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CHAPTER 10

Trolleybuses

Background

The trolleybus (or trolley coach or trackless trolley) as an electrically powered transit mode running on streets has several interesting features, but it has never reached the top ranks among service choices. It is a cross between a bus and a streetcar, and not necessarily only the best characteristics of those two are to be found in the resulting vehicle. It looks and acts almost like a bus, except that it is tied to an overhead network of wires for power supply; it operates somewhat like a streetcar, but the reach of the power pickup poles allows it to move across several lanes.

In 1998, there were 880 active trolleybus vehicles operating in the United States, accommodating 182 million passenger miles that year.[1] The number of vehicles represent 0.7 percent of the national transit fleet, the passenger-miles only 0.4 percent of the total. The corresponding figures in 1984 (an interim peak) were 664 vehicles and 364 million passenger-miles. (The all-time peak for trolleybuses in the United States were the years 1949 and 1950, with ridership dropping steeply during the following decade.)

[1] American Public Transportation Association (APTA), *Public Transportation Fact Book,* (APTA, 2000).

The trolleybus has service capabilities that are almost identical to those of a regular diesel bus, and, therefore, only those elements that are different will be described and discussed in this chapter. (For anything else, please refer to Chap. 8.)

Development History

It did not take very long after a practical electric motor was developed to think of its placement in a vehicle. This would have required a rather long extension cord to supply power, but that problem could be solved by running a pair of live wires parallel to the path with rolling or sliding contacts linking them to the vehicle. Obviously, bare high-voltage wires could not be placed where people might touch them, but overhead was safe enough. That's all there is to the trolleybus concept (except that the moving power pick-up arrangements appear to have generated the need for more engineering attention than anything else in the early days).

Experiments with such transport devices started in the 1880s,[2] with working models being built in both Germany and France. They were not reliable or sturdy, but they proved that it could be done. The first regular services were opened in Germany—in Königstein-Bad Königsbrunn, as developed by Werner von Siemens (1901), and in Bielatal by Max Schiemann (1902). This was followed by a number of other lines not only in Germany, but also in Italy, Switzerland, Great Britain, and Denmark. In the United States prior to World War I, besides some demonstrations, a short trolleybus route was in operation in Hollywood (Laurel Canyon, 1910), and for a very brief period in Merrill, Wisconsin (1913). All these efforts remained very much in the shadow of streetcars, which at this exact time were expanding explosively in most cities, offering reasonably reliable and responsive service. Trolleybuses were attempted only in those instances where the demand was so low that the construction of costly tracks could not be justified. Since the streets at that time usually were in a sorry state and the vehicles not particularly resilient, the service was decidedly not attractive.

[2] Historical material on trolleybuses can be found in various specialized publications; summaries are provided in TRB Special Report 200, *The Trolley Bus: Where It Is and Where It's Going,* 1983, chap. 1, and V. Vuchic's *Urban Public Transportation: Systems and Technology* (Prentice-Hall, 1981, pp. 37–41).

Starting in the early 1920s, a series of efforts, while still separate and incremental, were initiated again to explore the possibilities and implement trolleybus routes in several cities of North America and Europe. Each was, in effect, a pilot project, and experience was gained and lessons learned. Toronto, for example, instituted operations utilizing vehicles built by Packard; Staten Island in New York City had a fleet of trolleybuses manufactured by the Atlas Truck Company. In Great Britain, Birmingham experimented with double-deckers, and petrol-electric vehicles—true harbingers of a distant future—ran between Middlesborough and Easton. The latter had an auxiliary internal combustion engine, allowing the vehicles to leave the power line. Several other cities in North America attempted trolleybus service, but they all faded with the exception of Philadelphia, which started this mode then and still has it today. The Staten Island effort is deemed to be the first truly successful trolleybus operation in the United States.

Toward the end of the 1920s, technology was sufficiently advanced to develop new models from the ground up that could offer fast and smooth running, good and quiet acceleration, and the use of low-cost power. Much of this was achieved by designing the trolleybus as a light over-the-road vehicle with pneumatic tires, rather than a sturdy streetcar. Better brakes and a workable power pickup (from under the wires) resulted in a suitable vehicle. Particularly successful was the design by Guy Motors of Great Britain, first introduced in Wolverhampton and then used widely in London.

This was also the period when streetcars started to be seen as obsolete transportation devices, candidates for wholesale replacement. (See Chap. 11.) This happened in London, but also in several cities in France, and on a massive scale in American communities. In most cases the replacements were motor buses, but trolleybuses were seen as a "modern" approach as well, particularly in places that wished to preserve the investment made in electrical power distribution networks but could no longer afford to lay and maintain track and wished to be relieved of the obligation to maintain street pavements that streetcar companies carried. (Many streetcar franchises placed considerable burdens of street maintenance on rail operators.)

The first large-scale effort in the United States was the implementation of an extensive trolleybus system in Salt Lake City (1928) employing the new, more efficient vehicles. A contributing factor in this and several other instances was the opportunity to use public streets at no additional costs, because street surfaces by this time had been improved considerably in response to the demands of automobile owners. Other communities monitored the Salt Lake City experience and reached favorable conclusions. Chicago followed next (1930) with a sizable network and several routes that accommodated large passenger loads previously not considered feasible (50,000 daily patrons on a route, some with 45-second headways).

The 1930s were a significant expansion period for trolleybuses in North America, boosted by transit demands during World War II. Notable among the many communities that embarked on this path is Seattle, which made a complete conversion starting in 1939 and built a system with 100 route-miles and 300 vehicles. That service is still basically in operation. The other large effort of that period was found in the old urbanized areas of northeastern New Jersey. The Public Service Coordinated Transport Company there established a complex network of routes and a diverse fleet of rolling stock that included trolleybuses with gasoline engines to reach sections of routes without power lines. They were manufactured by Yellow Coach Company and operated from 1935 to 1948. No trace remains of these operations, replaced by areawide bus service.

By 1940, some 60 communities in the United States had trolleybus service, accommodated by 2800 vehicles. In the early 1950s, which represent the peak period for this mode, there were more than 6500 units in operation. Thereafter, a period of decline commenced. After the war years, which were characterized by deferred maintenance, the infrastructure and the vehicles had worn out, but, with the onset of a precipitous drop in transit ridership, no capital-intensive efforts could be supported. Acquisition and operating costs of trolleybuses started to escalate, particularly in comparison to regular buses—presumably because of the smaller size of these operations and lack of any economies of scale.

There had been no particular incentives to upgrade the simple technology and the vehicle itself, which had not changed for decades. Above all, the service was seen as inflexible and the wires as unsightly. There were several technical improvements in the late 1960s, but they came from general upgrading of electric and electronic elements by the basic industries in Europe and

North America. Chopper control, for example, reduced power consumption considerably and assured smooth changes in speed. Regenerative braking and better power contacts were also introduced. None of this made much difference, and the decline continued.

There were no effective spokespeople for trolleybuses until concern with air pollution on city streets became a pervasive public issue. But by that time, however, it was too late to generate significant momentum back to a mode that had lost its general appeal. The petroleum fuel crises of the 1970s did not change matters either, beyond generating some discussion.

Despite all the early important development work in Great Britain, all trolleybus services were abandoned in that country. This almost happened in North America too. After all, these vehicles do constrain automobile flow on streets. The last trolleybus ran in New York City (Brooklyn, to be specific) in 1960. Even in Seattle the route miles dwindled down from 100 to 26. A watershed event was the closing of trolleybus services in 1973 in Chicago, which once had the largest system in the United States. Toronto stopped in 1961 and Calgary in 1975.

At this time (since 1973), only five American cities have trolleybuses: Boston, Dayton, Philadelphia, San Francisco, and Seattle. There are two more in Canada (Edmonton and Vancouver), and two in Mexico (Mexico City and Guadalajara). At the peak of their operations in the early 1950s, trolleybuses represented about 10 percent of the transit activity in the United States; today they accommodate less than 1 percent of the national total.

Trolleybuses on a street in Lausanne, Switzerland.

The events were not quite as dramatic in the rest of the world. Some countries in Western Europe, particularly Switzerland and Germany, have upgraded trolleybus technology and have strong operations in several places. A number of developing countries, particularly those that are reluctant to import expensive petroleum-

Trolleybus in front of the Belorussia Hotel in Moscow.

based fuels but can produce sufficient electrical energy, have turned to this mode.

The largest systems with the greatest number of applications, however, are found within the former socialist bloc. As is not uncommon, the claim has been made that a Russian engineer produced the first trolleybus—an electric autotrain with six cars at the beginning of the twentieth century. The USSR had a single-minded policy of promoting this hardware within all the countries and cities under its rule because electric energy was considered to cost only half as much as petroleum-based fuels. All of the more than 26,000 vehicles (several ZIU models) that were in operation at one time across the empire and its satellites were produced by the Uritski Works. The technology was not particularly advanced, but the vehicles were robust. Several hundred cities received trolleybuses, and, regardless of the recent political changes, they are still there by and large. Because of economic constraints, new replacement vehicles are scarce. Thus Eastern Europe and China are the places to observe full-scale trolleybus operations, if not always at the best service level.

Types of Trolleybuses and Their Operation

Trolleybuses at this time are basically buses with a different power plant—an electric motor and power pickup poles on the roof. They are usually made by diesel bus manufacturers, adding the electrical components to a regular bus. At one time, for example, a GMC New Look bus equipped with Brown-Boveri electric components was on the market. The choices of models are limited because the market is small. Basically, standard size and articulated units are available. The external differences, besides the motor and all associated internal controls, are the two side-by-side poles that tap the power lines from below with sliding, grooved, swiveling carbon shoes.

Unlike buses, however, there is a need for rather extensive infrastructure represented by the power supply system, which has to cover the entire length of all routes as well as storage and

Trolleybus Systems Around the World

Argentina	3	Georgia	9*	Norway	1
Armenia	2*	Germany	4	Poland	4*
Austria	4	Greece	1	Portugal	2
Azerbaijan	5*	Hungary	3*	Romania	15*
Belarus	7*	Iran	1	Russia	89*
Belgium	1	Italy	12	Slovakia	5*
Bosnia	1*	Kazakhstan	8*	Switzerland	15
Brazil	6	Kirgizia	3*	Tajikistan	2*
Bulgaria	16*	Korea (DPR)	7*	Turkmenistan	1*
Canada	2	Latvia	1*	Ukraine	44*
Chile	1	Lithuania	2*	United States	5
China (PR)	25*	Mexico	2	Uzbekistan	8*
Czech Republic	13*	Moldova	4*	Yugoslavia	1*
Denmark	1	Mongolia	1*	Total	348
Ecuador	1	Nepal	1		
Estonia	1*	Netherlands	1		
France	6	New Zealand	1		

Source: Jane's Urban Transport Systems, 1999–2000.
* Formerly included in the Soviet sphere.

maintenance yards. The double wires, usually placed 18.5 ft (5.6 m) above the pavement, have to be held in place by insulated support cables from roadside poles or be attached to adjoining buildings. The elevation may range from 12 to 20 ft (3.7 to 6.1 m). A constant elevation has to be maintained for the bottom of the power wires, which requires rather elaborate catenary[3] arrangements. Substations are needed at regular intervals to step down the voltage to 600 to 650 dc volts. Power has to be purchased from utility companies or generated separately by the operating agency. All this represents a considerably lower capital cost than for light rail transit (no track), but is higher than for regular bus systems, even if no fueling facilities are needed in storage and maintenance yards.

The vehicle does not have to be driven directly under the wires, but can deviate as much as 13 ft (4 m) from the center line

[3] A freely hanging cable from two points, supporting the power line at a fixed elevation along the entire route.

on both sides, i.e., can move in the adjoining lanes. Temporary obstacles can thus be bypassed, as long as the power poles are not blocked.

Even in the early days, an auxiliary gasoline or diesel engine or a bank of batteries were sometimes added to allow the vehicle to move "off wire," at least for short distances to bypass obstacles or navigate inside maintenance yards. These options continue to be available, and experiments with rather esoteric auxiliary power sources have been attempted (flywheels, for example). Such efforts to develop a more flexible vehicle are becoming more common. This may be a trend for the future.

Trolleybus Systems in the United States

City/Responsible Agency	Number of Routes	Route Length, mi (km)	Passenger Boardings per Year (millions)	Fleet Size	Vehicle Model(s)
San Francisco San Francisco Municipal Railway (Muni)	17	98 (158)	78.8	331	Flyer (1975) New Flyer articulated (1992)
Seattle King County Metro	14	124 (199)	Not available separately	147	AM General (1979) M.A.N. (1987) Breda dual (1990)
Philadelphia Southeast Pennsylvania Transportation Authority (SEPTA)	5	21	6.6	66	AM General (1979)
Dayton, Ohio Miami Valley Regional Transit Authority	7	16 (25)	3.4	46	Skoda (1995) ETI (1996)
Boston Massachusetts Bay Transportation Authority (MBTA)	4	16 (25)	3.4	46	Flyer E800 (1976)

Sources: Jane's Urban Transport Systems, Jane's Information Group, 1999–2000; *Metro,* September/October 2001.

Note: It is very regrettable that a number of transit agencies report in their official statistics that they operate "trolleybuses," which are actually the newly minted "heritage" (fake) trolleys—quaint passenger boxes intended to resemble a vintage streetcar mounted on a truck or bus chassis with a diesel engine. There is no accounting for taste or historical integrity, but the tourists apparently like them. But at least the terminology should not be misused—there are only five real trolleybus services in the United States.

Reasons to Support Trolleybus Systems

The positive features of trolleybuses are quite significant, and they stem almost entirely from the direct use of electrical power. It has even been suggested by dedicated advocates of this mode that trolleybus drivers are more friendly, or at least laid back, than other transit workers because they operate environmentally friendly vehicles.

- *No exhaust* is emitted by the electrical motor, and thus no air pollution is generated. A central power plant is needed, of course, but that is usually placed at a remote location and can be properly equipped and managed as a controlled large-scale operation. After passage of the Clean Air Act of 1990, commitment to clean vehicles became mandatory, and studies in several communities were undertaken to explore the feasibility and pollution control capabilities of trolleybuses. Los Angeles in particular, under the strict California state requirements, looked closely at this option, but no conversions happened. While cleaner air can certainly be attained, the amount of benefits gained by such action has not been a compelling argument in the larger environmental debate in any metropolitan area.
- *Quiet running* characterizes trolleybus operations because of the nature of pneumatic tires and electrical motors, which are not noisy even when surge power demands are placed upon them.
- *Acceleration* is quick because of the traction of rubber tires, and there are sufficient power reserves to climb steep grades, beyond the capabilities normally shown by regular buses. Advanced models incorporate regenerative braking, which feeds power back into the system instead of wasting it through brake friction or heat generation.
- Claims are being made that standard trolleybuses are *durable* and *easy to maintain* because of the simplicity of the components. That is not necessarily the case with advanced models, but the propulsion and control systems are less complex than those of comparable regular buses. However, any operating agency that already has diesel buses will want to keep the composition of its fleet as simple as possible,

with not too much variety requiring special equipment, spare parts, and different skills. While it is true that the average age of a trolleybus in the United States is considerably older than that of a regular bus (16.2 versus 8.5 years),[4] it is not entirely clear that this is due to the greater durability of trolleybuses rather than to delays in replacing the fleet.

- *Petroleum-derived fuels* are not used, and thus the scarcer energy resources are conserved. Depending on the energy supply market at any given time and any given place, this may represent a significant savings in fuel costs. Switzerland, for example, has maintained a strong national policy of minimizing dependency on fuel imports. Nepal and Canada are also rich in hydroelectric resources and try to hold on to their trolleybuses.

Reasons to Exercise Caution

Most operating agencies in North America do not particularly favor trolleybuses, which explains to a large extent these vehicles' lack of prominence in the transit sector in this part of the world. The crux of the matter appears to be that most of the positive features resonate well with users and communities, who do not see the expense sheets, while the shortcomings directly affect the efficiency of agency operations, which is always under public scrutiny. The need for overhead wires is the principal drawback of trolleybus systems that generates most of the specific negative features. They represent a significant capital investment (particularly the copper wire itself, which wears out), and there are considerable engineering and construction efforts involved in keeping them on top of busy streets at an even and constant elevation.

- Unsightliness is the most often cited problem in public evaluations of this mode, as expressed by the overhead wires. At a large intersection where several routes converge and make turns, the spiderweb above can be a structurally heavy and visually oppressive presence. Even on simple straight runs

[4] APTA, *Public Transportation Fact Book,* 2000, p. 84.

there will be span and support cables, electric insulators, junction elements, poles and anchors, and feeder cables. On the other hand, perceptual surveys of city residents frequently indicate that people do not "see" the wires, i.e., they fade to the background in the total urban scene. Nevertheless, once alerted, most everybody will notice them and complain about violations of their aesthetic sensibilities. Some screening can be provided by trees, provided that they are properly trimmed to avoid contact. Feeder cables can be placed underground.

- The vehicles are tied to the lines without much flexibility in selecting a path. Trolleybuses can usually drive around small obstacles, but this mobility is limited to the next lane on either side. Temporary diversion of a route to a different street (to repave or do major utility work) involves considerable effort and expense in moving and replacing the overhead wires.
- The wires may be obstacles to other activities, such as vehicles with high loads, fire ladders, parades, etc. Running a route below structures with low clearances may also be a problem.
- The power pickup shoes frequently lose contact since there is little to keep them in place except a groove and the pressure of a spring on the pole. The replacement can be done quickly enough, but it does require the driver to leave the seat and walk to the back to fit them back manually, thereby losing at least a few minutes on the schedule. Mechanical devices have been invented to do this job, but they do not appear to be worth the trouble in normal situations. Snow and ice under extreme weather condi-

Operations on a snow-covered street (Riga, Latvia).

tions can interfere with power pickup arrangements. If the shoes are maintained properly, and switches and sharp turns are negotiated at reduced speed, problems should be minimal.

- The purchase price of a trolleybus is high as compared to a regular bus. A few years ago, a 50 percent premium was not uncommon for a vehicle of the same capacity. Currently, the price of an electric trolleybus is $642,000 (a 40-foot regular transit bus sells for $295,000).[5] This is certainly due to the limited market, since for all practical purposes every unit has to be individually made. With comparable production volumes, a trolleybus should cost the same as, if not less than, a regular bus.
- Costly infrastructure has to be in place, which was not a large problem in the early days when streetcar power distribution systems (including overhead wires, poles, feeders, substations, etc.) could be readily adapted. It is, however, a major consideration if a new network has to be created. There is no reliable cost experience to go by because little has been built in the trolleybus sector for several decades in North America.

Application Scenarios

In the 1980s, the general consensus among transportation specialists was that trolleybuses are and should be viable contenders in the modal spectrum.[6] They were seen as fitting in between light rail transit and regular buses, particularly for midsize cities (population 250,000 to 500,000). It was acknowledged that higher capital costs were involved than for buses, but it was estimated that with high-intensity use this expense could be readily absorbed. The construction of any rail line, or course, is more expensive still. The benign environmental characteristics were given much weight. Every time one of the existing trolleybus systems acquired new vehicles, a rebirth of the mode was expected.

[5] As reported in *Metro,* 2000 Fact Book Issue, p. 33.

[6] J. D. Wilkins, "Trolley Buses: Back on the Road in a Revival." *Mass Transit,* 1980, pp. 28–30; G. M. Smerk, "The Trolleybus Returns," in *Bus Ride,* September 1992, p. 53; J. Dougherty, "Electric Trolley Buses Are Making a Comeback," *Passenger Transportation,* September 16, 1991, pp. 6–7.

It did not quite work out that way. Basically, trolleybuses provide a service not much different than regular buses, but the systems are more expensive to implement and are constrained by the infrastructure.

In the process of preparing dozens of transportation studies for whole systems or specific corridors in American communities, trolleybuses have been included frequently as one of the possible modal choices. The final decisions, with only two exceptions, have been that this mode is not suitable for regular transit service under normal conditions today. Since the benefits of air quality improvement at the scale of regions is not a dominant variable in the evaluation equation, the determining factor has usually been the local agency's economic calculations related to the purchase, operation/maintenance, and fueling of vehicles. In a number of instances where electrical power has been especially accessible, the analyses have shown a reasonably competitive situation—except that the ever widening gap in rolling stock price has knocked trolleybuses out of contention.

Thus, trolleybuses remain a mode for special conditions: steep hills, unventilated spaces, or communities with a singular commitment to air quality or historical image. Two recent major efforts in the United States and one in Brazil illustrate this contemporary situation.

Seattle

Seattle, which has a long history of trolleybus use, reconfirmed its commitment to this mode in 1977 to 1979, when it closed dowthe entire system for refurbishment. The hilly terrain and the effection of local residents and officials for trolleybuses are significant factors in this community. The city extended the physical network and purchased a new fleet of 109 vehicles. In 1987, additional 46 articulated M.A.N. units were placed into service.

A downtown transit plan was also started in 1978 to streamline the city's public service operations. The decision was soon reached to build a transit tunnel that would provide direct access to major destination points and remove many vehicles from surface streets. City and suburban service routes would be channeled through this facility; later conversion to light rail transit could be provided for. Diesel buses in the tunnel would require tall ventilation towers, and "pure" trolleybuses would not be able to operate along several of the limited-access highways that are parts of

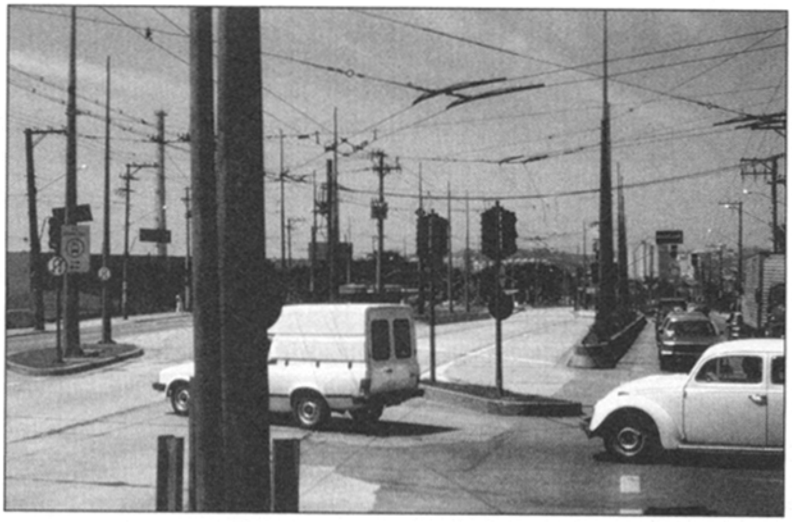
Articulated trolleybus (Esslingen, Germany).

the service network. After much discussion, the logical choice in 1985 was dual-mode rolling stock, admittedly rather complex vehicles, but already in use for years in Esslingen, Germany, Nancy, France, and elsewhere. Bids were received from European manufacturers, and Breda Construzioni Ferroviarie was selected—60-foot articulated vehicles with 66 seats and three doors, propelled by a diesel engine and an electric motor fed by retractable rooftop poles. Each unit cost $430,000 in 1986, and deliveries of the 236 vehicles started in 1989. Various parts and components came from different countries.

The L-shaped tunnel was opened in 1990; it is 1.3 mi (2.1 km) long and runs under Third Avenue and Pine Street. There are five underground stations with multiple berths, bypass lanes, mezzanines, convenient pedestrian access from the street, and artwork. The platforms are 380 ft (116 m) long and 13 to 15 ft (4.0 to 4.6 m) wide. Travel for passengers on buses within the downtown area is free, but the tunnel is closed on weekends. Before the opening of the facility, it took up to 30 minutes to cross downtown on the surface; the tunnel path now consumes 8 minutes. Best results are achieved when buses are moved in platoons through the tunnel.

Boston

Boston has not given up on its trolleybuses either and has found a new application for them. This is the so-called Silver Line that will eventually connect Roxbury to Logan Airport, planned as a replacement for the pending removal of the Orange Line of the metro. The original intention was to place trolleybuses on Washington Avenue, but this met with opposition from members of the community, who demanded light rail service. Buses propelled by natural gas on reserved lanes were opposed as well, and therefore the compromise reached in 1996 was a dual-mode system with the potential for the conversion of lanes later to light-rail transit. This became just about mandatory because the route was to be extended via several tunnels past South Station, through South Boston to Logan Airport.



Overhead power lines at a trolley depot in São Paulo.

São Paulo

It is appropriate to conclude this review of contemporary trolleybus projects by referring to the effort now under way in São Paulo, Brazil.[7] In addition to the rather elaborate transit networks that service this very large urban agglomeration,[8] a new tracked trolleybus route—the *Fura Fila*—is being developed. The vehicle design is based on the double-articulated Volvo model used in Curitiba (four axles, 25 m [82 ft] long, 270 passengers), but it is equipped with O-Bahn-type horizontal guide wheels. High platforms will be used on a grade-separated busway, much of it elevated so that it can be added to the already built-up districts. The first line will run from the center of the city to residential areas to the southeast; there are plans for a very extensive network and a large fleet of these special vehicles.

The governing factors that led to this choice are that Brazil already has extensive experience with trolleybuses, that petroleum fuel conservation and air quality upgrading are concerns of national policy, that all the necessary elements and vehicles can be produced within the country, and that the comparative costs are most favorable. Their estimates show that the busway will cost U.S. $15 million per kilometer, while a light rail transit route would cost U.S. $40 million and a full subway U.S. $100 million per kilometer. This is a project that may very well be a crucial test case for trolleybuses anywhere in the foreseeable future.

[7] Bill Luke, "São Paulo Gets Trolleybus System," *Metro* magazine, January/February 1999, pp. 39–42.
[8] See the description of its busway in Chap. 9.

Conclusion

Trolleybuses continue to operate, but their future as a general transit mode is not particularly bright. They do have a role in special situations, but the global trends are still negative. Nobody likes the overhead wires (except copper manufacturers), and the problems of urban air quality are being attacked through means other than hoped-for massive switch of motorists to nonpolluting transit. If and when hybrid buses reach a competitive state in the market, which appears to be quite likely in the near future, the trolleybus may reach the status of cable cars—remaining in use in some places with special characteristics, but otherwise just being remembered with affection.

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Transportation Research Board: *Trolley Bus: Where It Is and Where It's Going,* Special Report 200, 1983, 64 pp. A reasonably complete effort to support reactivation of trolleybus service in the United States. Relevant articles can also be found in *TRB Reports* No. 1433 (1994), No. 1451 (1994), and No. 1503 (1995).