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Operationalizing E-bus Fleets: Lessons Learned From China

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The Status of E-bus in China

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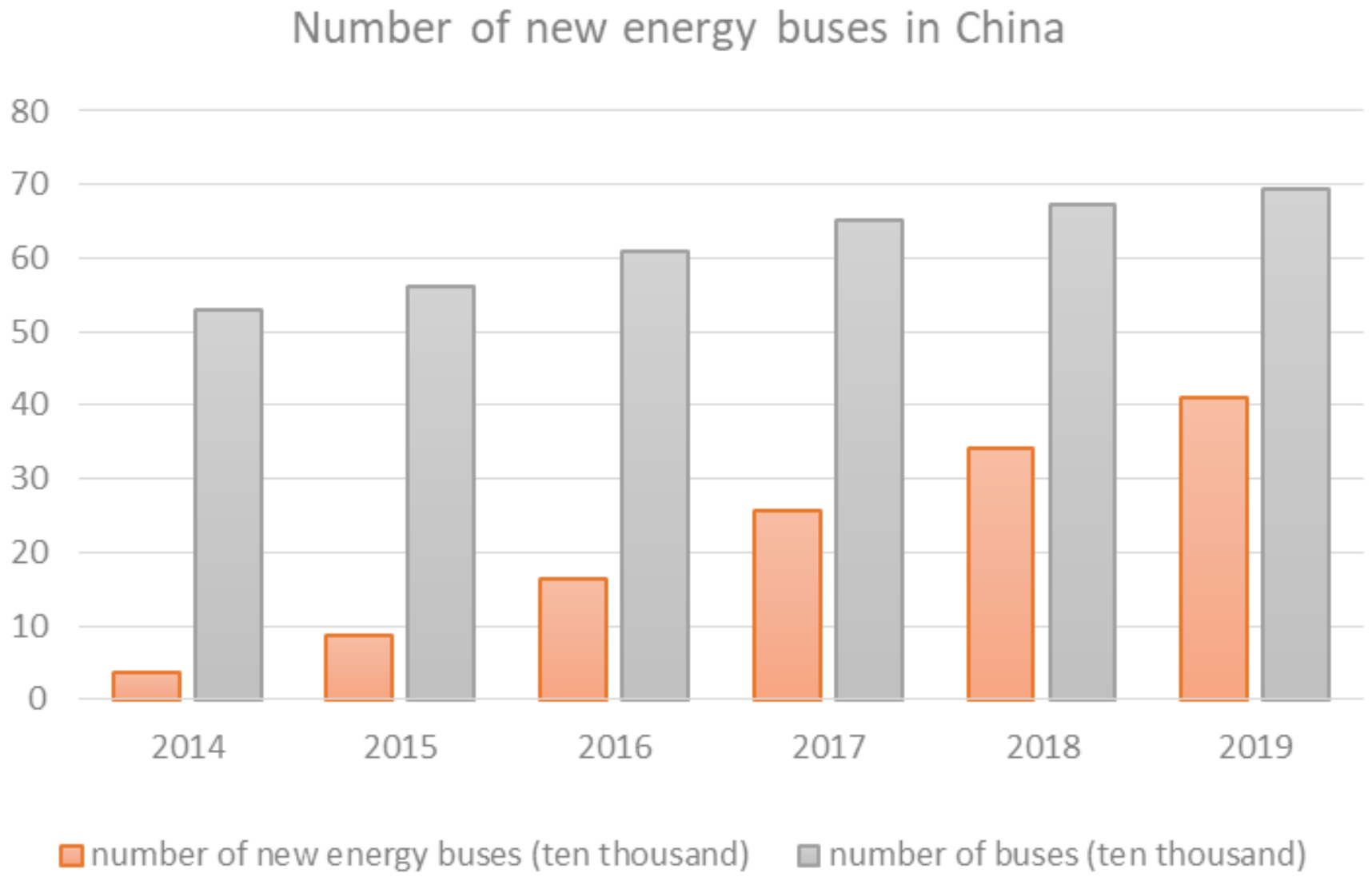
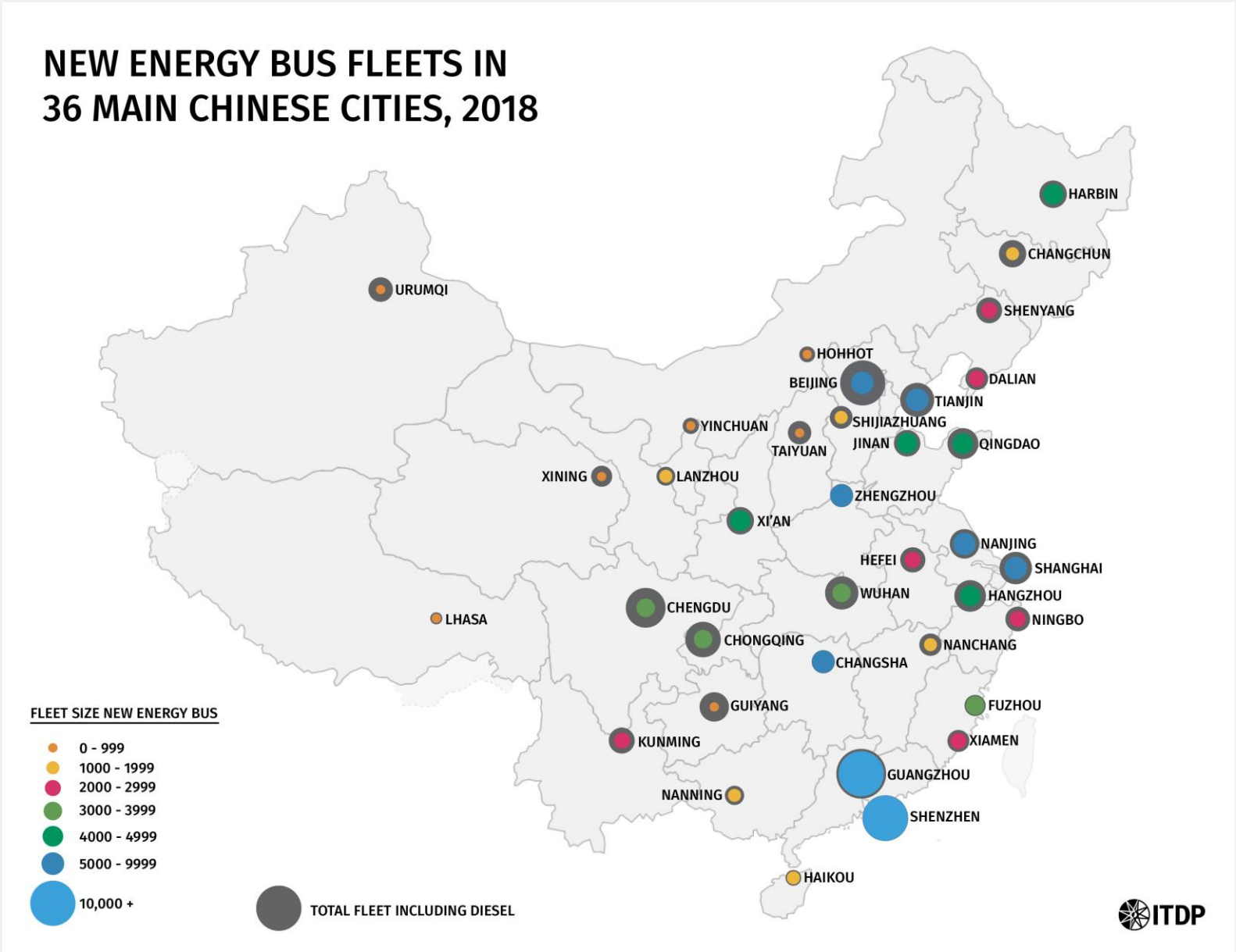
Current status in China

- Till 2019, the total bus fleet is 693,000, new energy buses(497,000) account for 59.1% of whole bus fleet.
- New energy buses include: BEB, hybrid bus and fuel cell bus.
- In new energy buses in China, the BEB account for 75%.



New Energy Bus in China



- In the city of Shenzhen, Guangzhou, Zhengzhou, Changsha, new energy buses account for the largest proportion.

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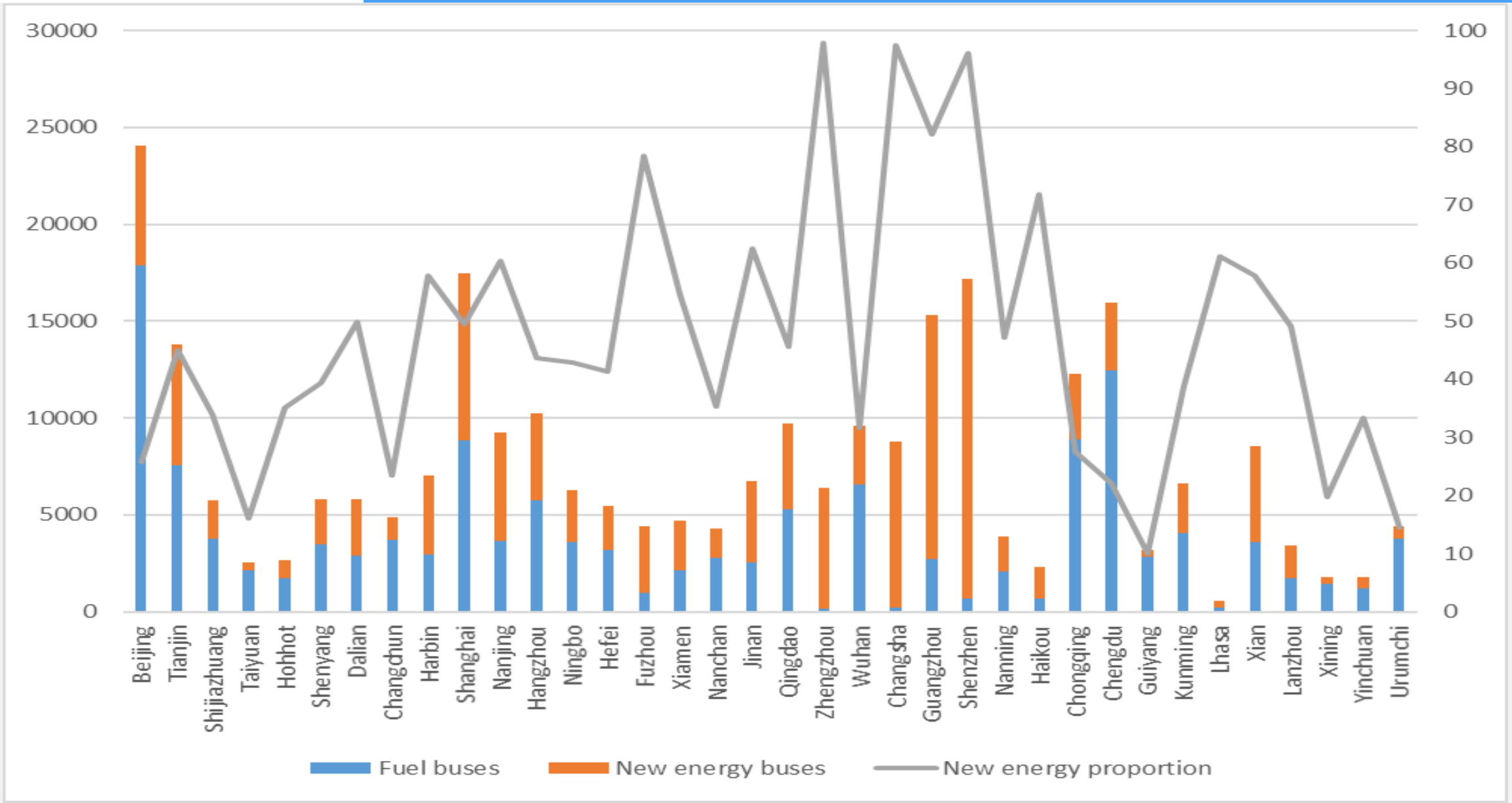
Promotion of New-Energy Buses in 36 Major Cities of China in 2018



The Major Driving Force of E-bus Development

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Policy Oriented E-bus Development

Four most important driven forces in promoting e-bus

- **Policy support** plays the most important role in promoting e-bus development in China since 2009.
- **E-bus industry,** cities with E-bus manufactures have the largest proportion of e-buses.
- **Environmental pressure**. National government set ambitious electrification target to regions have severe air pollution issue
- **Infrastructure** has to ensure efficient e-bus daily operation

National Policy

- Stage I (2009-2013): Pilot program get started
- Stage II (2013-2018): Gradual expansion
- Stage III (2018-2020): Nationwide promotion

2009.1 — Notice on Launching Pilot Project of Demonstration and Promotion of New Energy Vehicles

Known as "ten cities and one thousand vehicles" project, each city will launch 1,000 new energy vehicles to carry out demonstration operation, and strive to make the operation scale of new energy vehicles nationwide and account for 10% of the automobile market share by 2012.

2012.6 — Notice of the State Council on Issuing the Development Plan for Energy Saving and New Energy Vehicle Industry (2012-2020)

Government should play a guiding role in procurement, and gradually expand the scale of purchasing energy-saving and new energy vehicles by public institutions. By 2020, the production capacity of new energy vehicles will reach 2 million vehicles, with a cumulative production and sales volume of more than 5 million vehicles.

2013.8 — Notice on Continuing to Promote and Apply New Energy Vehicles

Government agencies, public institutions and other fields of vehicle procurement should be inclined to new energy vehicles, new or updated public transport, government official vehicles, logistics, sanitation vehicles in the proportion of new energy vehicles is not less than 30%

2014.7 — Guiding Opinions of the General Office of the State Council on Accelerating the Promotion and Application of New Energy Vehicles

From 2014 to 2016, the proportion of new energy vehicles purchased by central government and pilot project cities will be no less than 30% of the total number of vehicles purchased in that year, and the application scale will be expanded year by year thereafter.

2014.11 — Notice on Rewards for Construction of Charging Facilities for New Energy Vehicles

From 2013 to 2015, the Ministry of Finance will give awards in different degrees according to the annual number of new energy passenger car units promoted in cities (divided into three major urban agglomerations and two levels in other regions). The amount of awards will be increased year by year, with the range between 10 million and 120 million.

2015.3 — Implementation Opinions on Accelerating the Promotion and Application of New Energy Vehicles in Transportation Industry

By 2020, the number of new energy vehicles in the public sector will reach 300,000 (200,000 buses, 100,000 taxis and urban logistics vehicles). The proportion of new or updated new energy vehicles in pilot cities will not be less than 30%, and that in Beijing, Tianjin and Hebei will not be less than 35%

National Policy

- Stage I (2009-2013): Pilot program get started
- Stage II (2013-2018): Gradual expansion
- Stage III (2018-2020): Nationwide promotion

2015.4 — **Notice on Financial Support Policies for the Promotion and Application of New Energy Vehicles from 2016 to 2020**

The subsidy of will be appropriately downgraded except fuel cell vehicles . The subsidy for 2017-2018 will be reduced by 20% from 2016 and the subsidy for 2019-2020 will be reduced by 40% from 2016.

2015.10 — **Opinions of the General Office of the State Council on Accelerating the Construction of Charging Infrastructure for Electric Vehicles**

For electric vehicles operating at designated sectors as public transportation, sanitation and airport commuting, priority should be given to the construction of charging facilities at parking lots and stations based on needs, fast charging stations and battery exchange stations should be equipped.

2018.6 — **Implementation Opinions on Strengthening Ecological Environment Protection in Pollution Prevention and Control**

By the end of 2020, the number of new energy vehicles in urban public transportation, taxis, urban delivery should reach 600,000, and all buses in municipalities directly under the central government, provincial capitals and cities specifically designated in the state plan will be replaced with new energy vehicles.

2018.6 — **"Notice of the State Council on Three-Year Action Plan to Win the Battle of Defending Blue Sky"**

Accelerate the use of new or clean energy vehicles for public transportation, sanitation, postal services, rental, commuting, and light-weighted delivery vehicles in urban built-up areas, with the proportion of use in key areas reaching 80%.

2019.5 — **"Notice on Supporting the Promotion and Application of New Energy Buses"**

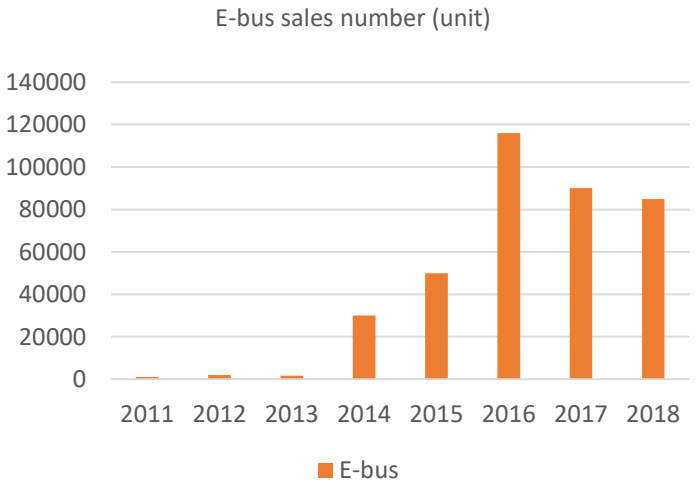
The local purchase subsidy is generally abolished, the local government should continue to provide subsidy for new energy buses. Implement the policy of Exempting New Energy Buses from Vehicle Purchase Tax and Travel Tax.

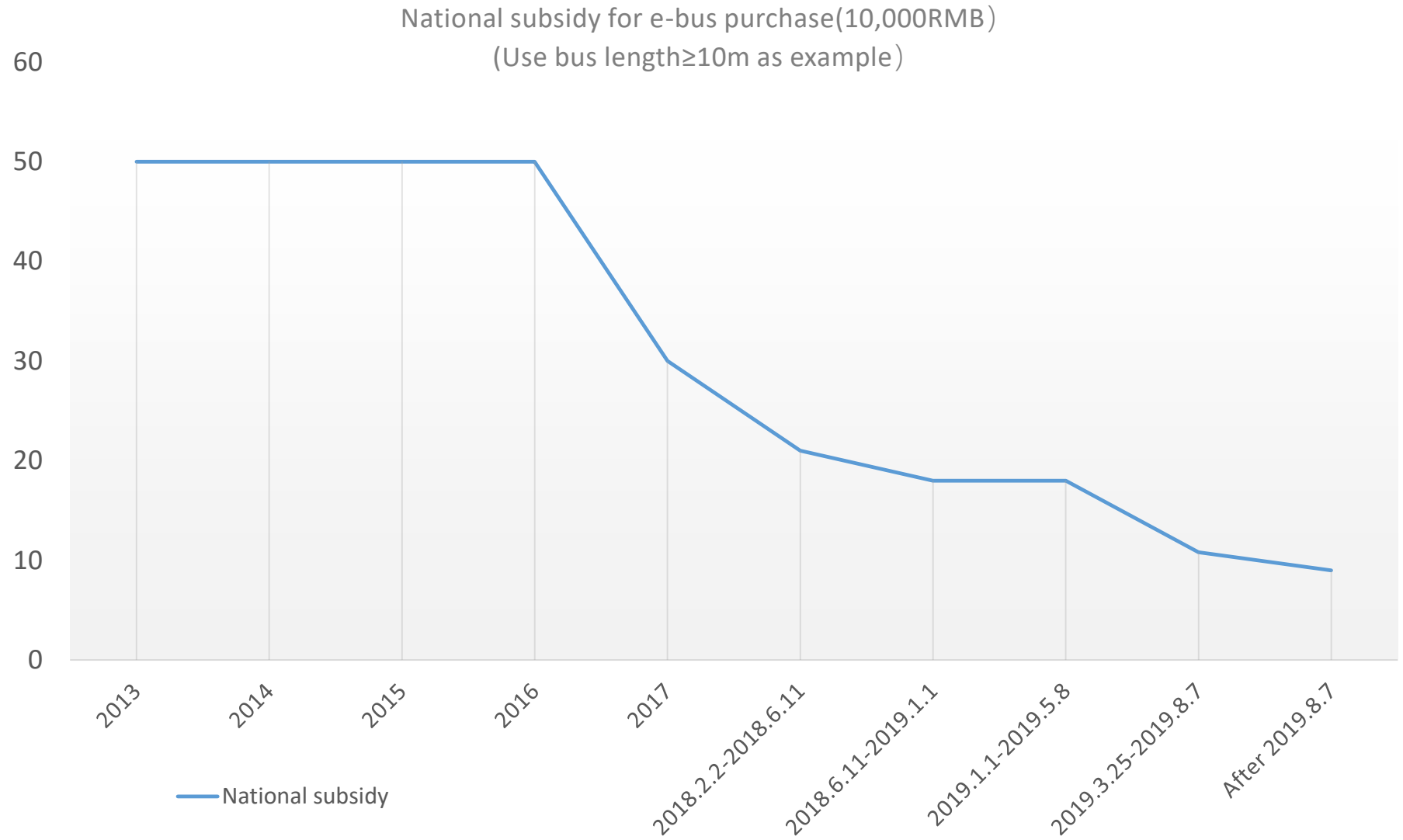
2019.8 — **"Implementation Opinions on Implementing General Secretary Xi 's Instructions and Promoting High-quality Development of Postal Industry"**

Promote the new and updated postal and express vehicles in urban built-up areas to use new energy or clean energy vehicles with the proportion of key areas to reach 80% by the end of 2020.

Stage I	Stage II	Stage III
Pilot Start	Gradual Improvement	Nationwide Promotion

National Subsidy





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National Subsidy

Year	2013-2015	2016	2017	2018	2019
Indicators of subsidy quota	Vehicle Length	Vehicle length; Driving Range; Energy Consumption per unit load;	Vehicle Length; Energy density of battery system; Efficiency of fast charging (Fast charging system for pure electric buses)	Vehicle Length; Energy density of battery system; Efficiency of fast charging (Fast charging system for pure electric buses) ; Energy Consumption per unit load;	Vehicle Length; Efficiency of fast charging (Fast charging system for pure electric buses) ; Energy Consumption per unit load;
Min/Max of indicators for subsidy	/	/	Driving Range; Energy Consumption per unit load; Energy density of battery system; Total battery system mass as a percentage of total vehicle mass	Driving Range; Energy Consumption per unit load; Energy density of battery system; Efficiency of fast charging	Driving Range; Energy Consumption per unit load; Energy density of battery system; Efficiency of fast charging

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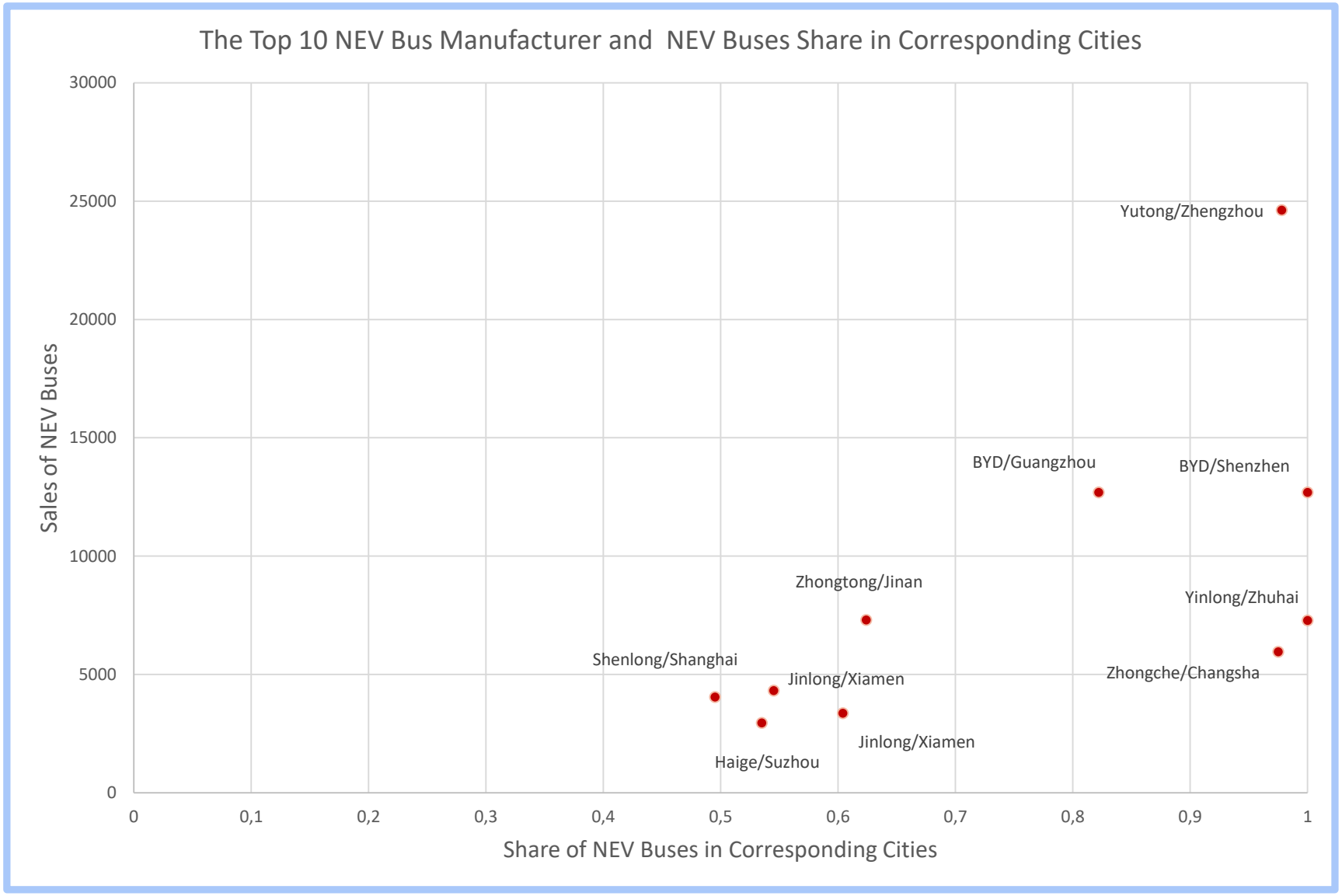
E-bus industry



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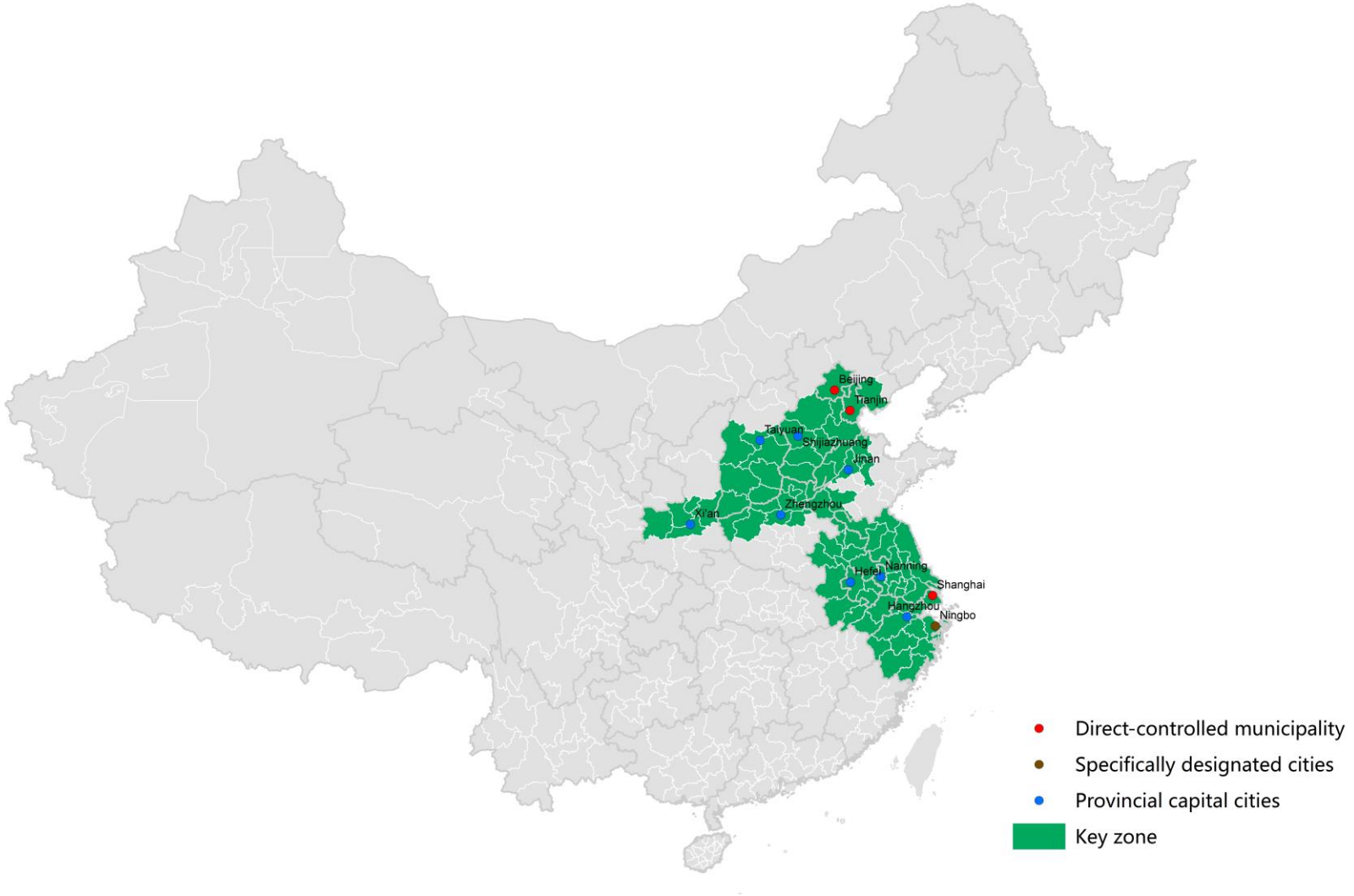
Environmental Pressure

'Blue Sky' Three Years Actions Key Zone and Core Cities



E-bus Operational Data

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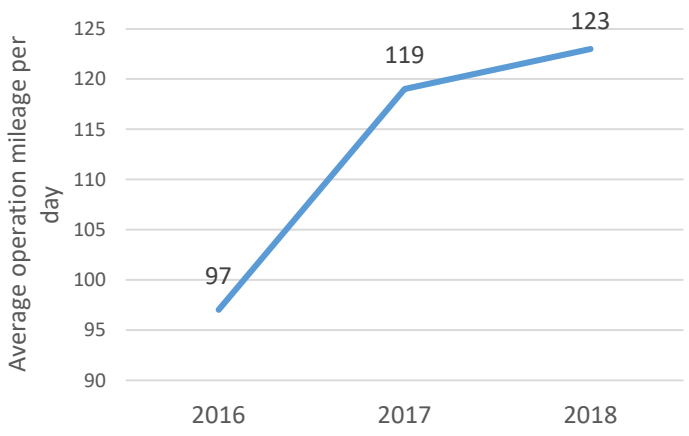
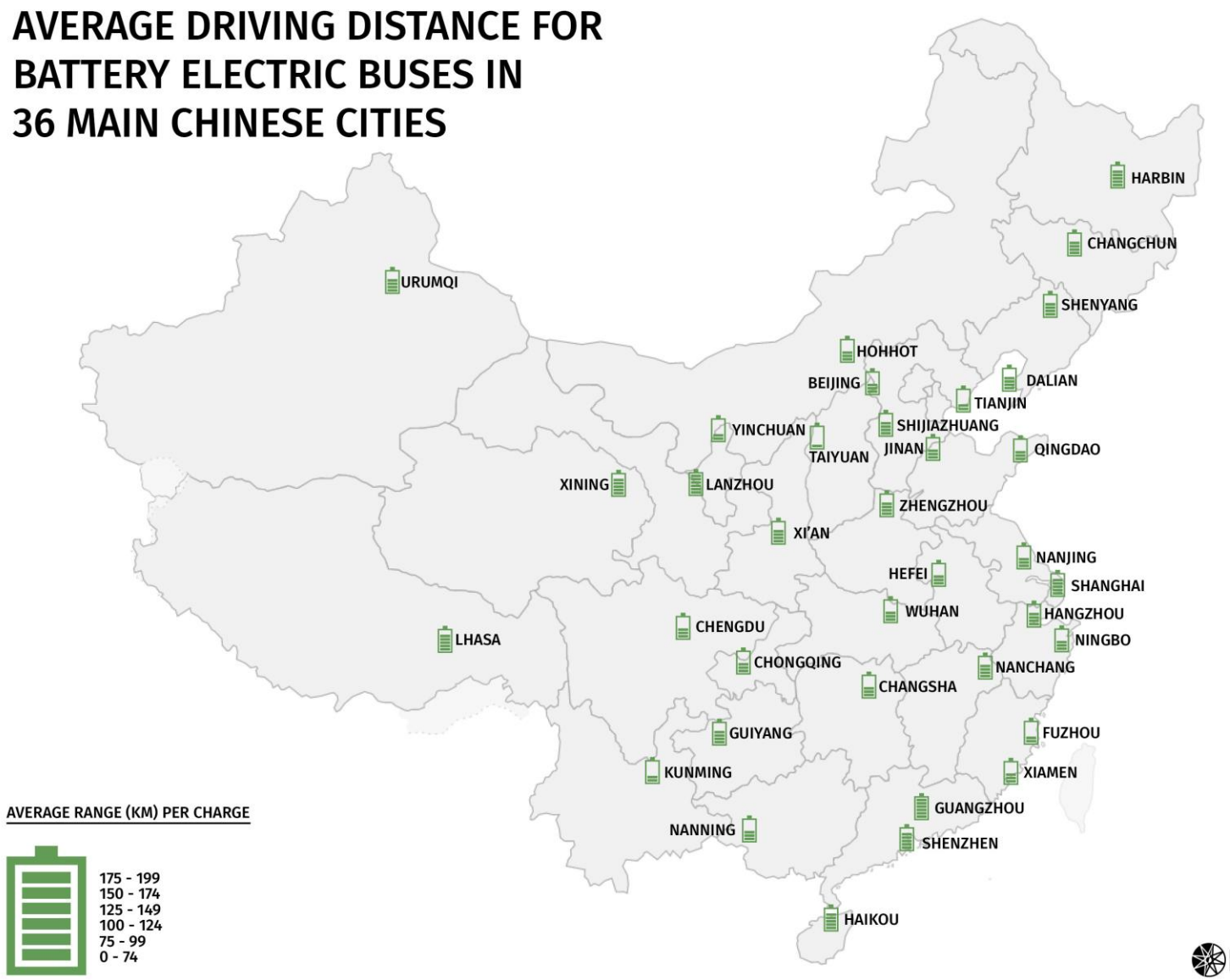
Average Driving Distance





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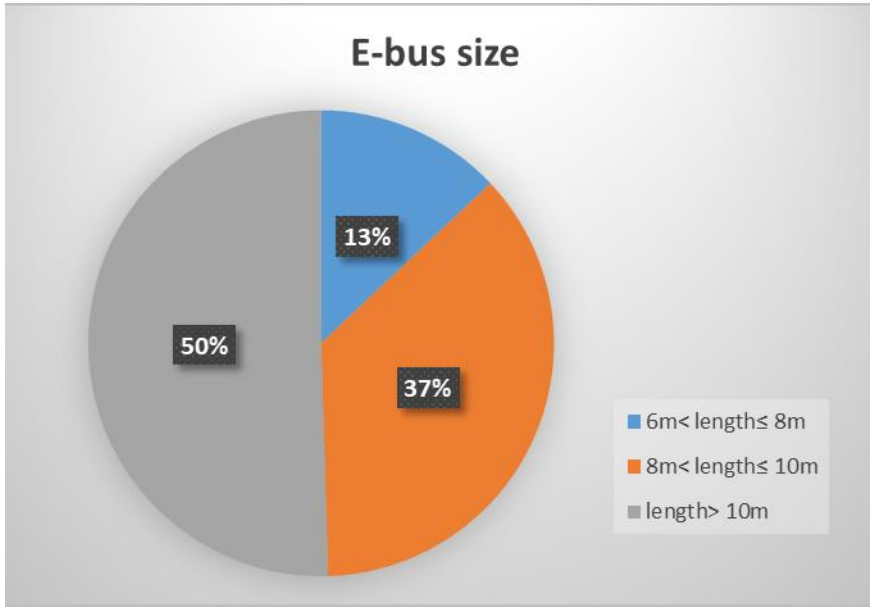
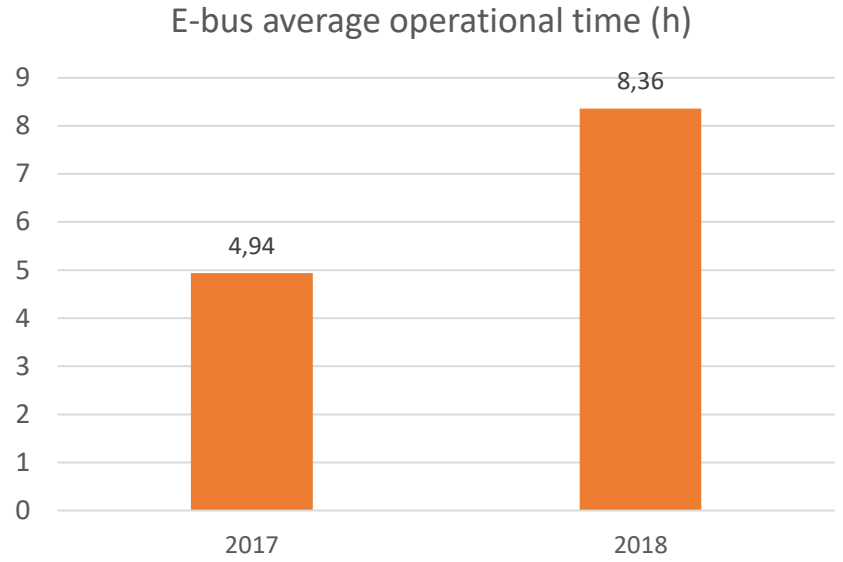
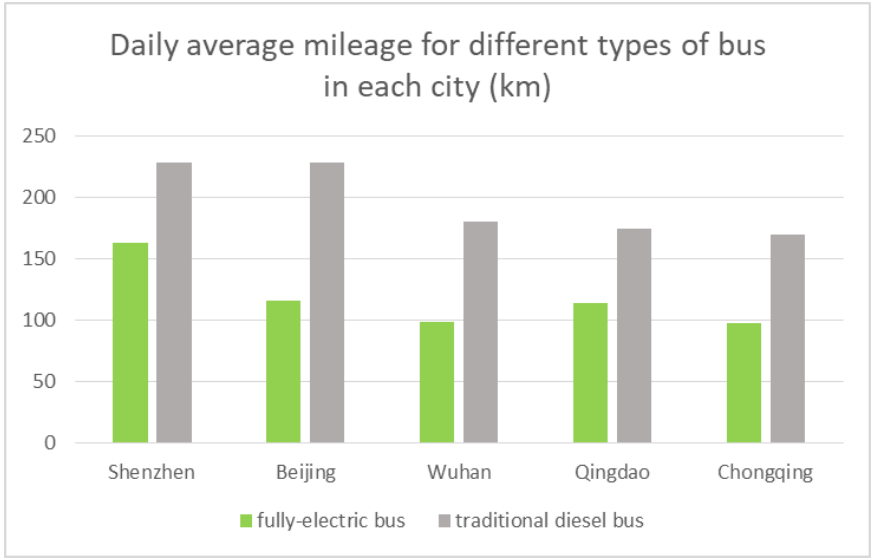
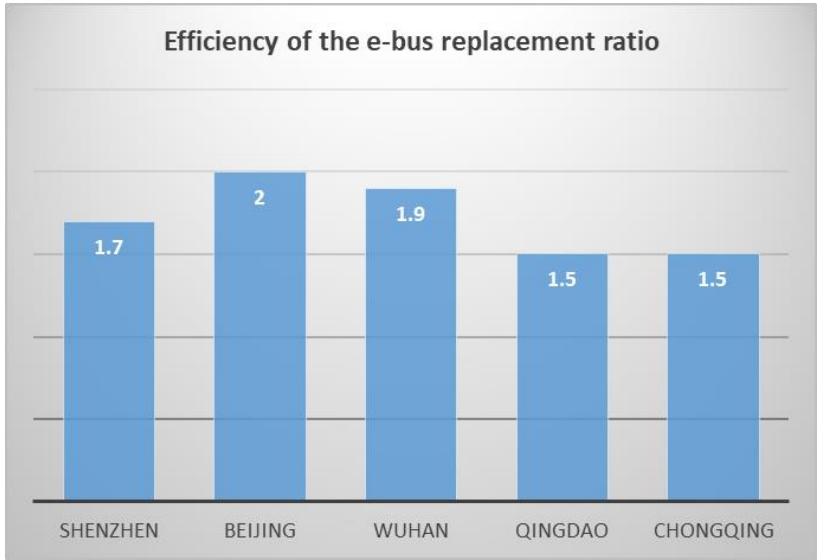
Operational data









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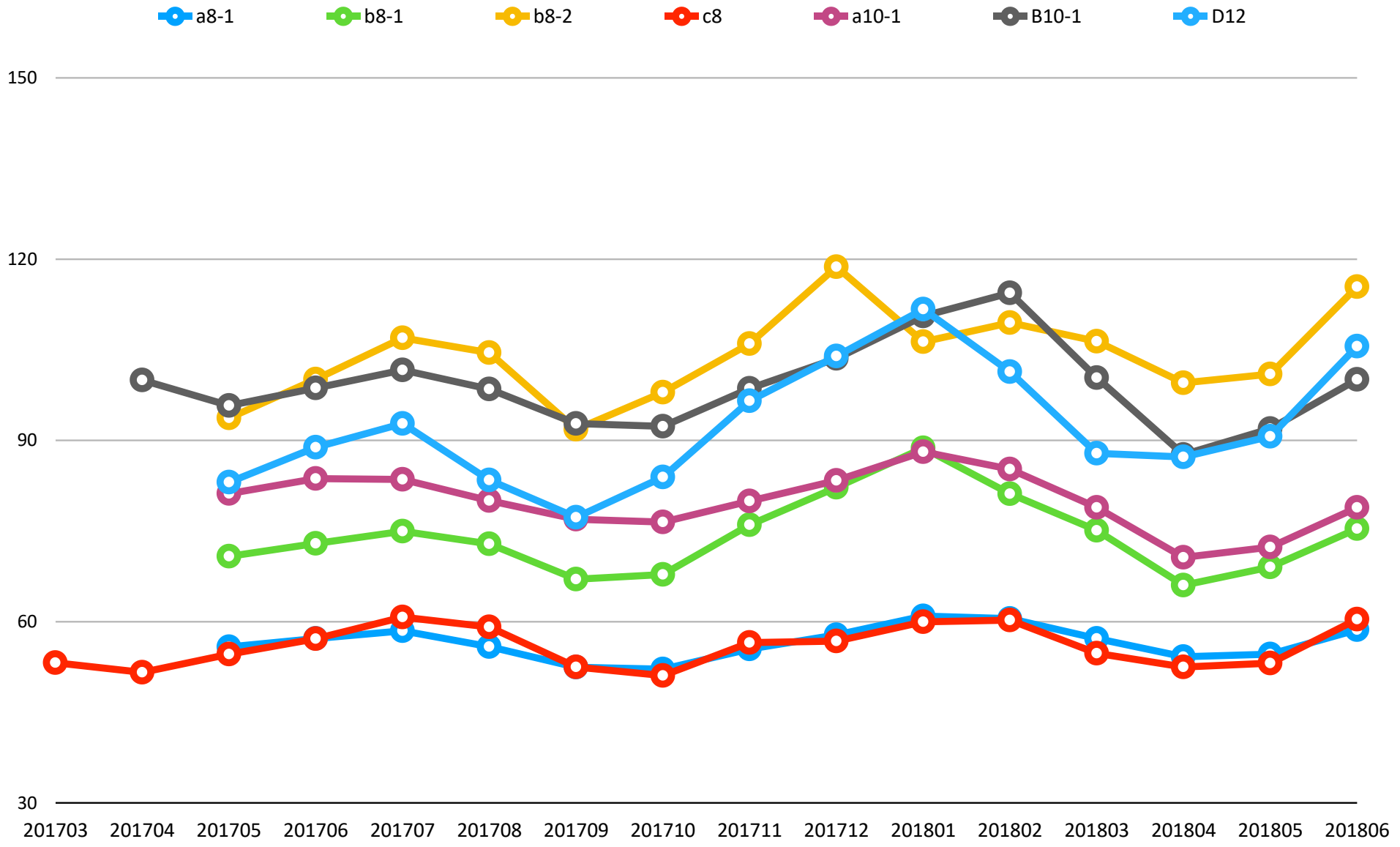
Energy Consumption



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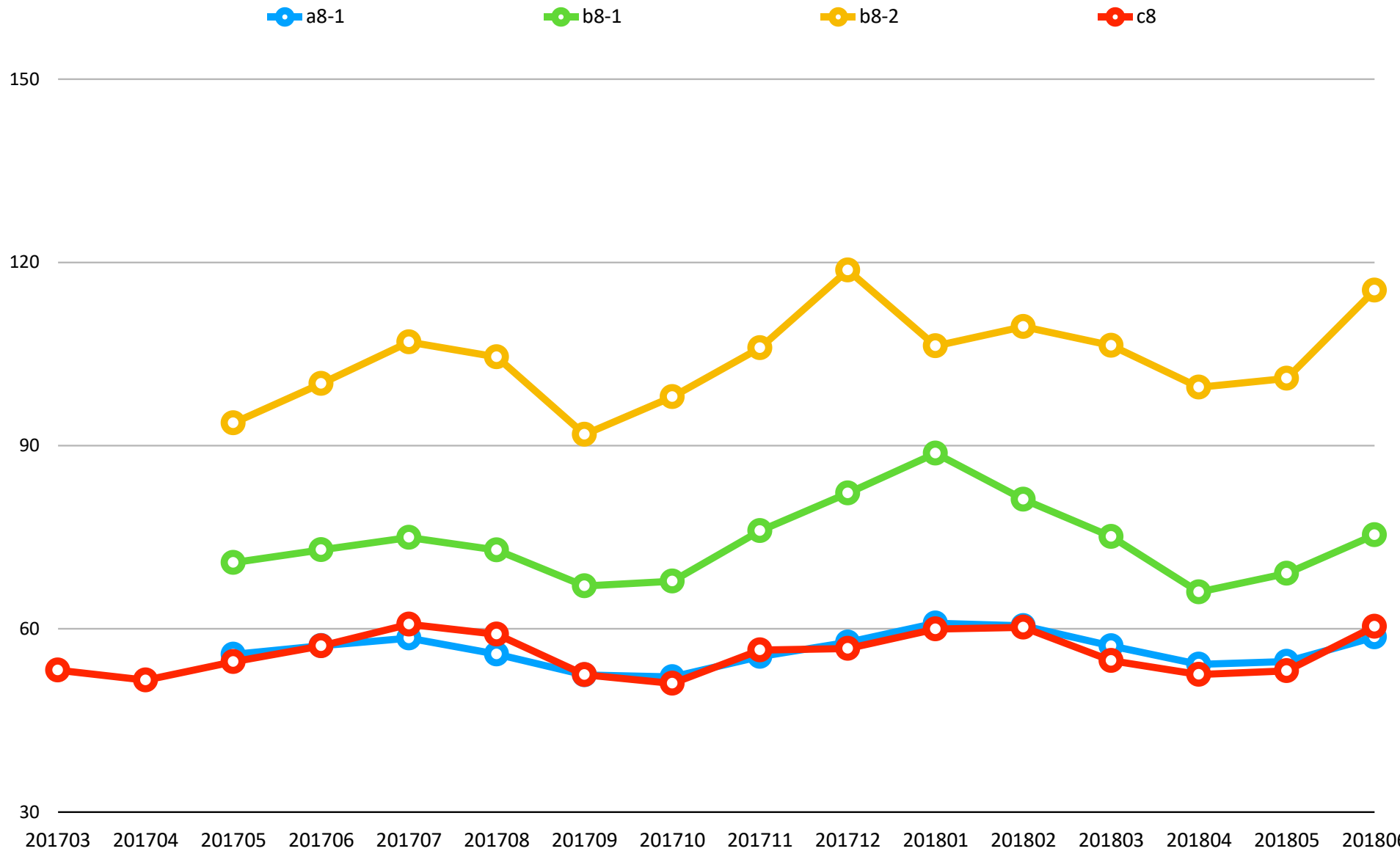
Energy Consumption



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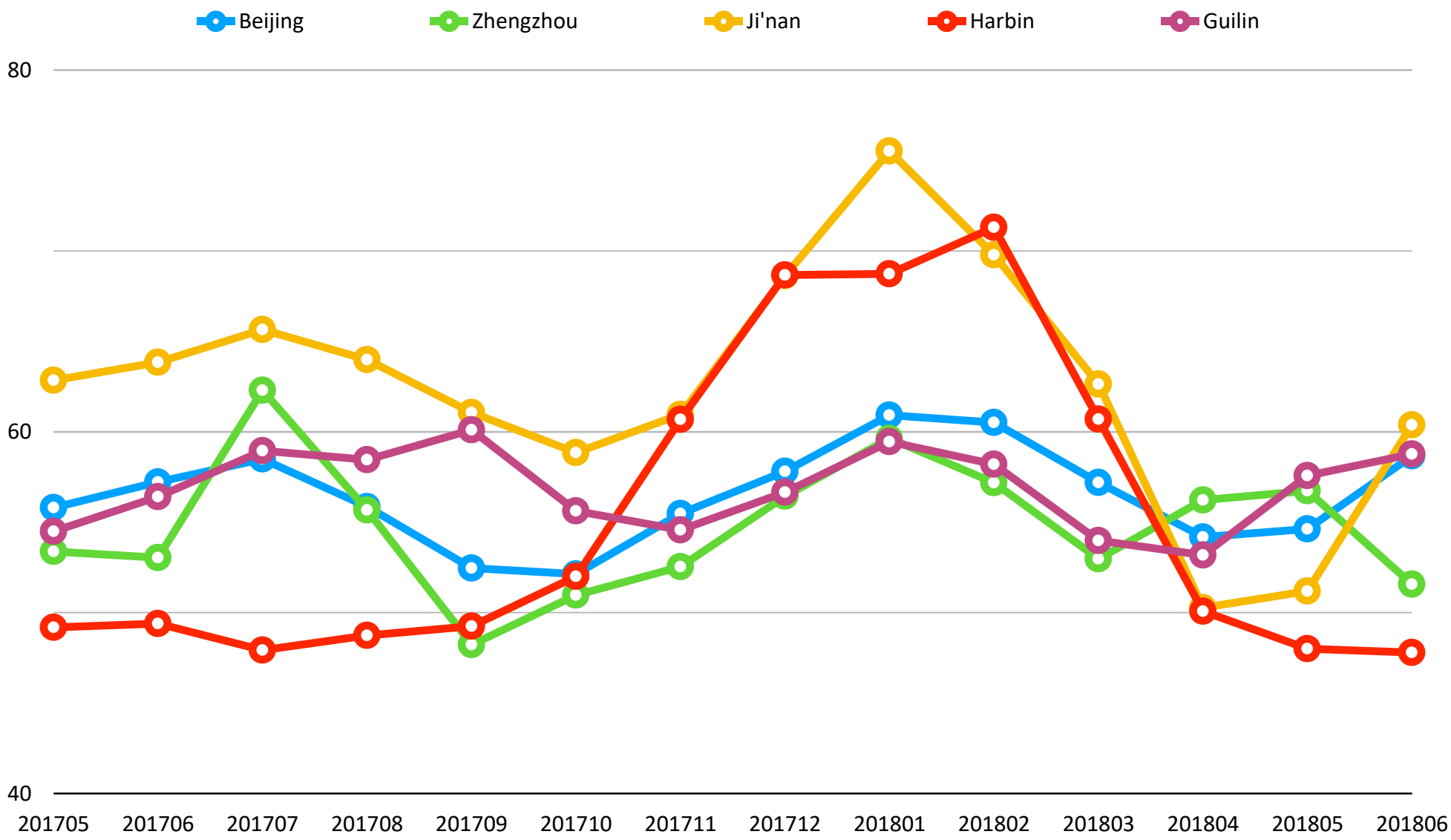
Energy Consumption



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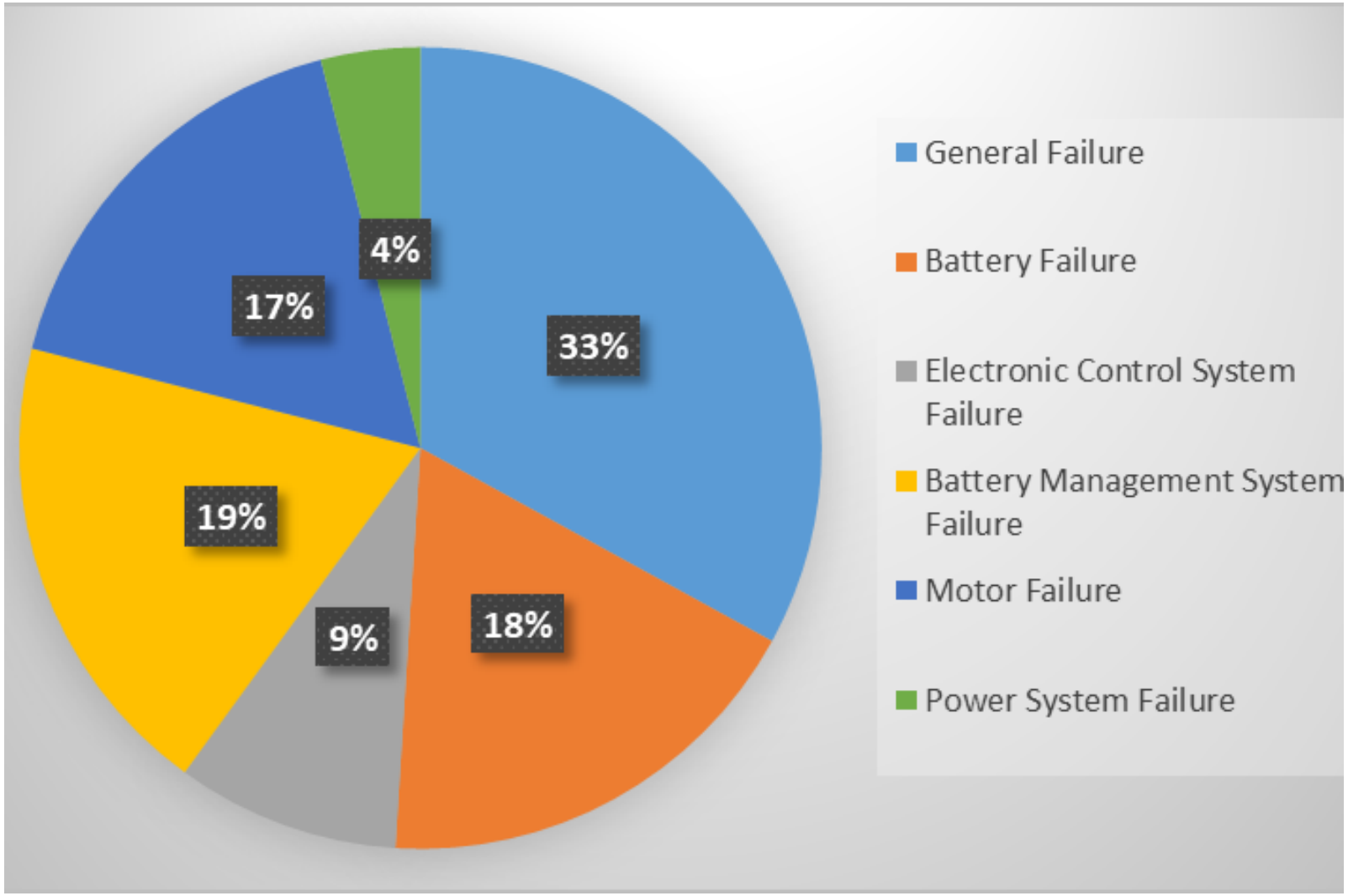
Operational Failure



Charging infrastructure

Charging Infrastructure

Type	Power	Pros	Cons	Location
Plug-in 	AC: 20-50Kw	• Lower initial cost • Low grid pressure • Charging at night, supporting the grid with 'cutting peak and filling valley' strategy • Cheaper operational cost	• Long charging time, not ideal for e-bus operation • Space requirement	Bus depot
	DC: 50-150Kw	• Fast charge in the daytime support flexible operation • Charging at night, supporting the grid with 'cutting peak and filling valley' strategy • Short charging time	• High pressure on grid • Space requirement	
Pantograph 	360Kw and above	• Fast charge support flexible operation • Installed along bus lines, less requirements on space	• High initial investment • High pressure on grid • Harmful to batteries life	Flexible, located along bus lines and depots

Plug-in DC charge is most common and matured technology in China for e-bus.

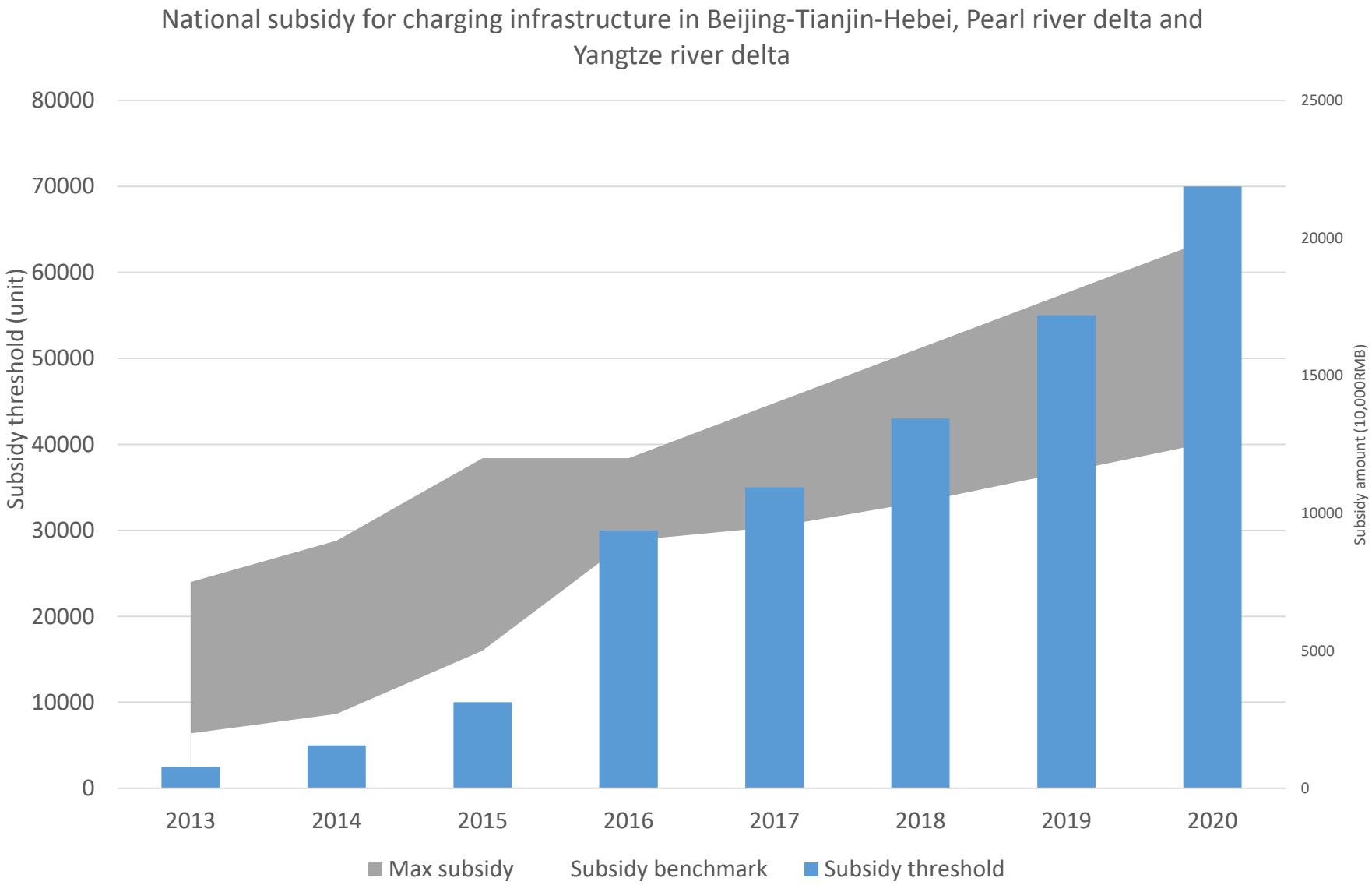
Pantograph Charging

Pantograph charging

Two demonstration pantograph charging stations installed in Shanghai.

Subsidy for charging infrastructure

The national subsidy has been shifted from bus procurement to infrastructure support from 2016.



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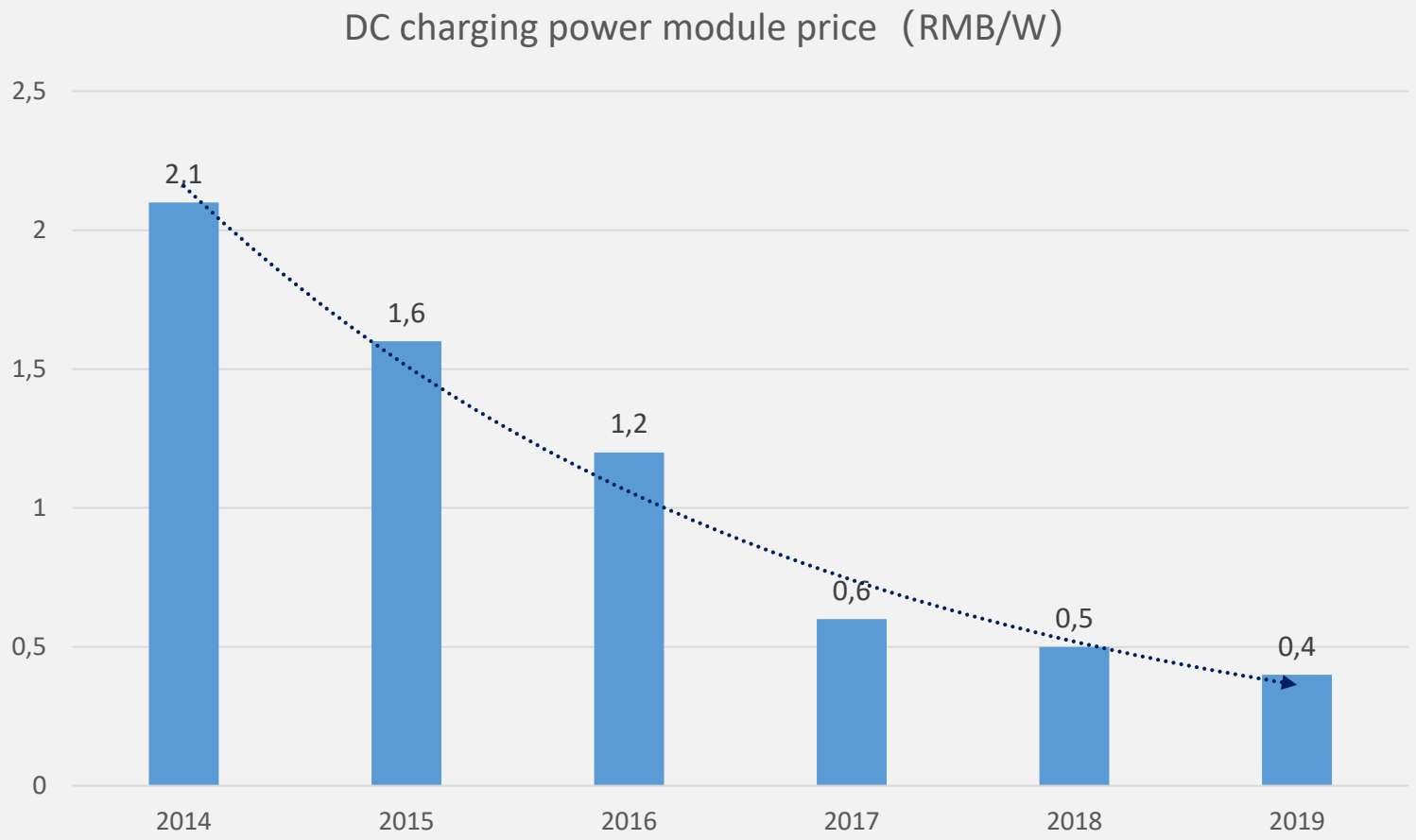
Price for DC Charging Module



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Suggestions

- National government, local government, bus company, bus industry should work together on:
  - Establish testing, evaluation, monitoring and report mechanism on E-bus real world performance
  - Establish e-bus **monitoring platform** to help to make better decision on e-bus procurement and operation
- Charging infrastructure should be planed before e-bus procurement
- Optimized bus route plan and operational plan should be conducted before e-bus procurement
- Detailed operational plan should based on different types of buses and charging infrastructures.

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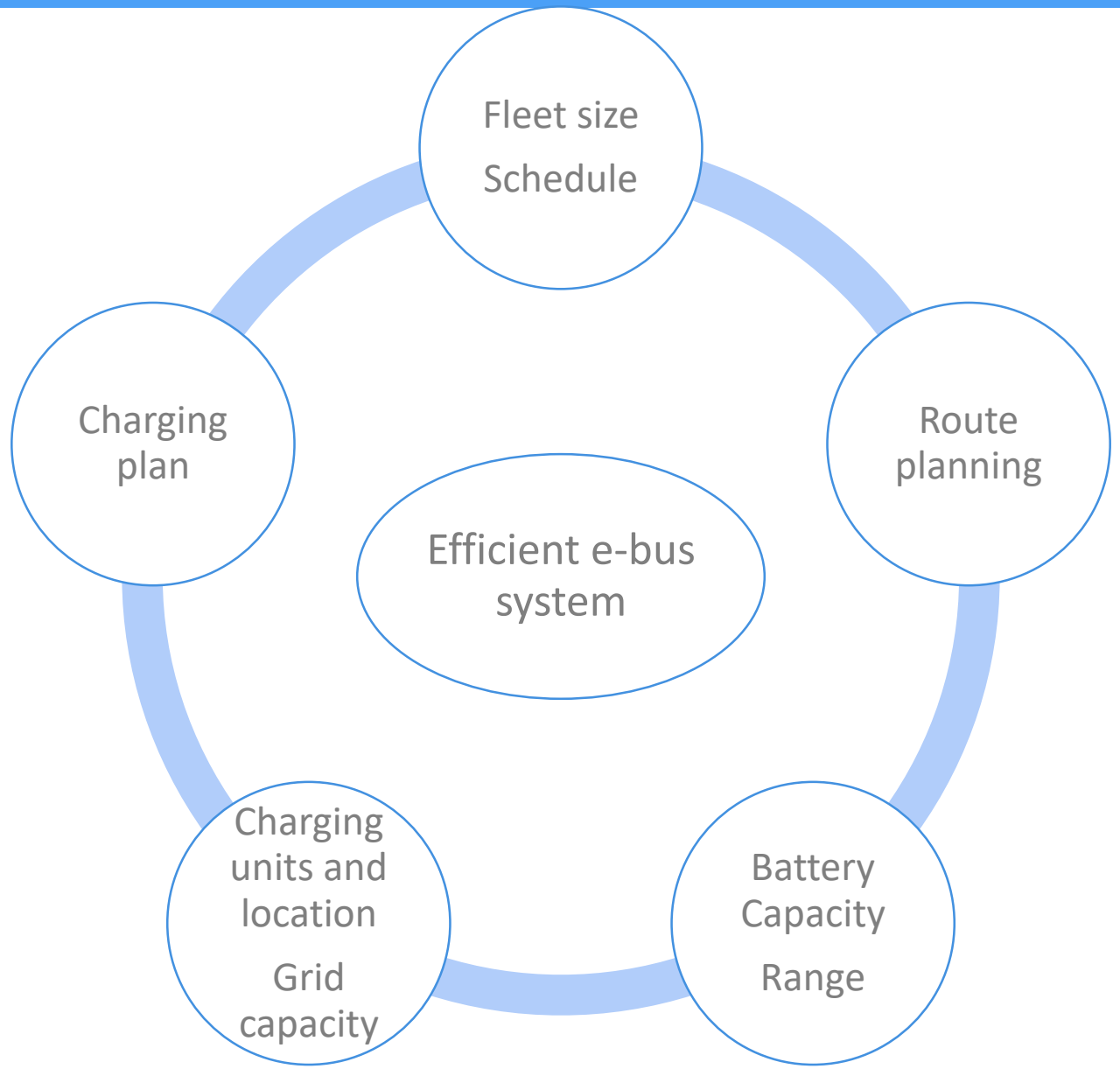
Start from a Pilot Project



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Data collection and analysis

- Power comsuption, record changes in differnt temporature
- Driving range, driving range in differnt temporature
- Performance review for e-bus from different manufactures
- Battery decay rate
- Charging pattern: including time and frequency
- Major operational failures
- Operational cost
- Monitor the bus performance and charging behaviors
- Benefits: energy saving, CO2 reduction, pollutant reduction

Shenzhen Case Study

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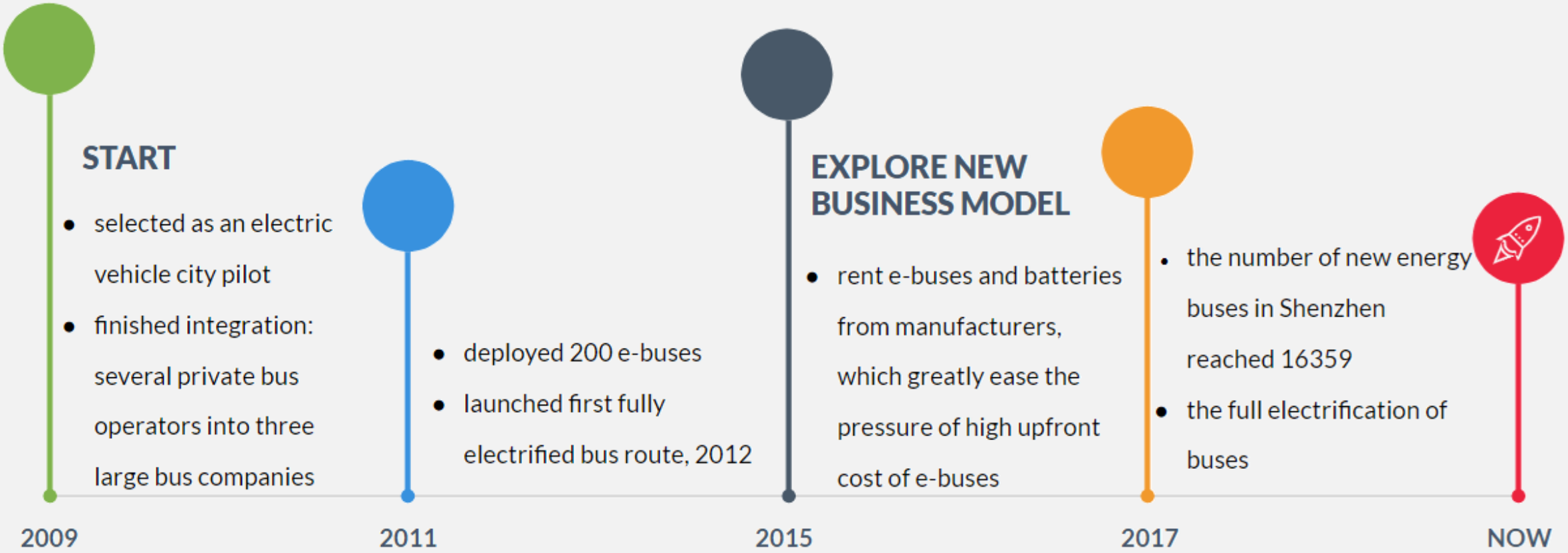
Overview:

The Development of New Energy Vehicles in Shenzhen



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Overview:

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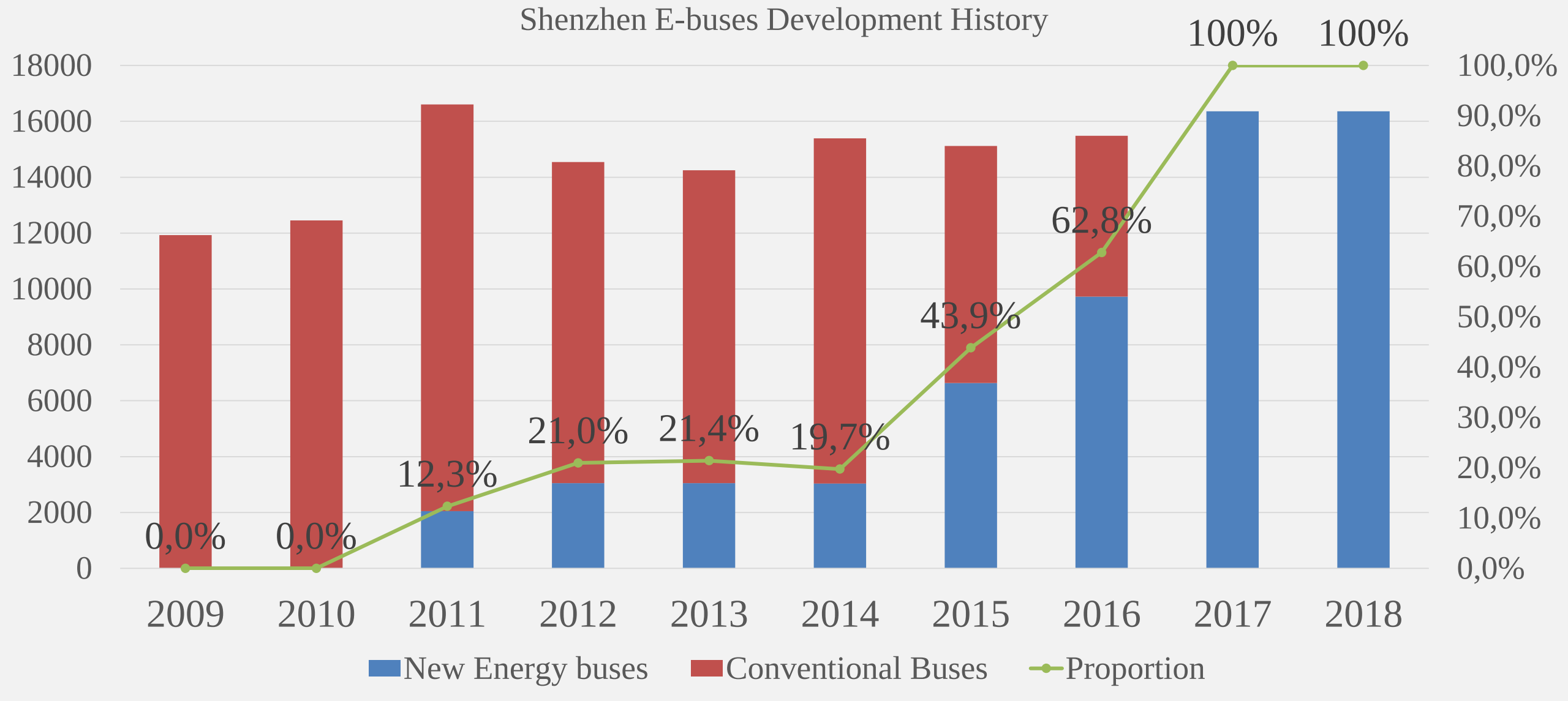

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Successful Experience

Governments at all levels attach great importance and issue various policies to support—

Year	Name of policy and measures issued
2009	The Shenzhen New Energy Industry Development Plan (2009-2015)
2014	Shenzhen '13th Five-Year Plan'
2015	Working plan for developing new energy vehicle in Shenzhen
	Policies and measures for promotion and application of new energy vehicles in Shenzhen
	Implementation rules for record management for operators of charging facilities for new energy vehicles in Shenzhen.
2016	Methods for distributing stipend in operating new energy bus during promoting period.
2017	Method for distributing stipend for refined oil prices and operation of new energy buses in Shenzhen from 2015 to 2019 (trial)
2018	A sustainable action plan named "Shenzhen blue"
	Interim measures for the management of charging facilities for new energy vehicles in Shenzhen

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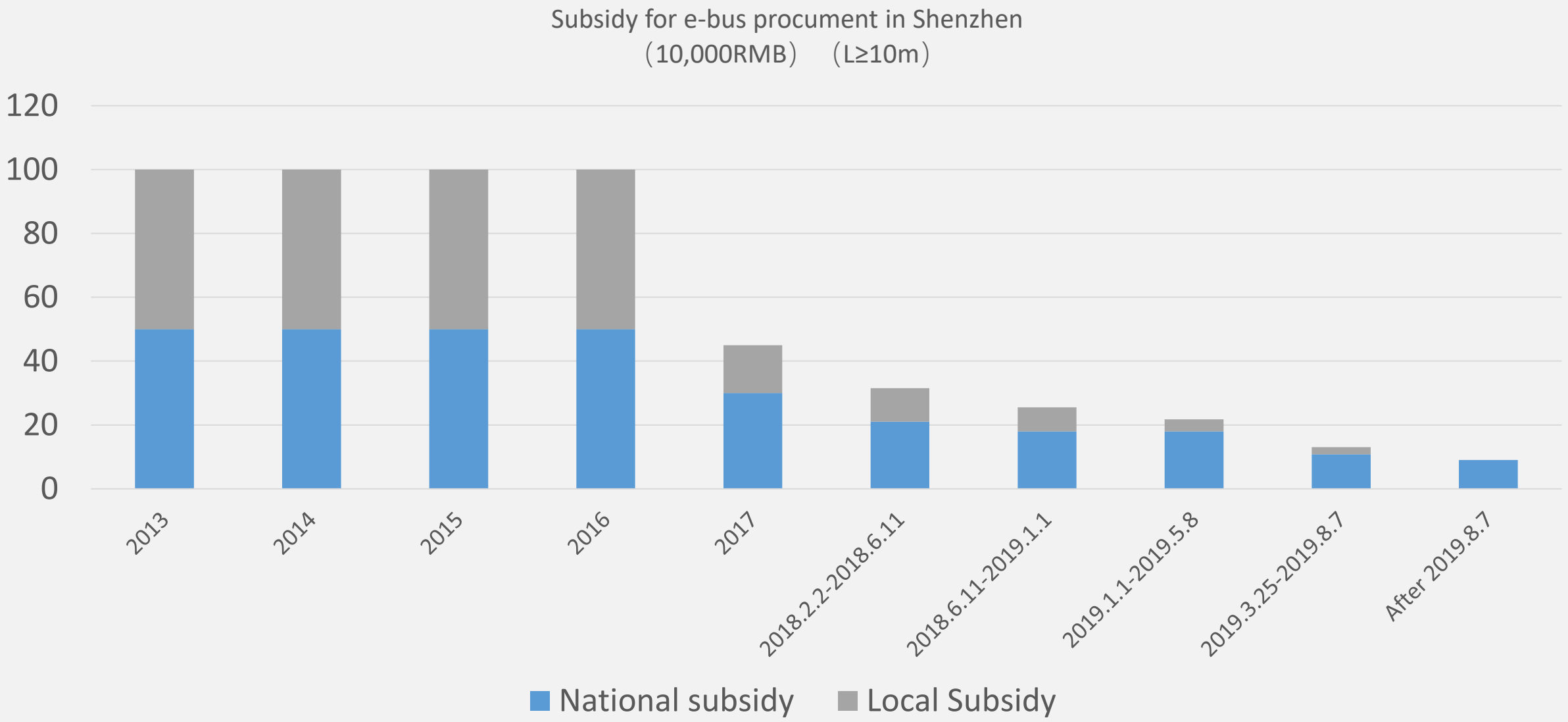
Successful Experience

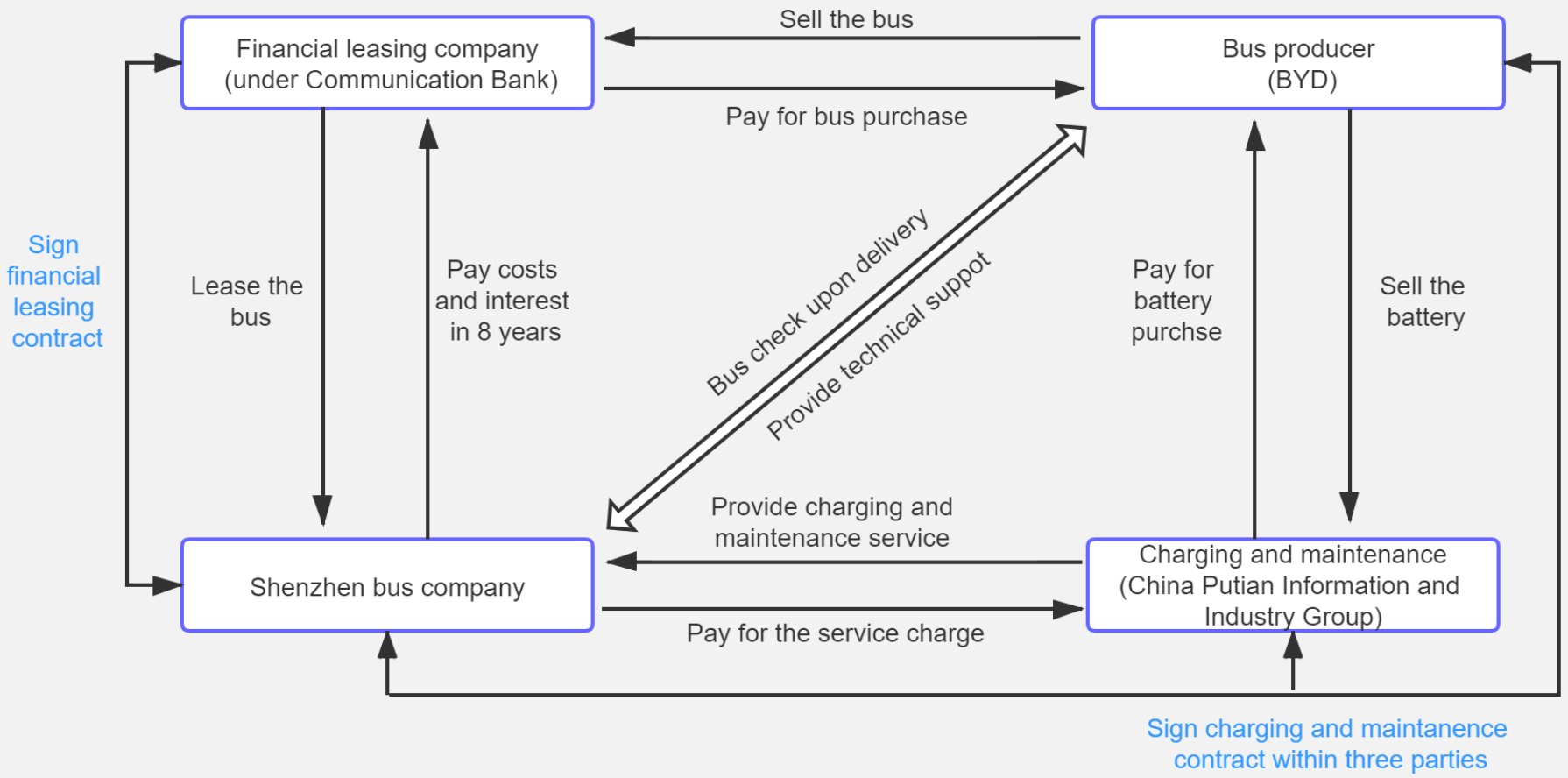
Financial Support and Model Innovation—



Successful Experience

Financial Support and Model Innovation—

- adopted a system of integrating multiple parties to reduce the overall cost burden and market risks
- innovates the financial model for e-bus procurement and operation, which is **'financial leasing, separation of vehicle and battery, outsourcing of charging and maintenance'**, to reduce the upfront cost, and encourage bus companies to speed up the transition.



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Thanks!

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