BRIEFING

JUNE 2023

Zero-emission truck market developments and opportunities in Sichuan province China

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INTRODUCTION

Cities in Sichuan province are playing an important role in emissions reduction in China's Chengdu-Chongqing region, which is a "key region" in the national *Action Plan for the Battle Against Diesel Truck Pollution*.[1] In 2021, Sichuan reported a 29.9% reduction in carbon emissions during the 13th Five-Year Plan period from 2016 to 2020, and an annual average fine particulate matter ($PM_{2.5}$) concentration of 31.8 μg/m^3—a 4.5% reduction from the 2018–2020 average.[2] The provincial government followed that in 2022 with the *Guidelines on Achieving Carbon Peaking and Carbon Neutrality* and pledged to peak carbon emissions before 2030 and to be carbon neutral by 2060.[3] The *14th Five-Year Plan for Ecological and Environmental Protection for Sichuan Province* also features targets for improving air quality by 2025, including a 29.5 μg/m^3 annual average for $PM_{2.5}$ and a 5-year nitrogen oxides (NO_x) reduction of 59,500 tonnes.[4]

The *Guidelines* recognize promotion of new energy vehicles (NEVs)—these are battery-electric, fuel-cell electric, and plug-in hybrid electric vehicles—as a significant pathway for achieving carbon neutrality, and the People's Government of Sichuan Province's

1 Chinese Central Government, "The Action Plan for the Battle Against Diesel Truck Pollution," (November 2022), http://www.gov.cn/zhengce/zhengceku/2022-11/17/content_5727605.htm.

2 People's Government of Sichuan Province, "The 14th Five-Year Plan For Ecological And Environmental Protection Of Sichuan Province," (January 2022), https://www.sc.gov.cn/10462/zfwjts/2022/1/17/516b4a42e34043c5b6c2b5ff6f3716a4/files/3fcbce39b3f64bca848b60f09930c8be.PDF; Department of Ecology and Environment of Sichuan Province, "2021年四川省生态环境公报," (2022), http://sthjt.sc.gov.cn/sthjt/c104157/2022/6/5/c0b70beeaf7c4562b47f6ee43645eede.shtml.

3 People's Government of Sichuan Province, "Guidelines On Achieving Carbon Peaking and Carbon Neutrality," (2022), https://www.sc.gov.cn/10462/10464/10797/2022/3/31/aeed3b7b7f3c4b189d68d891e50e95b6.shtml.

4 People's Government of Sichuan Province, "The 14th Five-Year Plan For Ecological And Environmental Protection Of Sichuan Province."

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March 2022 *"Electric Sichuan" Action Plan* is recognized as an important policy for promoting NEVs.[5] The *Action Plan* cites targets for increasing NEV market penetration in the province to make it a sales leader in China by 2025; targets include reaching over 80% of NEVs in sales of new public transportation vehicles (including taxis and city buses) and over 50% of NEVs in new sanitation vehicles; pilot programs on freight vehicle electrification; deploying 6,000 fuel-cell electric vehicles (FCEVs); and installing 120,000 charging stations and more than 60 hydrogen refueling stations.

Table 1 provides an overview of achievements and targets for NEV adoption in Sichuan province as of the end of 2022.[6] A previous ICCT study discussed Sichuan's achievements in new energy light-duty vehicles.[7] In the heavy-duty vehicle space, 87.2% of Sichuan's public bus stock in 2021 consisted of NEVs, and the province is targeting that 100% of new bus sales be NEVs by 2025. Meanwhile, truck electrification remains in an early stage with few developments reported, and targets for Sichuan and its cities are unclear.

Table 1. Achievements and targets for NEVs development in Sichuan province.

	Achievements	2025 targets
New energy vehicles	• 330,000 NEVs in stock in 2021 • 87.2% of NEVs in city buses stock in 2021 • 400,000 NEVs in stock in 2022 • 220 FCEVs by August 2020	• 100% NEVs in new bus sales • 6,000 FCEVs in stock, including heavy trucks, medium and light logistics vehicles, and passenger vehicles
Infrastructure development	• 42,000 public charging stations in 2021	• 120,000 charging stations • Over 60 hydrogenation stations

This paper provides an overview of the market development of heavy-duty new energy trucks (NET) in Sichuan and then seeks to identify challenges and opportunities for zero-emission truck (ZET) adoption in the province. Note that ZET refers to battery-electric trucks (BETs) and fuel-cell electric trucks (FCETs); NET is a broader category used in China that also includes plug-in hybrid electric trucks.

ZET MARKET DEVELOPMENT AND INCENTIVES IN SICHUAN

Sichuan was among the top three Chinese provinces for ZET sales from 2019 to 2022, as shown in Figure 1. In those 4 years, 10,224 BETs and 134 FCETs were sold in the province; these were 6% of total truck sales. ZET sales in Sichuan in 2022 were nearly quadruple what they were in 2019.

5 People's Government of Sichuan Province, "'Electric Sichuan' Action Plan," (2022), https://www.sc.gov.cn/10462/zfwjts/2022/4/1/cd43e7ed8ea8482291fc648bc108d02f/files/a71c4a297569465d864eb8d6e2819802.pdf.

6 People's Government of Sichuan Province, "The 14th Five-Year Plan For Comprehensive Transportation Of Sichuan Province," (2022), https://www.sc.gov.cn/10462/11555/11562/2021/11/24/4d41e6b77c9c4d5ea89ce4a71a8e11bf.shtml; Sichuan Provincial Economic and Information Department, "新能源与智能汽车产业2022年度工作方案," (2022), https://jxt.sc.gov.cn/scjxt/wjfb/2022/3/31/e3d29ebca4c04d979174c2054c5cf3d1.shtml; People's Government of Sichuan Province, "Hydrogen Industry Development Plan for 2021-2025," (2021), https://jxt.sc.gov.cn/scjxt/wjfb/2020/9/21/12979ab0d1cf41b18489d7d9559e4abf.shtml.

7 Yidan Chu, et al., "Assessment of Leading New Energy Vehicle City Markets in China and Policy Lessons," (ICCT: Washington, D.C., 2022), https://theicct.org/publication/china-city-markets-new-energy-sep22/; Yidan Chu and Hui He, "Leading New Energy Vehicle City Markets in China: A 2021 Update," (ICCT: Washington, D.C., 2022), https://theicct.org/publication/ev-china-city-markets-2021-update-nov22/.

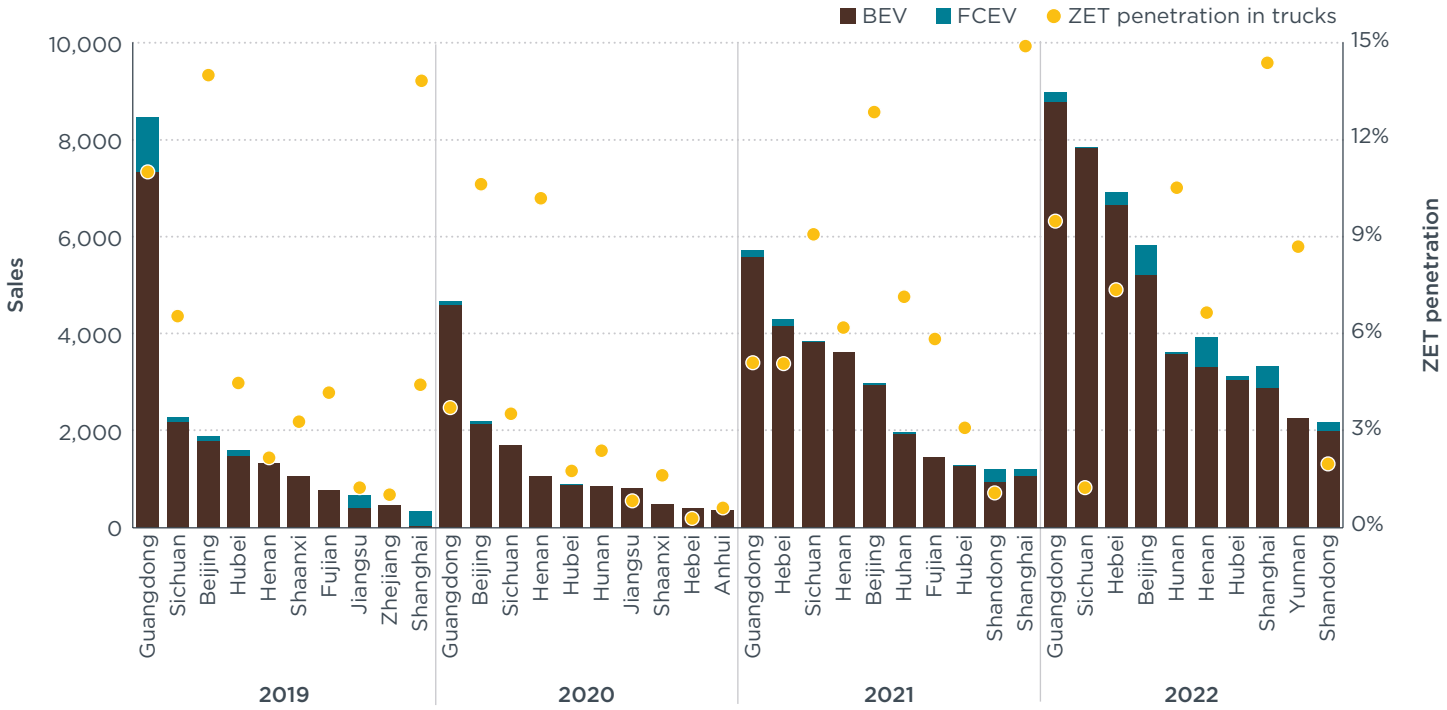

Figure 1. Top 10 provinces in China for ZET sales, 2019–2022.

To further strengthen ZET market development, in 2021, Sichuan announced the *Policies and Measures to Support the Development of New Energy and Intelligent Vehicle Industry.*[8] It complements a national subsidy that had been the only incentive policy.[9] The key incentives in Sichuan's measures are:

- Manufacturers can receive CNY 1,000,000 (~US$142,000) for each new ZET model recorded in the *Catalog of New Energy Automobile Application Recommended Models* from the Ministry of Industry and Information Technology. If 500 BETs or 50 FCETs are sold within 1 year of the model being recorded, the manufacturer can receive another CNY 1,000,000 subsidy. In all, subsidies for ZET model development can reach CNY 4,000 (~ US$570) per BET sold and CNY 40,000 (~ US$5,700) per FCET.
- Manufacturers can receive a one-time award equal to 0.5% of the annual sales value if more than 5,000 ZETs are sold in a year. If the annual sales value increases more than 10% from the previous year, the manufacturer can receive a subsidy of up to CNY 10,000,000. In all, subsidies for ZET sales can reach CNY 2,000 per truck.
- Subsidies up to CNY 2 (for the first year) and 0.4 (for the second year) per kWh for electric battery manufacturers that reach 5 GWh of annual production. The province will provide CNY 5,000 (first year) and CNY 1,000 (second year) per kW to hydrogen battery manufacturers with 10 MW annual production.

The incentives remain in effect through 2023. They are expected to increase ZET sales in Sichuan. However, the incentives are mainly targeted at manufacturers, and there is less emphasis on spurring consumer demand for the vehicles. In terms of the total cost of ownership (TCO), financial incentives and subsidies, especially direct purchase subsidies, could be very effective and attractive to buyers and motivate them to buy ZETs.[10]

8 People's Government of Sichuan Province, "四川省支持新能源与智能汽车产业发展若干政策措施 (至2023.09" (2020), https://www.sc.gov.cn/10462/c103044/2020/9/30/5a37938af489498b861716f17e236964.shtml.

9 State Council, "国务院办公厅关于加快新能源汽车推广应用的指导意见" (2014), http://www.gov.cn/zhengce/content/2014-07/21/content_8936.htm.

10 Tianlin Niu, Felipe Rodríguez, and Pierre-Louis Ragon, "International Vehicle Labeling Programs and Recommendations for a Heavy-Duty Vehicle Greenhouse Gas Emission Labeling Program in China," (ICCT: Washington, D.C., 2022), https://theicct.org/publication/china-hvs-hdv-labeling-china-oct22/.

CITY SALES AND INCENTIVES

Figure 2 lists ZET sales for cities in Sichuan from 2019 to 2022. The provincial capital of Chengdu claimed over 90% of sales during those 4 years and the cities of Yibin, Mianyang, and Nanchong recorded 4%, 3%, and 1% of ZET sales, respectively. In 2022, ZETs comprised 28%, 25%, 22%, and 21% of all new trucks sold in Yibin, Chengdu, Aba, and Ganzi, respectively, all much higher than these cities' penetration rates from 2019 to 2021. Furthermore, while only Sichuan's five main cities recorded ZET sales in 2019, all 21 cities (including three autonomous prefectures) had sales in 2022.

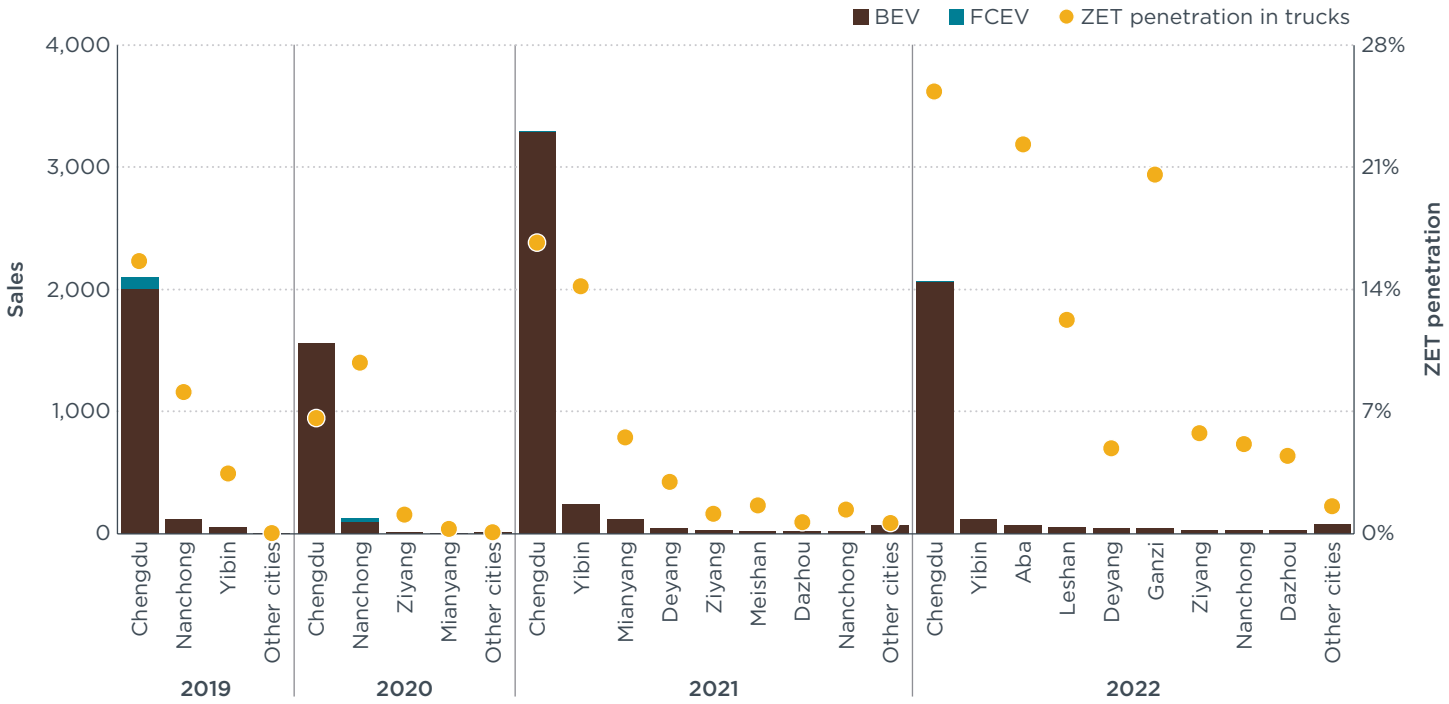

Figure 2. City-level ZET sales in Sichuan province, 2019-2022.

These sales increases were mainly driven by additional incentives offered by the cities. For example:

- Chengdu established a purchase subsidy of up to CNY 300,000 for each ZET sold for construction and logistics operations; a scrappage subsidy of up to CNY 8,000 for replacing traditional fossil-fuel vehicles, including trucks, with an NEV; and parking discounts and relief from driving restrictions (e.g., daytime access to the urban center). The city also provides subsidies for services such as building public charging facilities and green hydrogen production.[11]
- Yibin is committed to creating "Electric Yibin" and has become a national NEV pilot city for the heavy-duty vehicle electrification transition.[12] The city government will provide subsidies up to CNY 10 million to manufacturers working on NETs.

11 Chengdu Government, "成都市人民政府办公厅关于印发成都市优化交通运输结构促进城市绿色低碳发展行动方案、成都市优化交通运输结构促进城市绿色低碳发展政策措施的通知" (2022), http://gk.chengdu.gov.cn/govInfo/detail.action?id=139274&tn=6; People's Government of Sichuan Province, "成都发布优化能源结构促进城市绿色低碳发展行动方案" (2022), https://www.sc.gov.cn/10462/10464/10465/10595/2022/6/20/191c9ca01c3149449fec2e1400a41166.shtml.

12 People's Government of Sichuan Province, "助力打造沿江绿色发展典范 宜宾市全面推动 '电动宜宾' 建设" (2022), https://www.sc.gov.cn/10462/10464/10465/10595/2022/4/12/b5699d3d1c0442c98bd89ea5129fb017.shtml.

» Meishan provides up to a CNY 30,000 subsidy for purchasing logistics trucks.[13]

» Panzhihua is offering incentives to meet a target of 1,000 hydrogen fuel cell vehicles by 2025.[14]

At the city level, more incentives offer direct benefits for buying trucks, and this benefits buyers from a TCO perspective. However, these policies and plans do not explicitly cover most types of heavy-duty trucks, even though these vehicles contribute significantly to carbon emissions and air pollution.

ZET SALES BY TRUCK TYPES

Electrifying a light urban delivery truck is not the same as electrifying a heavy long-haul truck. That makes a market analysis by truck type important. Here

we have data from 2021 and focused on the three truck types that are most commonly used for commercial purposes: logistics trucks, dump trucks, and tractor-trailers. All additional types are classified as "other" below. Logistics trucks are van trucks with a gross vehicle weight (GVW) range from 3.5 t to 12 t, according to the Definition of Urban Logistic Trucks (GB/T 29912-2013_3750), and other trucks are mainly straight trucks, utility vehicles, or vocational trucks that perform sanitation, ambulance, cement mixing, or other services.[15]

Figure 3 shows the provincial distribution of new BETs sold in absolute numbers in 2021 by city and truck type. Over 90% of electric logistics trucks were sold in Chengdu, as were four of the five electric dump trucks sold in the province and all seven electric tractor-trailers. Nearly 56% of new BETs were logistics vehicles, while electric dump trucks and tractor-trailers comprised less than 0.4% of BETs sold that year in the province. The chart does not present FCETs; only two were sold in 2021, both in Chengdu.

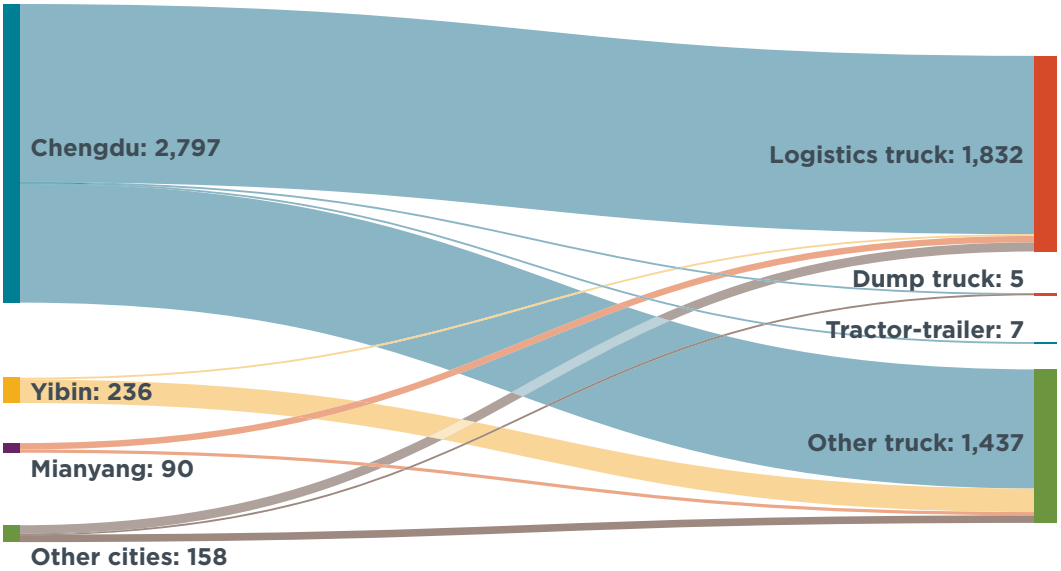

Figure 3. BET sales in Sichuan in 2021, by city and major truck type.

13 Sichuan Bendibao, "Overview of NEV Purchase Subsidies in Sichuan in 2022," (2022), http://cd.bendibao.com/live/2022620/139312.shtm.

14 Panzhihua Government, "攀枝花市 '十四五' 工业发展规划" (2022), http://www.panzhihua.gov.cn/tzfw/zwgk/ghjh/4119794.shtml.

15 "Technical Requirements for Lectotype of Urban Logistics Distribution Vehicles," November 2013, https://max.book118.com/html/2019/0810/5021110243002113.shtm.

As shown in Figure 4, zero-emission dump trucks and tractor-trailers have little to no penetration in the broader markets in Sichuan's cities. There is good ZET penetration for logistics trucks only in Chengdu (38%) and Mianyang/Yibin (20%); electrified logistics trucks as a percentage of total new electric truck sales were 4% for other cities.

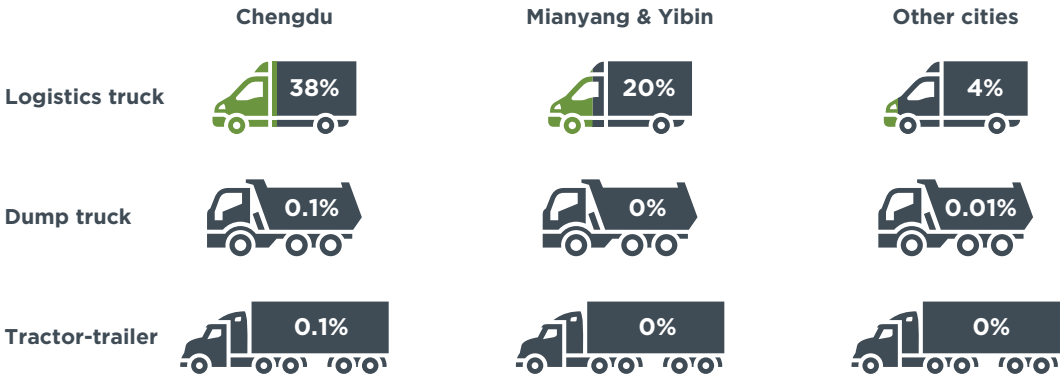

Figure 4. ZET sales penetration in Sichuan in 2021 by city and major truck type; the shade indicates the portion of ZETs in total new truck sales.

CAPACITY OF ZETS IN SICHUAN

While financial and nonfinancial incentives can promote demand for ZET models, the trucks need to handle the same duties as their diesel counterparts if they are to succeed in the market. The technical analysis below can identify the capabilities of deployed ZETs and help explore opportunities for ZET technology development.

TOP SELLERS AND PAYLOAD CAPACITY

Tables 2 to 4 present specifications for both the top-selling ZETs in 2021 in Sichuan in the logistics truck, dump truck, and tractor-trailer categories and their best-selling diesel counterparts. The data show similar payload capacities and engine power between the ZET and diesel models with the same or similar GVW or gross combined weight (GCW).

Table 2. Top-selling diesel and electric logistics trucks weighing 4.5 t in Sichuan, 2021.

	Diesel	Electric
Vehicle model	BJ5048XXY-F3	DFA5040XXYEBEV
OEM	Futian (Foton)	Dongfeng
Brand	Futian	Dongfeng
Sales (2021)	195	221
Payload (kg)	1,495	1,445
GVW (kg)	4,495	4,495
Engine power (kW)	115	115
Engine displacement (L) / Electric range (km)	2.78	345/365

Table 3. Top-selling diesel and electric dump trucks weighing between 4.5 t and 12 t and the top seller among all dump trucks in Sichuan, 2021.

	Diesel	Electric	Diesel (among all dump trucks)
Vehicle model	CDW3091A1Q5	NJA3090EDH32BEV	CQ3316HYVG426L
OEM	Sinotruk	Nanjun (CNJ)	Shangqi (SAIC)
Brand	Wangpai	Nanjun	Hongyan
Sales (2021)	40	5	807
Payload (kg)	4,450	4,670	15,370
GVW (kg)	9,495	9,100	31,000
Engine power (kW)	95	105 (max165)	415/385/353
Engine displacement (L) / Electric Range (km)	3.76	255	12.88

Table 4. Top-selling diesel, electric, and fuel-cell electric tractor-trailers with 48 t GCW in Sichuan, 2021.

	Diesel	Electric	Fuel-cell electric
Vehicle model	DFH4250D	XGA4254BEVWCA	CQ4250FCEVSS404
OEM	Dongfeng	Xugong (XCMG)	Shangqi (SAIC)
Brand	Tianlong	Xugong	Hongyan
Sales (2021)	2,708	4	1
Payload (kg)	39,805	38,070	38,070
GCW (kg)	48,805	48,870	48,870
Engine power (kW)	323/343	215 (max 350)	180 (max 360)
Engine displacement (L) / Electric range (km)	11.12	200	1,000

ZET ENGINE CAPACITIES

Engine power is a critical technical parameter to represent the capacity of trucks. We first identified four representative GVW segments for heavy-duty trucks, and those are 3.5 t–4.5 t, 4.5 t–12 t, 12 t–30 t, and over 30 t. As shown in Figure 5, all logistics trucks sold in 2021 were in the 3.5 t–4.5 t segment, and the BETs had the same engine power range as their diesel counterparts. Diesel dump trucks sold in Sichuan were mostly in the 3.5 t–4.5 t and 12 t–30 t segments, and each of these represented about 40% of total sales; about 18% of new diesel dump trucks were over 30 t. However, all four new electric dump truck models were in the 4.5 t–12 t segment, with engine power in the range of 150 kW to 200 kW. For tractor-trailers, all BETs sold were in the heaviest segment (>30 t), and all seven models were similar in capacity to their diesel counterparts.

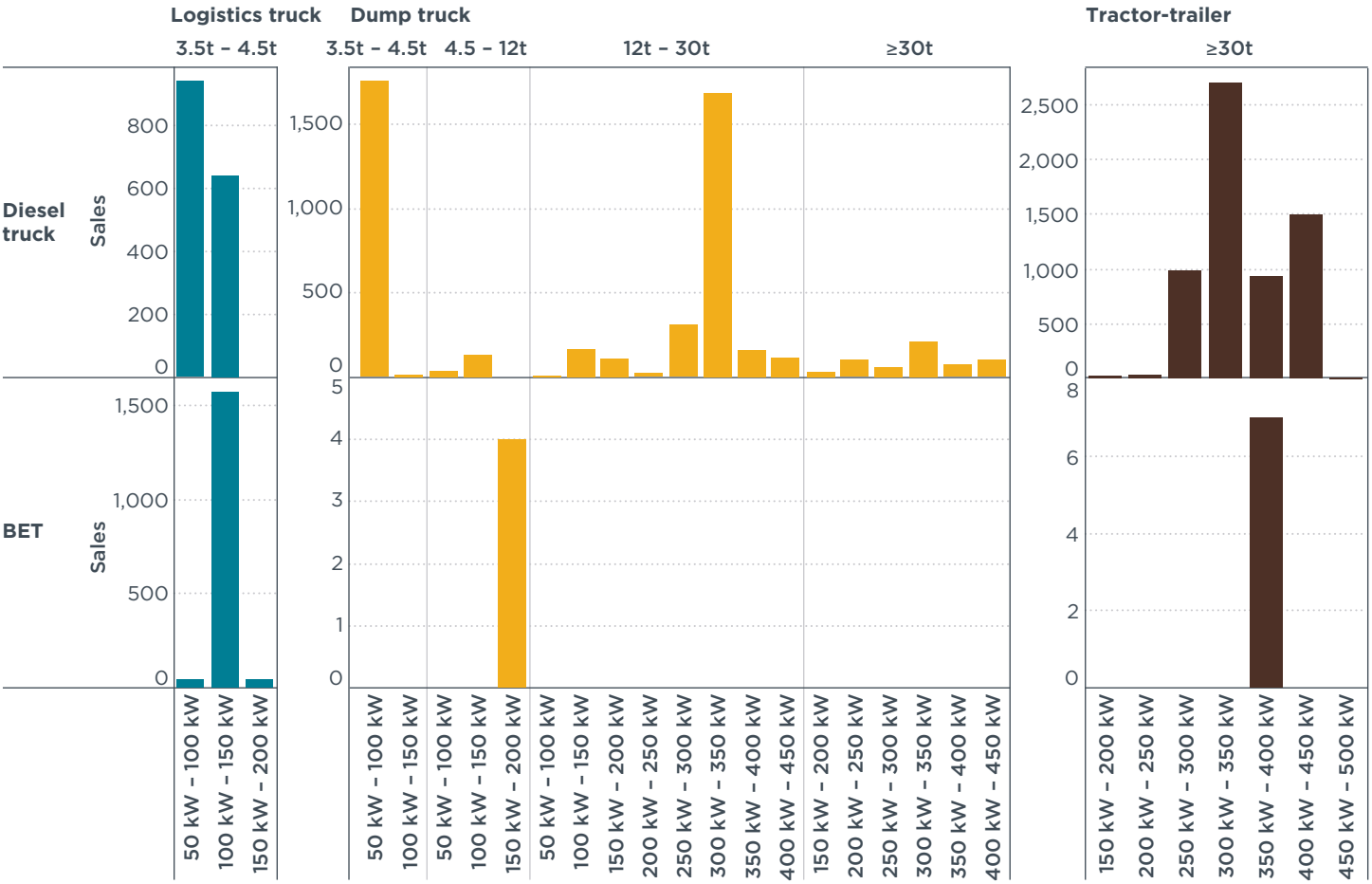

Figure 5. Sales in 2021 in Sichuan for each truck type by engine power and weight segment.

ELECTRIC RANGE FOR BETS

The electric range for trucks, which is mainly determined by the battery technology, directly influences the feasibility of using BETs instead of diesel trucks. Figure 6 presents the certified electric range for all new BET models sold in 2021 in Sichuan. Each circle represents one vehicle model, and the size of the bubble represents total sales.

The more than 600 BET logistics trucks models sold had ranges of 300–550 km, with half of them above 400 km. This is enough for one day of deliveries, considering the 200 km daily driving average for logistic trucks in Sichuan.[16]

Heavy dump trucks and tractor-trailers are estimated to have daily average mileages of 200 km–300 km and over 400 km, respectively. The respective ranges for electric heavy dump trucks and tractor-trailers sold in Sichuan are only about 250 km and 200 km, respectively. Accounting for battery degradation, the range for electric dump trucks would be sufficient with intermediate charging, but electric tractor-trailers' range would be insufficient for long-haul deliveries.[17]

16 Department of Transportation of Sichuan Province, "2021年四川省交通运输行业发展统计公报," 2022, http://jtt.sc.gov.cn/jtt/c101520/2022/8/11/cbcbecbc7a614ff78626ac1bfe01999d.shtml.

17 Shiyue Mao et al., "Real-World Performance of Battery Electric Heavy-Duty Vehicles in China: Energy Consumption, Range, and Charging Patterns," (ICCT: Washington, D.C., 2023), https://theicct.org/publication/hdv-china-real-world-performance-apr23/.

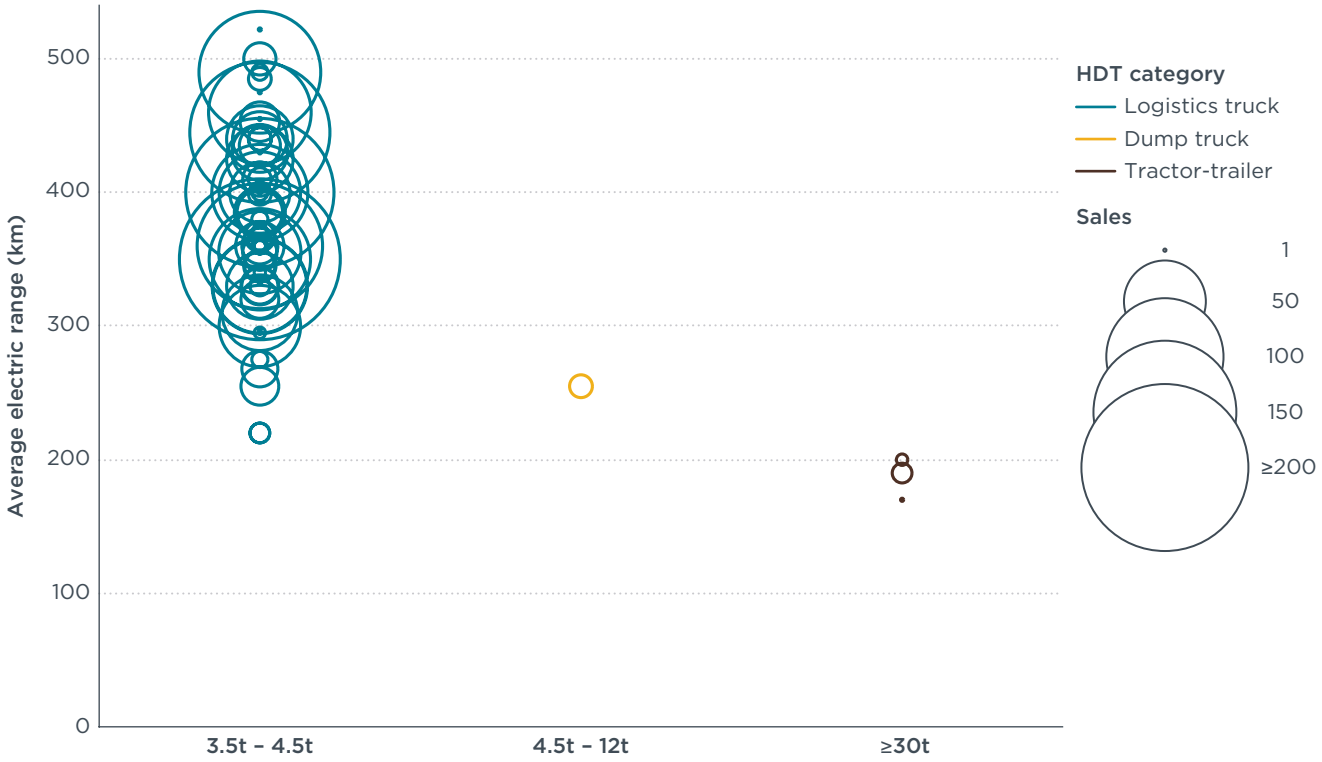

Figure 6. Range for BETs sold in Sichuan cities in 2021.

WELL-TO-WHEEL CO_2 REDUCTION

Figure 7 shows the distribution of well-to-wheel (WTW) CO_2 emissions for the three typical truck segments, logistics trucks weighing 3.5 t–4.5 t, dump trucks in the 4.5 t–12 t segment, and tractor-trailers over 30 t. The WTW CO_2 emissions are estimated with a simplified methodology, and key assumptions and data are described below.

The WTW CO_2 emissions are calculated based on the energy consumption in MJ/km converted from the certified energy consumption in L/100 km or kWh/100 km for each vehicle, and from the WTW CO_2 emission factors (in g/MJ) from the ICCT Roadmap model.[18] Grid emissions in Sichuan are based on the city's energy supply in 2020, reported by the *14th 5-year Plan for Energy Sector Development:* 84.9% hydro, 11.5% coal, 2.6% wind, and 1.0% solar.[19] Actual emissions depend on the vehicle model, and the results would change for several reasons, including improvements in grid energy supply and engine efficiency.

The results indicate that each new BET could reduce WTW CO_2 emissions significantly compared with a new diesel model: up to 70% for logistics trucks weighing 3.5 t–4.5 t, up to 50% for dump trucks in the 4.5 t–12 t segment, and 45% for tractor-trailers over 30 t.

18 "Roadmap Model Documentation," International Council on Clean Transportation, 2022, https://theicct.github.io/roadmap-doc/.

19 People's Government of Sichuan Province, "The 14th Five-Year Plan for Energy Sector Development of Sichuan," (2022), https://www.sc.gov.cn/10462/zfwjts/2022/3/4/f09dbec42f7349589d042145437004a6/files/eef02940c46d4baab309791d96350b22.PDF.

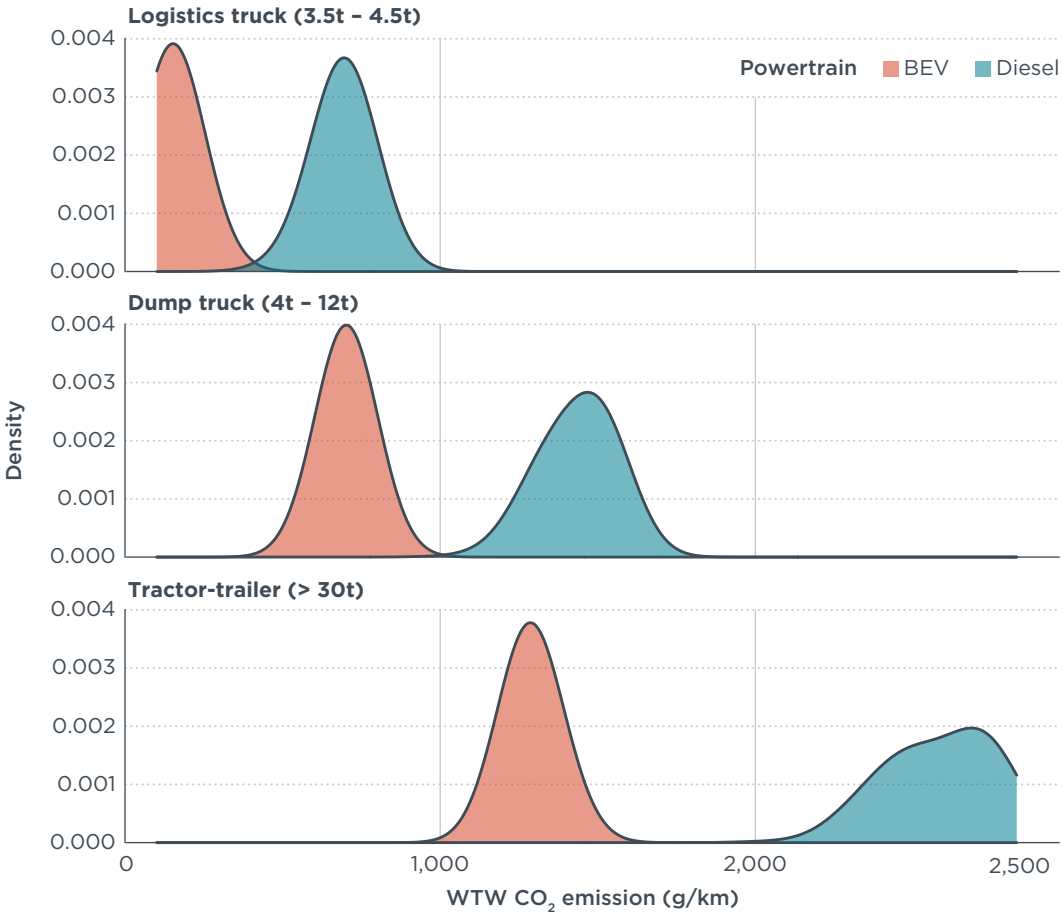

Figure 7. WTW CO_2 emissions for three typical truck types sold in 2021 in Sichuan.

CHALLENGES AND OPPORTUNITIES

The results above demonstrate the significant developments in the electrification of logistics trucks in Sichuan province, and also reveal the challenges for local stakeholders. Generally, Sichuan's ZET market has grown quickly in the past few years. Among all cities, Chengdu is dominating the market for each type of heavy-duty truck. Cities such as Yibin and Mianyang have made progress in recent years, but they must explore additional supporting efforts if they are to further develop their markets.

In considering the market by vehicle type, we saw that logistics trucks have already shown considerable ZET sales and there are capable ZET models in terms of engine power and battery. For dump trucks, there is a need to introduce or support developing ZET models that have enough engine power to serve the weight segments with the highest local demand in Sichuan: 3.5 t–4.5 t and 4.5 t–30 t. For tractor-trailers, the current ZET models still need improvements in battery technology to cover long-haul deliveries. Last but not least, promotion policies and measures remain necessary to develop capable ZET models for dump trucks and tractor-trailers and to motivate fleet owners to buy ZETs.

There are two key policy opportunities for stakeholders in Sichuan province to further develop ZET markets to support decarbonization and air quality improvement:

First, we suggest that Sichuan put forward stronger financial incentives and other measures to spur manufacturers to build zero-emission trucks that align with the market demand. For example, manufacturers would receive subsidies only if their ZET products have a quantified engine and battery capacity. This ensures the ZETs in the market are capable of taking over duties now handled by diesel trucks.

Second, Sichuan should develop separate incentives to motivate truck users to purchase ZETs rather than diesel trucks. The incentives need to be formulated from the TCO perspective. Subsidies for purchase cost and taxes, road access privileges, and toll fee discounts have already proven useful in Chengdu. Additionally, setting goals for infrastructure development like building charging or battery-swapping stations, and subsidies for hydrogen stations and other incentives to reduce energy prices, can also promote the ZET market and benefit ZET owners.