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Objet : Extraits de TECHNICAL REFERENCE MANUAL FOR ELECTROMOBILITY IN BRAZILIAN CITIES 2022

23-1315V PDeb TECHNICAL REFERENCE MANUAL FOR ELECTROMOBILITY IN BRAZILIAN CITIES

En anglais https://itdpbrasil.org/wp-content/uploads/2023/08/Caderno-Tecnico-de-Referencia-para-a-Eletromobilidade-nas-Cidades-Brasileiras_ingles.pdf

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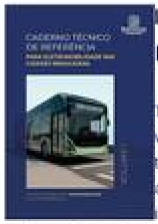
Merci à ITDP (www.itdp.org) qui, dans son infolettre d'août 2023, présente ce remarquable document.



ITDP Brazil Publishes Technical Guidelines for Implemeting Electric Mobility in Brazilian Cities

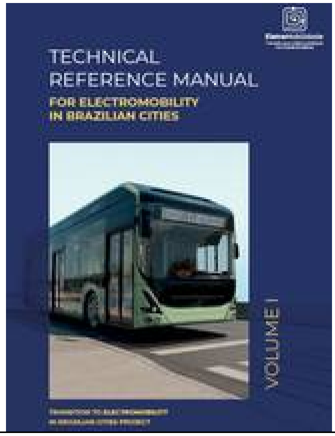
The comprehensive document, developed in partnership with Logit, provides cities with an in-depth guide for acquiring and implementing electric fleets in Brazil's public transport systems. The Reference Technical Guidelines explain what electric buses are, how they work, and why they are critical to mitigating climate change and improving urban health and accessibility. The report includes step-by-step implementation plans, resources for integration, and scalability guidelines. The Guidelines are part of a "Electromobility in Brazil" project sponsored by the Brazilian Institute of Development and Sustainability (IABS), the World Bank, and the Ministry of Regional Development.

Ce document s'adresse manifestement à des gens, services techniques de villes et élus, qui ne sont pas forcément de grands experts en transports, et il apparait très bien fait, avec des données chiffrées intéressantes et nombre de liens donnés vers d'autres documents.

Il est en revanche très surprenant qu'en quelques lignes, il « assassine » le trolleybus qui, de tous les bus électriques, a le Coût Total de Possession (TCO) le plus faible, le rendement énergétique le meilleur, et qui est le plus écologique, comme l'ont montré deux études récentes, l'une pour Berlin, l'autre pour San Francisco (https://www.climateandcommunity.org/_files/ugd/d6378b_1169940f862d44e2a6ef2b39751e943f.pdf).

Il est certain qu'après ces quelques lignes assassines, aucune ville ne va penser au trolleybus pour électrifier ses lignes.

Et pourtant, quand on lit bien, des tas de données sur les batteries sont en fait autant d'arguments en faveur du trolleybus IMC.

Page PDF	Texte initial 23-1315V PDeb TECHNICAL REFERENCE MANUAL FOR ELECTROMOBILITY IN BRAZILIAN CITIES	Observations P Debano
1		

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6	LIST OF ACRONYMS AND ABBREVIATIONS **ABNT** Brazilian Association of Technical Standards **Aneel** Brazilian Electricity Regulatory Agency **ANTP** National Association of Public Transportation **IDB** Inter-American Development Bank **BNDES** National Bank for Economic and Social Development **BRT** Bus rapid transit **BYD** Build Your Dreams **ICMS** Tax on Circulation of Goods and Services **Idec** Brazilian Institute for Consumer Protection **IEMA** Institute for Energy and Environment **IoT** Internet of things **IPI** Tax on Industrial Products **ITDP** Institute for Transport and Development Policy	Surprenant, on trouve le nom d'un constructeur, BYD, pourquoi pas, mais pas de constructeurs comme Marcopolo, Scania, Volvo, et pas l'acronyme IMC (In Motion Charging)
10	EXECUTIVE SUMMARY The Technical Reference Manual (TRM) for Electromobility in Brazilian Cities (Volume I) seeks to contribute with reliable and systematized technical content on battery electric bus projects and how to properly plan, implement, operate, and manage them. Many cities still face difficulties in this area or do not know how to begin the transition to fleets with cleaner and zero-emission technologies. This manual seeks to make this process easier by proposing short, medium, and long-term tools and recommendations for an effective and large-scale operation.	Parce que l'électromobilité ce ne semble être que le BEB Bus Electrique Batteries, pas un mot sur le trolleybus.
10	As a result, city leaders are being challenged to radically change the operation of their transport systems to make them financially and environmentally sustainable.	Et le trolleybus est le bus le moins coûteux en TCO et le plus écologique de tous les bus électriques

11	The initial investment is high and can vary from US$260,000 to US$475,000 in Latin America; on the other hand, the costs of operating and maintaining electric fleets (including batteries and charging infrastructure) have the potential to be up to 70% lower than conventional diesel buses [1]. [1] ICCT. Benefícios de tecnologias de ônibus em termos de emissões de poluentes do ar e do clima em São Paulo. Relatório Técnico. 2019. Available at: https:// theicct.org/publications/beneficios-de-tecnologias-de- -onibus-em-termos-de-emissoes-de-poluentes-do-ar-e-do-clima. Accessed in: June 2022.	Dommage qu'on ne donne pas le prix des bus Diesel pour comparer A noter que la technologie des BEB étant très récente, on n'a pas de recul sur la durée de vie des batteries, pour laquelle on n'a que les déclarations optimistes des fournisseurs. Mais Eindhoven a changé ses batteries au bout de seulement 6 ans d'âge ; bien évidemment, le communiqué de presse ne dit pas qu'elles étaient arrivées en fin de vie pour l'exploitation, mais explique que c'est pour bénéficier de batteries plus performantes !!.
11	The experience of pioneer cities in Latin America, such as Bogotá (Colombia) and Santiago (Chile), demonstrates that the contractual separation for the implementation and operation of electric buses between public and private entities is potentially advantageous given the uncertainties surrounding the initial stage of a technology that is still little disseminated [2]. [2] ITDP. From Santiago to Shenzhen: How Electric Buses are Moving Cities. Report. 2021. Available at: https:// www.itdp.org/publication/from-santiago-to-shenzhen- -how-electric-buses-are-moving-cities/Accessed in: June 2022.	
12	The stages of implementation of corridors or lines using electric buses should provide for the detailing of the regulatory model; the definition of fleet funding; the definition of the route to be electrified; the definition of the type and location of the charging infrastructures; monitoring and management of the operation; maintenance; and support activities.	
12	In short, implementing electric buses implies planning a new public transport system. However, despite the challenges, it is an opportunity to rethink and improve urban mobility as a whole (not just passenger transport service).	Très bien vu et non pas comme l'ont fait certains ou envisageaient de le faire, simplement changer de technologie pour une ligne de bus qui conservait toutes ses caractéristiques, bonnes et mauvaises, comme ce fut le cas du trolleybus de Nancy (France) des années 80, et le cas des projets d'électrification de lignes de bus à Montréal et Laval (Canada) des années 90.

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12	In addition to technological innovation, the cities that implement electromobility projects should be able to provide means for a more equitable and comprehensive economic and social development, mainly benefiting the population groups that depend most on public transport: low-income population, black people, women, people with disabilities, the elderly, and children. In this sense, prioritizing the electrification of the most demanded routes by this public is equivalent to investing in expanding access to opportunities with relevant social and economic returns.	Je n'épiloguerai pas sur cette liste à la Prévert qui oublie les Blancs, les Jaunes, les Inuits, les LGBTQIA sans oublier le +. En fait, comme c'est dit à la fin, il faut électrifier les lignes où la demande est la plus forter en prenant en compte toutes les catégories d'usagers. Et comme l'a remarquable dit M. MEZGHANI, mieux vaut un bus Diesel dans un couloir bus qu'un bus électrique dans les embouteillages. Et j'ajouterai, ce n'est pas parce que les pauvres n'ont pas de quoi manger qu'il faut continuer à les entasser à 8 debout par m2 dans les bus.
13	Electromobility is one of the most powerful solutions to drive sustainable and inclusive urban development. Yet, for more than half a century, the primacy of fossil fuel-powered transport has helped shape and expand polluted, hard-to -reach cities.	Sustainable, oui, inclusive, on ne voit pas pourquoi. C'est la primauté de l'automobile et le démantèlement de tous les réseaux de tramways et trolleybus, et non pas que les bus fonctionnent au Diesel, qui a conduit à la situation actuelle.
13	Despite the numerous social, economic, and environmental benefits already tracked and proven [3], battery electric buses are still a technology whose adoption faces several challenges. [3] ICCT. Benefícios de tecnologias de ônibus em termos de emissões de poluentes do ar e do clima em São Paulo. Relatório Técnico. 2019. Available at: https:// theicct.org/publications/beneficios-de-tecnologias-de--onibus-em-termos-de-emissoes-de-poluentes-do-ar-e-do-clima. Accessed in: June 2022. ITDP. From Santiago to Shenzhen: How Electric Buses are Moving Cities. Report. 2021. Available at: https:// www.itdp.org/publication/from-santiago-to-shenzhenhow- electric-buses-are-moving-cities/Accessed in: June 2022.	Ilya une technologie électrique vieille d'un siècle et parfaitement maîtrisée, le trolleybus
15	1 - ELECTRIC BUSES IN THE NATIONALCONTEXT	
16	Currently, Brazil has 350 electric buses circulating in nine cities in the South, Southeast, and Midwest regions [5], and an increasing number of cities are conducting tests to add electric vehicles permanently to their fleet.	Ils sont étonnants ces Brésiliens, ils poussent cocorico pour 350 bus électriques batteries, mais pas un mot sur les 290 trolleybus très récents qui circulent à Sao Paulo (voir article allemand tout à la fin).
17	Cities must take action to meet their commitments to reduce pollutant emissions. Between 70% and 80% of greenhouse gas emissions and other air pollutants resulting from the burning of fossil fuels are generated in large urban centers, especially in the transport sector.	On oublie de préciser que dans les transports, en matière de pollution, les transports publics représentent peu de chose face à la voiture.
18	In 2021, the bus fleet in São Paulo issued more than one hundred tons of particulate matter. The impact of exposure to polluted air corresponds to smoking five cigarettes per hour, according to results of research led by Professor Paulo Saldiva from the Medical School of the University of São Paulo (USP), which assessed the lungs of 413 autopsied corpses in the state capital [9].	Comparaison avec la cigarette est intéressante

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18	Introducing electric fleets allows cities to make their bus services more comfortable, safe, and reliable, especially for people who rely most on them to move around the territory —such as low-income people, people with reduced mobility women, and black people. These benefits are further explored in Chapter 2.	Plus confortable, oui par l'absence de vibrations et de bruit, mais le véritablement plus confortable serait de ne plus entasser les gens à 8 personnes debout par m2. Pour le reste des déclarations, le bus électrique n'apporte rien de plus par rapport à un bus Diesel
18	Electric cars, for example, use less polluting vehicle technology than combustion-powered cars; but do not contribute to a fairer distribution of public spaces on the streets and avenues Figure 1 illustrates the efficiency of using space in transport according to the type of vehicle. It is observed that in a usual situation of trips in individual motorized transport with a person driving, the space occupied is 60m2, while in an exemplary operation of public transport of 45 passengers per bus, the space occupied per person falls to 9.8m2.	Très bien dit

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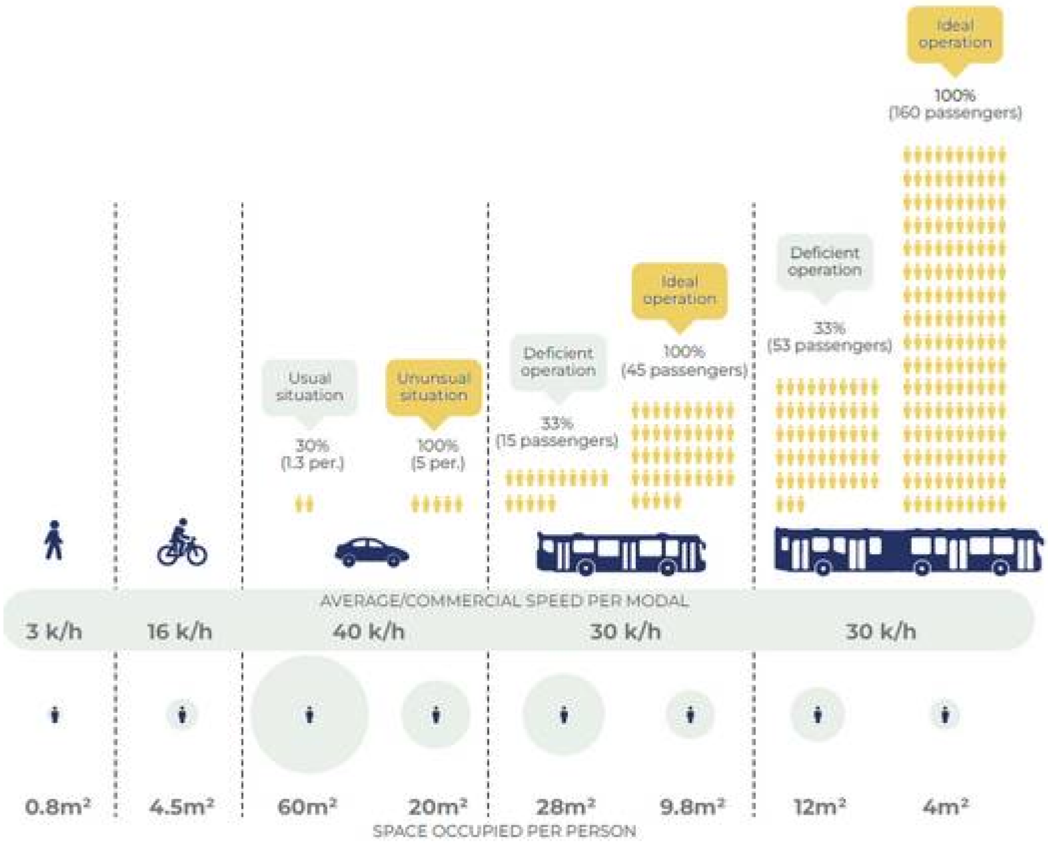
19	**Figure 1 – Efficiency of the use of space in transport by type of vehicle**  Source: Own elaboration, based on ITDP (2015) [10]. [10] ITDP Brasil. Eficiência do uso do espaço em transporte segundo veículo. Infográfico, 2015. Disponível em: https://itdpbrasil.org/programas/desestimulo-ao-automovel/.Acesso em: maio de 2022. https://projetocolabora.com.br/mobilidade-urbana/ha-espaco-para-mais-carros/	Tableau très intéressant mais certaines choses posent question. Un bus 12 m, c'est 45 sièges donc 45 passagers en version interurbaine sans passagers debout ; en version urbaine c'est 70 passagers en comptant 4 passagers debout par m2 plus les sièges Un bus urbain de 18 mètres, c'est 110 passagers en comptant 4 passagers debout par m2 plus les sièges ; à 160 passagers, c'est l'entassement .

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19	It is estimated that it takes about one hundred electric cars to provide the same benefits a single 18-meter (articulated) electric bus offers. For every 1,000 electric buses circulating in the road space, 500 barrels of diesel are saved. In contrast, 1,000 battery electric cars prevent the use of only 15 barrels of oil [11]. [11] WILT, J. Do Androids Dream of Electric Cars? Public Transit in the Age of Google, Uber, and Elon Musk. Toronto: Between the Lines, 2020.	Renvoi 11 c’est un livre 27,95 USD https://ourtimes.ca/article/do-androids-dream-of-electric-cars Even electric cars are not the panacea to climate change they appear to be. Manufacturing electric vehicles requires mining raw materials, often in conflict zones with few to no labour laws. Wilt notes that “replacing all two billion cars worldwide would require a 70 per cent increase in the production of neodymium and dysprosium, a doubling of copper output, and over a tripling in cobalt mining.” The federal government recently promised up to $500 million in funding to subsidize Ford Motor Co. to bring electric vehicle production to its Oakville assembly complex. It’s a move that will continue that trend, while doing little to meet our climate targets.
19	The transition to electromobility is also a way to eliminate several stigmas attributed over time to public transport by bus, such as thermal discomfort and noise pollution.	Il ne faut quand même rien exagérer, les bus Diesel modernes sont très confortables et s’il y a un inconfort thermique, c’est peut-être (sûrement) parce qu’on entasse les gens dans les bus à plus de 4 personnes debout par m2
21	1.2 ELECTROMOBILITY IN THE PUBLIC TRANSPORT SYSTEM BY BUS Electromobility refers to vehicle motorization technologies that adopt electric energy as a driving force. In addition to electric buses, the term covers a range of other vehicles that have already been developed by the industry, such as electric bicycles, electric scooters, electric cars, electric motorcycles, and even electric trucks. Several terms are also commonly used to deal with electromobility: electric mobility, e-mobility, and transport electrification, among others. The electromobility in public transport includes hybrid and fully electric buses, which can be trolleybuses or battery-powered (Figure 3). Figure 3 – Trolleybus in operation in the Metropolitan Region of São Paulo (left) and battery electric buses in Maringá, in Paraná (right) :  Credits: Renato Lobo (2018); Rafael Calabria (Idec, 2019).	Enfin le mot trolleybus

21	The trolleybus is a vehicle that has, at its top, cables connected to an overhead electrical network covering the entire itinerary. This technology has been consolidated in Brazil since the 1940s. Cities such as Rio de Janeiro, Niterói, Araraquara, Recife, Belo Horizonte, Ribeirão Preto, and Porto Alegre have already used this technology in their public transport systems by bus throughout the 20th century; until 2021, the trolleybuses were present only in the Metropolitan Region of São Paulo [13]. An advantage of the trolleybus is that they have guaranteed autonomy throughout the route. However, they lack the flexibility to change the route due to the rigidity of the infrastructure.	Manifestement, c'est un copié-collé de ce qui a dû être écrit ans les années 50 quand on ne connaissait pas le trolleybus IMC. Et donc, cela discrédite le trolleybus.
22	Autonomy is the capacity that a battery vehicle travels considering a full charge. Generally, the battery electric buses adopted in Brazil and Latin America have average autonomy to travel approximately 250 km uninterrupted at each complete charge, usually made in the garage.	250 km d'autonomie, cela veut dire que pour certains services de grande amplitude, il faudra injecter des bus supplémentaires pour remplacer les bus arrivés en fin de batterie.
22	Battery-powered buses adopt a more modern technology than the trolleybus. They have greater flexibility to move around the city with more independence, which increases the capillarity and efficiency of the public transport system. The battery embedded in the vehicle is usually composed of lithium ions, a chemical element with high energy efficiency. This extends the ability to keep vehicles in circulation without requiring sequential charges. In addition, they also have a regenerative braking system, whose energy used in the engine deceleration process is transferred to the battery by charging, broadening the efficiency and autonomy of travel.	"more modern technology than the trolleybus", là c'est une info capitale!!; Soyons sérieux, les deux sont au même niveau de modernisme technologique. "regenerative braking system" :là aussi c'est une info capitale !!. Mais comment s'appelait le système qui grâce au moteur compound ou au moteur série associé à un hacheur élévateur (voir les PER 180 Renault), renvoyait au freinage du courant dans la ligne aérienne ??Oui, le freinage à récupération existe depuis longtemps en trolleybus. Où comment on dénigre de fait un mode concurrent en prétendant des innovations sans dire que le concurrent les pratique depuis longtemps.
22	Why do battery electric buses have greater strategic potential? Battery electric buses have enormous potential to improve public transport systems sustainably and equitably. They are becoming popular and gaining scale thanks to several enhancements: • Ability to travel potentially longer distances as they can be improved, in addition to battery technology, driver training to drive the vehicles, charging methods, and good maintenance practices; • As the industry achieves economies of scale, acquisition costs can potentially decrease; • Evidence-based decision-making with increased data an d good practices shared between cities; • A better understanding of how to use technologies as more cities conduct pilot projects in diverse geographic and economic contexts; and • Funding opportunities can be made possible by donations and innovative funding programs. The possibilities in this sector are diverse and still poorly developed, considering the needs of the municipalities.	Bon, c'est du baratin mais on peut dire strictement la même chose pour le trolleybus IMC en ajoutant : - des dizaines d'années d'expérience - le moins coûteux en TCO (Coût total de possession) - le moins énergivore - le plus économe en métaux rares

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23	The traditional plug-in charge is the most common method – and usually more accessible to cities. In addition, it is what makes less intensive use of electricity. A cable coming out from the vehicle connects to a switch installed in a totem, which can vary in size depending on the manufacturer and electrical power. The charging time is variable, but usually takes five to eight hours to reach full charge. These infrastructures can be allocated in specific garages and/or points, commonly at the beginning or end of routes. Generally, a plug-in infrastructure can power one or two vehicles simultaneously. The average power ranges from 25-150 kW. Although the infrastructure is more financially accessible, the battery pack is more expensive than other charging methods, such as pantograph and wireless. Batteries are also bigger and heavier [14]. This charging method is also called overnight charging, as many batteries are charged at dawn to start operation the next day with the full charge or close to 100%.Overnight charging can also be adopted as an alternative to reduce costs since the value of electricity tends to be lower during the nighttime. [14] BANCO INTERAMERICANO DE DESENVOLVIMENTO (BID); MINISTÉRIO DO DESENVOLVIMENTO REGIONAL (MDR). Guia de eletromobilidade. Orientações para estruturação de projetos no transporte coletivo por ônibus. Brasília, 2022.	On oublie de parler de la puissance installée nécessaire dans le dépôt pour charger tous les bus électriques en même temps, et de la limitation du nombre de voyageurs dans le bus quand on veut une autonomie importante, le poids élevé des batteries diminuant le poids acceptable des voyageurs, donc leur nombre.

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<table>
<tr>
<td>25</td>
<td>In China, the world’s largest electric bus and charger market in 2021, the traditional plug-in is the most popular method [15].

Table 1 – Battery electric bus charging infrastructures
<table>
<tr><th></th><th>Traditional plug-in</th><th>Charging by pantograph</th><th>Inductive Charging</th></tr>
<tr><td>How to transfer electricity?</td><td>Also known as night loading. Most common and accessible method.</td><td>Contact between a pantograph and the rods installed on the vehicle's roof.</td><td>Inductive or by opportunity charging uses an electromagnetic field to transfer electricity.</td></tr>
<tr><td>Charging time</td><td>Slow: from 5 to 8 hours to reach full load.</td><td>Fast: 5 to 20 minutes.</td><td>Fast and dynamic: from 20 minutes to 1 hour to reach full charge.</td></tr>
<tr><td>Where is it located?</td><td>At the end/start of routes or in garages.</td><td>At the end/beginning of the routes; in garages or stations; and charge along the route (in the case of trolleybuses).</td><td>At the end/start of routes, along routes, or in garages.</td></tr>
</table>
Source: Own elaboration.</td>
<td>Un mélange un peu dangereux car nuisant à la compréhension de la charge par pantographe pour des BEB et la charge en mouvement IMC des trolleybus

A noter que pour les BEB, la charge implique un véhicule stationnaire donc immobilisé, ce qui n’est pas le cas du trolleybus IMC.

Je ne connais pas tout mais il me semble que les systèmes de charge inductive sont encore au stade expérimental.

Pas de mention de systèmes de charge statique au sol (type SRS d’Alstom)</td>
</tr>
<tr>
<td>26</td>
<td>Pantograph charging requires the bus to stop under or near a charging device that connects the battery pack to electricity supply through a rod. The top or side charging mode depends on where the battery pack is located in the vehicle structure. As a rule, battery electric buses charged by pantograph have batteries at the top. These batteries are smaller than those used exclusively for plug-in charging, which makes vehicles lighter and more spacious. The charger’s power ranges from 50-450 kW [16].</td>
<td>On ne dit pas pourquoi les batteries sont plus petites ; en fait parce que du fait de la possibilité de charger plusieurs fois dans la journée, l’autonomie nécessaire est plus faible</td>
</tr>
</table>

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26	On the other hand, although the battery pack is cheaper than those used in plug-in charging, pantograph infrastructure is more expensive for acquisition and leasing [17]. Quick charging can also threaten battery life and autonomy. Moreover, it requires a greater electrical grid capacity to power vehicles with agility, especially when the rate is eventually higher. Pantograph use is more common in cities with electric fleets in Europe and North America but is also beginning to become popular in China [18].	Des écrits indiquent des coûts de batteries NMC (préférées pour des BEB à forte autonomie) moins élevés que ceux des batteries LTO
27	Finally, there is inductive charging — also called opportunity charging or wireless. Inductive charging uses an underground electromagnetic field to transfer electrical energy to vehicles. Inductive charging tends to have higher costs and longer deployment time, as the infrastructure partially covers sections of the route operated by the vehicles. The power ranges from 50-200 kW. The technology has been successfully evaluated and adopted in some European cities, such as Madrid (Spain), Berlin and Mannheim (Germany), London (United Kingdom), and Geneva (Switzerland), among others.	A ma connaissance, mais je ne connais pas tout, Berlin et Mannheim, ce sont les essais de Primove de Bombardier, sans suites, et à Genève il n'y a pas eu de charge inductive pour les bus.
28	Investing in electromobility is urgent and allows, at once, to respond to urban sustainability challenges, health, economy, and accessibility.	Pas certain que ce soit suffisant, voir même efficace. Un transfert modal important de l'automobile vers les transports publics, même polluants, serait peut-être plus efficace sur tous les points cités.
28	The potential of electric buses to boost an innovative and prosperous economic complex, with new jobs related to research and innovation activities, is high.	Affirmation toute gratuite, et par ailleurs, on nous dit que les bus électriques demandent moins d'entretien, donc moins d'emplois; ce n'est pas forcément une mauvaise chose d'ailleurs

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The Chilean government estimates that the operation and maintenance of the new fleet are 70% and 37% more economical than those of diesel-powered buses [24], respectively.

[24] GOVERNO DO CHILE. Plataforma de Electromovilidad. Ministerio de Energía. 2021. Disponível em: https:// energia.gob.cl/electromovilidad/transporte-de-pasajeros/buses-electricos-red. Acesso em: junho de 2022.

https://energia.gob.cl/electromovilidad/transporte-de-pasajeros/buses-electricos-red

CONSUMO ENERGÉTICO BUSES PROPULSIÓN ELÉCTRICA
TRANSPORTE PÚBLICO URBANO SANTIAGO

Bus			Capacidad Baterías [kWh]	Capacidad Pasajeros	Consumo [kWh/km]	Autonomía [km]
Clase	Marca	Modelo				
B2	BYD	K9 FE	276,5	81	1,57	176,1
B2	YUTONG	ZK6128BEVG	324,4	87	1,48	219,7
B2	FOTON	eBus U12 QC	151,55	90	1,67	90,9
A1	BYD	K7	156,6	45	1,13	138,6
A1	FOTON	eBus U8,5 QC	129	47	1,24	104,0
B2	ZHONGTONG	LCK6122EVG	351,237	88	1,58	222,3
B2	KING LONG	XMQ 6127G PLUS	374,65	90	1,74	215,0

Más información: https://www.mtt.gob.cl/3cv

https://energia.gob.cl/electromovilidad/transporte-de-pasajeros/buses-electricos-red

Des informations intéressantes

100 buses BYD K9 operados por METBUS.
100 cargadores BYD 50 kW en AC, operados por METBUS.
100 buses Yutong E12 operados por Vule y STP.
50 cargadores Yutong 150 kW en DC, operados por Vule y STP.
El mantenimiento de los buses es más simple de lo esperado y con esto se ha logrado tener una alta disponibilidad (sobre el 97% para el caso eléctrico). El mantenimiento ha resultado tener ahorros en costos de un 70% respecto al bus diésel Euro VI. (L'entretien des autobus est plus simple que prévu, ce qui se traduit par une disponibilité élevée (plus de 97 % dans le cas de l'autobus électrique). L'entretien a permis de réaliser des économies de 70 % par rapport à l'autobus diesel Euro VI.)

Consommation des bus électriques : voir tableau colonne de gauche (on attend la même chose des exploitants français)

30	Considering the forecast that 25% of buses will be electric by 2030, it is estimated that the number of people affected by respiratory diseases will fall from 40,613 in 2019 to 2,175 in 2030, thanks to improved air quality. Therefore, the expectation is that mortality levels will be zeroed until then, maintaining only the cases of professional leaves/absences and lost school days related to this type of disease [25]. [25] JEREZ, P. O. O. Evaluación Económica Y Social De La Incorporación De Buses Eléctricos Al Transporte Público Urbano De Santiago. Tese (doutorado em Engenharia Industrial). Universidad de Chile. 2019. Disponível em: https://repositorio.uchile.cl/bitstream/handle/2250/171777/Evaluacion-economica-y-socia.- de-la-incorporacion-de-buses-electricos-al-transporte. pdf? sequence=1&isAllowed=y. Acesso em: junho de 2022. https://repositorio.uchile.cl/bitstream/handle/2250/171777/Evaluacion-economica-y-socia.-de-la-incorporacion-de-buses-electricos-al-transporte.pdf?sequence=1	
31	Electric buses already circulate in Brasília (Federal District), Bauru (SP), Campinas (SP), Maringá (PR), São Paulo (SP), Metropolitan Region of São Paulo (SP), Baixada Santista (SP), and Salvador (BA). Most vehicles in circulation consist of trolleybus (302), followed by 48 battery-powered buses. Table 2 presents the number of electric buses, the respective vehicle technologies, and manufacturers per municipality.	

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Table 2 – Brazilian municipalities with permanent electric buses in the fleet, types of vehicles, and manufacturers

City	Total of vehicles	Type of vehicles				Manufacturers		
		Trolleybus	Midi battery	Conventional battery	Articulated battery	BYD	Eletra	Others
Brasília (DF)	6	-	-	6	-	6	-	-
Bauru (SP)	2	-	-	2	-	2	-	-
Campinas (SP)	15	-	-	15	-	15	-	-
Maringá (PR)	3	-	1	2	-	3	-	-
São Paulo (SP)	219	201	-	18	-	18	201	-
Região Metropolitana de São Paulo (SP)	96	95	-	-	1	73	-	23
Santos (SP)	7	6	1	-	-	1	-	6
Volta Redonda (RJ)	3	-	-	3	-	3	-	-
Brazil	350	302	2	45	1	120	201	29

Source: E-Bus Radar Platform (June 2022).

33	**Table 3 – Brazilian municipalities with permanent electric buses in the fleet, types of vehicles, and manufacturers.** Country | Initial cost of diesel buses (in US dollars) | Initial cost of BEB (in US dollars) | Approximate percentage variation of electric vehicles China | $ 60,000–$90,000 | $ 140,000–$350,000 | ~ 250% Europe | $244,000–$420,500 | $575,000–$807,000 | ~ 110% India | $30,000–$80,000 | $105,000–$250,000 | ~ 220% Latin America | $200,000–$225,000 | $260,000–$475,000 | ~ 75% North America | $300,000–$510,000 | $550,000–$1,200,000 | ~ 115% Global average | ~ $210,000 | ~ $480,000 | ~ 155% Source: ITDP. From Santiago to Shenzhen (2022).	
34	The initial high investment in electric buses, ranging from US$260,000 to US$475,000 in Latin America, and the infrastructure associated with them may discourage many cities from planning electromobility projects. Even if the total cost of ownership (TCO) of electric buses decreases over time compared to diesel vehicles [29], the lowest price criterion still guides many administrative processes and credit lines that legally enable the acquisition and leasing of these technologies. [29] SOUZA LIMA, G. et al. Mobilidade elétrica: o ônibus elétrico aplicado ao transporte público no Brasil. Revista dos Transportes Públicos, ANTP, ano 41, 2º quadrimestre. 2019.	SOUZA LIMA, G. et al. Mobilidade elétrica: o ônibus elétrico aplicado ao transporte público no Brasil http://files.antp.org.br/2019/7/29/rtp152-e.pdf Page 53 (55 PDF)

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36	Although the vehicular technology used in electric vehicles is free of local emissions to move around, the production chain can be intensive in carbon emissions – especially in battery production and energy sources used for electricity generation. In other words, with no careful and comprehensive planning, pollution that ceases to be emitted on the streets is transferred to power plants or mining and processing raw materials (such as lithium, nickel, and cobalt) to produce batteries. Besides being an environmental challenge, it has also proved to be a geopolitical issue involving extractive territorial disputes, child and slave labor complaints, and threats to the continuance of indigenous peoples [33]. [33] MIT CLIMATE PORTAL. How much CO2 is emitted by manufacturing batteries? February 16, 2022. Disponível em: https://climate.mit.edu/ask-mit/how-much-co- 2-emitted-manufacturing-batteries. Acesso em: junho de 2022. https://climate.mit.edu/ask-mit/how-much-co2-emitted-manufacturing-batteries	
37	The recycling methods of batteries used in BEBs in Brazil are still under development, and are currently adopting the following solutions [36]: • Battery use in a second-life cycle, such as in solar or wind energy storage, with 96% efficiency. BYD in Brazil is already selling solar panels and closing sales packages for this purpose; • After the second life cycle (30 years), batteries must be subjected to recycling, in which lithium-ion components are used, and other chemical components to produce new units. [36] WORLD BANK (2019). GREEN YOUR BUS RIDE Clean Buses in Latin America. Report, 2019. Disponível em: https://documents1.worldbank.org/curated/en/410331548180859451/pdf/133929-WP-PUBLIC-P-164403-Summary-Report-Green-Your-Bus-Ride.pdf. Acesso em: 29 junho de 2022. https://documents1.worldbank.org/curated/en/410331548180859451/pdf/133929-WP-PUBLIC-P164403-Summary-Report-Green-Your-Bus-Ride.pdf	
44	2 - SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACTS	
47	On the other hand, the “silence” of electric buses could cause road safety problems [46]. One way to mitigate this impact is to implement graphic signs and road safety sound warnings on sidewalks and crossings for people with hearing and visual impairment. For example, in 2019, Transport for London (TfL), the body responsible for the transport system in London, implemented equipment with a recognizable sound alert that would help draw the attention of people with visual deficiency or partial hearing impairment (in addition to other pedestrians and cyclists) to the presence of electric buses and thus avoid accidents [47]. [47] TFL. Transport for London to trial innovative new bus sound to improve road. Notícia, 18 de dezembro. 2019. Disponível em: https://tfl.gov.uk/info-for/media/press-releases/2019/december/tfl-to-trial-innovative-new-bus-sound-to-improve-road-safety. Acesso em: junho de 2022. https://tfl.gov.uk/info-for/media/press-releases/2019/december/tfl-to-trial-innovative-new-bus-sound-to-improve-road-safety	

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48	An electric bus generates about 5 decibels less external noise during engine acceleration than a diesel vehicle and 7 decibels less than natural gas-powered buses. The introduction of electric buses can improve the comfort of users and the working conditions of the people who drive the buses [48]. [48] BORÉN, S. et al. Preferences of Electric Buses in public Transport; Conclusions from Real Life Testing in Eight Swedish Municipalities. International Journal of Environmental and Ecological Engineering, 10(3), pp. 259–268. 2016. Disponível em: https://publications.waset. org/10003929/pdf. Acesso em: junho de 2022. https://www.researchgate.net/publication/299351717_Preferences_of_Electric_Buses_in_Public_Transport_ Conclusions_From_Real_Life_Testing_in_Eight_Swedish_Municipalities	
48	The sustainability certification of lithium-ion batteries is also another environmental factor to be analyzed since their production and recycling are more intensive in raw materials than the production of traditional combustion engines. By 2022, most lithium was extracted from hard rock mines or underground brine reservoirs, predominantly in the South American Triangle formed by countries such as Argentina, Chile, and Bolivia. However, part of the energy used to extract it from hard rocks and process it still comes from fossil fuels: for every ton of lithium extracted, 15 tons of CO_2 are emitted. For comparison, each ton of CO_2 represents the same as a gas-powered car would emit, running about 4025km. In addition, the production of lithium-ion batteries implies using high volumes of water at the risk of contaminating and depleting natural reservoirs [50]. [50] MIT CLIMATE PORTAL. How much CO2 is emitted by manufacturing batteries? February 16, 2022. Disponível em: https://climate.mit.edu/ask-mit/how-much-co-2-emitted-manufacturing-batteries. Acesso em: junho de 2022. https://climate.mit.edu/ask-mit/how-much-co2-emitted-manufacturing-batteries	
49	Over 12 years of service life, using an electric bus instead of a diesel bus can reduce operating emissions by 1,690 tons of carbon and 10 tons of nitrogen oxides. On average, considering the life of battery-powered vehicles in the U.S., they emit 33% fewer GHG emissions, 93% less carbon monoxide, and 32% less black carbon than vehicles with internal combustion engines. In Latin America, replacing the annual acquisition of conventional buses with BEBs could reduce CO_2 emissions by more than 5.7 million tons each year and by 124,000 tons of nitrogen oxides [51]. [51] ITDP. From Santiago to Shenzhen: How Electric Buses are Moving Cities. Relatório. 2021. Disponível em: https://www.itdp.org/publication/from-santiago-to-shenzhen-how-electric-buses-are-moving-cities/Acesso em: junhode 2022.	
49	In 2022, a lithium-ion battery lasts an average of 15 years. Battery life is measured by the number of cycles it can complete or by the temporal durability stipulated by the manufacturer. When storage capacity is below 80% of the initial value, their performance is inappropriate for use in the operation of electric buses.	

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49	2.2 SOCIAL IMPACTS Most low-income communities rely on walking and cycling trips to access public transport on their daily mobility. The social groups most benefiting from electrification are also the most vulnerable from the point of view of mobility —low-income people, black people (especially women), people with disabilities, the elderly, and children.	On ne voit pas en quoi le fit que le bus soit électrique change considérable la donne par rapport à un bus Diesel. Ce que tous ces gens-là demandent, ce sont des bus fréquents et confortables (pas d'entassement)
51	**Figure 9 – Women represent just over half of the people who use public transport by bus and are the most exposed to polluted air (especially black women and those living in the suburbs)**  Credit: Combat environmental racism.	On peut supposer que cette photo montre des conditions favorables (mais déjà peu confortables) car l'entassement doit être en réalité beaucoup plus important
52	The highest percentage in Brazil of black women living near a medium and high-capacity transport route in theMetropolitan Region of Rio de Janeiro does not exceed 15% [58]. The replacement of conventional buses with electric buses would generate substantial advantages for the well-being of this portion of our society, which is equivalent to 27.8% of the Brazilian population (according to data from the IBGE National Household Sample Survey 2018). Furthermore, an electrification project associatedwith unique corridors would also make commuting faster, dignified, and more reliable, considering their transport needs. In addition, many women have to make several trips at off-peak times to take care of household chores, childcare, and work assignments.	Le fait que le bus soit électrique, c'est epsilon dans l'amélioration des conditions de transport. Ce sont les fréquences et les vitesses commerciales qui sont importantes

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52	Mobile internet coverage inside electric buses and at pickup points allows passengers to be distracted and/or maintain adequate communication with children, stepchildren, relatives, and friendly people along the way especially for emergencies. Effective electric bus tracking system helps provide users with real-time service monitoring, with greater predictability of waiting at pickup points.	On parle de personnes pauvres (qui n'ont sans doute pas les moyens de se payer une connexion internet) et on parle d'internet dans les bus. Le bon modèle ne serait-il pas Budapest des années 70 avec un réseau de transport public dense, remarquablement géré de ce qu'on m'en a dit, et sans internet. Et quand les bus sont fréquents et respectent l'horaire, pas besoin de solutions sophistiquées et coûteuses pour informer les gens. Combien de ceux qui font ces propositions utilisent les bus dont ils parlent ?
56	2.3 ECONOMIC IMPACTS One of the concerns of cities that want to invest in electromobility is the increased expenses with fleet management, operation and maintenance, and capital risk. On the other hand, economic impacts can be positive in the medium and long term compared to the same expenses to maintain a diesel fleet.	
57	First, battery electric buses can be more financially efficient because they require less energy per kilometer than diesel buses (comparing equivalent energy and fuel). A feasibility study conducted for the city of Monterrey (Mexico) found that, with 50 kWh (the energy equivalent to 5 liters of diesel or 4.5 liters of CNG), a battery electric bus has a range of 30 km, while a diesel bus travels 12 km, and a bus on CNG, only 8 km [64].	Si intellectuellement c'est intéressant, pratiquement parlant cela n'apporte pas grand-chose entre différents type d'énergie. Une comparaison intéressante serait entre les BEB et les trolleybus, même énergie
57	Although the initial costs can reach twice that of a diesel vehicle, energy costs per kilometer traveled are half [65]. This is partly due to electricity rates being lower than the amount charged per liter of diesel and the more efficient energy conversion on the go. This is one of the main factors that make electric buses a more advantageous and economical option in the medium and long term. In addition, the operating and maintenance costs of battery electric buses may be lower than those of diesel buses, as the electric propulsion system does not require the same type of overhaul as a combustion engine, nor does it require frequent replacement of parts after a certain period. For example, figure 12 shows that the TCO for a fleet in São Paulo is 9% lower than a diesel model [66]. [65] [66] SLOWICK, P. et al. Avaliação Internacional de Políticas Públicas para Eletromobilidade em Frotas Urbanas. Relatório (PROMOB-E). Brasília: Ministério da Indústria, Comércio Exterior e Serviços; GIZ. 2018. Disponível em: https://theicct.org/publication/avaliacao-internacional-de-politicas-publicas-para-eletromobilidade-em-frotas-urbanas/. Acesso em: junho de 2022. https://theicct.org/wp-content/uploads/2021/06/ICCT_Brazil-Electromobility-PT-20122018.pdf	

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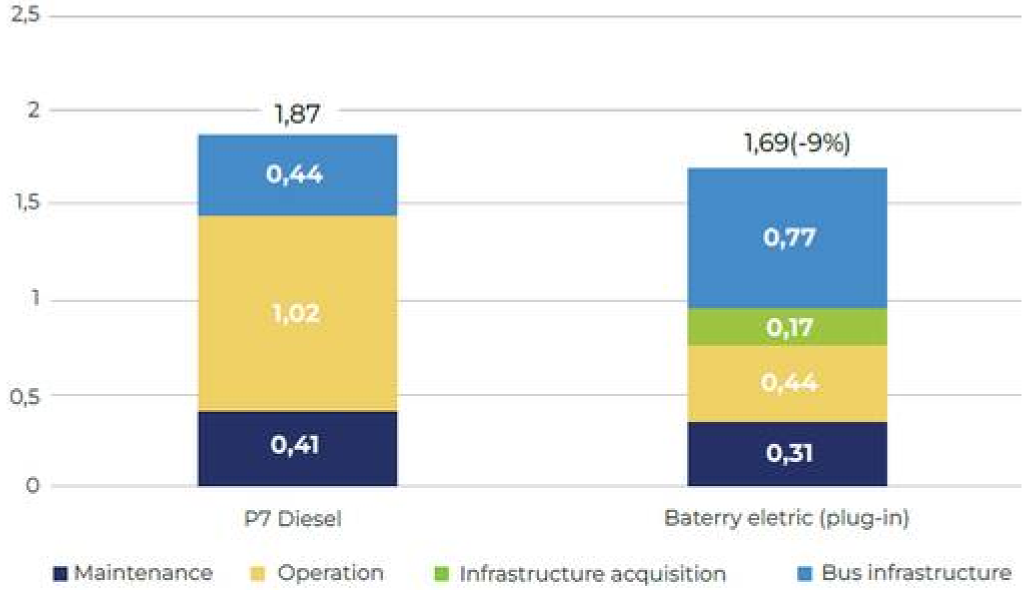
Figure 12 – Total cost of ownership (over ten years) of conventional and electric buses in São Paulo in 2018 (in millions of reais)

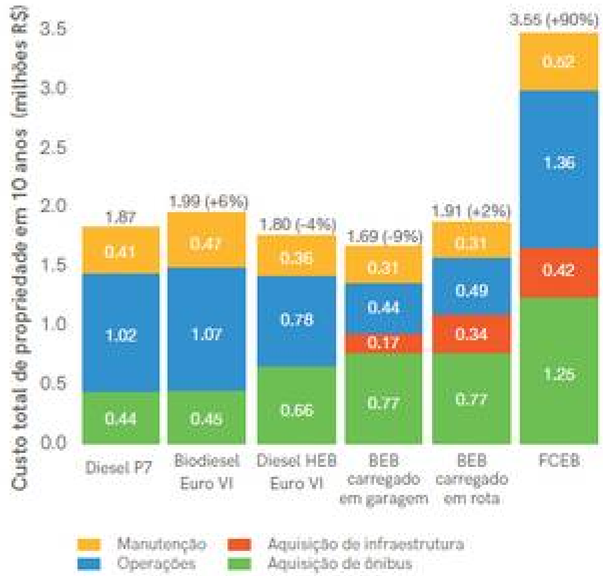


Source: Adapted from Slowick *et al.* (2018, p. 14) [67].

Although the costs of acquiring an electric bus are higher, which can range from US$260,000 to US$475,000 in Latin America, operating expenses for diesel buses are twice as high. Comparing the two TCOs shows discrete variations between both technologies but with relative infrastructure acquisition and maintenance advantages [68].

[68] SLOWICK, P. et al. Avaliação Internacional de Políticas Públicas para Eletromobilidade em Frotas Urbanas. Relatório (PROMOB-E). Brasília: Ministério da Indústria, Comércio Exterior e Serviços; GIZ. 2018. Disponível em: https://theicct.org/publication/avaliacao-internacional-de-politicas-publicas-para-eletromobilidade-em-frotas-urbanas/. Acesso em: junho de 2022.

https://theicct.org/wp-content/uploads/2021/06/ICCT_Brazil-Electromobility-PT-20122018.pdf



On raisonne là par bus.

Il aurait été intéressant de détailler dans les coûts d'exploitation :
- la gestion du service
- les conducteurs
- les coûts d'énergie

A noter qu'il n'est pas rare qu'il faille plus de BEB charge de nuit que de bus Diesel (aussi que de trolleybus), du fait de l'autonomie limitée en kilomètres, pour assurer le même service, et plus de conducteurs. Cela devrait être pris en compte pour une comparaison.

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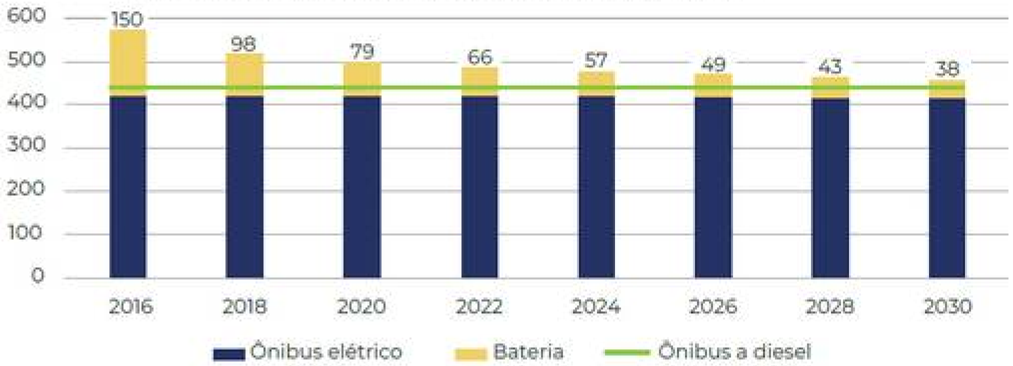
<table>
<tr><td>59</td><td>Figure 13 – Forecasting costs of electric and diesel buses in the European context (in thousands of U.S. dollars)


Source: C40 Cities; WRI (2018) [69]. Note: Battery electric bus with 250 km of autonomy. Inicial price of the battery is 600 dollars/kWh.

[69] C40 CITIES; WRI. Electric Buses in Cities: Driving Towards Cleaner Air and Lower CO2. Relatório. 2018. Disponível em: https://www.transformative-mobility.org/publications/electric-buses-in-cities-driving-towards-cleaner-air-and-lower-co2. Acesso em: junho de 2022.

https://transformative-mobility.org/multimedia/electric-buses-in-cities-driving-towards-cleaner-air-and-lower-co2/</td><td></td></tr>
<tr><td>60</td><td>3 – ELECTROMOBILITY PLANNING</td><td></td></tr>
</table>

65	Figure 14 – in São Paulo, the bus corridor of Avenida Rebouças complies with some of the principles of DOTS, ensuring that the population has quick access to opportunities in the south and west of the city  Credit: IEMA (2019).	
72	Establish deadlines for the provision or ownership of vehicles for electric buses Due to the high cost of acquiring electric vehicles, a period of 15 years is more compatible with the amortization of the investment. It also corresponds to payback, the time for the cost of purchase of the electric vehicle to be fully recovered.	
72	Stipulate operating times of less than ten years to ensure the incorporation of innovations and establish greater Competitiveness Operating times of less than ten years encourage operators to plan to ensure innovations following contractual rules.	Pas certain qu’un contrat qui ne correspond pas à la durée de vie du véhicule soit une bonne chose si l’exploitant est propriétaire de ses véhicules. Sans doute difficulté à vendre à bon prix correspondant au reste de sa durée de vie un véhicule de 10 ans. Risque que le candidat opérateur base son offre en amortissant les véhicules sur la durée du contrat.

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Table 7 – Financial variables in the total cost of ownership of electric buses

Category	Aspect	Description
Acquisition *(buses and components)*	Initial payment/ capital financing	Initial payment, which may come from existing funds or grants. It does not include the financing to be returned.
	Payment(s) of loan(s)/ debt financing	Payment(s) of loans and related interest over the specified schedule.
	Resale value	Applicable only when the vehicle's life exceeds the system's operating time when the option is for purchase.
Operating costs *(operations and maintenance)*	Supply with electricity	Annual expenditure on electricity tariffs to charge batteries.
	Other operations	Annual cost of additional materials required for operations, such as air conditioning.
	Bus maintenance	Annual maintenance cost.
	Infrastructure maintenance	Annual cost of maintaining the charging infrastructure (both on the route and in the garages).
	Review of buses	Bus and battery overhaul costs, e.g., battery replacement in cases of failure before the end of scheduled useful life.
Category	**Aspect**	**Description**
Final destination costs	Destination of buses and charging components	If the useful life of the buses does not exceed the operating period of the system, the cost of the destination of vehicles and components shall be foreseen.
	Battery destination	Cost of battery allocation. Manufacturers may be responsible for the disposal if under warranty or a disposal system called a contract.

Source: Own elaboration.

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75	In Brazil, four main taxes focus on electric buses. Most of them are federaltaxes, but they impact the budget of cities: • Import Tax (II), taxed when the bus enters the national territory when imported, and with a rate for the complete electric vehicle (mounted) of 35%; • Tax on Industrial Products (IPI), tied to the vehicle's technical specifications and characteristics, ranges from 7% to 25%. The IPI of the lithium-ion battery, for example, corresponds to approximately 15% of the total value; • Social Integration Program (PIS) and Contribution for the Financing of Social Security (Cofins), which can exceed 15% when added and; • Tax on Circulation of Goods and Services (ICMS), the only state tax listed, generated when a commodity or service circulates within or outside the state, with a rate of up to 20%[73].	
82	4 – BUSINESS MODELS FOR ELECTROMOBILITY	
89	4.2 BUSINESS MODEL ANALYSIS FOR ELECTRIC BUSES	

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98 à 108	Présentation détaillée des différents types de contrats 4.2.1 Alternative 1 The first alternative is the constitution of a public company dedicated to operating and implementing an electric fleet system. The public company would also articulate the organizations responsible for the operation and implementation of associated infrastructures. 4.2.2 Alternative 2 This alternative refers to implementing and operating electric buses under full private responsibility 4.2.3 Alternative 3 This alternative refers to the shared responsibility for implementing and operating electric buses between public and private entities 4.2.4 Alternative 4 This alternative refers to implementing and operating electric buses under private responsibility in two separate contracts The first contract, aimed at implementation, defines the agent responsible for deploying vehicles and charging infrastructure, including civil works and systems, in a long-term contract.(...) As the maintenance of the systems and eventually the maintenance of the vehicles themselves are incorporated into the contract, partially or completely, the arrangement would constitute an administrative public-private partnership (PPP) with long-term remuneration The second contract, regarding the operation, involves the construction of garages, terminals, other collection systems, control, monitoring, management, and others. It also implies, in addition to the realization of investments aimed atthe provision of services not included in the first contract, the full execution of the operation and maintenance of operational assets, including those provided under the first contract. Furthermore, the responsibility must be established on the assets (buses) under its custody and use.	

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109	In 2019, the Colombian capital revised its concession contracts for its BRT (bus rapid transit) system, TransMilenio. One of the main innovations was to separate the provision services (Capex, capital investments, or acquisition costs) and operation (Opex, operating expenses, or operating costs) of the fleet into separate contracts and bidding processes [78]. Thanks to the new business model, stakeholders with greater financial capacity began to join forces with local operators in the concession of the service, conferring viability and stability. For example, Volvo's partnership with two private operators provided 300 hybrid electric buses for the TransMilenio. The cost of the buses was separated from the batteries: private operators bought the buses from Volvo, and the city signed a leasing contract for the batteries [79]. [78] WRI BRASIL. Contratos de concessão de Bogotá e Santiago são inspiração para transporte coletivo no Brasil. Blogpost, 16 de novembro. 2020a. Disponível em: https://wribrasil.org.br/pt/blog/cidades/mobilidade-urbana/contratos-concessao-bogota-santiago-inspiracao-transporte-coletivo-brasil. Acesso em: junho de 2022. https://www.wribrasil.org.br/noticias/contratos-de-concessao-de-bogota-e-santiago-sao-inspiracao-para-transporte-coletivo-no [79] ITDP. From Santiago to Shenzhen: How Electric Buses are Moving Cities. Relatório. 2021. Disponível em: https://www.itdp.org/publication/from-santiago-to-shenzhen-how-electric-buses-are-moving-cities/Acesso em: junho de 2022.	
111 à 118	4.3 NATIONAL CONTEXT AND OPPORTUNITIES FOUND FOR BUSINESS MODELS	
119 à 124	4.4 CRITERIA FOR SELECTING BUSINESS MODELS	
125	MEANS OF IMPLEMENTING PROJECTS	
127	5.1 POLICY-REGULATORY INSTRUMENTS FOR IMPLEMENTATION	
133	5.2 GOVERNANCE MECHANISMS	

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133	**Table 15 – Comparison of common financing mechanisms for battery electric buses**	

Options	Advantages	Considerations
Costing with existing resources or subsidies	+ Common and simple model. + Resources do not need to be refunded. + Acts as a catalyst for transition.	- High initial burden. - It requires a large volume of resources or subsidies and is not possible everywhere. - It does not necessarily lead to a large-scale fleet transition.
Debt financing, including concessional loans and green bonds	+ Distributes costs over time, allowing lower initial burden. + Concessional loans can offer flexible loans and much lower interest rates, making them more affordable.	- It may not offer enough financial support. - May require additional coordination between various stakeholders (if it involves loans from national and international development banks).
Leasing of components (batteries)	+ By transforming some capital costs into operating expenses, it balances initial and ongoing expenses. + Sometimes, it can be combined with better maintenance or replacement of components by manufacturers. + Allows the transition of the fleet on a large scale.	- Involves more stakeholders and divided responsibilities. - Attractiveness of the enterprise and appetite of the market.
Operational leasing	+ Distributes the financing, allowing less concentration of the total burden in one of the parties. + Allows the transition of the fleet on a large scale.	- Involves more stakeholders and divided responsibilities. - Attractiveness of the enterprise and appetite of the market. - It may increase in the long run as more parties get involved.
Financial leasing	+ Distributes the financing, allowing less concentration of the total burden in one of the parties. + It can be a much more robust option financially. + Allows the transition of the fleet on a large scale.	- Involves more stakeholders and divided responsibilities. - Attractiveness of the enterprise and appetite of the market. - It may increase in the long run as more parties get involved.

Source: Own elaboration.

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136	**Leasing of components (batteries)**. In this model, the operator or local government rents the bus and/or battery from the manufacturer or supplier (often with the support of a third-party investor, such as a development bank or a niche financing company) to reduce the initial financial risk of a lease of its own. The arrangement is called battery leasing. By separating the purchase of some components (such as infrastructure) and the rental of other components (such as buses and/or batteries), the initial cost is comparable to that of diesel and CNG buses. This benefits manufacturers by expanding the market of transport operators interested and able to fund electrification in this way. It also benefits operators by making electric buses a viable financial option both at the beginning and during the life of vehicles. Third-party investors, such as development banks, are motivated to support electrification projects to achieve environmental and social objectives. In addition, the leasing contract is not always the only financial mechanism —it can be adopted in parallel with subsidies or loans to reduce upfront costs further. For example, this arrangement was used in Bogotá, Colombia, with Volvo, in conjunction with a loan to operators for the acquisition of hybrid electric buses, as well as in Park City, Utah, USA, with the company Proterra. Similarly, in São Paulo, battery leasing was used to purchase 15 battery electric buses in 2018. For the pilot project, BYD helped finance the vehicles (with 20% entry and the rest in 60 months with market rates). The city signed a battery rental contract (R$ 9,500.00/month, equivalent to about US$ 1,700/month) to be paid in 15 years. In this way, funding programs can help reduce barriers to fleet financing and the initial pilot project. In addition to the benefit of reducing upfront costs, in the case of batteries, leasing agreements can offer battery life guarantees, battery performance guarantees, and/or replacement with new batteries in the middle of life. The latter option is particularly beneficial as operators can obtain a battery with more advanced technology at no exorbitant cost. Unfortunately, there is relatively limited information on good battery leasing practices in Bogotá and other cities, but growing interest in this model should result in good practices in the coming years.	
137	**Operational leasing**. In this model, a third party acquires the agreed assets (e.g., buses) and leases such assets and/or infrastructure for operations. A public service ownership agreement can be an operating lease (or leasing). Cities such as Santiago, Chile, and Portland, Oregon, USA, used this model with utilities that acted as asset or infrastructure owners. For example, in Santiago, two separate concessionaires own the buses and rent them to transport operators. Different variations of this model are increasingly popular. By separating upfront costs between the various stakeholders, the model can alleviate the high-cost capital challenges for the operator and provide different benefits to stakeholders. For example, for the manufacturer, this increases sales; accelerates electrification without generating huge financial responsibilities; for the owner of the buses/batteries (such as a utility company), it generates additional revenue and creates a stronger balance sheet; and for the capital provider, it expands its autonomy in the electric bus market while ensuring a stable return from the lessor.	

138	Financial leasing. There are several types of financial leasing contracts, such as direct leasing, after-sales lease, and trust lease. The model is similar to a loan and often involves multiple stakeholders. However, it is different from leasing components (buses/batteries) and operational leasing by including another interested party with capital for the rental resource. Often, the financial leasing company buys the buses with or without batteries and rents the fleet to the bus operator, who pays the rent for a certain period.	
142	Cities must also ensure that the inclusion of electric buses is accompanied by effective measures to avoid congestion. To a large extent, zero-emission vehicles solve problems related to air quality. On the other hand, they are vehicles that congest streets and avenues, like diesel buses. The Avoid-Change-Improve approach should guide planning in the effective transition to electric fleets. It is not enough to incorporate zero-emission vehicles into the public transport system; it is necessary to adapt the road system, prioritizing pedestrians, cyclists, and electric buses. This makes the system more inclusive and efficient. In addition, it is worth mentioning a technical justification: when electric buses spend less time in traffic jams with the engine running, the battery life is better used. As a result, buses can make more trips and transport more people, contributing to better use of invested resources and less environmental impact.	Remarquablement bien dit
142	Many routes defined behind closed doors by decision-makers do not satisfactorily meet the population’s day-to-day life.	Très bien dit. Mais le fait que ce soit conçu dans un bureau fermé n’est pas le plus grave. Ce qui est le plus grave, c’est que bien souvent les concepteurs ne sont pas utilisateurs des bus, et encore moins souvent en ont conduit.
143	6 - MONITORING AND EVALUATION	
144	6.1 EVALUATION TOOLS	

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Table 16 – Indicators of evaluation of electric buses pilot projects

General data	- Vehicle characteristics (e.g., model, weight, dimensions, battery capacity, etc.).
	- Weather conditions of the city or test site.
	- Qualitative perception of the satisfaction of users and drivers.
	  - Internal lighting.
	  - Cleaning.
	  - Ventilation and temperature.
	  - Visibility through the window.
	  - Availability of places to travel.
	  - Capacity/quantity of passengers.
	  - Comfort of the seats.
	  - Internal noise level.
	  - Internal vibration level.
	  - Conservation status.
	  - Places of pick up and drop off.
	  - Drivers' work (for users).
	  - General satisfaction with the experience.

Cost data	Capital costs - Vehicle. - Charging infrastructures. Operating costs - Electricity rate. - Bus maintenance. - Infrastructure maintenance.
Operational data	- Topographic conditions. - Extension traveled with road priority in the planned route. - Number of pick up and drop off points. - Daily mileage traveled per vehicle. - Average daily route. - Average speed per trip. - Vehicle availability. - Energy consumption per trip. - Passengers transported per trip. - Passenger rate per km.
Charging data	- State of charge per vehicle (SoC). - Average charging time spent per vehicle. - Energy costs.
Maintenance data	- Reason and duration of maintenance stops - Average mileage between failures - Failure rate per month - Qualitative perception of the challenges of maintenance and satisfaction of the professionals responsible for this function.
Data on environmental benefits	- Energy saving - Avoided greenhouse gas emissions - Avoided emission of local pollutants

Source: Own elaboration based on the activities carried out within the framework of the Tumi E-bus Mission and ITDP (2021).

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148	The duration of contracts must be defined to enable the continuous quality of the service, maintain the predictability of investments and ensure the competitiveness of the bidding process. In addition, the duration of the contract influences greater or lesser flexibility to enable changes in the bus transport sector in response to new environmental and technological requirements or structural changes in urban mobility standards. Moreover, it affects the willingness of operators to invest more or less in the service. In this sense, the time of provision or possession of conventional and electric vehicles must be different in contractual terms. The contract duration should be up to 15 years for electric buses and up to ten years for other vehicular technologies. In the latter case, stipulating operating times of less than ten years facilitates the guarantee of incorporation of technological updates and greater competitiveness. Although they offer greater security to operators, long terms can also stimulate market dominance by a few companies, to the detriment of improvements for users. Shorter contracts promote greater competition in the sector. Besides, they need adequate investment costs and may demand more government management actions. Therefore, the definition of the contract duration requires a balance between the specific constraints of each city.	
152	Regenerative braking, one of the performance attributes of electric vehicles, can increase battery capacity and battery life by up to 20%. However, it is necessary to know how to operate it properly.	
153	7 - FINAL CONSIDERATIONS	
156	8 - APPENDIX	

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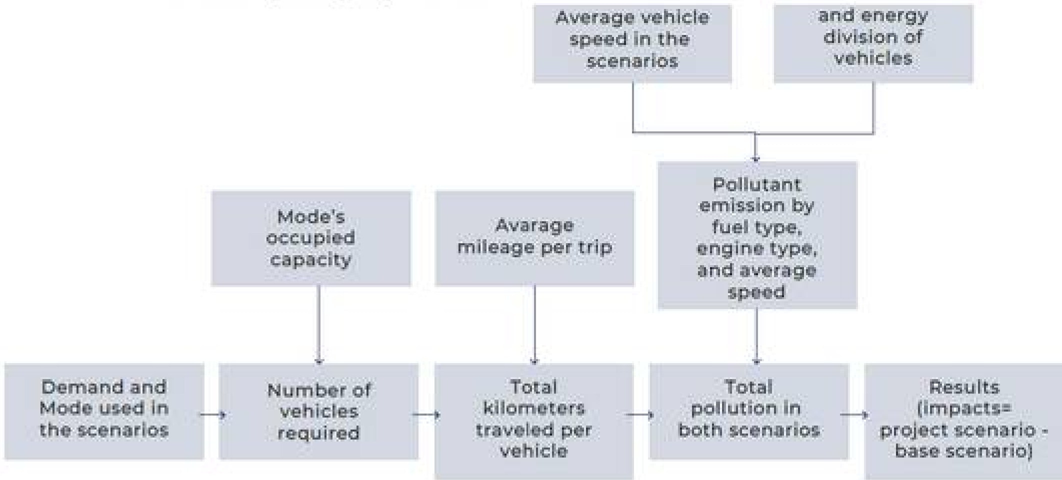
1. Transport Emissions Evaluation Models for Projects (TEEMP)
Developed by the Clean Air Initiative for Asian Cities and ITDP, it assesses the impact of new BRT corridors to be implemented or in operation in terms of greenhouse gas emissions and local pollutants, considering the different existing vehicle technologies and including electric buses in the fleet.
How does it work? The TEEMP model calculates the total emissions avoided by implementing a new BRT corridor.
Thus, emissions from a base scenario without the project implementation are compared with those of the post-project scenario. The TEEMP model offers a simple alternative (shortcut method or shortcut) and a complete (full or full method, as shown in Figure 33).

Figure 33 – Flowchart of the steps for calculating emissions in the complete (full) method



Source: ITDP (2022) [91].

[91] ITDP. Transport Emissions Evaluation Models for Projects (TEEMP). Disponível em: https://www.itdp.org/2012/08/06/transport-emissions-evaluation-model--for-projects-teemp-brt/. Acesso em: junho de 2022.

https://www.itdp.org/2012/08/06/transport-emissions-evaluation-model-for-projects-teemp-brt/

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<td>3. Simulator for Feasibility Assessment of Electric Bus

Developed by the Energy Research Office (EPE), it allows making a technical and economic evaluation of electric buses. The main data generated by the simulator are the internal rate of return, the total cost of ownership (TCO), the net present value (NPV), and the return-on-investment
time (payback).

How does it work? The tool requires the insertion of data on the average distance traveled and the days of bus operation per year; the number of electric buses that the city wishes to incorporate into the fleet; the price of diesel; the electricity distributor; the cost of purchasing a diesel bus; and the cost of equity (i.e., how much the city expects a return on its investments).

Figure 35 – Platform interface with thematic grouping of data entry by the user

Source: EPE (2022) [93].

Particularities: The list of premises adopted in the tool may present variables requiring completion attention. For example, the service life of buses is considered 5 years for diesel models and 10 years for electric (the present value of the technology in 2022 estimates useful life of 15 years). Another example is the price of a liter of diesel, whose reference by states dates from January 2019.
How to access? Excel file for download, or online fill in at: https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/simulador-para-avaliacao-de-viabilidade-de-onibus-eletrico.

https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/simulador-para-avaliacao-de-viabilidade-de-onibus-eletrico

[93] EPE. Guia de Usuário do Simulador para Avaliação de Viabilidade de Ônibus Elétrico. Disponível em: https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/simulador-para-avaliacao-de-viabilidade-de-onibus eletrico. Acesso em: junho de 2022.</td>
<td>https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/simulador-para-avaliacao-de-viabilidade-de-onibus-eletrico

Traduction de Simulador para Avaliação de Viabilidade de Ônibus Elétrico
Simulateur d'évaluation de la faisabilité des autobus électriques

Empresa de Pesquisa Energética met à la disposition du marché et de la société en général un outil d'évaluation technique et économique des autobus urbains électriques.

Les bus électriques pourraient devenir une alternative aux bus diesel conventionnels dans les villes brésiliennes. Grâce à cet outil, nous invitons les utilisateurs à évaluer la faisabilité de l'adoption de ces véhicules dans leurs flottes municipales, voire à identifier les principaux obstacles à l'adoption de cette alternative dans le système de transport public routier.

Les outils d'évaluation des alternatives technologiques ne visent pas seulement à encourager l'adoption de nouvelles technologies. Ils cherchent à identifier les principales variables impliquées dans l'utilisation de chaque alternative et permettent à l'utilisateur de vérifier sa viabilité technique et économique, réduisant ainsi l'asymétrie d'information inhérente au problème.

Video
https://youtu.be/AGyVEi3_SSc

Acesse o simulador (versão Excel)
https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/Documents/Simulador_PT_V1.2.xlsm
Acesse o guia de uso
https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-378/GuiaPratico.pdf</td>
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168	**8. Total Cost of Ownership Estimator** Developed by California's Hybrid and Zero-Emission Bus and Truck Voucher Incentive Project, the tool compares the estimated TCOs of zero- or nearly zero-emission buses and trucks with zero or near zero emissions and fossil fuel-powered vehicles such as gasoline, diesel, and vehicular natural gas. **How does it work?** The tool requires the insertion of data on the vehicles to be compared, such as technical specifications, the purchase value of the vehicle and components, receipt of incentives or deductions, and taxes, among others. **Particularities:** Available in English. The data and results generated are limited to the United States. **How to access?** Online filling in English. [98] HVIP. Total Cost of Ownership Estimator. Disponível em: https://californiahvip.org/. Acesso em: junho de 2022.	Semble ne pas pouvoir être utilisé pour des calculs concernant d'autres pays que les USA
170	9 - . REFERENCES	

Article sur les trolleybus de Sao Paulo

https://www.urban-transport-magazine.com/guenstige-voraussetzungen-elektrifizierung-des-busverkehrs-in-sao-paulo/

Günstige Voraussetzungen: Elektrifizierung des Busverkehrs in São Paulo

Des conditions favorables : Électrification du transport par bus à São Paulo

von Dirk Budach
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Terminal Jabaquarra - Metra (EMTU) Gelenktrolleybus Mercedes-Benz/CAIO/WEG-Eletra Typ "Millenium BRT" Baujahr 2013 | © Budach

Die brasilianische Megapolis São Paulo hat in der Metropolregion mehr als 20 Millionen Einwohner. Ein wesentliches Rückgrat des öffentlichen Verkehrssystems in der Stadt ist das Metrosystem mit seinen fünf Linien, das durch eine Reihe von elektrischen Vorortzügen – manchmal ähnlich dem Metro-Standard – und eine Einschienenbahn ergänzt wird. Es gibt jedoch immer noch Stadtteile und Vororte, die ausschließlich auf Busse angewiesen sind.

Entlang vieler Ausfallstraßen wurde in fast allen Stadtteilen ein ausgedehntes Netz baulich getrennter Busspuren eingerichtet, das BRT (Bus Rapid Transit) in Form einer Mischung aus zwei- und dreiachsigen Solobussen sowie drei- und vierachsigen Gelenkbussen ermöglicht. Letztere sind bis zu 23 Meter lang und bieten eine eindrucksvolle Passagierkapazität an, besonders interessant vor allem auf den stark befahrenen Strecken des Netzes. Die Länge der getrennten Buslinien nach BRT-Standard beträgt insgesamt etwa 127 km und soll deutlich ausgeweitet werden.

La mégapole brésilienne de São Paulo compte plus de 20 millions d'habitants dans sa région métropolitaine. L'une des principales colonnes vertébrales du système de transport public de la ville est le système de métro avec ses cinq lignes, complété par une série de trains électriques de banlieue - parfois similaires au standard du métro - et un monorail. Cependant, il existe encore des quartiers et des banlieues qui dépendent exclusivement des bus.

Le long de nombreuses routes d’accès, un vaste réseau de voies de bus séparées a été mis en place dans presque tous les quartiers de la ville, permettant le BRT (Bus Rapid Transit) sous la forme d'un mélange de bus solo à deux et trois essieux et de bus articulés à trois et quatre essieux. Ces derniers mesurent jusqu'à 23 mètres de long et offrent une capacité de passagers impressionnante, particulièrement intéressante sur les lignes très fréquentées du réseau. La longueur totale des lignes de bus séparées selon le standard BRT est d'environ 127 km et devrait être considérablement augmentée.

BRT-Bustrasse mit Mittelplattform | © Budach

Halt an beiden Seiten der Bussteige im Zuge der aktuellen BRT-Buslinien! | © Budach

BRT-Trasse ohne physische Abgrenzung der Busspuren, mit Seitenbahnsteigen | © Budach

Imposant sind diese 23 Meter langen CAIO Dieselgelenkbusse vom Typ „Millenium BRT" | © Budach

Eletra/CAIO e-bus Prototypen | © Eletra

Mercedes-Benz/Eletra/CAIO e-bus für den BetreiberTranswolff | © Eletra

(zum Vergrößern bitte eines der Bilder anklicken)

Der weltweite Trend zur Elektromobilität wird natürlich auch in São Paulo nicht übersehen, und es werden Programme für eine groß angelegte Einführung von Elektrobussen entwickelt. Eine bescheidene Anzahl von etwa 50 Batterie-Elektrobussen ist bereits im Einsatz, so hat u.a. das Unternehmen Transwolff seit Ende 2022 eine Reihe von Mercedes-Benz/CAIO/Eletra-Wagen in Dienst gestellt.

La tendance mondiale à la mobilité électrique n'est évidemment pas ignorée à São Paulo, et des programmes de déploiement à grande échelle de bus électriques sont en cours d'élaboration. Un nombre modeste d'une cinquantaine d'autobus électriques à batterie est déjà en service. L'entreprise Transwolff, entre autres, a mis en service une série de voitures Mercedes-Benz/CAIO/Eletra depuis fin 2022

Gut vorbereitet

Der Großraum São Paulo ist jedoch in der privilegierten Situation, bereits seit Jahrzehnten über zwei rein elektrische Bussysteme zu verfügen: Beide werden heute mit rund 290 modernen Niederflur-Trolleybusse betrieben. Das städtische System im Besitz von „SP Trans“ unterhält derzeit 10 Linien, während die Regionalverwaltung durch das in ihrer Hand befindliche Unternehmen EMTU Eigentümer der Infrastruktur eines 33 km langen Systems (66 km doppelspurige Fahrleitung) in den südlichen und südöstlichen Vororten der Metropolregion ist, das von dem privaten Unternehmen Metra betrieben wird. Dieses System ist ein geradezu ideales Beispiel dafür, wie BRT und Elektrobetrieb perfekt zusammenpassen, denn die verschiedenen, sich meist überschneidenden Strecken entlang des so genannten ABD-Korridors zwischen Jabaquara, Ferrazópolis und São Mateus sorgen für eine schnelle, reibungslose Fahrt auf den räumlich getrennten Busspuren, und das vollkommen emissionsfrei, stammt der Strom doch ausschließlich aus Wasserkraft. An mehreren Stellen des Netzes gibt es Umsteigepunkte zur Metro, zur Vorortbahn und zur Einschienenbahn, und in São Mateus sogar zum städtischen Obussystem der SP Trans.

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Bien préparé

L'agglomération de São Paulo se trouve toutefois dans la situation privilégiée de disposer depuis des décennies déjà de deux systèmes de bus entièrement électriques : Les deux sont aujourd'hui exploités par environ 290 trolleybus modernes à plancher bas. Le système urbain, propriété de "SP Trans", gère actuellement 10 lignes, tandis que l'administration régionale, par l'intermédiaire de l'entreprise EMTU qu'elle détient, est propriétaire de l'infrastructure d'un système de 33 km (66 km de caténaires à double voie) dans les banlieues sud et sud-est de la région métropolitaine, exploité par l'entreprise privée Metra. Ce système est un exemple idéal de l'adéquation entre le BRT et l'électricité, car les différents trajets, qui se recoupent souvent, le long du corridor dénommé ABD entre Jabaquara, Ferrazópolis et São Mateus, permettent un déplacement rapide et fluide sur les voies de bus séparées, et ce sans aucune émission puisque l'électricité provient exclusivement de l'énergie hydraulique. En plusieurs endroits du réseau, il existe des points de correspondance avec le métro, le train de banlieue et le monorail, et même avec le système de trolleybus urbain de SP Trans à São Mateus.


Trasse und Haltestellendesign im Stil der 1980er Jahre beim EMTU-Netz im Süden | © Budach


Mercedes-Benz/CAIO Trolleybus 7401 von Metra im Terminal Jabaquarra | © Budach


Vollständig abgetrennte Eigentrasse beim ABD-Corridor mit Brasiliens erstem Niederflur-Trolleybus 7301 | © Budach


Aus Dieselbus umgebauter Gelenktrolleybus 8153 (Volvo/Busscar/WEG-Eletra) auf der Eigentrasse des EMTU-Netzes nahe Terminal Sao Mateus | © Budach

Nur am Terminal Sao Mateus treffen beide Trolleybusnetze aufeinander, links EMTU, rechts SP Trans | © Budach

Eine gemischte Flotte von Solo- und Gelenk-Trolleybussen verkehrt auf zehn, sich meist überschneidenden Linien entlang des Korridors, allerdings meist im Mischbetrieb mit Dieselbussen, da die Trolleybusflotte bei weitem nicht ausreicht, um alle Linien abzudecken. Die Busse und Trolleybusse der Metra sind in der Regel stark ausgelastet und oft überfüllt – wie die meisten anderen öffentlichen Verkehrsmittel in der Region auch.

Une flotte mixte de trolleybus solo et articulés circule sur dix lignes, qui se recoupent généralement, le long du corridor, mais la plupart du temps en exploitation mixte avec des bus diesel, car la flotte de trolleybus est loin d'être suffisante pour couvrir toutes les lignes. Les bus et trolleybus de Metra sont généralement très chargés et souvent bondés - comme la plupart des autres moyens de transport public de la région.

Intensivere Nutzung des Trolleybussystems zur Beschleunigung der Elektrifizierung
Das SP Trans-System war einst viel größer als heute, doch aufgrund einer kurzsichtigen politischen Entscheidung vor etwa 20 Jahren schrumpfte das Netz auf die Hälfte seiner früheren Größe. 198 Niederflur-Obusse, zwei- und dreiachsig, die zwischen 2008 und 2014 gebaut wurden, bedienen 10 Linien auf einem Fahrleitungsnetz von 201 km Länge. Das Stromversorgungssystem und die Oberleitung wurden in den letzten 10 Jahren fast vollständig erneuert. Seit der Unterzeichnung des neuen Vertrags ist für Ende 2020 eine zusätzliche Linie unter Nutzung der bestehenden Oberleitungen geplant (zwischen Terminal Penha und dem Stadtzentrum), was bislang jedoch noch nicht umgesetzt wurde.

Utilisation plus intensive du système de trolleybus pour accélérer l'électrification
Le système SP Trans était autrefois beaucoup plus grand qu'aujourd'hui, mais en raison d'une décision politique à courte vue prise il y a une vingtaine d'années, le réseau s'est réduit de moitié par rapport à sa taille précédente. 198 bus à plancher bas, à deux et trois essieux, construits entre 2008 et 2014, desservent 10 lignes sur un réseau de caténaires de 201 km. Le système d'alimentation électrique et la caténaire ont été presque entièrement rénovés au cours des dix dernières années. Depuis la signature du nouveau contrat, une ligne supplémentaire utilisant les caténaires existantes est prévue pour fin 2020 (entre le terminal de Penha et le centre-ville), mais cela n'a pas encore été réalisé.

Mercedes-Benz/CAIO-Trolleybus 1914 der SP Trans im Zentrum | © Budach

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Trolleybus im Stau im Znetrum – mehr BRT-Eigentrassen könnten Abhilfe schaffen | © Budach

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SP Trans hat 100 dieser Dreiachser Scania/CAIO/WEG-Eletra Trolleybusse | © Budach

Sowohl das SP Trans-System als auch das ABD-Netz bieten der Stadt São Paulo die Möglichkeit, das bestehende Oberleitungsnetz zu nutzen und die Nutzungsmöglichkeiten durch moderne Batterie-Obusse zu erweitern. Auf diese Weise kann die Auslastung des Fahrleitungsnetzes wesentlich intensiviert werden und mehr Linien, die sich einen Teil ihrer Strecke mit den Trolleybuslinien teilen, können problemlos im vollelektrischen Modus betrieben werden: In-Motion-Charging ist hier also klar die Betriebsform der Wahl.

Die Stadtverwaltung hat kürzlich die Anschaffung von 1.100 batterieelektrischen Bussen in diesem Jahr und von weiteren 1.200 im nächsten Jahr angekündigt. Im gesamten Großraum São Paulo sind derzeit mehr als 20.000 Busse im öffentlichen Liniendienst unterwegs. Es scheint, dass man sich in São Paulo derzeit auf die Anschaffung von reinen Batteriebussen anstelle von In-Motion-Trolleybussen konzentriert, obwohl den Verantwortlichen der SPTrans mehrere technische Studien von verschiedenen Experten vorgelegt wurden.

Die Ambiental Company, der Trolleybusbetreiber in São Paulo, hat im Juni 2023 etwa 40 Batteriebusse von ELETRA erworben, um eine Reihe von Dieselbussen zu ersetzen, die neben den Trolleybussen verkehren. Die eigentliche Trolleybusflotte sollte von 2024 bis 2028 ersetzt werden, aber es gibt einen Zeitraum von drei zusätzlichen Jahren. Experten erstellen Studien und Hintergrundinformationen, um SPTrans und den Betreiber davon zu überzeugen, In-Motion-Charging-Trolleybusse anstelle von Batteriebussen zu kaufen.

Der brasilianische Hersteller ELETRA produziert derzeit den ersten In-Motion-Oberleitungsbus-Prototyp, der ab Juli 2023 auf dem neuen METRA-BRT-Korridor eingesetzt werden soll. Es handelt sich um einen 21 Meter langen Gelenktrolleybus – Tests auf beiden Systemen in São Paulo sollen die Effizienz dieser Betriebsart demonstrieren.

Für das EMTU-Metra-System ist die Anschaffung von etwa 80 In-Motion-Trolleybussen geplant, die vor Ort von ELETRA hergestellt werden, um einen neuen 11 km langen BRT-Korridor von São Bernardo do Campo zum südlichen Sacomã-Terminus in São Paulo bedienen zu können. Die Fahrleitung wird dabei nur in einer Fahrtrichtung errichtet, in Richtung São Bernardo do Campo – für die Rückfahrt ist die Nutzung der Traktionsbatterien vorgesehen.

Darüber hinaus werden weitere neue Oberleitungsbusse als Ersatz für die bisherige, zwischen 2001 und 2013 gebauten Wagen für den Betreiber Metra erwartet, wahrscheinlich ab Ende 2024.

Tant le système SP Trans que le réseau ABD offrent à la ville de São Paulo la possibilité d'utiliser le réseau de trolleybus existant et d'étendre les possibilités d'utilisation par des Trolleybus IMC à batterie modernes. De cette manière, l'utilisation du réseau de caténaires peut être considérablement intensifiée et davantage de lignes, qui partagent une partie de leur trajet avec les lignes de trolleybus, peuvent facilement être exploitées en mode entièrement électrique : Le trolleybus IMC à Charge en Mouvement est donc ici clairement le mode d'exploitation de choix.

La municipalité a récemment annoncé l'achat de 1.100 bus électriques à batterie cette année et de 1.200 autres l'année prochaine. Dans l'ensemble de l'agglomération de São Paulo, plus de 20.000 bus sont actuellement en service public régulier. Il semble que l'on se concentre actuellement à São Paulo sur l'acquisition de bus uniquement équipés de batteries plutôt que de trolleybus IMC, bien que plusieurs études techniques aient été présentées aux responsables de la SPTrans par différents experts.

Ambiental Company, l'opérateur de trolleybus de São Paulo, a acheté en juin 2023 une quarantaine de bus à batteries d'ELETRA pour remplacer une série de bus diesel qui circulent à côté des trolleybus. La flotte de trolleybus proprement dite devait être remplacée de 2024 à 2028, mais il y a une période de trois ans supplémentaires. Des experts préparent des études et des informations de base pour convaincre SPTrans et l'opérateur d'acheter des trolleybus IMC à chargement en mouvement plutôt que des bus à batterie.

Le fabricant brésilien ELETRA produit actuellement le premier prototype de trolleybus IMC qui sera mis en service sur le nouveau corridor METRA-BRT à partir de juillet 2023. Il s'agit d'un trolleybus articulé de 21 mètres de long - des tests sur les deux systèmes à São Paulo doivent démontrer l'efficacité de ce mode d'exploitation.

Pour le système EMTU-Metra, il est prévu d'acquérir environ 80 trolleybus In-Motion, qui seront fabriqués sur place par ELETRA, afin de pouvoir desservir un nouveau corridor BRT de 11 km de long entre São Bernardo do Campo et le terminus sud de Sacomã à São Paulo. La caténaire ne sera installée que dans un sens, en direction de São Bernardo do Campo - pour le retour, il est prévu d'utiliser les batteries de traction.

En outre, d'autres nouveaux trolleybus sont attendus pour remplacer les voitures actuelles construites entre 2001 et 2013 pour l'opérateur Metra, probablement à partir de fin 2024.

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Fazit

Die Elektrifizierung des Busnetzes von São Paulo wird noch einige Jahre in Anspruch nehmen – ein Zeitraum von 15 Jahren erscheint realistisch. Batteriebusse werden in diesem Prozess, der nicht nur die Anschaffung neuer Fahrzeuge, sondern natürlich auch die Anpassung der Infrastruktur erfordert, sicherlich eine wichtige Rolle spielen. Es liegt jedoch auf der Hand, dass die Nutzung des bestehenden Trolleybusnetzes und dessen Aufrüstung mit modernsten Batterie-Trolleybussen für In-Motion-Charging viele zusätzliche Vorteile mit sich bringt und nur dazu beitragen kann, den Elektrifizierungsprozess zu beschleunigen – im Interesse einer nachhaltigeren, umweltfreundlicheren Abwicklung des Verkehrs in diesem dicht besiedelten Raum.

Vielen Dank für zahlreiche Ergänzungen zum Text von Jorge F. Moraes.

Conclusion

L'électrification du réseau de bus de São Paulo prendra encore quelques années - une période de 15 ans semble réaliste. Les bus à batterie joueront certainement un rôle important dans ce processus, qui nécessite non seulement l'achat de nouveaux véhicules, mais aussi, bien sûr, l'adaptation de l'infrastructure. Il est toutefois évident que l'utilisation du réseau de trolleybus existant et sa mise à niveau avec des trolleybus à batterie ultramodernes pour la chargement en mouvement présentent de nombreux avantages supplémentaires et ne peuvent que contribuer à accélérer le processus d'électrification - dans l'intérêt d'une gestion plus durable et plus écologique des transports dans cette zone densément peuplée.

Merci pour les nombreux compléments apportés au texte par Jorge F. Moraes.

Bislang einziger umlackierter Trolleybus der städtischen SP Trans ist Wagen 1594 | © Budach

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FIN

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