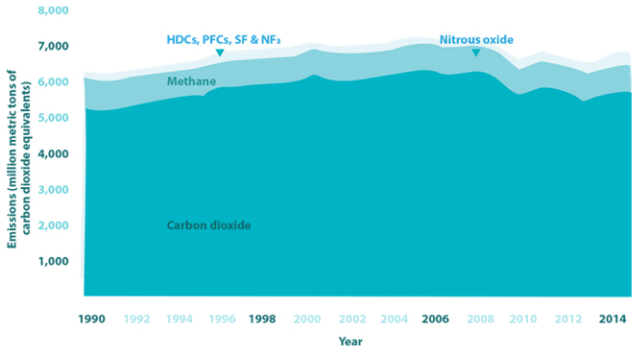
The Greenhouse Gas Emissions Factor

A report from the EPA on emissions per capita in the U.S. from 1990 to 2014 (see charts) indicated significant progress during most of those years, but progress pretty much stalled after 2012.

(The chart also shows trends in real GDP, population, and emissions per dollar of real GDP. All data are indexed to 1990 as the base year, which is assigned a value of 100).



Some 200 million private automobiles were on American roads in 2021. Each one emitting about 4.6 metric tons of carbon dioxide (CO2) per year, according to the EPA. In addition to CO2, automobiles produce methane (CH4) and nitrous oxide (N2O) from the tailpipe, and although their volume is very small compared to CO2, they have a higher global warming potential.



Progress has been especially slow in reducing Americans' preference for private automobiles and the internal combustion engine in meeting their mobility needs. As the New York Times reported in October of 2019:

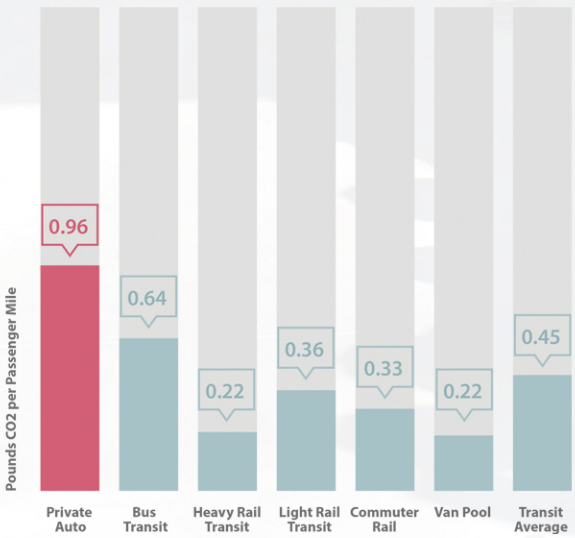
Even as the United States has reduced carbon dioxide emissions from its electric grid, largely by switching from coal power to less-polluting natural gas, emissions from transportation have remained stubbornly high. . . .

Reducing emissions from driving has been a big challenge, said Conor Gately, who led the project mapping CO2 on America's roads as a postdoctoral researcher at Boston University. Emissions dipped during the recession of 2008-9, but have been ticking back up since 2013.

Add the emissions output from roughly 100 million other types of vehicles (trucks, buses, motorcycles, etc.) and it's easy to understand why a transition from fossil-fuel based transport systems to low-carbon or carbon-free systems is deemed essential. A vehicle that operates exclusively on electricity will not emit any tailpipe emission, although greenhouse gases are emitted during the production and distribution of electricity. A fuel cell vehicle operating on hydrogen will emit only water vapor.

CO2 Emissions per Passenger Mile

National averages show significant greenhouse gas emission savings from trnasit...

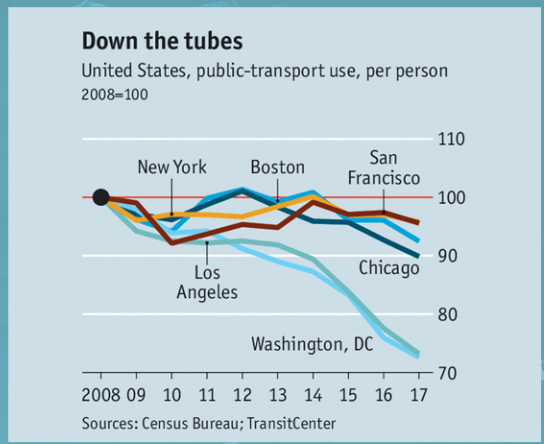


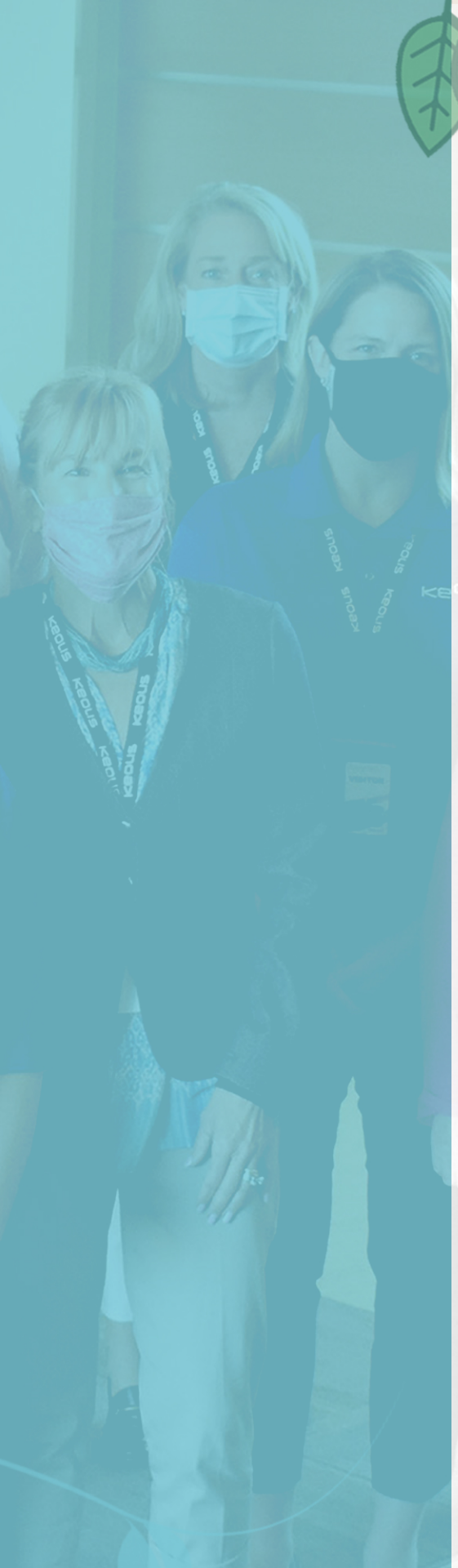
The Covid Factor

Covid-19's impact on economic activity in general was devastating, and it was no less so for public transit in our cities and suburbs.

Even prior to the pandemic, and with limited exceptions, ridership on metropolitan trains and buses was trending downward. And that was despite healthy growth in urban populations and employment. (See chart)

Why? That can be answered in one word: Competition. Which is to say that the number of viable alternatives to buses and trains has grown. In addition, working habits have changed. Most obviously, working from home, which was a modestly growing phenomenon prior to 2020, suddenly skyrocketed.





Curing Car Addiction

Looking abroad for an assessment of best practices, the Keolis Group has launched a number of industry initiatives that point the way toward transit systems that are both environmentally sustainable and attractive enough to lure drivers from their cars. A few examples:

In Greensboro, North Carolina, Keolis since 2019 has overseen the complete modernization of the city's bus operations, deploying all-electric Proterra buses along 16 routes and delivery of 3.8 million passenger trips annually.

On the outskirts of San Luis Obispo in California, Keolis is working with the transit authority to deploy 20 hydrogen fuel-cell buses and begin the construction of a hydrogen fueling station.

In Blois, France, the city executed a Keolis plan that saw public transport usage increase by 38% in seven years (2013-2020), including the launch of a 100% electric bus line.

Ultimately though, the optimal metro transit system may be one that enables travelers to switch from trains to taxis to bicycles, scooters, or buses as needed and do it all *for a single fare.* To build a user platform to support that kind of system requires extraordinary cooperation and collaboration among technology firms together with both the new and the legacy transit systems. But it can happen.

At Keolis, we define ourselves as the benchmark integrator for all types of mobility.

International Best Practices

After years of declines in ridership, public transportation in the United States is poised for an unprecedented comeback. So says David Scorey, CEO of Keolis North America. Scorey sees the opportunities for public transit falling into three broad categories, each presenting its own challenges and each involving different spheres of activity:

1. Making public transit the mode of choice among the majority of residents within transit service areas.
2. Capitalizing on the flood of new federal investment in infrastructure.
3. Competition among private operators that can help public transit agencies with innovative technologies and services. With respect to the first category, here are a few of the more interesting developments internationally, beginning with bus rapid transit.

- Blois is a small city (46,000 population) in the Loire valley region of France, where Keolis is overhauling the bus transit network and converting the bus fleet to 100% electric. The network is being expanded to encompass 42 other municipalities in the region.

- In the northeast corner of France near the border with Belgium is Lille (population 233,000), where more than 430 public buses are all fueled by natural gas. Some of that is biogas, produced from conversion of green waste matter collected in the Greater Lille area. All in all, 100% of public transport journeys in Lille are now made using an alternative to diesel—that is, gas for buses and electricity for trams and light rail. The light-rail metro system (which, by the way, is fully automated and driverless) is made up of two lines that together extend 45 kilometers (28 miles) and serve 60 stations.

- In Stockholm, Sweden, 36% of the city's buses, all operated by Keolis, run on biogas, which is produced from the city's waste material. Since 2015, Keolis has been operating a fleet of hybrid electric buses (from Volvo) in the center of Stockholm—vehicles that produce 90% less pollution than comparable diesel buses.

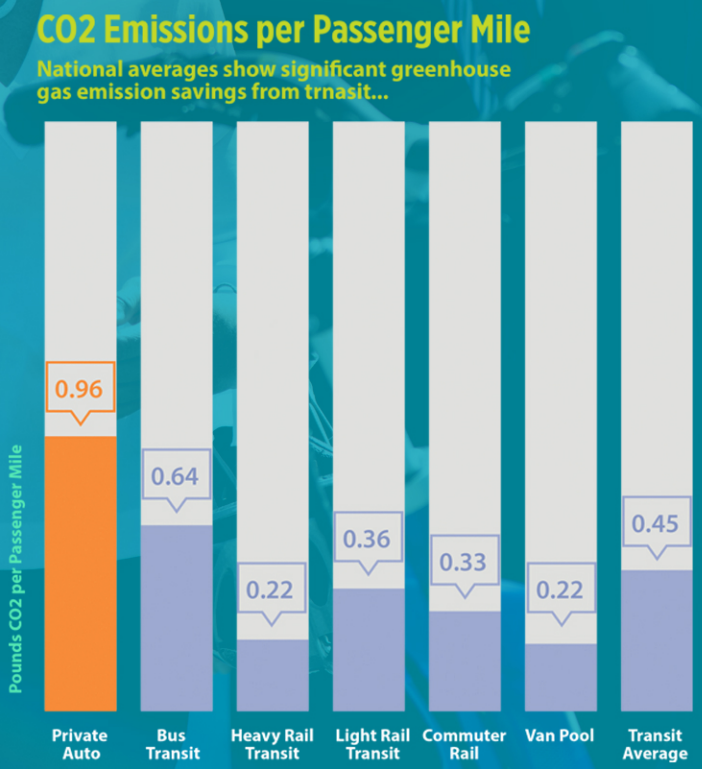
The fact remains that, in advanced economies, cars are still the preferred means of travel. The Economist magazine reports that for every ten miles travelled, Americans use the car for eight, Europeans for seven, and Chinese for six. Europe is friendlier to public transport than either America or China, but even there, in 2017, only one in six miles was travelled on buses, trams, and coaches.

A recent survey of American travel habits was done by the London-based consulting firm L.E.K.

It reports that individual journeys on public transit and ride-hailing services declined by 55-to-65% in 2020—the pandemic year—while trips via privately-owned cars declined by only 9%.

Regional/ intercity Rail

There is a growing awareness of the huge carbon footprint of commercial air travel – particularly of commuter flights that could potentially be replaced by train. Steeper jet-fuel prices, congested airports, congested highways, and tighter security rules have all increased the relative attractiveness of high-speed or inter-city travel.



Trains produce only a fraction as much CO2 per passenger mile as cars do, so they are high on the list of options for infrastructure planners.

One example concerns the busiest travel corridor in the nation—that between Boston, New York, Philadelphia, and Washington, D.C. In 2022, Amtrack's Acela Express trainsets are due to be replaced on the corridor with new trainsets, named Avelia Liberty. Together with track and signaling upgrades, they are expected to deliver significant time and speed improvements.

Wherever electric railways like Acela operate, they require huge amounts of energy and make stringent demands on power grids. Equipment supplier ABB Ltd. cautions that trains taking power from catenary cables require stable supply voltages. Any imbalances between voltage and current need to be held to strict limits to avoid affecting an entire area's power grid.

Help from the Feds

Thanks to funding in the infrastructure bill that became law in America in November 2021, budgets for transit projects across the country will be about 30% fatter on average. It may take some time before particular projects get off the planning boards, but the eventual benefits to public transit should be substantial. Just for starters, over 10,000 fossil-fuel-powered federal transit vehicles will be retired and replaced with cleaner electric or low-emission vehicles.

Luring People from Their Cars

Urban planners are natural allies of public transit systems. Their primary focus, however, is on zoning policies, commercial and residential developments, and the street configurations that city dwellers navigate on wheels or on foot. Even so, their most ambitious concept has public transit at its center. They call it transit-oriented development (TOD).

The ideal transit-oriented development consists of a public transit hub—whether for rail or bus—surrounded by high-density residential and mixed-use establishments. Basic characteristics of a TOD are:

- Essential services for residents – transportation especially – can be reached within a 10-minute walk. That's about a half-mile radius around a public transit station.

- The highest housing densities are closest to the transit center, decreasing urban sprawl.

- Parking facilities are carefully calibrated and managed. Parking is not so spacious or inexpensive as to encourage a drive to the station, and not so costly as to make taking the car more attractive.

- Transit modes that are clean, inviting, punctual, and dependable.

Examples of TODs are seen around the world. Some of the earliest sprang up in Japan after World War II, others on reclaimed land in the Netherlands or as exurban developments in Denmark. In more recent times the government of Arlington County, Virginia, has dedicated itself to TOD principles in several locations, including an extensive bicycle-sharing network.

In all cases the goal is the same: reduce reliance on the automobile.

Other schemes for achieving that goal have ranged from the simple and straightforward to the wild and bizarre. An example of the latter was a lane-straddling super-bus (pictured here) that five years ago got a brief tryout in the Chinese port city of Qinghuangdao. Alas, the system has had no takers.

Simpler and straightforward is the idea of road pricing (a.k.a. congestion pricing), which has taken hold in many core urban areas. For example, it costs you £15 (around $20) if you want to drive within the eight square miles of central London, designated a "low-traffic neighborhood" (LTN). In Glasgow, Scotland, city leaders have announced plans to ban all cars from the city center over the next five years. Various other congestion and/or anti-pollution schemes are in effect in cities like Stockholm, Oslo, Paris, and Singapore.

The most ambitious plan yet (the draft document is over 3,000 pages) is under consideration by the government of New York City. If implemented (a big if) it would sharply reduce car traffic below 60th street in Manhattan. In Los Angeles, too, where car worship is legendary, the transit authority there is studying congestion pricing.

In Boston, Mayor Michelle Wu, perhaps taking a cue from far-off Estonia, has promised to make several major bus routes free. In Cleveland, Ohio, Mayor Justin Bibb has vowed to put "people over cars" by turning more traffic lanes into protected bike lanes.

Another way urban officials are trying to nudge people out of their cars is to clamp down on "parking minimum" rules. These are rules that require developers to provide a minimum number of free parking spaces at new buildings. Such rules are being cut back or even eliminated, making a drive to work less enticing.

Public transit authorities, too, of course are looking for more ways to attract the increasingly disfavored car owner. And with powerful digital technologies readily available, they have many more tools with which to enhance the public transit experience. Such tools don't necessarily involve large budget outlays.

One example is employing artificial intelligence (AI) to reduce delays in urban train systems. Some of those delays are caused by the tendency of commuters to crowd around the train doors waiting to board, thus slowing the flow of passengers getting off. When the train is about to depart, passengers will hold open the doors for late-arriving travelers, causing further delay. In Japan, the Railway Bureau found that almost half of all train delays were caused by passengers attempting to board after the scheduled departure times.

Enter AI. A team at the University of Lancaster, in Britain, has been testing an AI system that processes video from CCTV cameras inside the train cars and on the train platform. Digital algorithms assess the congestion factors as revealed in the videos, then activate LED lighting along the train platform to guide passengers to the less-congested doors. It remains to be seen if this experiment gains traction, but it's only one of many, and some will surely see widespread use.

Be that as it may, in America and elsewhere, further breakups of the love affair between people and their cars won't be easy. In New York City, congestion-charging plans have been hampered by the state assembly and the federal government. In London, expansion of the LTN idea beyond the city center has been met with public protests and vandalism. Given all this,

Switching Fuels

Kermit the Frog made it abundantly clear that it's not easy being green. Officials of public transit agencies (PTAs) know all about it. In their efforts to design mobility systems that meet various decarbonization targets, they encounter numerous, often changing, and usually costly obstacles. Among the sources of these obstacles are:

- Pressure from multiple societal and political sources to transition away from hydrocarbon fuel sources .
- Market and systems disruptions.
- All the things that need to be rethought and redesigned when switching fuels — like operations, maintenance, information systems, land management, and regional planning.
- The long-term financial implications and the politics associated with it.
- Navigating different and often overlapping regional and local regulations. A number of countries and jurisdictions, for example, say they will ban petroleum-fueled vehicles by a certain date (as we noted earlier about London).

To illustrate the last point (regional and local regulations), the experts in energy transitions at Keolis have tallied the number of different regulations and incentives pertaining to just some of the more obscure aspects of vehicle energy usage. They looked at four states (California, Massachusetts Nevada, and North Carolina) plus the federal government. Keolis then sorted them into a matrix that looks like this:

Jurisdiction	Acquistion or fuel use	Driving or idling	Registration or licensing	Fuel taxes	Fuel production or quality	Renewable fuel standard or mandate	Air quality or emissions	Climate change or energy initiatives	Others
Federal	5	2	2	1	2	1	4	2	2
California	12	5	1	2	2	1	21	4	26
Massachusetts	4	3	1	0	0	2	3	2	7
Nevada	2	3	1	1	2	0	2	0	8
North Carolina	11	9	9	8	7	18	4	14	0

The point is that in the regulatory area alone there is a lot that demands attention. And those are just four states; there are 46 others. Then, whatever the mobility power source may be, there are the fundamental concerns for a PTA, such as:

- Environmental impact.
- Operating range of the vehicles.
- Passenger comfort and satisfaction.
- Flexibility.
- Total cost of ownership (TCO).

In addition, a complete monitoring system and a system for inter-departmental collaboration must be set up well in advance of regular operations and maintenance.

What about timing and scheduling? To convert a vehicle fleet from, say, diesel or gasoline to natural gas or electrical, a PTA can realistically expect a concept-to-execution timeline that can take up to three years:

- 12 months for analysis of opportunities and the final selection (say, between NGV or EV).
- 9 months or so for system design and specification.
- 12 months for purchases, construction, and start-up.

This does not include whatever the term of a contract may be for operation and maintenance. Other factors in the planning of an energy-transition project will include one or more of the following, depending on the type of fuel/energy sources being adopted:

- Purchases of the alternative-fuel vehicles (i.e., NGV, electric, hydrogen).
- Renewal of high-performance or hybrid diesel vehicles.
- NGV refueling infrastructure.
- Electrical recharging infrastructure.
- Hydrogen production and recharging infrastructure.
- New or refitted buildings.

A transition project must be steered through and around the disruptions typically encountered in the public-transit marketplace, all of which have greatly complicated the management of change. This is where Keolis comes in.

The expertise at Keolis covers all the categories of vehicle type, fuel type, infrastructure, specialized IT, and finance. Around the world, Keolis teams are managing transitions from petroleum-based mobility technology to a range of more climate-friendly energy sources, from compressed natural gas (CNG) to hydrogen fuel cells to batteries, from the different infrastructures to the different operational and maintenance disciplines needed for each, and from suppliers to financing sources.

Accelerating the Energy Transformation

He who hesitates may indeed be lost, particularly when it comes to public transit.

Given the flood of new federal funding now available, what may be lost are once-in-a-decade opportunities to fund much-needed infrastructure improvements. But there's such a wide range of possible improvements to consider that deciding among them can lead to analysis paralysis – and a failure to decide at all. Here are the stakes:

The American Infrastructure Investment and Jobs Act (a.k.a. "The Bipartisan Infrastructure Law"), signed into law in 2021, contains several programs of importance to transit authorities, including:

– $39 billion for public transit.
– $6 billion for "Safe Streets and Roads for All".
– $7.5 billion for electric charging stations for EVs.
– $5 billion for the purchase of electric school buses and hybrids.

These and other related programs are available now and through fiscal year 2026, with applications being processed through the Federal Transportation Administration (FTA). Whichever infrastructure project may be undertaken, transit authorities can take it for granted that everything in their system will eventually need to be redesigned:

Your operations.
Your maintenance.
Your information systems.
Your land management.
Your planning methodologies.

That being the case, it's important to be realistic about the more likely circumstances to be expected in the foreseeable future. Net-zero-carbon targets by, say, 2050, point to ideal outcomes, but decisions made today that depend on projections that far out are fraught with risks.

In that regard, there's an interesting study done recently by two NGOs – the Paris-based Renewable Energy Policy Network for the 21st Century (REN21) and the Brussels-based International Association of Public Transport (UITP). Together they have almost 2,000 member companies and organizations in more than 100 countries.

Cities, they point out, are the key to decarbonizing transport. By virtue of their sheer size and scale, cities "are responsible for 75% of global CO2 emissions, with transport and buildings being among the largest contributors."
Yet, as noted earlier,

the shift to renewable energy in transport has been very slow. In the decade from 2008 to 2018, for example, the shareof renewables used in transport rose from 2.1% to 3.4% – that's little more than a 1% increase in ten years.

To accelerate from that snail's pace, REN21 and UITP suggest that the starting emphasis should be on infrastructure improvements that encourage less reliance on personal motorized transport. Simply put, this means making it easier for people to bike or walk to their destinations.

After that, they suggest, the emphasis can shift to more efficient, less carbon-intensive transit vehicles. But waiting too long – waiting for the most ideal, the perfect energy source to materialize – may be foregoing some very sensible options to meet current needs.

The point:

Don't wait for the most ideal trolleys, buses, and trains to arrive. But do determine practicalspecifications desired for your rolling stock. And start now to upgrade and retrofit your stationary infrastructure.

Also be sure your electrical grid will be able to support the upgraded mobility system you've designed for the near- to middle-term.

Summary & Conclusions

Public transit authorities face no small task in upgrading their infrastructures or transitioning to cleaner energy sources or attracting more ridership. Or doing it all. And doing it in the midst of constantly changing political and societal pressures.

Every transit agency must, for starters, have a thorough understanding of its own unique circumstances. Besides obvious ones like population, geography, history, growth, and political and economic environments, there are a host of others.

Reliable information on most of those things is not hard to find. But the same cannot be said when it comes to the challenge of energy transition for transit fleets. That area is an immense tangle of tradeoffs involving technologies that are often not well understood or not ready for prime time. Wrong choices can have long-term deleterious effects.

This is where an organization like Keolis comes in. As a neutral advisor, Keolis's primary mission is to ensure that its partners are armed with informed points of view. This advisory/consultative role is based on:

- Operational experience in all alternative fuel options in support of decision-making for energy transitions. For example, Keolis has some 6,000 alternative fuel vehicles of all types (electric, NGV and bioNGV, hydrogen, biodiesel, hybrid) under management in dozens of municipalities.

- A reservoir of feedback on the experiences of PTAs worldwide, including data on local pollutants, active operations, related safety constraints, total cost of ownership and so forth.

- Knowledge of the pertinent regional and local regulations across the globe.

Keolis and its partners and subsidiaries develop mobility solutions for modes including trains, buses and coaches, trolleybuses, river and sea-shuttle services, bike-share services, car sharing, fully electric driverless shuttles and urban cable cars. Keolis employs 68,500 people in 16 countries: Australia, Belgium, Canada, China, Denmark, France, Germany, India, the Netherlands, Norway, Qatar, Senegal, Sweden, the United Arab Emirates, the United Kingdom and the United States.

For more information go to www.keolisNA.com.