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ON ELECTRIC MOBILITY

China E-Bus Operations and Batteries Case Studies

Case Studies and Lessons for Southeast Asia







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China E-Bus Operations and Batteries: Case Studies and Lessons for Southeast Asia

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For further information on this report please address your enquiries to:

Weimin Ren
Director, Transport Division
Economic and Social Commission for Asia and the Pacific (ESCAP)
Email: escap-td@un.org

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Executive Summary

Southeast Asian cities are adding urban transport capacity faster than at any point in their history, and most of that capacity still runs on diesel. Shifting public bus fleets to electric power is one of the few measures that reduces transport emissions and urban air pollution at the same time. Progress has been held back by four practical constraints: the upfront cost of the vehicles, charging infrastructure planned only after the buses arrive, battery performance and warranty risk in tropical operating conditions, and unclear allocation of responsibility between governments, operators and suppliers.

China operates more than 90 per cent of the world's electric buses and has worked through each of these constraints over the past fifteen years. This report, prepared by China EV100 under the ESCAP Southeast Asia Electric Vehicle Accelerator Programme, examines the operations, policies and battery lifecycle strategies of China's electric bus sector and assesses what can be applied in Southeast Asian cities.

Bus electrification in China advanced through target setting and purchase subsidies at the national level, and cost sharing, depot land and operational support at the provincial and city levels. By the end of 2024, 74 per cent of China’s fleet was electric. The market has since moved past its expansion phase. Annual new energy bus sales held steady at 30,000 to 40,000 units between 2021 and 2024, and demand now comes from replacing vehicles aged eight years or older and replacing batteries in the first generation of electric fleets. Policy has followed, shifting from purchase subsidies toward operating support, depot charging and battery replacement.

Electrification on its own did not protect ridership. The share of urban passenger trips carried by buses fell from 50.7 per cent in 2020 to 36.2 per cent in 2024 as rail transit and ride-hailing expanded. Cities that held their ridership did so through bus lanes, signal priority, demand-responsive services and real-time passenger information.

Batteries account for 30 to 40 per cent of the purchase cost of an electric bus, and the most transferable part of China's experience is how that cost and the risk attached to it were shared. Shenzhen separated battery ownership from vehicle ownership: a leasing company bought the vehicle without its battery, a battery asset operator bought and maintained the

battery, and the bus company paid over an eight-year operating term. Chengdu and Jinan used municipal leasing platforms to the same end.

Southeast Asia would benefit from these five priorities: use tax instruments rather than large purchase subsidies; plan depot charging and grid connection before procuring vehicles; procure service packages rather than buses, covering the vehicle, battery, charger, maintenance, warranty, spare parts and end-of-life arrangements; hold battery assets separately from operations, through leasing companies, state-owned energy firms or development finance institutions; and write battery data and recycling obligations into the first tender rather than the last.

These measures require coordination across transport, finance, energy and planning agencies, which is why Chinese cities placed electrification under senior cross-departmental committees. The value of China's experience is not a ready-made template. It is the case for treating public transport electrification as an energy and asset management task rather than a vehicle purchase programme.

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Abbreviations

ASEAN	Association of Southeast Asian Nations
BEV	battery electric vehicle
BMS	battery management system
BOI	Board of Investment (Thailand)
BRT	bus rapid transit
CATL	Contemporary Amperex Technology Co., Limited
CNG	compressed natural gas
ERIA	Economic Research Institute for ASEAN and East Asia
EV	electric vehicle
LFP	lithium iron phosphate
MEE	Ministry of Ecology and Environment (China)
MIIT	Ministry of Industry and Information Technology (China)
MOF	Ministry of Finance (China)
MOT	Ministry of Transport (China)
NCM	nickel-cobalt-manganese
NDRC	National Development and Reform Commission (China)
NEA	National Energy Administration (China)
NEV	new energy vehicle
OEM	original equipment manufacturer
RMB	renminbi (Chinese yuan)
SOC	state of charge
SOH	state of health
THB	Thai baht
VAT	value added tax

1. Introduction

1.1 Background and Context

Rapid urbanization and economic growth across Southeast Asia have led to an unprecedented demand for urban transport. This expansion relies heavily on fossil fuels, accelerating greenhouse gas emissions, and worsening public health through severe urban air pollution. To meet Paris Agreement climate commitments and regional net-zero targets, countries must urgently transition public transit systems away from internal combustion engines.

However, the widespread deployment of electric buses (e-buses) in Southeast Asia faces significant systemic bottlenecks. Fleet operators and municipal planners grapple with high upfront capital expenditures, uncoordinated charging grid integration, tropical climate impacts on battery degradation, and a lack of clear regulatory frameworks. To overcome these hurdles, the region requires a proven blueprint for ecosystem development.

1.2 Relevance of the Chinese Experience

The People's Republic of China stands as the global pioneer in electromobility, operating over 90% of the world's electric buses. China's success was driven by a highly coordinated, multi-tiered ecosystem. This report examines how the Chinese electric vehicle (EV) market was structured through synchronized planning across three distinct levels of governance:

- **National Level:** Macro Targets, industrial policies, national subsidies, and standardized technical codes.
- **Provincial Level**: Localized supply chain integration, regional economic mandates, and grid capacity planning.
- **City Level:** Tailored operational subsidies, municipal low-emission zones, public-private risk-sharing mechanisms, and localized transit authority mandates

By analysing the institutional frameworks and collaboration mechanisms among governments, state grid utilities, private battery manufacturers, and municipal transit operators, this report translates China's experience to help accelerate Southeast Asia's electric public transport transition.

1.3 Objective and Scope

This report was prepared by China EV100 as a key deliverable under the ESCAP Southeast Asia Electric Vehicle Accelerator Programme. The initiative directly supports the acceleration of sustainable, electric public transport systems across Southeast Asia. By synthesizing operational data and governance insights from mature markets, China EV100 aims to provide regional stakeholders with the technical expertise and policy tools necessary to de-risk and scale e-bus deployments in Southeast Asia.

The primary objective of this report is to evaluate the operations, policies, and battery lifecycle strategies of China's e-bus sector to determine their direct applicability in Southeast Asian cities.

To provide a comprehensive roadmap for policymakers, development banks, and transit operators, the case studies within this report are evaluated across six core dimensions:

1. Policy and regulatory landscape
2. EV market review and private sector engagement
3. Energy and environment dimensions
4. Transport sector trends
5. Stakeholder mapping
6. Applicability in the Southeast Asia region

2. E-Bus Operations in China: Policy and Regulatory Landscape

2.1 National Level: From Pilot Demonstration to Full Electrification of Urban Public Transport

China's urban public transport electrification has moved from pilot demonstrations to comprehensive implementation. The policy focus has shifted from early-stage technology validation to medium- and long-term scale-ups. Key policies include:

- **2009**, the "Ten Cities, Thousand Vehicles" program made buses a priority application for new energy vehicles[1], setting the policy tone for public transport electrification.
- **2015**, the Ministry of Transport set a target of reaching **200,000** new energy buses by **2020**[2].
- **2018**, the State Council's Three-Year Action Plan for Winning the Blue-Sky Defence Campaign further required municipalities, provincial capitals, and other key regions to basically complete the new-energy transition of their bus fleets by the end of **2020**[3].

The New Energy Vehicle Industry Development Plan (2021-2035) then required that new energy vehicles account for no less than 80% of newly added or replaced buses in national ecological civilization pilot zones and key air-pollution-control areas[4].

Through successive target-setting, the central government has elevated bus electrification from an industrial promotion policy to a strategic pathway for ecological governance and urban public services.

The evolution of China's electric bus subsidy policy reflects the industry's transition from introduction to maturity. During the large-scale promotion period from 2015 to 2017, the national subsidy for pure electric buses longer than 10 meters was as high as RMB 500,000

[1] The term "New Energy Vehicles" (NEVs) is the official classification used in China to encompass Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PHEVs), and Fuel Cell Electric Vehicles (FCEVs). Traditional hybrid vehicles that cannot be plugged into the electrical grid are excluded from this definition.

[2] https://www.gov.cn/gongbao/content/2015/content_2883248.htm

[3] https://www.gov.cn/zhengce/content/2018-07/03/content_5303158.htm

[4] https://www.gov.cn/zhengce/content/2020-11/02/content_5556716.htm

(about US$76,000) per vehicle[5], and local governments such as Shenzhen provided matching subsidies of the same scale, bringing total subsidies to as much as RMB 1 million (about US$152,000) per bus.[6] Subsidies were paid directly to vehicle manufacturers, significantly reducing procurement costs for bus operators and accelerating new energy bus penetration. In Shenzhen, for example, an electric bus cost about RMB 1.8 million (about US$274,000) before 2016; after national and local subsidies, the actual purchase price fell sharply, enabling Shenzhen to become the world's first major city to achieve full bus electrification in 2017.

As technology matured and economies of scale emerged, subsidies gradually stepped down. In July 2024, the Ministry of Transport and the Ministry of Finance issued rules providing an average subsidy of RMB 80,000 (about US$11,000) for each replacement new-energy city bus and RMB 42,000 (about US$5,800) for each power-battery replacement, with support focused on urban buses aged eight years or older. In February 2025, three ministries further clarified that ultra-long-term special treasury bonds would fund the 2025 subsidy program, marking a shift to a new generation of policy instruments.

Policy has also evolved into an ecosystem-based support framework. In February 2025, the Ministry of Industry and Information Technology, the Ministry of Transport, and six other departments launched the second batch of pilot zones for the comprehensive electrification of public-sector vehicles[7]. The program supports ten cities and areas, including Tianjin, Changzhou, Wuxi, Yibin, Linyi, Huainan, Xi'an, Xianyang, Weinan, and Xiong'an New Area, in demonstrating vehicle-grid interaction, solar-storage-charging-swapping integration, intelligent connected vehicles, and other new technologies and models. The implementation period runs from 2024 to 2026, during which more than 250,000 new energy vehicles are expected to be promoted, more than 240,000 charging points built, and 365 battery swap stations installed.

Compared with the first batch of 15 pilot cities launched in November 2023, the second batch extends further into second- and third-tier cities and is linked with county-level charging-infrastructure gap filling, vehicle-road-cloud integration pilots, and vehicle trade-in policies. At the same time, ultra-long-term special treasury bonds are being used to

[5] Unless otherwise stated, United States dollar equivalents are indicative and are converted at annual average exchange rates published by the United States Federal Reserve (G.5A): RMB 6.56 per US$ for the 2015-2017 subsidy period; RMB 7.20 per US$ for 2024; RMB 7.19 per US$ for 2025; and THB 32.86 per US$ for 2025. Figures are rounded.

[6] Shenzhen Municipal Development and Reform Commission. http://fgw.sz.gov.cn/gkmlpt/content/5/5737/post_5737962.html

[7] https://www.gov.cn/lianbo/bumen/202502/content_7006403.htm

subsidize power-battery replacement for buses aged eight years or older and to support new energy bus replacement.[8] This shows that urban bus electrification has entered a post-scale-up stage: the policy question is no longer whether buses should be electrified, but how the bus-energy-city ecosystem can operate in a coordinated manner.

In practice, responsibilities are divided across multiple departments:

- Transport departments oversee route operations and service quality;
- Finance departments arrange and disburse subsidies; development and reform commissions coordinate charging-infrastructure policies and energy issues;
- Industry and information technology departments manage new energy vehicle catalogues; natural resources departments secure depot land;
- Ecology and environment departments are responsible for carbon-emission accounting and supervision.

2.2 Local Level: Fiscal Support, Operational Implementation, and Differentiated Management

Local fiscal support follows a three-tier cost-sharing system of central leadership, provincial coordination, and differentiated municipal and county implementation. Under the 2025 implementation rules for subsidies for new energy city bus and power-battery replacement, the central and local governments share subsidy funding at an overall ratio of 90:10, with regional adjustments: 85:15 for eastern provinces, 90:10 for central provinces, and 95:5 for western provinces[9]. Sub-provincial cost-sharing arrangements are determined by provincial finance departments according to the allocation of central funds. Local governments then adjust support based on their fiscal capacity, passenger-flow structure, and electrification timetable. Examples of this include:

- **Shanghai** allocated RMB 60 million (about US$8.3 million) in ultra-long-term special treasury bond funds in 2025 to support the replacement of 883 new energy city buses[10];

[8] Ministry of Transport. https://xxgk.mot.gov.cn/2020/jigou/ysfws/202503/t20250319_4165744.html

[9] https://xxgk.mot.gov.cn/2020/jigou/ysfws/202503/t20250319_4165744.html

[10] "Implementation Plan for Shanghai's 2025 Policy on Subsidies for the Replacement of National New Energy City Buses and Power Batteries"

- **Fujian** set subsidies at RMB 90,000 (about US$12,500) for vehicles under 7 meters and RMB 100,000 (about US$13,900) for vehicles of 7 meters and above, plus an additional RMB 10,000 (about US$1,400) for low-floor and low-entry vehicles to meet age-friendly mobility needs[11];
- **Inner Mongolia** increased the replacement subsidy to RMB 110,000 (about US$15,300) per vehicle, with an additional RMB 10,000 (about US$1,400) for low-floor and low-entry models[12];
- **Jiangsu** raised the replacement subsidy directly to RMB 120,000 (about US$16,700) per vehicle[13].

City governments are the last-mile responsible entities for bus electrification and must implement a full chain of operational tasks, including fleet renewal, depot construction, route optimization, and charging infrastructure. The Several Opinions on Promoting the Healthy and Sustainable Development of Urban Public Transport, issued by the Ministry of Transport and eight other departments, clarify that urban public transport is a municipal- and county-level fiscal responsibility[14]. Local governments should establish local cost-accounting and subsidy-compensation mechanisms and disburse funds in a timely manner. They are also encouraged to use local government for special bonds and other instruments to support charging facilities at bus operators owned or leased depots and to ensure power-access conditions.

Beijing, for example, has issued a plan supporting municipal state-owned enterprise in building supercharging stations at bus depots and providing eligible projects with construction and operation incentives as well as municipal fixed-asset investment subsidies[15]. At the urban level, the core challenge has shifted from buying buses to using buses well; policy priorities have moved from purchase subsidies to operational support and infrastructure coordination, requiring cities to integrate land, power, fiscal resources, and route planning.

[11] "Detailed Implementation Rules for Subsidies for the Replacement of New Energy City Buses and Power Batteries in Fujian Province by 2025" (Min Cai Jian [2025] No.4)

[12] "Detailed Implementation Rules for the 2025 Subsidy Program for Upgrading New Energy City Buses and Power Batteries in the Inner Mongolia Autonomous Region" (Neijiao Yunshu Fa [2025] No.23)

[13] "2025 Jiangsu Province Subsidy Application Guide for the Replacement of New Energy City Buses and Power Batteries"

[14] https://www.mot.gov.cn/jiaotongyaowen/202310/t20231011_3925502.html

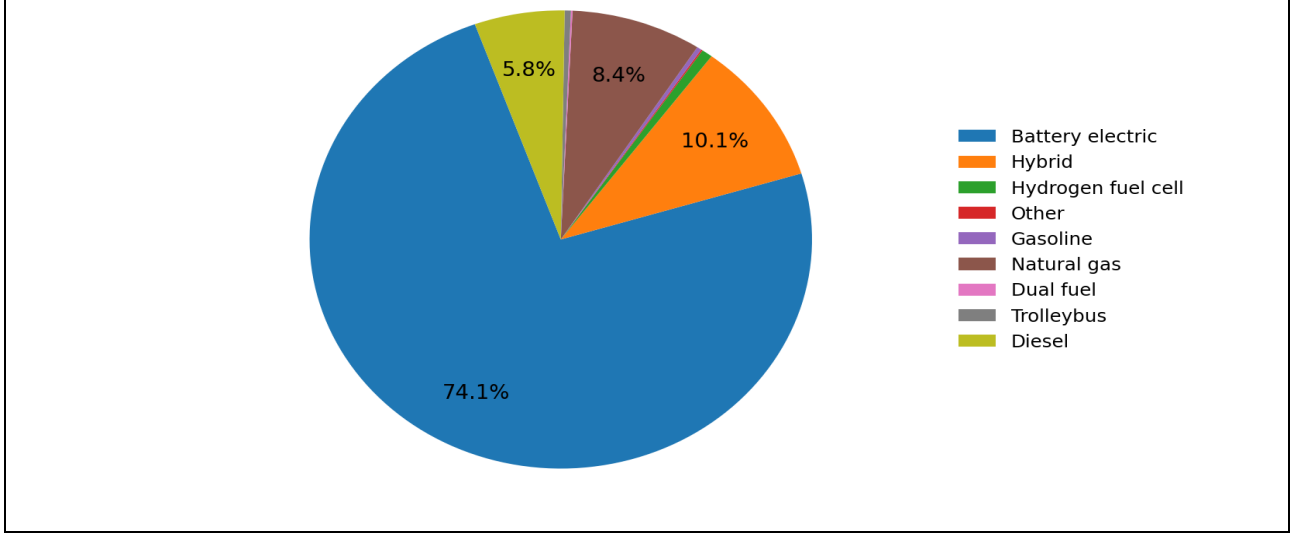
[15] Beijing Municipal Development and Reform Commission, Beijing Municipal Urban Management Commission. "Implementation Plan for Accelerating the Construction of Supercharging Stations for New Energy Vehicles in This City"

3. Electric Bus Market Analysis

3.1 Current Status of China's Electric Bus Market

Urban public transport was the first public-sector use case in China to achieve large-scale electrification. With policy support, China's public bus and trolleybus[16] fleet reached 658,100 vehicles by the end of 2024[17]. Of these, 487,500 were battery-electric buses, an increase of 13,600 vehicles, accounting for 74.1% of the total public bus and trolleybus fleet, up 4.7 percentage points year on year. Figure 1 shows the composition of the fleet by fuel type at the end of 2024.

Figure 1 Composition of China's public bus and trolleybus fleet by fuel type, end-2024



Source: Ministry of Transport of China.

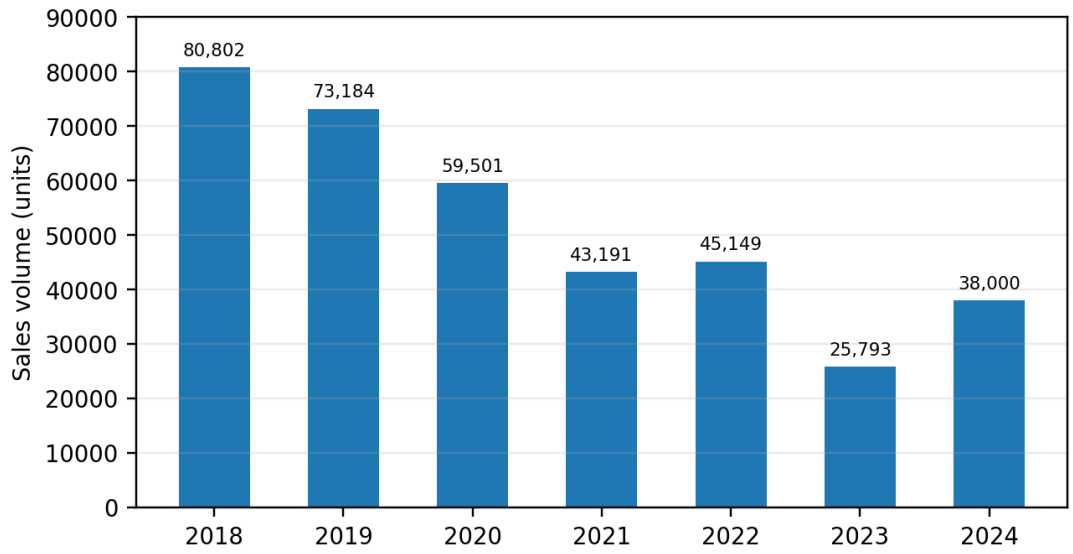
From a market-stage perspective, bus electrification no longer depends primarily on large-scale new purchases. Demand is shifting toward three categories: 1) replacement of vehicles aged eight years or older; 2) replacement of power batteries in early new energy buses; and 3) fleet upgrades toward smaller, low-entry, age-friendly, and intelligent vehicles in response to changing passenger flows. The first wave of large-scale deployment has largely completed new-build and replacement tasks in major cities, while many existing

[16] Under the statistical scope defined in the Statistical Bulletin on the Development of the Transport Industry by the Ministry of Transport, "bus and trolleybus" refers to vehicles owned by entities that have obtained a passenger transport operating license and are used for urban public passenger transport operations. This category includes regular buses, Bus Rapid Transit (BRT), double-decker buses, articulated buses, and trolleybuses (electric bus that draws power from two overhead wires).

[17] https://xxgk.mot.gov.cn/jigou/zhghs/202506/t20250610_4170228.html

vehicles have not yet entered the concentrated five- to eight-year renewal cycle. From 2021 to 2024, national new energy bus sales remained broadly stable at 30,000 to 40,000 units per year, indicating a transition from rapid expansion to regular operations. Figure 2 shows annual new energy bus sales from 2018 to 2024.

Figure 2 Annual sales volume of new energy buses, 2018-2024



Source: Commercial vehicle insurance registration data.

3.2 E-Bus Manufacturers

In terms of manufacturer market share, China's new energy bus market remains led by established bus OEMs and companies with proven experience in local public transport projects. Based on the publicly available sales structure for new energy buses above 6 meters[18], Yutong Bus is in the leading tier, with an annual market share of around 25%. CRRC Electric, BYD, Xiamen King Long, Xiamen Golden Dragon, Suzhou Higer, Zhongtong Bus and Geely Farizon each account for approximately 6% to 9% of the market, making them the main participants in China's new energy bus sector.

3.3 Procurement

Local governments and public transport operators generally do not directly designate a specific brand. Instead, procurement is conducted through open tendering or state-owned

[18] China Bus Statistical Information Network, www.chinabuses.com

enterprise procurement procedures. Eligible bidding models must be listed in the Ministry of Industry and Information Technology's Catalogue of Road Motor Vehicle Manufacturers and Products and the State Taxation Administration's Catalogue of New Energy Vehicle Models Exempted from Vehicle Purchase Tax. Winning suppliers are then selected based on a combination of operational and commercial criteria, including vehicle length, low-floor or low-entry configuration, driving range, charging compatibility, total cost of ownership, delivery capability, after-sales service capacity and overall suitability for public transport operations.

3.4 Bus Operators

The public-service nature of China's urban bus system determines that the main operating entities are public transport groups, urban investment or transport investment platforms, or their controlled companies within the state-owned capital system. The State Council's Guiding Opinions on Prioritizing the Development of Urban Public Transport define urban public transport as a public welfare undertaking and require fiscal compensation for policy-related losses arising from low fares, discounted fares, and government-assigned tasks.

The Urban Public Transport Regulations, effective from December 1, 2024, define urban public transport as a basic service that meets the public's essential travel needs and confirm the national strategy of prioritizing public transport through planning, land, fiscal, and financial measures[19]. The Several Opinions on Promoting the Healthy and Sustainable Development of Urban Public Transport further classify urban public transport as a municipal- and county-level fiscal responsibility and require local governments to define the scope of operating subsidies and incorporate them into local budgets.

Unlike private-sector-led commercial bus operating models, urban bus transit in China is a government-led public service subject to public welfare obligations. Bus fares are generally below full cost, and operators also undertake senior and student concessions, low-demand routes, and major-event transport tasks. Operating cash flow therefore depends on fiscal subsidies. The government controls routes, fares, and subsidies; state-owned enterprises run daily operations; and private enterprises participate mainly in vehicle manufacturing, battery leasing, charging infrastructure, and digital dispatching.

[19] https://www.gov.cn/zhengce/zhengceku/202410/content_6982322.htm

Public transport operators are the core nodes of the electric bus ecosystem and the bridge between policy objectives and actual services. In terms of ownership, China's urban bus operators mainly take two forms: 1) municipally owned or controlled bus groups, such as Shenzhen Bus Group and Beijing Public Transport Group; and 2) companies involving social capital under franchise arrangements.

Under the Ministry of Transport's provisions on urban bus and trolleybus passenger transport, operators must obtain route rights through franchising or licensing and sign route-franchise agreements with the urban public transport authority. The core responsibilities of operators cover six areas:

- **Vehicle procurement and management**, including selecting appropriate new energy models for route needs, completing vehicle registration and operating procedures, and establishing technical records.
- **Route operation**, including driver recruitment and training, scheduling, punctuality control, and energy-consumption management.
- **Charging coordination**, including working with charging service providers to schedule charging and ensure a range of sufficiency.
- **Maintenance**, including a dedicated maintenance system for new energy buses and especially monitoring and maintenance of the battery management system (BMS).
- **Safety and emergency management**, including driver safety training, vehicle inspections, and contingency plans.
- **Data reporting and passenger information services**, including regulatory data submission and real-time arrival and transfer information for passengers.

4. Energy and Environmental Dimensions

Under China's current power mix, pure electric buses already deliver clear life-cycle carbon-reduction and environmental benefits. They produce no tailpipe emissions in operation and can significantly reduce nitrogen oxides, particulate matter, and noise along urban roads.

Although coal still accounts for more than half of China's power generation, life-cycle assessments show that, compared with diesel buses, pure electric buses reduce life-cycle greenhouse gas emissions by 46%, VOC emissions by 69%, and NOx emissions by 93%[20]. The carbon-reduction potential of electric buses depends heavily on upstream grid decarbonization; as the power system continues to shift toward green and low-carbon electricity, the life-cycle environmental benefits of new energy buses will continue to expand.

Several Chinese cities have achieved meaningful carbon-reduction results through new energy bus deployment:

- In 2024, Beijing Public Transport Group supplied green electricity to all electric buses in the city, consuming about 330 million kWh of green power and reducing CO2 emissions by about 200,000 tons[21].
- After Shenzhen achieved 100% pure-electric bus operation in 2017, the city reduced CO2 emissions by an average of 1.353 million tons per year[22].
- In Luzhou, Sichuan, 817 new energy buses achieved full coverage of clean-energy operation, reducing carbon emissions by about 33,000 tons annually[23]. These cases show that both large metropolitan areas and smaller cities can obtain significant life-cycle carbon reduction and air-quality benefits from bus electrification.

[20] China Society of Automotive Engineers "2019 Evaluation Report on Greenhouse Gas and Atmospheric Pollutant Emissions During the Automotive Life Cycle"
[21] Official website of the Beijing Municipal Development and Reform Commission
[22] Official Website of the Shenzhen Municipal People's Government
[23] Official website of Luzhou Municipal Transportation Bureau

5. Trends in the China Electric Public Transport Sector

China's urban passenger-transport structure is being reshaped. The diversification and personalization of urban mobility are reducing the relative role of conventional buses. According to the Ministry of Transport's annual statistical bulletins, total urban passenger volume[24] across multiple modes reached 106.797 billion passenger trips in 2024, a record high and a year-on-year increase of 5.7%. Public bus and trolleybus ridership reached 38.670 billion trips, up only 1.6%, much slower than urban rail transit (+9.6%) and taxis (+7.1%). The substitution effect from rail transit and taxis has continued to intensify: the share of public buses and trolleybuses in total urban passenger trips fell from 50.7% in 2020 to 36.2% in 2024, down 14.5 percentage points over the four years. Key contributing factors of the sharp include the displacement of bus ridership by urban rail transit, modal shift toward individualized mobility options (ride-hailing services, private vehicles, and e-bikes), and divergent post-pandemic recovery patterns across transport modes. Traditional public bus and trolleybus services are therefore in passive contraction within a more diversified mobility system, and future bus electrification efforts must shift simultaneously toward route restructuring, service-quality improvement, and public-transport priority measures. Table 1 sets out the underlying ridership trends.

[24] Coverage extends to public buses and trolleybuses, urban rail transit (subways, light rails, trams), taxis and ride-hailing services, and urban passenger ferries.

Table 1 Urban Passenger Trips and Public bus/trolleybus ridership in China, 2020-2024

Year	Total urban passenger trips (100 million)	YoY growth	Public bus/trolleybus trips (100 million)	Public bus/trolleybus share
2020	871.92	-31.8%	442.36	50.7%
2021	993.84	14.0%	489.16	49.2%
2022	755.11	-24.0%	353.37	46.8%
2023	1,010.00	27.7%	380.50	37.7%
2024	1,067.97	5.7%	386.70	36.2%

Source: Ministry of Transport of China.

Simply replacing buses with new energy vehicles cannot reverse declining bus attractiveness. The paradigm must shift from vehicle priority to road priority and data priority. **For electric buses, without continuous bus lanes, signal priority, and real-time passenger information, zero-emission buses alone cannot retain passengers in competition with other modes.** The Several Opinions on Promoting the Healthy and Sustainable Development of Urban Public Transport emphasize the construction of dedicated bus lanes, promotion of bus signal priority, and improvement of intelligent public transport services. Some recent initiatives include:

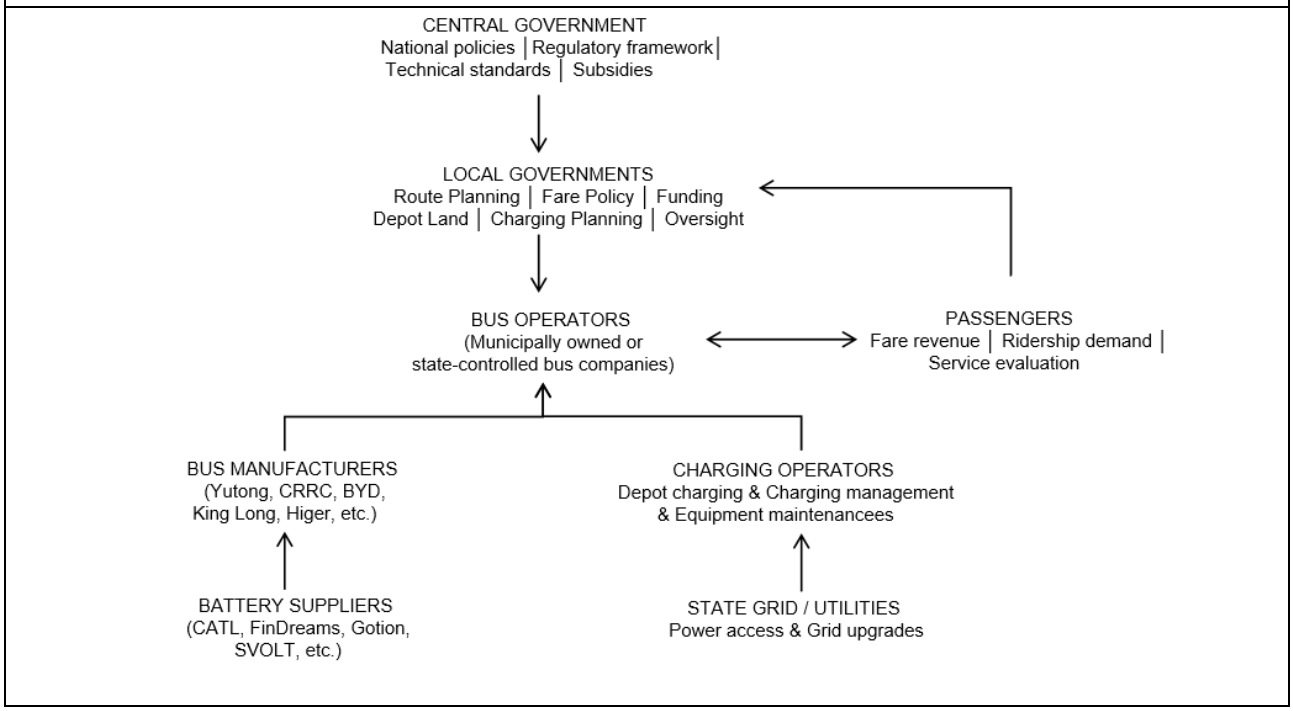
- Guangzhou Bus Group has used mobility big data and automated dispatching to integrate passenger, vehicle, route, and depot data into an online road-passenger-transport management system, enabling intelligent scheduling, operating monitoring, and cost control, with annual cost savings of more than RMB 7.8 million (about US$1.08 million). In low-density areas such as night-time, off-peak periods, and new communities, Guangzhou has introduced demand-responsive buses.
- By early May 2026, Huangpu Knowledge City had served more than 175,000 passengers, with the response rate rising to 68%, the matching rate remaining above 95%, and average waiting time of only seven minutes.
- In Nansha’s Wanqingsha area, resource integration improved operating efficiency by about 10% to 15% compared with conventional bus services;

- In Baiyun’s Zhongluotan area, links to Metro Line 14 achieved an order-completion rate of 93%. Digital dispatching, customized bus services, and demand-responsive transport will therefore be key tools for improving operating efficiency.

6. E-Bus Stakeholder Mapping

China's new energy bus ecosystem is not a simple buyer–supplier relationship. It is a public-service delivery system in which government authorities define service obligations and provide fiscal support, bus operators translate policy objectives into daily operations, industrial suppliers provide vehicles, batteries and charging solutions, and passengers provide both fare revenue and service-quality feedback. The central feature of this system is that farebox revenue alone is generally insufficient to cover the full cost of bus operations. As a result, the sustainability of electric bus deployment depends on a closed-loop mechanism of linking service standards, cost accounting, fiscal subsidies, operational performance, and user satisfaction. Figure 3 maps the main actors in this system and the resources exchanged between them.

Figure 3 Stakeholder mapping of China's new energy bus ecosystem



Source: China EV100 analysis.

At the policy level, national ministries set the overall direction for bus electrification through vehicle standards, product catalogues, subsidy rules, safety requirements, and broader public transport policies. Local governments then convert these national policy signals into local implementation plans, budgets, and performance targets. Article 16 of the Regulations on Urban Public Transport provides:

> *City people's governments shall organize relevant departments to, on the basis of conducting operational service quality evaluations of urban public transport enterprises and reviewing their annual cost accounting reports, comprehensively take into account factors such as fiscal affordability and the enterprises' potential for revenue growth and cost reduction, and provide subsidies and compensation in a timely manner in accordance with prescribed procedures.*

This division of responsibilities means that the government is not only a regulator, but also the ultimate purchaser of public service obligations, including low fares, concessionary fares, low-demand routes, and government-mandated transport tasks.

At the operational level, bus companies are the central node of the ecosystem. They procure vehicles, organize routes, manage charging schedules, maintain batteries and vehicles, report operational data, and provide real-time passenger information. Their financial position is shaped by both operating revenue and public compensation. In many cities, operators also need to coordinate with charging service providers, grid companies, and depot owners to ensure that vehicle deployment is matched with charging capacity and power access. In this sense, electrification changes the role of bus operators from conventional fleet managers into integrated mobility and energy coordinators.

At the industrial level, e-bus manufacturers and battery suppliers provide the core assets and technologies required for electrified operations. E-bus manufacturers compete through vehicle reliability, range, low-floor or low-entry designs, safety performance, after-sales service and delivery capability. Battery suppliers influence vehicle performance and life-cycle cost through battery chemistry, warranty terms, thermal management, and replacement arrangements. In some cases, financial leasing institutions further reshape the asset structure by converting large upfront vehicle purchases into longer-term lease payments, thereby reducing immediate capital pressure on operators. Table 2 summarizes the role, responsibilities, and resource flows of each stakeholder group.

Table 2 Stakeholder roles and interactions in China's new energy bus ecosystem

Stakeholder	Primary Role	Key Responsibilities	Main Resource Provided	Main Resource Received
Central Government (MOT, NDRC, MOF, MIIT, MEE, NEA)	Policy maker and funding provider	Set electrification targets, technical standards, subsidy frameworks, carbon policies	National policies, subsidies, regulatory framework	Operational data and policy outcomes
Local Governments	Implementing authority	Route planning, fare regulation, depot land allocation, subsidy distribution, performance assessment	Local funding, operating mandates, land resources	Service performance and passenger feedback
Bus Operators	Service provider and system integrator	Vehicle procurement, fleet operation, charging coordination, maintenance, passenger services	Public transport services, operational data	Subsidies, fare revenue, vehicles and charging services
Bus Manufacturers	Vehicle supplier	Design, production and after-sales service of electric buses	Electric buses and technical support	Procurement orders and operational feedback
Battery Suppliers	Technology and component provider	Battery supply, warranty, battery replacement support	Battery systems and technical services	Purchase contracts and performance data
State Grid / Utilities	Energy infrastructure provider	Grid connection, electricity supply, capacity upgrades	Power supply and grid access	Electricity revenue
Charging Operators	Charging service provider	Depot charging, charging management, equipment maintenance	Charging infrastructure and energy services	Charging service fees

Stakeholder	Primary Role	Key Responsibilities	Main Resource Provided	Main Resource Received
Passengers	End users	Use public transport services and provide feedback	Fare revenue, ridership demand, service evaluation	Affordable and reliable mobility services

Source: China EV100 analysis.

Overall, China's new energy bus ecosystem is governed through a multi-stakeholder coordination mechanism. National ministries provide policy direction and technical rules; municipal governments finance and organize local implementation; transport authorities supervise service delivery; operators coordinate vehicles, charging, maintenance and passenger services; manufacturers, battery suppliers, utilities and financial institutions provide the industrial and infrastructure base; and passengers influence route design and subsidy performance through ridership and satisfaction feedback. The effectiveness of electric bus deployment therefore depends less on vehicle procurement alone and more on whether cities can align policy incentives, financing tools, energy infrastructure, operational management and user demand within one integrated governance framework.

In recent years, tighter local fiscal conditions and high purchase costs for new energy buses have put pressure on many bus companies. With elevated debt ratios and limited bank credit. Financial leasing and mixed leasing have therefore become important solutions. For example, Shenzhen's official documents show that the city used financial leasing at an early stage to resolve the large capital requirement for bus procurement. Shenzhen Eastern Bus **adopted a mixed leasing model that combined financial leasing for bare vehicles with operating leasing for batteries and electric drive systems**, converting lump-sum investment into phased payments and completing the replacement of more than 5,500 pure electric buses from 2015 to 2017.

Bus groups in Chengdu, Jinan, and other cities also procured new energy buses at scale through financial leasing. Looking ahead, financial leasing and vehicle-battery separation are likely to spread further, moving bus operations from asset-heavy vehicle ownership toward more asset-light vehicle use. This arrangement helped reduce the upfront capital burden on bus operators and transferred part of the technology and battery-performance risk to professional assets and service providers.

7. Insights for Southeast Asia's e-Bus Acceleration

The core experience of China's new energy bus development is the creation of an integrated ecosystem covering institutional design, fiscal incentives, operator cultivation, supporting infrastructure, industrial-chain coordination, and data regulation. Bus electrification in Chinese cities has relied on strong central fiscal support, a mature state-owned public transport operation system, relatively complete grid infrastructure, and a full domestic new energy vehicle supply chain. These conditions are not fully available in most Southeast Asian cities. The following analysis explains how China's experience can be converted into actionable approaches for Southeast Asian countries across five dimensions: policy tools, infrastructure coordination, business models, governance mechanisms, and digital management.

7.1 Transfer and Localization of Policy Incentive Mechanisms

In the early phase of electric bus deployment, China used a policy mix of high purchase subsidies, operating subsidies, and road-priority measures to break through procurement-cost barriers. For Southeast Asian countries, replicating large-scale direct fiscal subsidies is unrealistic, but China's experience of **linking fiscal incentives with industrial resources** is highly relevant.

Thailand's Royal Decree No. 798 (2025) provides an enhanced corporate income tax deduction for large commercial electric vehicle manufacturers[25]. Domestically produced or assembled large electric buses and trucks are eligible for a deduction equal to twice the investment amount, while imported vehicles are eligible for a 1.5-times deduction. The measure was valid until December 31, 2025, and was expected to cover about 10,000 commercial vehicles, including 6,000 buses and 4,000 trucks. Although it implies an estimated tax revenue loss of about THB 10.6 billion (about US$320 million), its objective is to stimulate local production and employment.

[25] The Royal Gazette of Thailand. https://ratchakitcha.soc.go.th/documents/78097.pdf

Indonesia links tax incentives more directly to localization. Under Minister of Finance Regulation No. 8/2024, electric buses with local-content ratio of 40% or above are eligible for a 10% value-added-tax incentive, meaning the government bears VAT and enterprises pay only 1%[26]; buses with local content ratio of 20% to 40% receive a 5% VAT incentive. This encourages international automakers to establish local assembly operations and raise local supply chain participation.

The Thai and Indonesian cases suggest that, under limited fiscal space, Southeast Asian countries are better suited to long-term incentive mechanisms that combine tax rebates or exemptions with non-fiscal measures, while leveraging economies of scale to guide local supply-chain development. Direct large-scale purchase subsidies similar to China's 2015-2022 approach would strain fiscal sustainability in many Southeast Asian markets. Indirect instruments such as tax deductions and VAT incentives are more operationally feasible and financially sustainable.

7.2 Planning E-Bus Charging Infrastructure Before Large-Scale Fleet Deployment

One of the most important lessons from China's public transport electrification is that e-bus charging infrastructure must be planned before, or at least in parallel with, vehicle deployment. For electric buses, charging is not simply a public charging service. It is part of the bus operating system, closely linked to depot layout, route length, daily mileage, charging windows, grid connection capacity, electricity tariffs, and fleet dispatching. If charging facilities lag behind vehicle procurement, cities may face vehicle idleness, inefficient charging schedules, high peak-load pressure, and lower-than-expected utilization of electric buses.

This lesson is particularly relevant for Southeast Asian cities, where public charging networks are often designed primarily for private cars rather than high-utilisation bus fleets. In Thailand, public charging facilities remain heavily concentrated in Greater Bangkok, while secondary cities and rural areas lag behind. For bus electrification, the key constraint is therefore not only the number of public chargers, but whether bus depots and terminals have sufficient land, grid access, transformer capacity and charging management systems to support scheduled fleet operations.

[26] Indonesia National Regulatory Database (JDIH BPK): https://peraturan.bpk.go.id/Details/279522/pmk-no-8-tahun-2024

Vietnam provides a more visible example of this challenge. In Hanoi, only five of the city's 11 bus operators have installed 113 chargers serving 16 routes[27]. The lack of unified technical standards also reduces infrastructure interoperability, as chargers installed by VinBus cannot be shared by other bus operators. Hanoi's construction authority has noted that the city still lacks a comprehensive plan for charging infrastructure and power networks, while the legal framework for pricing and managing privately invested charging facilities remains incomplete. This shows that e-bus charging development requires not only hardware investment, but also technical standards, grid planning, tariff mechanisms, and rules for third-party infrastructure access.

For Southeast Asian cities, the priority should be to shift from a vehicle-first approach to a route-and-depot-based charging plan. Charging needs should be back-cast from actual bus operations: route mileage, layover time, peak-hour dispatching, depot parking capacity, battery size, and overnight charging demand should determine the number, location and power rating of chargers. Large depots may be suitable for overnight slow or medium-power charging, while high-frequency routes may require selected fast chargers at terminals or transfer hubs. Where grid capacity is limited, cities can consider phased deployment, smart charging, load management, and solar-storage-charging depots to reduce peak-load pressure and defer costly grid upgrades.

China's experience also suggests that **charging infrastructure should be integrated into the governance and financing model** of bus electrification. Municipal governments need to coordinate **transport planning, depot land, grid connection** approvals, and electricity pricing. Bus operators need to align charging schedules with route dispatching and maintenance plans. Utilities and charging service providers need to participate early in depot design and **power-capacity assessment.** In addition, **standardized charging interfaces and open-access rules** are important to avoid operator-specific infrastructure silos and to improve charger utilization across fleets.

7.3 New Business and Operating Models Aligned with Southeast Asia's Fiscal Environment

The high initial capital expenditure of electric buses poses a challenge for public finance in any country. Financial leasing and battery leasing models explored in Chinese cities,

[27] Vietnam News Agency/People's Army Daily https://en.qdnd.vn/social-affairs/news/hanoi-prioritizes-charging-infrastructure-to-drive-green-transport-581372

including Shenzhen's vehicle-battery separation and mixed leasing model, offer Southeast Asian countries a way to reduce reliance on direct fiscal purchases.

The core architecture of the Shenzhen model is **financial leasing, vehicle-battery separation, and outsourced charging and maintenance:**

- Under this model, China Putian Information Industry Group acted as sponsor and guarantor and obtained bank financing[28].
- Putian financed battery purchases, while a financial leasing company financed bare-vehicle purchases; the complete vehicles were then leased to bus operators for eight years.
- Following the four-year battery warranty period, Putian continued to maintain the batteries.
- During the eight-year operating period, the participating parties shared revenues, while the total cost of charging and maintenance services was designed not to exceed the fuel costs of comparable diesel buses.

This model effectively reduced the one-off procurement burden on bus operators and enabled the large-scale deployment of new energy buses.

Southeast Asian countries could adapt China's financial leasing experience into a cross-border service-procurement model that combines multilateral development finance with private-sector concessions.

This model has three advantages:

1) it turns one-off fiscal expenditure into multi-year performance-based payments, reducing short-term fiscal pressure;

2) it brings in private-sector operational efficiency and technical expertise; and

3) it lowers overall financing costs through concessional or preferential funding from development finance institutions.

7.4 Building Cross-Ministerial Collaborative Governance Mechanisms

Bus electrification is a systemic undertaking involving transport planning, grid access, urban planning, and fiscal support. Chinese cities commonly establish cross-departmental

[28] China Association of Automobile Manufacturers http://www.caam.org.cn/chn/8/cate_81/con_5109126.html

coordination mechanisms led by relevant authorities, reducing coordination challenges during policy implementation. Southeast Asian countries face similar administrative fragmentation and departmental barriers, making high-level coordination essential for effective decision-making.

A top-down cross-ministerial framework should include several key design elements:

- The committee should be chaired at a sufficiently senior level, preferably by the Prime Minister or Deputy Prime Minister, to ensure authority across government departments.
- The secretariat should be housed within an agency with investment-promotion functions, such as Thailand's Board of Investment (BOI), to facilitate coordination between policy design and project implementation.
- Clear performance indicators and implementation timelines are needed to prevent prolonged deliberation without concrete action.
- Regular public progress reports can enhance transparency and strengthen public accountability.

Southeast Asian countries with administrative structures different from China's **can adapt this model to their own governance structure and central-local arrangements** and redefine the committee's composition and functions accordingly.

7.5 Digital Enablement and Refined Operations Management

In China, public data platforms, onboard GPS, and mobile payments have become core digital tools for optimizing bus networks, distributing subsidies accurately, and supporting all-day operations and dispatching. This digital transformation is highly relevant to Southeast Asian cities that are modernizing their bus systems.

An appropriate data-collection and feedback mechanism can help Southeast Asian governments improve the accuracy and effectiveness of subsidy payments. Subsidies can be verified using actual mileage and energy-consumption data rather than a simple per-vehicle approach. Digital tools can also help attract passengers back to public transport by improving the user experience through real-time arrival information, mobile payment, and onboard Wi-Fi, thereby strengthening operators' self-sustaining capacity. China's experience in digital subsidy verification suggests that data platforms should start with simplified functions and prioritize two objectives: 1) precise subsidy distribution; and 2) operational

optimization. Excessive platform construction should be avoided to prevent unnecessary cost burdens.

In summary, deeper application of China's new energy bus experience in Southeast Asia requires coordinated progress across five dimensions:

1. Policy incentives
2. Infrastructure
3. Business models
4. Governance mechanisms
5. Digital management

These dimensions are not isolated. Together, they form a mutually reinforcing ecosystem: policy incentives provide the initial deployment push, infrastructure enables scaled operation, business models create a financial basis for sustainability, governance mechanisms support cross-departmental coordination, and digital management enables refined operations.

8. China's Public Transport Battery Market

8.1 Current Status of the EV Public Transport Battery Market

In terms of battery technology, lithium iron phosphate batteries are the mainstream choice for electric public buses in China. This is because bus operations are fixed-route and relatively predictable, and operators place greater emphasis on safety, cycle life, life-cycle cost, and maintenance convenience than on maximum energy density. Although buses account for only a limited share of China's total power-battery installations, each electric bus represents a large and long-lived battery asset. According to compulsory insurance data (terminal registration data)[29], battery installations in the new-energy bus segment were about 10.6GWh in 2025, up slightly from about 9.9GWh in 2024.

8.2 Battery Matching for Major Electric Bus Models

Battery matching for electric buses is mainly determined by vehicle length, passenger capacity, route intensity, daily mileage, charging windows, and local grid capacity. In general, 6–8m buses are suitable for feeder and community routes and usually require less than 200kWh; 10–12m buses are the backbone of urban trunk routes and typically use 250–500kWh packs; 18m articulated buses or BRT vehicles require larger batteries or higher-power charging. Table 3 sets out representative models and their battery configurations.

[29] GGII (Gaogong Industry Research Institute)

Table 3 Representative electric bus models and battery configurations

OEM	Representative model	Length	Passenger capacity	Range	Battery capacity	Battery type	Battery supplier
Yutong	U12 / E12PRO electric city bus	12 m	U12: up to 95; E12PRO: 70–90 (market-dependent)	U12: up to 600 km (SORT2); E12PRO: varies by configuration	U12: up to 528.03 kWh / 465.99 kWh; E12PRO: 350–422.87 kWh	LFP	CATL
CRRC Electric	CSR6121GLEV2 12 m fast-charging electric bus	12 m	98–104 persons (layout-dependent)	240 km (constant speed)	143.1 kWh	LFP	CATL
King Long	MU12E electric city bus	12 m	Market configuration varies	500–550 km	465.99 kWh	LFP	CATL
King Long	PEV8 electric city bus	8 m	58 persons (17 passenger seats + 1 wheelchair + 1 driver)	300–350 km	210.6 kWh	LFP	CATL
BYD	B12.b electric bus	12 m	Up to 105 persons	Up to 600–650 km (SORT III)	Up to 500 kWh (multiple configs: 311 / 429 / 495 kWh)	LFP	FinDreams
Geely Farizon	C8E / C10E / C12E electric city bus series	8–12 m	Varies by model	Over 300 km	Configured by model / tender (not publicly unified)	LFP (predominantly)	CATL / Gotion High-Tech
Geely Farizon	U11E city-bus version	10.9 m	24–46 persons (market configuration)	240–370 km (working condition)	255 kWh (public brochure)	LFP	CATL (predominantly)

Source: Company official websites.

Overall, battery matching in mainstream electric buses shows three features. First, LFP is the dominant chemistry. Second, 12m city buses typically require 300–500kWh-level packs for full-day operation. Third, OEM–battery relationships fall into two patterns: vertically integrated vehicle–battery systems, represented by BYD, and multi-supplier or tender-specific matching, represented by Yutong, King Long, CRRC Electric, and Farizon, which may work with CATL or other battery-system suppliers depending on model approval and procurement batches.

8.3 Battery Leasing Models

From the purchase-cost perspective, the battery is one of the largest cost components of an electric bus. In the early deployment stage, battery costs could exceed half of the total vehicle cost. As LFP battery prices declined, a more practical benchmark today is roughly 30%–40% of the vehicle's purchase cost. For example, a 300kWh battery pack priced at around RMB 1,000/kWh (about US$139/kWh) would cost about RMB 300,000 (about US$42,000); for an electric bus priced at around RMB 800,000–1,000,000 (about US$111,000–139,000), the battery would account for about 30%–40% of the total purchase cost[30]. Public bus operators therefore face not only vehicle procurement pressure, but also battery replacement risk, warranty-expiry risk, and residual-value uncertainty.

Because batteries account for a large share of the vehicle cost and public bus operators often face capital-expenditure constraints, battery leasing, vehicle–battery separation, financial leasing, and mixed leasing models have emerged. Their core logic is to **transform batteries from an upfront procurement cost into a long-term operating asset or a periodic service payment.** This lowers the initial financial burden on bus operators and allows part of the battery maintenance, warranty, replacement, and recycling responsibilities to be transferred to battery companies, financial institutions, or specialized operators.

[30] https://m.bjnews.com.cn/detail/1692936714129640.html



Case 1. Shenzhen: financial leasing and vehicle-battery separation

Shenzhen was one of the earliest cities to explore vehicle-battery separation and mixed leasing for electric buses[31]. **Battery assets** were purchased by specialized energy-service entities such as Potevio New Energy, while leasing companies purchased the **bus body and chassis without batteries** and leased the complete vehicle to bus operators. The lease term was aligned with the bus operation cycle, and after the battery warranty period, the battery operator continued to provide maintenance and operational support. **This reduced upfront bus procurement expenditure** and improved professional battery maintenance.



Case 2. Shenzhen Eastern and Western Bus: the mixed leasing model

Shenzhen Eastern Bus and Shenzhen Western Bus[32] explored a mixed leasing model under which vehicle **manufacturers sold buses and charging facilities to third-party financial institutions** and remained responsible for maintenance during operation, while the bus companies signed lease contracts with the financial institutions. This bundled vehicle procurement, charging-infrastructure deployment, maintenance service and financing, allows operators to expand electric fleets through a lighter-asset model.

[31] https://www.sz.gov.cn/cn/xxgk/zfxxgj/zwdt/content/post_9044762.html
[32] https://finance.sina.cn/2018-01-24/detail-ifyqyesy0944255.d.html



Case 3. Chengdu and Jinan: municipal leasing platforms

Chengdu's industry policy supports **financial leasing and vehicle-battery separation** through municipal financial leasing platforms, such as Chengdu Industrial Investment Financial Leasing Co., Ltd., which provide customized financial services to public transport enterprises and lower their initial acquisition costs. Jinan Bus[33] has cooperated with commercial-vehicle manufacturers such as Sinotruk through public-vehicle financial leasing arrangements to introduce large numbers of pure-electric and hybrid buses in phases. For bus operators, these models ease procurement pressure after subsidy reductions, smooth cash flow, and **integrate vehicle renewal, battery replacement and maintenance into longer-term financing arrangements.**

From the perspective of private-sector engagement, the electric bus battery market is not only about selling batteries or vehicles, but about providing life-cycle services:

- Vehicle manufacturers match bus platforms with battery systems.
- Battery companies provide cells, packs, BMS, and safety management.
- Financial institutions reduce upfront costs through financial leasing, battery leasing, and asset-based financing.
- Charging operators and digital platforms manage charging schedules, SOC/SOH monitoring, and energy consumption.
- Recycling companies handle testing, second-life use, and material recovery. As China's first large wave of electric buses enters the 8–10-year renewal cycle, battery-

[33] https://news.iqilu.com/shandong/shandonggedi/20170620/3590635.shtml

replacement subsidies, full-life-cycle traceability, and battery asset management will become key growth areas in the electric public transport market.

As China's first large wave of electric buses enters the eight- to ten-year renewal cycle, battery-replacement subsidies, full-life-cycle traceability and battery asset management will become key growth areas in the electric public transport market.

9. Energy and Environmental Dimensions of Batteries for Electric Public Transport

9.1 Carbon Footprint

Power batteries are a key focus on life-cycle carbon management for new energy vehicles. According to the explanatory document for the 2025 draft standard *Quantification Method and Requirements for Product Carbon Footprint—Power Batteries* issued by China's Ministry of Ecology and Environment[34], the current average carbon footprint of power batteries in China is about 83.5 kgCO_2e/kWh. Based on China's 2023 power-battery output of 778.1GWh, this corresponds to approximately 64.97 million tonnes of carbon emissions. The document also notes that power-battery product carbon footprints generally range from 60 to 98 kgCO_2e/kWh, depending on system boundaries, accounting rules, electricity mix, material sourcing, and production processes.

9.2 Chemistry

Battery chemistry matters. Research shows that the average life-cycle CO_2 emission intensity of Nickel/Cobalt/Manganese (NCM) batteries declined from 158 kg/kWh in 2015 to 111 kg/kWh in 2020; advanced batteries had already reached 86 kg/kWh, and the level is expected to fall to 58 kg/kWh by 2030. The same study indicates that LFP batteries have 30%–50% lower life-cycle CO_2 emission intensity than NCM batteries.[35]

Battery emissions are concentrated in materials and manufacturing. Cathode-material manufacturing as a major contributor, accounting for about 20%–50% of a power battery's carbon footprint. For NCM batteries, the cathode-related footprint is particularly significant, with lithium, nickel, cobalt, and other raw-material acquisition contributing more than 65% of cathode-material emissions. Battery manufacturing also involves slurry preparation and coating, electrode drying and rolling, electrolyte injection and sealing, formation and capacity grading, module assembly, pack assembly, and system testing, all of which require substantial electricity and thermal management.

[34] https://www.mee.gov.cn/xxgk2018/xxgk/xxgk06/202503/W020250328550123536021.pdf

[35] Wang, F., Zhang, S., Wu, Y., et al. (2023). Multisectoral drivers of decarbonizing battery electric vehicles in China. *PNAS Nexus*, *2*(5), pgad123. https://doi.org/10.1093/pnasnexus/pgad123

9.3 China's Renewable Energy Expansion and the Green-Certificate Market

Decarbonizing electricity supply is critical for reducing manufacturing-stage emissions from electric buses and power batteries. According to the National Energy Administration[36], China's renewable-energy installed capacity reached 1.889 billion kW by the end of 2024, accounting for about 56% of total installed capacity; newly installed renewable capacity reached 373 million kW in 2024, accounting for 86% of China's newly installed power capacity. In parallel, the National Development and Reform Commission and the NEA are building a green-certificate market and aim to basically establish green-power consumption accounting, certification, and labelling systems by 2027, providing an institutional basis for bus and battery manufacturers to reduce manufacturing emissions through green-power transactions and green-certificate procurement[37].

9.4 Decarbonization Strategies for Electric Buses

At present, bus operators mainly handle vehicle procurement, fleet operation, charging organization, and retired-battery management, while production-side carbon reduction is mainly driven by new energy bus manufacturers, battery companies, and supply-chain enterprises. Publicly available information shows four major categories of action: green-power use and distributed photovoltaic deployment; energy-efficiency retrofits in painting, welding, final assembly, compressed air, lighting, and thermal management; life-cycle assessment, environmental product declarations, and green design; and battery recycling, material circularity, and supply-chain carbon management.

[36] https://www.nea.gov.cn/20250221/e10f363cabe3458aaf78ba4558970054/c.html
[37] https://www.ndrc.gov.cn/xxgk/zcfb/tz/202503/t20250318_1396627.html

10. Development Trends in China's e-Bus Battery Sector

China's e-bus battery technology route is shifting from solving early-stage range and availability constraints to **improving long life, safety, low degradation, cost efficiency and low-carbon performance.** For public buses, routes are fixed, daily mileage is predictable, and vehicles are usually parked and charged in depots. Therefore, battery selection is not driven only by maximum energy density, but also by safety, cycle life, thermal-management reliability, life-cycle cost, and traceability after retirement. The State Council's *New Energy Vehicle Industry Development Plan (2021–2035)* calls for development of the full power-battery value chain, a modular battery standards system, improved recycling, second-life use and resource-recovery systems, and stronger life-cycle supervision.

In the medium to long term, lithium iron phosphate (LFP) batteries are expected to remain the mainstream technology for urban electric buses. This is because LFP batteries are better suited to high-frequency public-service operations in terms of thermal stability, safety, cycle life and cost. The next stage is not a simple shift from LFP to Nickel/Cobalt/Manganese (NCM) but an upgrade within the LFP family: higher volumetric energy density, better low-temperature performance, faster charging, improved life consistency, and higher pack efficiency through chassis integration and advanced thermal management.

The **integration of transport and energy systems** will also reshape e-bus battery requirements. The *Guiding Opinions on Promoting the Integrated Development of Transportation and Energy*, issued by ten departments including the Ministry of Transport, state that by 2027 electricity should account for 10% of the transport sector's terminal energy use; by 2035, transport and the new energy system should achieve comprehensive integration and interaction, with charging and swapping stations built along highways, around cities and near distribution centres, and green electricity used for direct EV charging where possible . This means that e-bus batteries will no longer be treated only as vehicle components, but as part of an urban public-transport energy system combining depot charging, photovoltaics, energy storage, green-power procurement, time-of-use tariffs and smart charging.

11. Shenzhen Case Study: Financing and Risk-Sharing in the e-Bus Battery Ecosystem

China's electric bus battery ecosystem is not a simple vehicle procurement chain. It is a public-service, industrial-supply, energy-infrastructure, and financial-asset system. The core node is the bus operator: it converts government public-service requirements into daily operations, while coordinating vehicles, batteries, charging, maintenance, financing and passenger services.

Shenzhen E-Bus Battery Case Study

The key feature of the Shenzhen model is that the government **did not rely only on direct vehicle purchase subsidies**. It used a market-based structure involving bus operators, vehicle manufacturers, battery asset operators, leasing companies, and charging service providers. Shenzhen's official government portal describes an early **"financial leasing + vehicle-battery separation" model**:

- Through a concession arrangement, China Potevio was introduced into the local new-energy-vehicle industrial chain
- China Potevio provided guarantees and arranged bank financing
- Potevio purchased the batteries
- Leasing company purchased the vehicle body and chassis without batteries; and the complete vehicle was leased to bus companies for eight years.
- After the four-year warranty period promised by the battery manufacturer, Potevio continued to be responsible for normal battery use and maintenance.

In this structure, the **local government** provided policy direction, concession arrangements, fiscal support and infrastructure coordination; **bus operators** provided route operation, vehicle dispatching and passenger services; **BYD and other manufacturers** supplied electric buses and technical services; Potevio acted as a battery and charging-service operator; **leasing companies** converted heavy upfront capital expenditure into phased payments; and the **grid and charging-service providers** ensured electricity access and depot charging. **This structure helped solve three problems at the same time: high upfront vehicle cost, uncertainty over battery performance after warranty expiry, and lack of charging infrastructure.**

A later form of Shenzhen's electric-bus financing model: "mixed leasing"

Structure: Manufacturers sold buses and chargers to leasing companies, who rented them to bus operators.

Risk Sharing: Manufacturers handled maintenance and covered losses from technical failures (batteries, motors, chargers).

Benefit: Reduced upfront capital pressure and operational risk for bus companies.[38]

This case shows that the relationship among stakeholders in electric bus deployment is essentially a risk-sharing mechanism:

- The government bears public service obligations and provides policy and fiscal support.
- Bus operators bear service delivery responsibility.
- Manufacturers and battery suppliers bear product performance and maintenance responsibilities.
- Financial institutions bear financing and asset-holding functions.
- Charging operators bear infrastructure and energy-service responsibilities.
- And passengers provide ridership demand, fare revenue and service feedback. The more clearly these rights, responsibilities and risks are allocated, the more sustainable electric bus deployment becomes.

The more clearly these rights, responsibilities and risks are allocated, the more sustainable electric bus deployment becomes.

[38] https://www.rmzxw.com.cn/c/2018-05-08/2046306_1.shtml

12. Insights for Southeast Asia's e-Bus Battery Acceleration

Key message: from vehicle purchase to battery asset management

China's public transport battery ecosystem offers useful lessons for Southeast Asian countries, but it should not be understood as a simple export of vehicles, batteries or battery-swapping equipment. **The more relevant lesson is an integrated mechanism**: public-service planning, fleet procurement, depot charging, battery safety management, financial leasing, battery asset operation and end-of-life recycling need to be designed together.

For Southeast Asian public transport, **the priority should be depot charging plus battery asset management**, rather than large-scale battery swapping for buses. Urban buses run fixed routes, return to depots, and have predictable schedules. The first-order task is therefore to match bus deployment with depot charging power access, route scheduling, battery warranty, and maintenance capability.

12.1 Why Southeast Asia Needs an Asset-Based Battery Model

The main bottleneck for electric bus deployment in Southeast Asia is often not vehicle technology, but upfront capital cost, charging infrastructure, grid connection, and operational risk allocation. The World Bank's Vietnam e-mobility roadmap study[39] identifies three major obstacles for e-bus uptake in public city buses: high upfront purchase cost compared with diesel and CNG buses, lack of technical and operational frameworks among city governments, and high ridership risks due to infrastructure and policy gaps. The same report notes that battery electric buses are typically 1.4–2.8 times more expensive than diesel buses and 1.1–2.2 times more expensive than CNG buses in upfront vehicle price.

This is where China's experience is most relevant. The lesson is not that governments must pay for everything, but that the battery can be treated as a separable asset. Through vehicle-battery separation, financial leasing, battery leasing, warranty-backed service contracts, and residual-value arrangements, cities can reduce the initial burden on bus operators and

[39] World Bank《Viet Nam: Recommendations to the National E-Mobility Roadmap and Action Plan》

transfer part of battery-performance risk to professional asset operators, battery suppliers, financial institutions, and recycling companies.

For Southeast Asian cities, this means that e-bus projects should not be evaluated only by vehicle purchase price. Procurement contracts should define battery ownership, warranty duration, minimum state-of-health requirements, replacement thresholds, charging responsibility, spare-parts supply, data access, second-life use, and recycling obligations. This turns the battery from a hidden cost into a managed asset.

12.2 Recommended Implementation Model for Southeast Asia

A practical Southeast Asian implementation model should follow five steps.

First, cities should start with route and depot diagnosis before vehicle procurement. The basic questions to prevent the common problem of buying e-buses before charging capacity is ready are:

- Which routes have stable daily mileage?
- Which depots have sufficient land?
- Which substations have spare capacity?
- Which operators can manage charging schedules and maintenance?

Second, procurement should shift from buying buses to buying service packages. A standard package should include the bus, battery, charger, maintenance, software platform, warranty, training, spare parts, replacement battery plan, and end-of-life recycling arrangement. This is consistent with the ASEAN EV declaration's emphasis on EV ecosystem development, standards, infrastructure, financing, renewable energy use, and environmental impact management.

Third, battery ownership should be separated from battery use where fiscal or operator balance sheets are weak. Local governments, state-owned energy firms, municipal transport companies, leasing companies, development-finance institutions, or battery service providers can hold battery assets, while bus operators pay through lease, kilometres-based service fee, energy-service fee, or availability payment. This converts upfront capital expenditure into predictable operating expenditure.

Fourth, battery data should be treated as an infrastructure. Each battery pack should have a digital record covering production, vehicle matching, charging history, maintenance, state of health, safety warnings, replacement, second-life use, and recycling. The ASEAN Guidelines on Light Electric Vehicles also highlight the importance of monitoring indicators for funding, charging-station deployment, and adoption outcomes, and note that battery swapping and battery-as-a-service models require standardized networks and battery management.

Fifth, recycling responsibility should be included from the first tender. ERIA's report on EV battery reuse in ASEAN[40] points out that battery reuse can support stationary storage needs and variable renewable energy integration, but policy, safety, technical and market arrangements are needed to facilitate battery reuse.

12.3 Risk Control and Policy Priorities

The first risk is infrastructure mismatch. If e-buses are procured faster than depot charging, grid access, and maintenance capacity, vehicles may be underutilised. Southeast Asian cities should therefore require every e-bus procurement plan to include a depot power-capacity assessment, charging schedule, grid-connection plan, charger maintenance arrangement, and emergency charging plan.

The second risk is fiscal unsustainability. Electric buses have lower energy and maintenance costs, but their high upfront cost can still make projects financially difficult if fare revenue is weak. The World Bank's Vietnam study emphasises that public bus electrification must be pursued together with policies that reverse declining ridership and improve farebox revenue.

The third risk is weak after-sales and battery-performance responsibility. In hot and humid Southeast Asian climates, battery thermal management, corrosion protection, charging safety, spare-parts supply, and technician training are critical. Contracts should specify minimum battery SOH, replacement conditions, response time for faults, fire-safety responsibilities, and data-sharing obligations.

The fourth risk is delayed recycling regulation. If battery ownership, coding, transport, testing, second-life use, and recycling responsibility are not defined early, cities may face safety and environmental problems when the first wave of e-bus batteries retires. ASEAN's EV declaration already includes end-of-life disposal within the scope of regional EV

[40] ERIA《Reuse of Electric Vehicle Batteries in ASEAN》

standards, so battery recycling should be treated as part of the public transport battery ecosystem rather than an afterthought.

12.4 A Phased and Localised Replication Path

China's public transport battery ecosystem is applicable to Southeast Asian countries, but only through phased and localised adaptation. The most transferable elements are not large-scale subsidies or a single charging or swapping technology, but five governance mechanisms: coordinated vehicle-infrastructure planning, battery asset separation, long-term service contracts, battery data traceability, and end-of-life recycling responsibility.

For high-capacity markets such as Singapore, Thailand, Viet Nam and Indonesia, electric bus deployment can move from pilot projects to city-level fleet transition. For markets with weaker fiscal and grid capacity, the better approach is to start with fixed-route fleets, airport buses, BRT corridors, government fleets, and depot-based public-service routes. In all cases, battery leasing, financial leasing, depot charging, SOH monitoring, and recycling clauses should be built into the project design from the beginning.

In this sense, the value of China's experience is not to provide a ready-made template, but to show how public transport electrification can be transformed from a vehicle-purchase programme into a battery-centred urban energy and asset-management system.

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